AKADÉMIAI KIADÓ

Psychometric evaluation and validation of the Hungarian version of the Physical Activity Affect Scale (PAAS-H)

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RESEARCH ARTICLE

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ABSTRACT

Background: Feelings and emotions during sports and exercise determine commitment, adherence, and enjoyment of the activity. The Physical Activity Affect Scale (PAAS) combined two earlier instruments, the Exercise-Induced Feelings Inventory and the Subjective Exercise Experiences Scale, to investigate affective states generally characterizing post-exercise feelings based on the circumplex model of affect. Therefore, the PAAS measures positive affect, negative affect, fatigue, and tranquility on a five-point Likert scale having only 12 items. *Aim:* Its ease of administration and interpretation renders the PAAS a valuable tool in both research and practice, but it is unavailable to Hungarian scholars and sports and exercise professionals due to the lack of adaptation. Hence, this work aimed to develop and validate the Hungarian version of the PAAS. *Methods:* Three hundred sixty-two recreational exercisers (64.1% women), aged from 18 to 62 (mean of age: 27.0 [SD = 10.0]) years completed the questionnaires before and during their exercise (briefly interrupting activity). Measures: PAAS was used to measure positive affect, negative affect, fatigue and tranquility aspects of internal affective experience. Positive and Negative Affect Schedule (PANAS) was utilized to assess the actual mood state, consisting of positive affect and negative affect subscales. Arousal was measured with Felt Arousal Scale (FAS), while the pleasure–displeasure affective valence was assessed with the Feeling Scale (FS). *Results:* A confirmatory factor analysis indicated good fit of the four-factor model. The results also revealed configural, metric, and scalar measurement invariance between sexes. The internal reliabilities of the scales varied between (Cronbach's α) .73 and .85 before and during exercise. PAAS scales largely showed the expected associations with other measures of positive and negative affect and activation. The lowest association was between Tranquility (PAAS) and Felt arousal (r = .14), followed by Tranquility and Feeling (r = .27). Feeling and Felt arousal correlated negatively with Fatigue (PAAS, r = –.42 and r = –.44), as well as with the Negative affect (PAAS, r = –.61 and r = –.40). Positive affect from PAAS (PAAS PA) had a positive correlation with Feeling and Felt arousal (r = .64, r = .54). PAAS PA and Positive affect from PANAS (PANAS PA) correlated strongly (r = .77), similar to the Negative affect from both inventories (r = .78; p < .01 for all cases). *Conclusion:* Therefore, the Hungarian PAAS could assess exercise-induced affect in a reliable and valid way in recreational exercisers. However, its validity in competitive sports remains to be tested.

KEYWORDS

affect, exercise, feeling, leisure, training, confirmatory factor analysis, measurement invariance

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A Fizikai Aktivitás Affektus Skála (PAAS-H) magyar változatának pszichometriai vizsgálata és validálása

ABSZTRAKT

Elméleti háttér: A sport és testmozgás közbeni affektív állapot meghatározza az edzés iránti elkötelezettséget, a rendszerességet és a testedzés élvezetességét. A Fizikai Aktivitás Affektus Skála (Physical Activity Affect Scale; PAAS) két korábbi mérőeszközt, az Exercise-Induced Feelings Inventory-t és a Subjective Exercise Experiences Scale-t kombinálja az edzés utáni affektivitás mérésére.

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Az affektus cirkumplex modellje alapján a PAAS a pozitív és negatív affektivitást, a fáradtságot és a nyugalom érzetet méri ötfokú Likert-skálán, összesen 12 tétellel. *Cél:* Egyszerű kitölthetősége és értelmezhetősége miatt a PAAS értékes eszköz mind a kutatásban, mind a gyakorlatban; ugyanakkor a magyar adaptáció hiánya miatt a hazai szakemberek számára eddig nem volt elérhető. Jelen munka célja a PAAS magyar verziójának kidolgozása és értékelése volt. *Módszerek:* 362 rekreációs sportoló (64,1% nő, 18-62 évesek, átlagéletkor: 27,0 [SD = 10,0] év) mintáján, akik edzés előtt és azt röviden megszakítva töltötték ki a validáló kérdőívcsomagot. Mérőeszközök: Az affektív élmény pozitív affektus, negatív affektus, fáradtság és nyugalom dimenziójának mérésére a PAAS-t használtuk; az aktuális hangulati állapotot a Positive and Negative Affect Schedule (PANAS) kérdőívvel, az aktiváltsági szintet az észlelt arousal (Felt Arousal Scale) skálával, az affekív állapot kellemességét–kellemetlenségét a valencia skálával (Feeling Scale) mértük. *Eredmények:* A megerősítő faktorelemzés jó illeszkedést mutatott az elméletileg feltételezett négyfaktoros modellel. Emellett sikerült konfigurális, metrikus és skaláris mérési invarianciát kimutatni a nemek között. A mérőeszköz belső megbízhatósága az alskálák esetében 0,73 és 0,85 (Cronbach-α) között alakult az edzés előtt és közben mérve. A PAAS skálái jórészt a várt irányú és erősségű kapcsolatot mutatták a pozitív és negatív affektus és az aktiváció más mérőeszközeivel. A leggyengébb kapcsolat a PAAS nyugalom és az észlelt arousal (r = 0,14), valamint a PAAS nyugalom és a valencia (r = 0,27) között volt. A valencia és az észlelt arousal negatív kapcsolatot mutatott a PAAS fáradtsággal (r = –0,42 és r = –0,44) és a PAAS negatív affektussal (Pr = –0,61 és r = –0,40). A PAAS pozitív affektus pozitívan kapcsolódott a valenciához és az észlelt arousalhez (r = 0,64; r = 0,54). A PAAS poziítív affektus erős kapcsolatot mutatott a PANAS pozitív affektussal (r = 0,77), és a két negatív affektus skála együttjárása is hasonlóan erősnek mutatkozott (r = 0,78; p < 0,01 minden esetben). *Következtetések:* Eredményeink alapján a PAAS magyar nyelvű változata megbízhatóan és valid módon méri a rekreációs sportolók fizikai aktivitás által kiváltott affektusát. A mérőeszköz versenysportolókra vonatkozó érvényessége még tesztelésre szorul.

KULCSSZAVAK

affektivitás, edzés, érzés, rekreáció, tréning, konfirmatív faktoranalízis, mérési invariancia

1. INTRODUCTION

Regular physical activity benefits many aspects of physical and mental health (Physical Activity Guidelines Advisory Committee, 2018). For example, it prevents cardiovascular disease, various cancers, and mood and anxiety disorders (De Moor et al., 2006; Hardman & Stensel, 2009). Also, it contributes to well-being and psychological functioning in healthy individuals (Lox et al., 2010; Thayer, 1990). Therefore, a deeper understanding of factors that facilitate physical activity is of substantial practical relevance. Effective external motivational factors, such as obligatory participation in physical education classes and organized competitive sports, are available for children, adolescents, and young adults. After these years, however, the impact of external motivation decreases; thus internal (intrinsic) motivation becomes increasingly crucial in maintaining regular physical activity (Ekkekakis, 2003). The affective state felt during physical exercise might be such an essential internal factor; pleasure has an intrinsic rewarding value that can effectively reinforce activity, leading to repeated (i.e., regular) behavior (Ekkekakis, 2003; Ekkekakis et al., 2008, 2011; Kendzierski & DeCarlo, 1991). From a psychophysiological point of view, physical activity with slight to moderate intensity (technically, below the so-called aerobic threshold) evokes pleasure, whereas vigorous exercise (above the threshold) leads to displeasure, an aversive psychological state (Ekkekakis, 2009). Below-threshold physical activity is sustainable in the long run (Bramble & Lieberman, 2004; Raichlen & Alexander, 2017) and leads to improved cardiovascular fitness. Therefore, it shows disproportional health benefits compared to above-threshold exercise (American College of Sports Medicine, 2017). From a practical point of view, if individuals rely on affective information while setting the actual intensity of their physical exertion, they can remain in the sustainable domain, maximizing their well-being and physical and mental health (Ekkekakis, 2009). Therefore, accurate measurement of affective state is a critical factor in developing physical activity-related interventions.

Self-report questionnaires that measure affective states, such as the widely used *Positive and Negative Affect Schedule* (PANAS; Watson et al., 1988), typically focus on resting conditions and thus might not be valid in the context of physical activity (Lox et al., 2000). Other measures, such as the felt arousal (Svebak & Murgatroyd, 1985) and feeling scale (Hardy & Rejeski, 1989), are easy to administer and might be able to assess internal experience even during activity; however, they are considered inferior from a psychometric point of view (Lox et al., 2000). Keeping in mind the limitations of the available measures, authors of the *Physical Activity Affect Scale* (PAAS) aimed to develop a questionnaire that (1) focuses on affective states characterizing physical activity, (2) fits well Russel's (1980) circum-

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plex model of emotion (i.e., can assess the entire spectrum of affective states), and (3) is psychometrically sound (Lox et al., 2000). Development of the PAAS was based on the assumption that it would be able to assess the entire spectrum of affective experience with the two dimensions of valence (pleasure-displeasure) and arousal (low to high activation) (Lox et al., 2000). Despite its shortcomings, this approach proved useful in assessing physical activity-related affective changes (Ekkekakis, 2008).

The PAAS contains a blend of items of two previous scales that measured only subdomains of the affective spectrum, i.e., the *Exercise-Induced Feeling Inventory* (EFI; Gauvin & Rejeski, 1993) that focuses only on positive states, and the *Subjective Exercise Experiences Scale* (SEES; McAuley & Courneya, 1994) that lacks a subscale assessing tranquility (Lox et al., 2000). Exploratory factor analysis of the hybrid instrument indicated four factors (positive affect, negative affect, fatigue, and tranquility), explaining 72% of the total variance. Confirmatory factor analysis on the slightly modified version of the new scale showed an acceptable fit to the theoretically assumed four-factor model (Lox et al., 2000).

It is important to see that the dimensions (scales) of PAAS represent a rotated circumplex model of core affect, i.e., assessing the four quadrants of the valence and arousal dimensions (Stevens et al., 2016). Another study replicated the four-factor structure of PAAS and showed that item loadings (with one exception) show measurement invariance across active and inactive groups (Carpenter et al., 2010). The PAAS or its scales were used in several studies to assess affective states in various exercise settings (Kósa et al., 2023; Stevens et al., 2016; Tsai et al., 2023). Overall, the PAAS appears to be a sound instrument from a psychometric point of view.

The present study aimed to adopt and validate the Hungarian version of the PAAS. As for the validation part of the study, it was assumed that (1) PAAS Positive affect would show a positive association with PANAS Positive affect, Felt arousal and Feeling scale scores; (2) PAAS Tranquility would be positively associated with PANAS Positive affect and Feeling and negatively associated with Felt arousal; (3) PAAS Negative affect would be positively associated with PANAS Negative affect and Felt arousal, and negatively associated with Feeling; finally (4) PAAS Fatigue will be positively associated with PANAS Negative affect, and negatively associated with Feeling and Felt arousal.

2. METHODS

2.1. Participants

Participants were young physically active individuals (n = 362; 64.1% female; M_{age} = 27.0 years, SD_{age} = 10.0 years, $range_{age}$ = 18–62 years) involved in recreational (non-competitive) physical activity on average 2.3 (SD = 1.4) times a week. Inclusion criteria included age 18 or over, exercising regularly every week in non-competitive physical activity(ies), and lack of acute injury/pain. The reported physical activities were aerobics (n = 53; 14.6%), ball games (n = 70; 19.3%), dance (n = 54; 14.9%), karate/kung fu (n = 34; 9.4%), bodybuilding (n = 52; 14.4%), pole dance (n = 21; 5.8%), gymnastics (n = 22; 6.1%), airflow yoga (n = 19; 5.2%), and other activities with lower than 3% frequency (n = 17; 4.7%). Participants were recruited from sports clubs and gyms in the capital city through on-site advertisements and personal solicitations by a coach or fitness instructor. All signed an informed consent form, acknowledging their participation was anonymous, voluntary, and without compensation.

Participants were asked to complete the paper-and-pencil version of the questionnaires in Hungarian at two points of time: (1) directly before the beginning of physical activity (PRE measurement), and (2) 20–30 minutes after the beginning, briefly interrupting physical activity (POST measurement).

The Institutional Ethics Board of the Faculty of Education of Psychology, Eötvös Loránd University, Budapest, Hungary (Ethical approval No. 2018/96) granted permission for this study.

2.2. Measures

The *Physical Activity Affect Scale* (PAAS; Lox et al., 2000), measures actual internal affective experience with four 3-item scales (positive affect [PA], negative affect [NA], fatigue, and tranquility) on a 5-point Likert scale, ranging from 1 (not at all) to 5 (very much). Higher scores refer to a higher level of the respective state. Following the usual adaptation procedure, two colleagues made two separate translations and then developed a consensual version. The latter was back-translated into English by a third colleague and compared to the original English version by a fourth person. The final Hungarian version is presented in the *Appendix*.

The 10-item version of *Positive and Negative Affect Schedule* (PANAS; Watson et al., 1988; Hungarian version: Gyollai et al., 2011) assesses the actual mood state with two 5-item scales on a 5-point Likert scale, ranging from 1 (not at all) to 5 (very much). Positive affect (PA) refers to felt enthusiasm, activity, and alertness (e.g., "alert", "active"), whereas negative affect (NA) encompasses aversive states, such as distress, anger, and fear (e.g., "upset", "nervous"). Higher scores indicate higher levels of PA and NA, respectively. The Hungarian version of the PANAS proved to be psychometrically valid (Gyollai et al., 2011); its internal consistency values in this study were in the acceptable to good range for all assessments (Cronbach's α ranging from .72 to .84).

Arousal was assessed with the one-item ("Please estimate how aroused you actually feel") *Felt Arousal Scale* (FAS; Svebak & Murgatroyd, 1985), ranging from 1 ("very low

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arousal") to 6 ("very activated"), while pleasure–displeasure (valence) was measured with the one-item ("Please estimate how do you feel at this moment") *Feeling Scale* (FS) (Hardy & Rejeski, 1989), ranging from –5 ("very bad") to 0 ("neutral") and +5 ("very good"). The Hungarian version of the two scales was used in previous studies (e.g., Köteles et al., 2020).

Finally, demographic measures assessed participants' age, biological sex, and exercise habits, such as type of exercise and exercise frequency.

2.3. Statistical analyses

Kruskal–Wallis test was used to test the differences in PAAS dimensions between the sport categories at baseline measurement. Sports were classified into six different categories: "Dance", "Martial arts", "Spinning-running (aerobic)", "Bodybuilding", "Team/ball sports", and "Other". Dunn's test was used as a *post-hoc*, with Bonferroni adjusted *p*-values.

Confirmatory factor analysis (CFA) was performed together with the testing of the measurement invariance between men and women, using the multigroup CFA framework (He & Vijver, 2012; Milfont & Fischer, 2010; van de Schoot et al., 2012). To assess the global fit of the models, the following fit indices were used, with the cut-off values in parentheses: Comparative fit index – CFI (>.90), Tucker–Lewis index – TLI (>.90), root mean squared error of approximation – RMSEA (<.08), standardized root mean squared error – SRMR (<.08) (Hu & Bentler, 1999; van de Schoot et al., 2012). A non-significant χ^2 test indicates good model fit. However, researchers rarely rely solely on it, due to its sensitivity to the sample size, which can easily render the χ^2 statistically significant (Aiena et al., 2015; Byrne, 2016). Nevertheless, we still presented it. In measurement invariance, we relied on the χ^2 difference test, where the significant difference would indicate non-invariance, but again, χ^2 should be interpreted cautiously (Gana & Broc, 2019). Additionally, we judged the invariance based on ΔCFI (with the threshold being the value greater than .01), ΔRMSEA (greater than .015) (Putnick & Bornstein, 2016), Akaike information criterion (AIC), and Bayesian information criterion (BIC). A model with lower values of AIC and BIC would be considered better.

The internal consistency of the scales was assessed using Cronbach's α, inter-item correlation and descriptive statistics of the scales were also reported.

The construct validity was inspected using Pearson correlation, with Holm-adjusted *p*-values.

The analyses were conducted with R 4. 3. 1. programming language, using 'lavaan' (Rosseel, 2012), 'semTools' (Jorgensen et al., 2022), 'semPath' (Epskamp, 2022), and 'tidyverse' (Wickham et al., 2019), 'rstatix' (Kassambara, 2023), and 'psych' (Revelle, 2022) packages. R analysis code and data are available upon request.

3. RESULTS

3.1. Differences between the sport groups in PAAS subscale scores

The Kruskal–Wallis test indicated statistically significant differences at baseline in all dimensions of PAAS, except for Tranquility (H =16.47, p = .058). The test statistic values for other three dimensions were H = 42.70, p < .001 for Fatigue, then H = 35.63, p < .001 for Negative affect, and H = 26.61, p = .002 for Positive affect (df = 9 for all four tests). For details, see *Table 1*. Although the omnibus test was significant for Positive affect, no statistically significant differences were found in post-hoc pairwise testing.

3.2. Factor structure and internal consistency

Based on the four-factor CFA model (with factors Fatigue, Positive affect, Negative affect, and Tranquility), run on PRE (before exercise) and POST (after exercise) items, it could be concluded that both subsets fitted the data well on the overall sample (*Figure 1, 2*). Both data sets were characterized by similar (and high enough) standardized factor loadings. Inter-factor correlations were slightly higher in the PRE subset, but the overall pattern was similar in both subsets. While the male subsample had a good fit in both POST and PRE items, the female subsample exhibited slightly worse TLI (<.90) and RMSEA (>.08) in the PRE subset, and RMSEA that was slightly above the threshold in the POST subset. Nevertheless, other commonly used fit indices, such as CFI and SRMR, indicated a good model fit. The χ^2 fit index was statistically significant in all tested models (while a non-significant one would indicate a good fit), but this fit index is susceptible to sample size. Thus it would almost certainly be statistically significant in larger samples.

The gender invariance was tested on three levels, namely, configural (equal factorial structure among the groups), metric (equal loadings), and scalar (equal loadings and intercepts). Although the χ^2 difference test ($\Delta\chi^2$) was presented, it was not used as a primary criterion due to its sensitivity to the sample size. We relied on ΔCFI, where the cut-off of .01 was used, as well as ΔRMSEA (with .015 cut-off). The fit of all models on PRE and POST items, with measurement invariance results, are presented in *Table 2*, while *Table 3* presents the means, standard deviations, Cronbach's α reliabilities, and average inter-item correlations. In both PRE and POST item subsets, all four scales showed good reliability (Cronbach's α = .73–.85), with Tranquility exhibiting the lowest (Cronbach's α = .73 and .74, respectively) but within the acceptable range.

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Table 1. Medians (interquartile ranges) of the sport groups for each PAAS dimension and Dunn's post-hoc tests

Subscales	Aerobics (n = 53)[a]	Ball games (n = 70)[b]	Body conditioning (n = 52)[c]	Dance (n = 54)[d]	Gymnastics (n = 22)[e]	Martial arts (n = 34)[f]	Other (n = 17)[g]	Pole dance (n = 21)[h]	Stretching (n = 20)[i]	Yoga / pilates (n = 19)[j]
Tranquility*	11 (3)	11 (3)	10 (1.25)	9 (3)	10 (3)	10.5 (3)	11 (3)	9 (4)	10.5 (2.5)	9 (5)
Positive† affect	9 (3)	9 (3)	9 (3)	9 (2.75)	8 (3.75)	9.5 (4.75)	8 (3)	9 (3)	7 (4.5)	8 (2)
Negative affect	3 (2)[b]	5 (5)[c,f]	3 (1)	4 (3)	5 (2.75)	3 (2)	3 (2)	3 (3)	4.5 (2.5)	4 (3)
Fatigue	5 (4)[b,d,e]	7 (4.75)[c]	5 (3.25)[d,e,j]	8 (4)	9 (5.5)	6 (3)	7 (2)	6 (4)	7 (4.5)	8 (4.5)

Note: The dependent variables are in rows. In the table header, each sport group is denoted by a superscript letter. Superscripts within cells indicate groups that are statistically different from one another at the $p_{\text{Bonferroni}} < .05$ level for the corresponding dependent variable. † The post-hoc analysis was performed on Positive Affect due to a statistically significant omnibus test, but no significant differences were found in the post-hoc comparisons. * Tranquility post-hoc testing was not conducted due to the non-significance of the omnibus test.

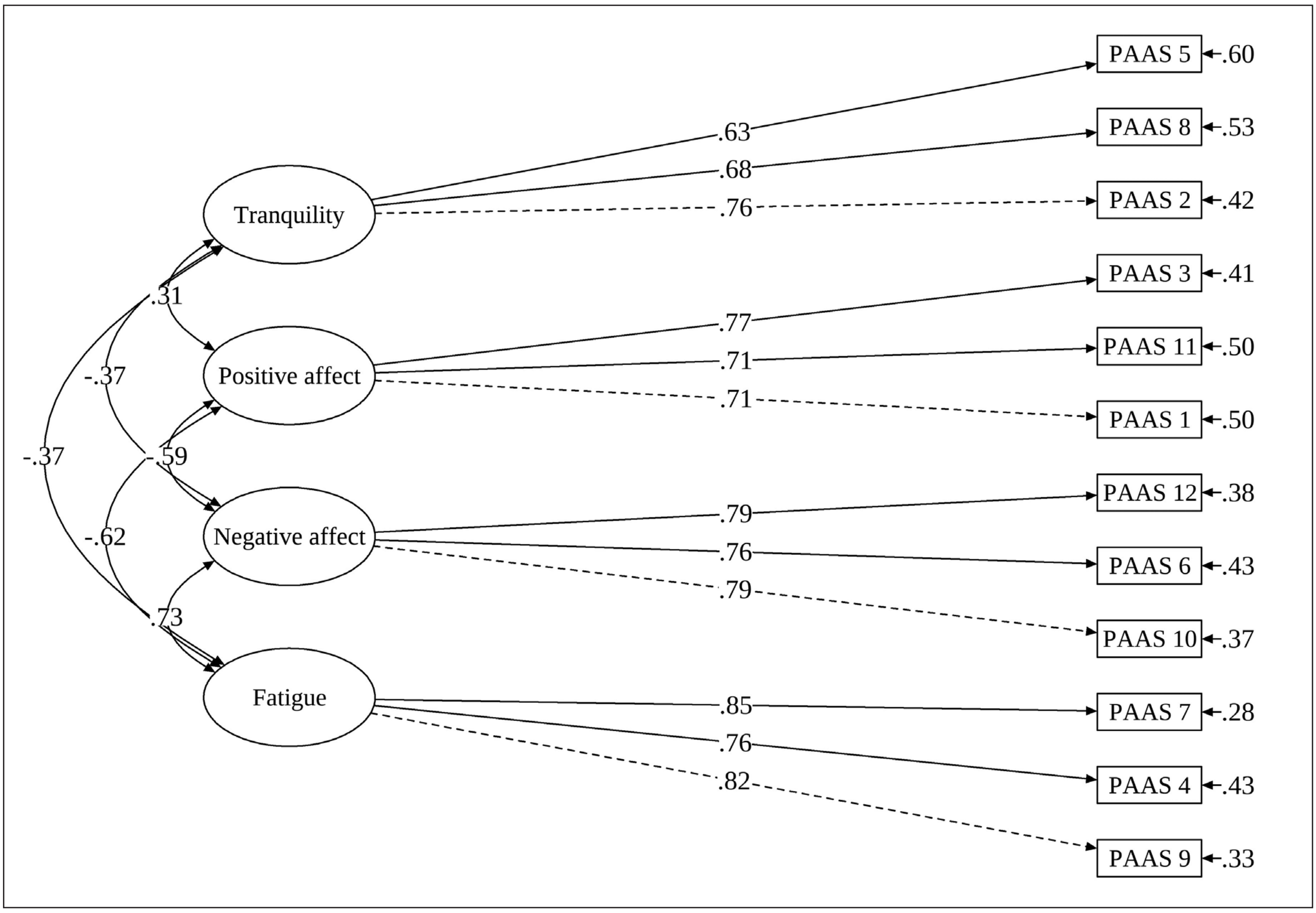

Figure 1. Graphical presentation of the results of confirmatory factor analysis on the factor structure of PAAS based on data collected before physical activity

Note: Single-headed arrows represent standardized loadings; double-headed arrows represent factor correlations; single-headed arrows next to the items are residual terms of the items; $p < .001$ for all factor loadings.

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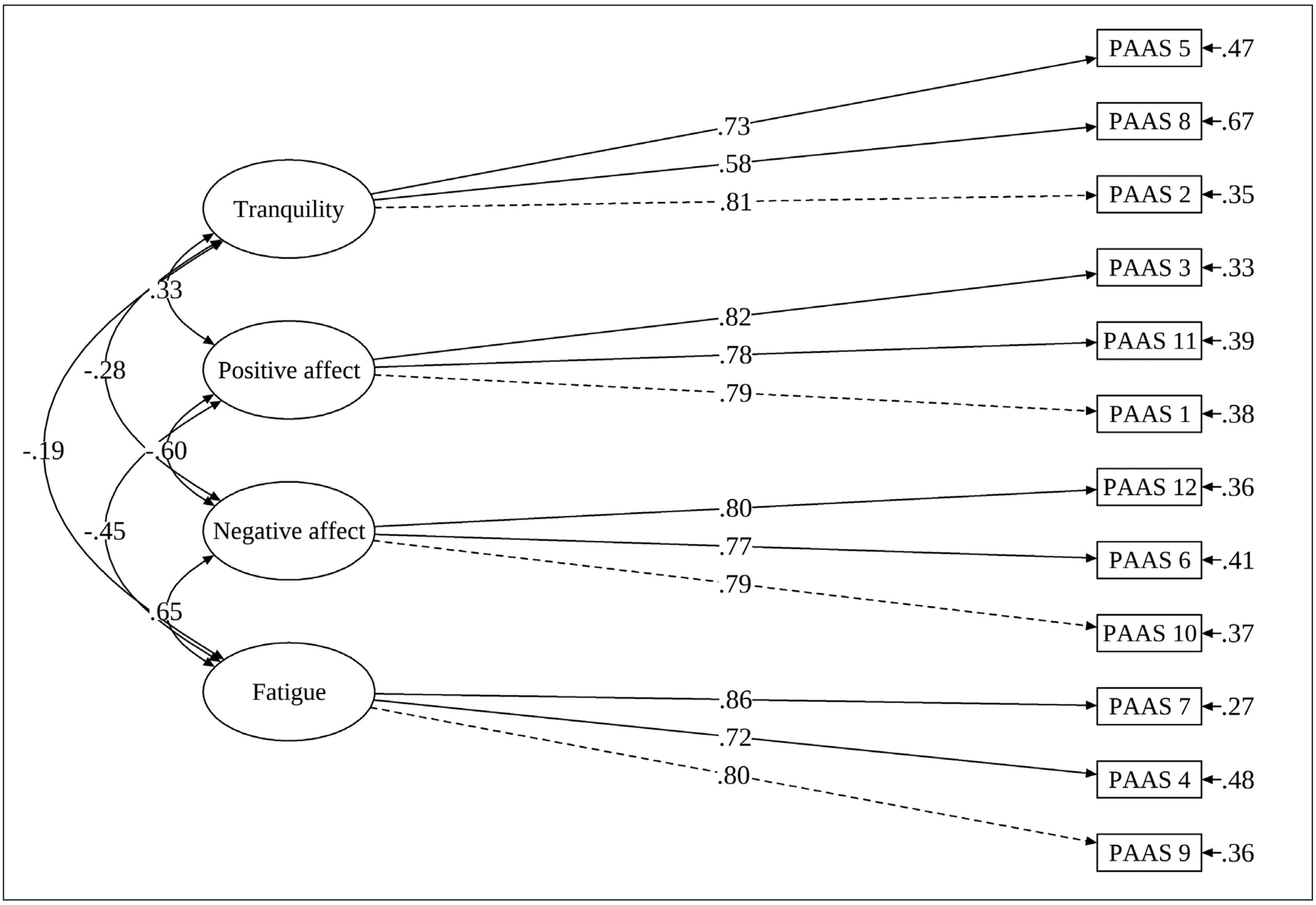

Figure 2. Graphical presentation of the results of confirmatory factor analysis on the factor structure of PAAS based on data collected after physical activity

Note: Single-headed arrows represent standardized loadings; double-headed arrows represent factor correlations; single-headed arrows next to the items are residual terms of the items; $p < .001$ for all factor loadings.

Table 2. Four-factor model fit and measurement invariance of PRE and POST PAAS items

Model	$\chi^2(df)$	CFI	TLI	RMSEA	SRMR	AIC	BIC	ΔCFI	ΔRMSEA	$\Delta\chi^2$	$\Delta\chi^2$ *p*-value	Invariant?
PRE items												
Overall	136.710 (48)	.950	.932	.071	.049	10900.221	11016.971	–	–	–	–	–
Males (n = 130)	80.539 (48)	.954	.937	.072	.056	3577.190	3663.216	–	–	–	–	–
Females (n = 232)	133.944 (48)	.921	.891	.088	.062	7265.952	7369.354	–	–	–	–	–
Configural	214.483 (96)	.934	.909	.0826	.056	10891.142	11218.040	–	–		–	–
Metric	219.606 (104)	.936	.918	.0784	.056	10880.264	11176.029	.00160	–.00421	5.1224	.7444	YES
Scalar	226.560 (112)	.936	.925	.0752	.056	10871.219	11135.851	.00058	–.00320	6.9549	.5415	YES
POST items												
Overall	152.797 (48)	.944	.924	.078	.060	10260.491	10377.240	–	–	–	–	–
Males (n = 130)	85.805 (48)	.942	.920	.078	.071	3497.943	3583.969	–	–	–	–	–
Females (n = 232)	126.340 (48)	.938	.915	.084	.067	6716.922	6820.324	–	–	–	–	–

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Table 2. *(continued)*

Model	$\chi^2(df)$	CFI	TLI	RMSEA	SRMR	AIC	BIC	ΔCFI	ΔRMSEA	$\Delta\chi^2$	$\Delta\chi^2$ *p*-value	Invariant?
Configural	212.145 (96)	.940	.917	.0818	.063	10262.865	10589.763	–	–		–	–
Metric	238.933 (104)	.930	.911	.0847	.075	10273.653	10569.418	–.00978	.00290	26.788	<.001	YES
Scalar	255.102 (112)	.925	.912	.0840	.076	10273.822	10538.454	–.00426	–.00064	16.169	.04002	YES

Note: CFI = confirmatory fit index; TLI = Tucker-Lewis index; RMSEA = root mean squared error of approximation; SRMR = standardized root mean squared error; AIC = Akaike information criterion; BIC = Bayesian information criterion; PAAS = Physical Activity Affect Scale.

Table 3. Descriptive statistics and internal consistency of the PRE and POST PAAS scales

	Pre				Post			
	Fatigue	Positive affect	Negative affect	Tranquility	Fatigue	Positive affect	Negative affect	Tranquility
M	7.23	9.09	4.74	9.85	6.60	10.97	4.10	9.85
SD	3.03	2.64	2.32	2.45	2.82	2.66	1.93	2.57
Cronbach's α	.85	.77	.82	.73	.84	.84	.83	.74
r_{ii}	.65	.53	.61	.47	.63	.64	.62	.48

Note: PAAS = Physical Activity Affect Scale; *M* = means; *SD* = standard deviations; r_{ii} = mean inter-item correlation.

3.3. Validity

Descriptive statistics of the PANAS, feeling, and felt arousal scales are presented in *Table 4*. Associations for the POST measurement are summarized in *Table 5*. Concerning the PAAS PA scale, strong positive correlations were found with PANAS PA, feeling, and felt arousal, whereas the PAAS NA scale showed a strong positive association with PANAS NA, a strong negative association with feeling, and a moderate negative association with felt arousal. Correlations between PAAS Fatigue and the feeling/felt arousal scales were negative in the moderate domain. Finally, PAAS Tranquility showed weak to moderate positive association with feeling, and a very weak positive association with felt arousal.

Table 4. Descriptive statistics of the validating scales (*n* = 362)

Variables	M	SD	IQR	skewness	kurtosis	Min.	Mdn	Max.
PANAS PA (PRE)	16.67	3.68	4.00	–0.43	0.25	5	17	25
PANAS NA (PRE)	6.76	2.48	2.00	2.03	4.81	5	6	20
Feeling (POST)	3.36	1.72	2.00	–1.36	1.94	–5	4	5
Felt arousal (POST)	4.46	1.17	1.00	–0.72	0.14	1	5	6
PANAS PA (POST)	18.82	3.74	4.00	–0.79	0.89	6	19	25
PANAS NA (POST)	6.30	2.42	1.00	2.69	8.49	5	5	21

Note: Feeling and Felt arousal have a single missing value each. IQR = interquartile range; Min. = minimum; Mdn = median; Max. = maximum; PAAS = Physical Activity Affect Scale; PANAS = Positive and Negative Affect Schedule; PA = Positive affect; NA = Negative affect.

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Table 5. Associations (Pearson correlations) between the PAAS scales and the validating scales at the POST measurement

Scales	1.	2.	3.	4.	5.	6.	7.	8.
1. PAAS PA	1							
2. PAAS NA	–.50	1						
3. PAAS Fatigue	–.38	.53	1					
4. PAAS Tranquility	.29	–.25	–.19	1				
5. PANAS PA	.77	–.42	–.40	.31	1			
6. PANAS NA	–.30	.78	.45	–.33	–.24	1		
7. Feeling	.64	–.61	–.42	.27	.63	–.47	1	
8. Felt arousal	.54	–.40	–.44	.14	.57	–.23	.58	1

Note: PAAS = Physical Activity Affect Scale; PANAS = Positive and Negative Affect Schedule; PA = Positive affect; NA = Negative affect; *p*-values were adjusted using the Holm method. All *p*-values were statistically significant at p <.001 level, except for PAAS Tranquility and Felt arousal, which had a p = .008.

4. DISCUSSION

In a sample of 362 young individuals with regular recreational physical activity, the Hungarian version of the Physical Activity Affect Scale (PAAS) showed the theoretically expected four-factor structure with a high level of measurement invariance between males and females. The four scales largely showed the hypothesized associations with other measures of affect and activation.

Our results support the four-factor structure of the Hungarian adaptation of PAAS in both PRE and POST exercise settings. Also, all four scales showed good internal consistency. In addition, we demonstrated measurement invariance between the biological sexes, allowing for a meaningful comparison of the scores between the sexes. We also note that the results more convincingly showed the full measurement invariance in PRE items, while in POST items, the results need to be interpreted with more caution. Although we marked all levels as invariant POST items, there may be some ambiguity as to whether the test is invariant at and beyond the metric level.

Supporting Kwan et al. (2008), the correlations between FS, FAS, and scales of the PAAS in our study emerged, as illustrated in *Table 6*. The PA scale of the PAAS should be consistent with the positive affect–high activation quadrant in the circumplex model. In contrast, the NA scale should be consistent with the negative valence–high activation quadrant. The Tranquility scale is expected to be consistent with the positive valence–low activation quadrant, and the Fatigue scale should fit in the negative valence–low activation quadrant. In this case, the correlations between FS, FAS, and PAAS should emerge, as illustrated in *Table 6*.

Table 6. Expected correlations between FS, FAS, and PAAS scales in light of the circumplex model

Circumplex	Positive affect	Negative affect	Tranquility	Fatigue
Valence (FS)	Positive (+)	Negative (–)	Positive (+)	Negative (–)
Activation (FAS)	Positive (+)	Positive (+)	Negative (–)	Negative (–)

Overall, our findings, including the associations between the four factors, agree with the circumplex model of affect (Ekkekakis, 2008). The PAAS PA and Fatigue scales showed the expected associations with the validating scales. The PAAS NA was positively associated with PANAS NA and negatively associated with the feeling scale as predicted by the circumplex model. However, the model assumes a positive association with felt arousal and we found a negative association. The data collection characteristics might explain this issue, but the residual effects of exercise might also play a role in this finding. We also found a weak positive correlation between Tranquility and FAS, possibly due to the carry-over effects of exercise impacting the felt arousal. The remaining associations matched the expected associations in *Table 6*. Our results match those of Kwan et al. (2008), who found six agreeing and two disagreeing correlations with the circumplex model, which they attribute to sample characteristics. These authors concluded that the PAAS is an acceptable instrument for measuring affective responses to exercise based on the circumplex model.

In our sample, the questionnaires were completed in the context of recreational physical activity, characterized by a

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pleasant internal state. Indeed, the average value of NA was relatively low, with comparatively slight variance. The comparatively higher NA values were associated with lower arousal values within this limited range, showing that low activation levels can lead to negative states.

Limitations of the study include the volunteer sample, which was not representative of the general population culturally, across sports, and age groups. Also, findings do not apply to competitive athletes. Finally, some participants were from team/cooperative sports, where affective states partly depend on factors other than individual sports (Muñoz et al., 2016).

In conclusion, the four scales of the PAAS are reliable and valid measures of affective states during physical activity using the circumplex model as the underpinning theory.

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REFERENCES

Aiena, B. J., Baczwaski, B. J., Schulenberg, S. E., & Buchanan, E. M. (2015). Measuring resilience with the RS-14: A tale of two samples. *Journal of Personality Assessment*, *97*(3), 291–300. https://doi.org/10.1080/00223891.2014.951445

American College of Sports Medicine. (2017). General principles of exercise prescription. In D. Riebe (Ed.), *ACSM's guidelines for exercise testing and prescription* (10th ed., pp. 143–179). Lippincott Williams & Wilkins.

Bramble, D. M., & Lieberman, D. E. (2004). Endurance running and the evolution of Homo. *Nature*, *432*(7015), 345–352. https://doi.org/10.1038/nature03052

Byrne, B. M. (2016). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (3rd ed.). Routledge. https://doi.org/10.4324/9781315757421

Carpenter, L. C., Tompkins, S. A., Schmiege, S. J., Nilsson, R., & Bryan, A. (2010). Affective response to physical activity: Testing for measurement invariance of the physical activity affect scale across active and non-active individuals. *Measurement in Physical Education and Exercise Science*, *14*(1), 1–14. https://doi.org/10.1080/10913670903454952

De Moor, M. H. M., Beem, A. L., Stubbe, J. H., Boomsma, D. I., & De Geus, E. J. C. (2006). Regular exercise, anxiety, depression and personality: A population-based study. *Preventive Medicine*, *42*(4), 273–279. https://doi.org/10.1016/j.ypmed.2005.12.002

Ekkekakis, P. (2003). Pleasure and displeasure from the body: Perspectives from exercise. *Cognition & Emotion*, *17*(2), 213–239. https://doi.org/10.1080/02699930302292

Ekkekakis, P. (2008). Affect circumplex redux: The discussion on its utility as a measurement framework in exercise psychology continues. *International Review of Sport and Exercise Psychology*. https://doi.org/10.1080/17509840802287200

Ekkekakis, P. (2009). Let them roam free?: Physiological and psychological evidence for the potential of self-selected exercise intensity in public health. *Sports Medicine*, *39*(10), 857–888. https://doi.org/10.2165/11315210-000000000-00000

Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2008). The relationship between exercise intensity and affective responses demystified: To crack the 40-year-old nut, replace the 40-year-old nutcracker! *Annals of Behavioral Medicine*, *35*(2), 136–149. https://doi.org/10.1007/s12160-008-9025-z

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The pleasure and displeasure people feel when they exercise at different intensities: Decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Medicine (Auckland, N.Z.)*, *41*(8), 641–671. https://doi.org/10.2165/11590680-000000000-00000

Epskamp, S. (2022). *semPlot: Path diagrams and visual analysis of various SEM packages' output* (1.1.6) [R package]. https://CRAN.R-project.org/package=semPlot

Gana, K., & Broc, G. (2019). *Structural equation modeling with lavaan | Wiley* (1st ed.). John Wiley & Sons, Inc. https://www.wiley.com/en-us/Structural+Equation+Modeling+with+lavaan-p-9781786303691

Gauvin, L., & Rejeski, W. J. (1993). The Exercise-Induced Feeling Inventory: Development and initial validation. *Journal of Sport and Exercise Psychology*, *15*(4), 403–423. https://doi.org/10.1123/jsep.15.4.403

Gyollai, A., Simor, P., Koteles, F., & Demetrovics, Z. (2011). Psychometric properties of the Hungarian version of the original and the short form of the Positive and Negative Affect Schedule (PANAS). *Neuropsychopharmacologia Hungarica*, *13*(2), 73–79.

Hardman, A. E., & Stensel, D. J. (2009). *Physical activity and health. The evidence explained* (2nd ed.). Routledge.

Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology*, *11*(3), 304–317. https://doi.org/10.1123/jsep.11.3.304

He, J., & van de Vijver, F. (2012). Bias and equivalence in cross-cultural research. *Online Readings in Psychology and Culture*, *2*(2). https://doi.org/10.9707/2307-0919.1111

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

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Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2022). *semTools: Useful tools for structural equation modeling* (0.5-6) [R package]. https://CRAN.R-project.org/package=semTools

Kassambara, A. (2023). rstatix: Pipe-friendly framework for basic statistical tests. R package version 0.7.2. https://CRAN.R-project.org/package=rstatix

Kendzierski, D., & DeCarlo, K. J. (1991). Physical Activity Enjoyment Scale: Two validation studies. *Journal of Sport and Exercise Psychology*, *13*(1), 50–64. https://doi.org/10.1123/jsep.13.1.50

Kósa, L., Körmendi, J., Ihász, F., & Köteles, F. (2023). Dissociations between coaches' fatigue rating, athletes' perceived fatigue, and objective training load. *International Journal of Sports Science & Coaching*, *18*(4), 1003–1009. https://doi.org/10.1177/17479541231156082

Köteles, F., Teufel, B., Körmendi, J., Ferentzi, E., & Szemerszky, R. (2020). Cardioceptive accuracy is associated with arousal but not with valence and perceived exertion under physical load. *Psychophysiology*, *57*(9), Article e13620. https://doi.org/10.1111/psyp.13620

Kwan, B. M., Bryan, A., Tompkins, S. A., Marcus, B., Williams, D. M., & Ciccolo, J. (2008). The physical activity affect scale and the circumplex model of affect: Theoretical and empirical support. *Medicine & Science in Sports & Exercise*, *40*(S5), S452.

Lox, C. L., Jackson, S., Tuholski, S. W., Wasley, D., & Treasure, D. C. (2000). Revisiting the measurement of exercise-induced feeling states: The Physical Activity Affect Scale (PAAS). *Measurement in Physical Education and Exercise Science*, *4*(2), 79–95. https://doi.org/10.1207/S15327841Mpee0402_4

Lox, C. L., Martin Ginis, K. A., & Petruzzello, S. J. (2010). *The psychology of exercise. integrating theory and practice* (3rd ed.). Holcomb Hathaway.

McAuley, E., & Courneya, K. S. (1994). The Subjective Exercise Experiences Scale (SEES): Development and preliminary validation. *Journal of Sport and Exercise Psychology*, *16*(2), 163–177. https://doi.org/10.1123/jsep.16.2.163

Milfont, T. L., & Fischer, R. (2010). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research*, *3*(1), 111–121. https://doi.org/10.21500/20112084.857

Muñoz, V., Lavega, P., Serna, J., Sáez De Ocáriz, U., & March, J. (2016). Estados de ánimo al jugar en solitario o en cooperación: Dos vivencias motrices y afectivas desiguales. *Anales de Psicología*, *33*(1), 196–203. https://doi.org/10.6018/analesps.33.1.233301

Physical Activity Guidelines Advisory Committee. (2018). *2018 Physical Activity Guidelines Advisory Committee*. U.S. Department of Health and Human Services.

Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review*, *41*, 71–90. https://doi.org/10.1016/j.dr.2016.06.004

Raichlen, D. A., & Alexander, G. E. (2017). Adaptive capacity: An evolutionary-neuroscience model linking exercise, cognition, and brain health. *Trends in Neurosciences*, *40*(7), 408–421. https://doi.org/10.1016/j.tins.2017.05.001

Revelle, W. (2022). *psych: Procedures for Personality and Psychological Research* (2.2.3) [R package]. https://CRAN.R-project.org/package=psych Version = 2.2.3.

Rosseel, Y. (2012). lavaan: An R Package for structural equation modeling. *Journal of Statistical Software*, *48*(1), 1–36. https://doi.org/10.18637/jss.v048.i02

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178. https://doi.org/10.1037/h0077714

Stevens, C. J., Smith, J. E., & Bryan, A. D. (2016). A pilot study of women's affective responses to common and uncommon forms of aerobic exercise. *Psychology & Health*, *31*(2), 239–257. https://www.tandfonline.com/doi/abs/10.1080/08870446.2015.1095917

Svebak, S., & Murgatroyd, S. (1985). Metamotivational dominance: A multimethod validation of reversal theory constructs. *Journal of Personality and Social Psychology*, *48*(1), 107–116. https://doi.org/10.1037/0022-3514.48.1.107

Thayer, R. E. (1990). *The biopsychology of mood and arousal*. Oxford University Press.

Tsai, Y.-J., Chueh, T.-Y., Catalán, D. G., Hsieh, S.-S., & Hung, T.-M. (2023). Effects of acute aerobic exercise with self-selected music on working memory and alpha oscillation. *International Journal of Sport and Exercise Psychology*. Advance online publication. https://doi.org/10.1080/1612197X.2023.2209333

van de Schoot, R., Lugtig, P., & Hox, J. (2012). A checklist for testing measurement invariance. *European Journal of Developmental Psychology*, *9*(4), 486–492. https://doi.org/10.1080/17405629.2012.686740

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R.,, & … Yutani, H. (2019). Welcome to the Tidyverse. *Journal of Open Source Software*, *4*(43), Article 1686. https://doi.org/10.21105/joss.01686

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APPENDIX: THE HUNGARIAN VERSION OF THE PHYSICAL ACTIVITY AFFECT SCALE (PAAS-H)

A Fizikai Aktivitás Affektus Skála magyar változata (PAAS-H)

Kérjük, jelölje be, hogy a különböző szavak mennyire írják le az állapotát ebben a pillanatban.

	egyáltalán nem	**egy kicsit**	**közepesen**	**erősen**	**nagyon erősen**
1. feldobott	1	2	3	4	5
2. nyugodt					
3. energikus					
4. fáradt					
5. békés					
6. rosszkedvű					
7. lestrapált					
8. ellazult					
9. kimerült					
10. lehangolt					
11. lelkes					
12. levert					

A skálaképzés az alskálákhoz tartozó tételekre kapott pontszámok összeadásával történik. Nincsenek fordított tételek.

Alskálák:

Pozitív affektus (PA): 1., 3. és 11. tétel
Negatív affektus (NA): 6., 10. és 12. tétel
Fáradtság: 4., 7. és 9. tétel
Nyugalom: 2., 5. és 8. tétel

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