

Does GPAQ exhibit a higher correlation with the maximum oxygen capacity than IPAQ among young adults?

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ABSTRACT

International Physical Activity Questionnaire (IPAQ) and the Global Physical Activity Questionnaire (GPAQ) are the two most widely used to measure physical activity (PA). Yet, their convergent validation with the maximum oxygen capacity (VO_2Max) among Indonesian young adults is unknown. This study compared physical activity (PA) assessments using IPAQ and GPAQ and their correlations with the maximal oxygen capacity (VO_2Max) in the young adult population. This study was a cross-sectional descriptive study on 63 Sports Science students (84.13% Male age ranged 18-22 years). PA was measured using both the GPAQ and IPAQ to calculate the total PA and PA in each domain (i.e. work-related, transport-related, and leisure). One additional domain which was household-related was assessed exclusively for the IPAQ based on the scoring guideline. The VO_2Max was measured using a standard equation based on participants' performance on a 1-mile run. Paired sample t-test was conducted to compare total PA based on GPAQ and IPAQ while the Wilcoxon sign rank test was conducted to compare GPAQ and IPAQ domains. Pearson or Spearman correlation test assessed the correlations among the VO_2Max , total PA, and PA on each GPAQ's and IPAQ domain. No significant difference in the total PA per week between IPAQ and GPAQ was found. Significant differences, however, were found in work and transport domains, but not in the leisure domains. A moderate correlation among GPAQ and IPAQ ($r=0.56$, $p=0.01$), a moderate correlation between GPAQ and VO_2Max ($r=0.41$, $p=0.01$) but a weak correlation between IPAQ dan VO_2Max ($r=0.25$, $p<0.05$) were demonstrated. While, this study has indicated convergent validity of both GPAQ and IPAQ, GPAQ has a higher correlation with VO_2Max compared to the IPAQ. Therefore, GPAQ is more recommended to be used to measure PA levels among Indonesian young adults compared to IPAQ.

Keywords: IPAQ; GPAQ; maximum oxygen capacity

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INTRODUCTION

Physical activity is important for maintaining and improving health (Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017). The WHO recommends that adults get at least 150-300 minutes of moderate-intensity

aerobic exercise, or at least 75-150 minutes of high-intensity aerobic exercise (Bull et al., 2020). Recommendations from the American Heart Association (AHA) and American College of Sports Medicine (ACSM) state that all healthy adults ages 18 to 65 should get at least 30 minutes of moderate-intensity aerobic exercise or at least 20 vigorous-intensity aerobic exercise every week. At least three days a week of a combination of the two (Haskell et al., 2007). Some tools such as pedometers and accelerometers have been used to measure physical activity (Cain, Sallis, Conway, Van Dyck, & Calhoun, 2013; Herrmann, Heumann, Der Ananian, & Ainsworth, 2013; Raustorp & Fröberg, 2018). However, this method is relatively more expensive and cannot be used for certain physical activities (Cain et al., 2013). Several self-report questionnaires have been developed to measure physical activity. These instruments are used more frequently in public health research, because of the ease of implementation, low burden, low cost, and valuable information (Ács et al., 2020). The two most widely used questionnaires for evaluating physical activity worldwide are the International Physical Activity Questionnaire (IPAQ) and Global Physical Activity Questionnaire (GPAQ).

IPAQ was developed to measure physical activity at the population level and had been translated and validated in 12 countries (Craig et al., 2003). There are two versions of IPAQ, namely the long format and the short format. The long-form IPAQ assesses the four areas of physical activity (occupation, transportation, family, and leisure) (Craig et al., 2003). The long version of the IPAQ provides comprehensive and detailed information about daily physical activity habits in 4 different fields. These fields include leisure time, occupation, housework, and transportation activities (Hallal et al., 2010). The long format IPAQ is also utilized in large-scale sports activity research to achieve detailed information about the intensity, frequency, and location of the reported activity (Stelmach, 2018). The short version of the IPAQ includes items on walking, moderate and vigorous physical activity, and sedentary behavior (Hallal et al., 2010). The development of the questionnaire is applicable to an extensive range of languages and cultures (Stelmach, 2018). The leisure and transportation is recommended to use as the part of the long format IPAQ to do monitoring and research to record the level of physical activity in Latin America (Hallal et al., 2010).

GPAQ was developed by the WHO and used for physical monitoring in various countries. It has been translated and verified in 9 countries/regions (Armstrong & Bull, 2006). The main result variables of the GPAQ analysis are categorical variables of total physical activity (high, medium, low); continuous variables of total physical activity in each fieldwork, transport, leisure (reported as median METmin/week) (Armstrong & Bull, 2006). GPAQ was produced for face-to-face interviews managed by employees trained to confront difficulties such as reading problems (Wanner et al., 2017). GPAQ is designed to monitor research in developing countries. Its basic principles and structures make it possible to measure various physical activities that improve health in multiple countries (Soo, Manan, & Suriati, 2015). GPAQ was also developed as an intermediate tool between the two versions of IPAQ to minimize differences in physical activity assessments between different countries (Stelmach, 2018).

Cardiovascular health seems to play a role in the accuracy of self-reported moderate and vigorous PA (Taylor, Tomaz, Lambert, & Karpul, 2016). Both GPAQ and IPAQ have been used to predict maximum oxygen uptake from adolescents to adults (Kamyran, Labania, Kamyran, Rahman, & Bagchi, 2020; Nainggolan, Indrawati, & Pradono, 2018; Piccinno & Colella, 2017). However, few studies have indicated some discrepancies with those findings. To illustrate, a study by Nainggolan et al., (2018) reported that GPAQ was not correlated with VO_2Max ($r=0.070$ and P value= 0.44), while IPAQ was found to be unrelated to maximal oxygen uptake (Bahnemiri, Roshan, & Movaghar, 2018). Further research, therefore is required to confirm these findings. Moreover, those studies have assessed the correlation between IPAQ and GPAQ with VO_2Max separately. Thus, comparison between GPAQ and IPAQ could not be made. They were also conducted in general population, thus it is unknown whether the correlation between GPAQ and IPAQ with VO_2Max is applied in the specific population such as young adults who tend to be physically active such as Sports Science students in the Indonesian context. Therefore, this study aimed to compare the assessment of physical activity between IPAQ and GPAQ and their correlations with the maximum oxygen capacity (VO_2Max) in this population. This study was expected to provide information and justify the use of the instruments in this target population.

METHOD

This study was a cross-sectional descriptive study conducted in the Physical, Health, and Recreation Education study program at Sports Science Faculty, Yogyakarta State University in September 2019.

Assessment of Physical Activity Levels

Assessments of physical activity were using GPAQ and IPAQ. The GPAQ consists of 16 questions which probed 3 physical activity domains, namely work-related, transport, and leisure-based physical activity domains. It also measures sedentary activity. GPAQ scoring protocol (WHO, 2012) was used to calculate the total METs score from GPAQ. The IPAQ consists of 27 questions that assess 4 domains which were the same domains with GPAQ with an additional domain (i.e. household-related physical activity domain). It also assesses time spent in sedentary activity. IPAQ scoring protocol (IPAQ Research Committee, 2005) was used to calculate the total METs score from IPAQ. Both the GPAQ and IPAQ were translated into the Indonesian language.

Assessment of Maximum Oxygen Capacity

Measurement of maximum oxygen capacity (VO₂Max) was done by doing a 1-mile run. Participants were instructed to complete the one-mile distance as quickly as possible. If the participant cannot continue running, walking is allowed. The test was carried out on a 400 m track. Calculation of VO₂Max was based on age, gender, and BMI using an equation from Cureton (Cureton, Sloniger, O'Bannon, Black, & McCormack, 1995). $VO_2Max = 0.21 (age \times gender) - 0.84 (BMI) - 8.41 (time) + 0.34 (time^2) + 108.94$. Where gender=1 for male; 0 for female; time = minutes.

Anthropometric and Social Demography Measures

Data for anthropometry were weight in kilograms and height in meters. Data on weight and height were used to calculate Body Mass Index (BMI). Body Mass Index (BMI) was calculated as body mass in kilograms divided by height in squared meters (kg/m²). Sociodemographic data included age and gender.

Statistical Analysis

Paired sample t-test was conducted to compare GPAQ and IPAQ. Wilcoxon sign rank test was conducted to see the differences between GPAQ and IPAQ domains. Pearson and Spearman correlation tests were carried out on the VO₂Max variable, GPAQ total score, GPAQ domains, IPAQ total score, and IPAQ domains to determine the significance of the correlation among them. The analysis was performed using SPSS version 25.

RESULTS AND DISCUSSION

A total sample of 63 people (84.13% were male) aged 18 to 23 years (mean=19.6±0.7) participated in this study. They included 53 males (84.1%) and 10 females (15.9%) and were on average considered normal weight. Table 1 shows descriptive statistics of the sample in total participants and based on sex.

Table 1. Descriptive Statistic of the Sample

	Total (n=63) Mean±SD	Male (n=53) Mean±SD	Female (n=10) Mean±SD
Age	19.6±0.7	19.6±0.6	19.9±1.2
Weight	59.5±10.6	60.7±10.7	53.1±7.3
Height	167.1±7.3	168.6±6.1	158.9±7.7
BMI	21.2±2.7	21.3±2.9	20.9±1.3

Table 2 shows descriptive statistics and VO₂Max in the gender group. All physical activity and domains scores were higher in the male than female group, as well as VO₂Max scores. But, males and females have the same score in sedentary domain of GPAQ. Female have higher score in domestic domain.

Table 2. Descriptive Statistic of VO₂Max, GPAQ and IPAQ

	Total (n=63) Mean±SD	Male (n=53) Mean±SD	Female (n=10) Mean±SD
GPAQ			
Total	10737± 4980	11242± 4807	8058± 5277
Work	5262± 2774	5485± 2645	4080± 3275
Transport	1057± 2630	1178± 2842	414± 661
Leisure	4418± 2391	4580± 2426	3564± 2100
Sedentary	262± 124	262± 132	262± 75
IPAQ			
Total	10724± 6826	11256± 7104	7902± 4342
Work	5266± 5201	5523± 5413	3899± 3816
Transport	985± 1236	1094± 1308	410± 444.22
Leisure	3226± 2469	3407± 2428	2265± 2592
Domestic	1247±1429	1232± 1467	1328± 1276
Sedentary	266± 127	273± 134	232± 74
VO₂Max	49± 5	50± 4	43± 3

Figure 1 shows descriptive statistics activity and VO₂Max. There is little difference in mean of physical activity between GPAQ and IPAQ. In addition, IPAQ mean total score has a significantly higher standard deviation than GPAQ mean total score.

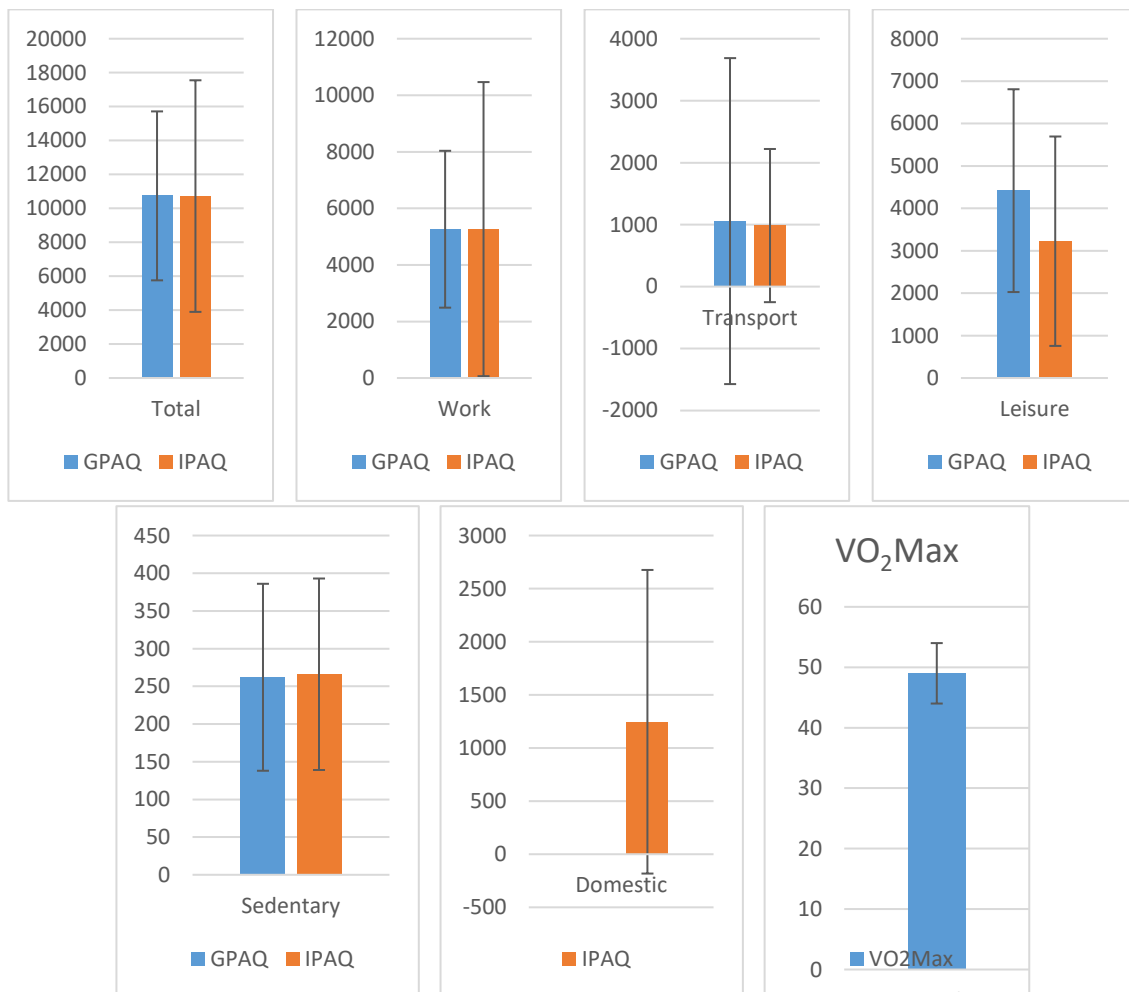


Figure 1. Mean of Physical Activity and VO₂Max Total Score

Table 3. The Comparisons of Physical Activity Measured with the IPAQ and The GPAQ (in Mets)

	Total (n=63)			Male (n=53)			Female (n=10)		
	GPAQ	IPAQ	P#	GPAQ	IPAQ	P#	GPAQ	IPAQ	P#
Total	10737± 4980	10724± 6826	0.986#	11242± 4807	11256± 7104	0.986#	8058±5277	7902±4342	0.922#
Work	5262± 2774	5266± 5201	0.205	5485±2645	5523± 5413	0.231	4080±3275	3899±3816	0.575
Transport	1057± 2630	985± 1236	0.037*	1178±2842	1094± 1308	0.043*	414± 661	410± 444	0.779
Leisure	4418± 2391	3226±2469	0.000*	4580±2426	3407± 2428	0.001#*	3564± 2100	2265±2592	0.004#*
Sedentary	262± 124	266±127	0.805	262± 132	273± 134	0.503	262± 75	232± 74	0.214

= Total PA was measured using paired sample t-test, while the other domains calculated using Wilcoxon Signed Rank test

Table 3 shows the mean total between IPAQ and GPAQ compared using paired sample t-tests. The result was no significant difference between IPAQ and GPAQ ($p>0.05$). Table 3 shows the mean differences of GPAQ and IPAQ domains. No significant differences were found in the work domain and sedentary domain ($p>0.05$). Standard deviation of IPAQ work domain was greater than GPAQ work domain. However, significant differences were found in the transport domain and leisure domain ($p>0.05$), while no significant differences were found in the transport domain in female group ($p >0.05$). The average of transport and leisure based-related physical activity measured using GPAQ was greater than those measured using IPAQ.

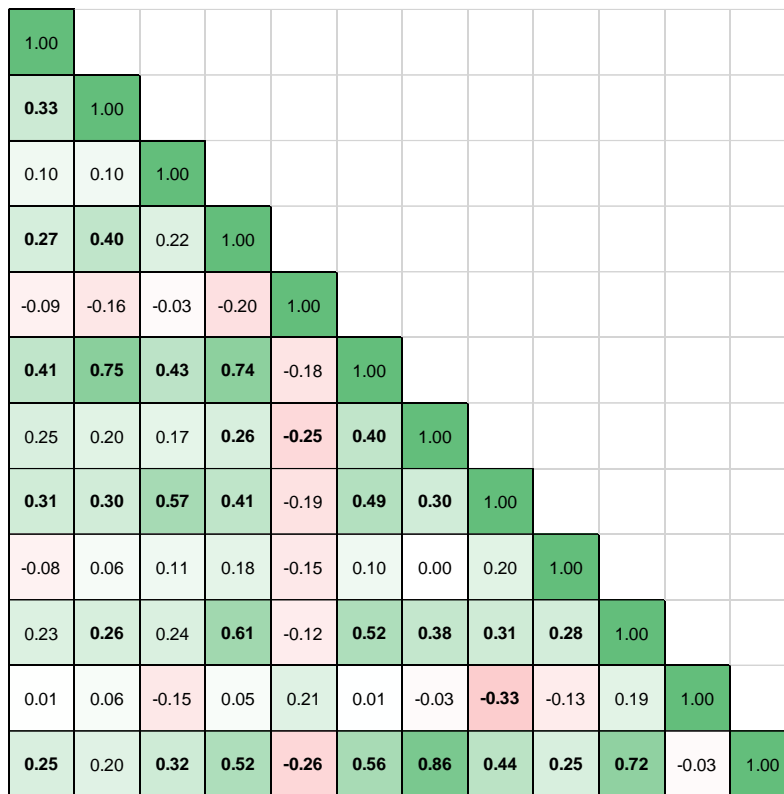


Figure 2. Correlation matrix among IPAQ, GPAQ, and VO₂Max

*Bold signifies a significant correlation while red and green shades signify negative and positive correlations with the darker shade represent higher correlation.

VO2Max	1.00														
GPAQ Work	0.19	1.00													
GPAQ Transport	0.01	0.03	1.00												
GPAQ Leisure	0.21	0.40	0.16	1.00											
GPAQ Sedentary	-0.05	-0.16	0.01	-0.15	1.00										
GPAQ Total	0.27	0.69	0.41	0.70	-0.14	1.00									
IPAQ Work	0.28	0.21	0.19	0.28	-0.19	0.45	1.00								
IPAQ Transport	0.25	0.24	0.53	0.38	-0.17	0.45	0.32	1.00							
IPAQ Domestic	-0.09	0.03	0.10	0.21	-0.25	0.10	0.00	0.17	1.00						
IPAQ Leisure	-0.01	0.21	0.16	0.52	-0.09	0.39	0.49	0.27	0.31	1.00					
IPAQ Sedentary	-0.05	0.04	-0.15	0.07	0.19	-0.01	-0.05	-0.36	-0.15	0.26	1.00				
IPAQ Total	0.16	0.18	0.31	0.38	-0.20	0.56	0.88	0.41	0.26	0.69	-0.03	1.00			
	VO2Max	GPAQ Work	GPAQ Transport	GPAQ Leisure	GPAQ Sedentary	GPAQ Total	IPAQ Work	IPAQ Transport	IPAQ Domestic	IPAQ Leisure	IPAQ Sedentary	IPAQ Total			

Figure 3. Correlation matrix among IPAQ, GPAQ, and VO₂Max in Male

*Bold signifies a significant correlation while blue and orange shades signify negative and positive correlations with the darker shade represent higher correlation.

VO2Max	1.00														
GPAQ Work	0.92	1.00													
GPAQ Transport	0.74	0.46	1.00												
GPAQ Leisure	0.83	0.57	0.58	1.00											
GPAQ Sedentary	-0.22	-0.14	-0.28	-0.41	1.00										
GPAQ Total	0.97	0.96	0.40	0.90	-0.29	1.00									
IPAQ Work	0.01	0.11	-0.05	-0.08	-0.29	-0.01	1.00								
IPAQ Transport	0.61	0.58	0.79	0.50	-0.24	0.66	-0.02	1.00							
IPAQ Domestic	0.22	0.23	0.41	0.10	0.11	0.24	-0.02	0.77	1.00						
IPAQ Leisure	0.55	0.23	0.74	0.65	-0.18	0.47	-0.52	0.51	0.20	1.00					
IPAQ Sedentary	-0.05	0.01	-0.14	-0.27	0.52	-0.12	-0.01	-0.16	0.03	-0.32	1.00				
IPAQ Total	0.52	0.37	0.37	0.54	-0.71	0.49	0.66	0.61	0.44	0.38	-0.20	1.00			
	VO2Max	GPAQ Work	GPAQ Transport	GPAQ Leisure	GPAQ Sedentary	GPAQ Total	IPAQ Work	IPAQ Transport	IPAQ Domestic	IPAQ Leisure	IPAQ Sedentary	IPAQ Total			

Figure 4. Correlation matrix among IPAQ, GPAQ, and VO₂Max in Female

*Bold signifies a significant correlation while yellow and purple shades signify negative and positive correlations with the darker shade represent higher correlation.

As shown in Figure 2, a moderate significant positive correlation was found between GPAQ and VO₂Max (r: 0.41; $p < 0.01$). In this study, we found that GPAQ has a stronger correlation with VO₂Max than IPAQ (GPAQ= r: 0.41, p : 0.01, IPAQ= r: 0.25; $p < 0.05$). GPAQ also has stronger correlation with VO₂Max than IPAQ in male and female group as shown in Figure 3 and Figure 4. In addition, we found that there was significant moderate positive correlation between GPAQ and IPAQ (r: 0.56; p : 0.01).

Our findings showed that men are more physically active and have higher levels of maximal oxygen capacity than women. Men's activity in sports, recreational activities, and work activities (university) also increased significantly. Female students are characterized by significantly more housework activities (Bergier, Bergier, & Tsos, 2016). Male also had higher absolute levels of VO₂Max when comparing physiological values between male and female (Koons, Suresh, Schlotman, & Convertino, 2019).

This study did not show a significant difference between GPAQ and IPAQ. Linges et al., (2016) compared Malaysian version of IPAQ and GPAQ using paired sample t-test. It was found that there was no significant difference between the mean MET-min week-1 between them ($p < 0.05$). The standard deviation of the mean in IPAQ is also larger than GPAQ. It is indicating that there is a greater variance in physical activity scores using IPAQ. Study by Misra et al., (2014) indicated that GPAQ is equivalent to IPAQ for measuring physical activity and can be used to measure physical activity in community settings. Thus, it can be concluded that GPAQ can be safely used instead of IPAQ for measuring physical activity.

Although GPAQ and IPAQ did not differ in this study, they did differ in domain structure. When the GPAQ and IPAQ domains were compared, the results varied. Meanwhile, physical activity related to household chore activity (domestic domain) could not be compared because even though both instruments have similar domains, but their structures are different (Armstrong & Bull, 2006). Work and domestic activities are presented as separate domains in IPAQ, and are formed under the work domain of GPAQ (Shaheen, Puri, & Tandon, 2016).

Our finding was in accordance with a finding by Malavia and Shah, (2019) that explores the correlation between cardiorespiratory fitness and physical activity among the security guards aged 20 to 40 years. It was indicated in that study that there was a strong positive relationship between MET minutes of total physical activity per week and aerobic capacity (r: 0.847; $p < 0.01$). It means that physical activity has a significant effect on physical fitness. The positive correlation coefficient indicates that the higher the physical activity score (MET), the higher the physical fitness score (VO₂Max) (Kriswanto, Prasetyowati, Sunardi, & Suharjana, 2020). However, a study by Nainggolan et al., (2018) indicated that there is no correlation between GPAQ version 2 and VO₂Max using ergocycle with astrand method in women aged 25 to 54 years old (r: 0,070; p : 0,4465). Our study participants were majority males thus it may explain the discrepancy.

We also found that there was a weak significant positive correlation between IPAQ dan VO₂Max (r: 0.25; $p < 0.05$). The finding is in line with the results of a study by Batista et al., (2013). They evaluated the association between muscular strength and endurance, flexibility, and cardiorespiratory in 408 healthy men aged 21-43 years with the results of IPAQ-SF. The participants performed sit-ups and push-ups, hand grip dynamometer, sit-and-reach, and 20-m shuttle run test. The study also indicated that there was a weak positive correlation between IPAQ and VO₂Max (r: 0.22; p : 0.01).

We also found that GPAQ has a stronger correlation with VO₂Max than IPAQ and there was significant moderate positive correlation between GPAQ and IPAQ. Fernate et al., (2019) did a study to determine the correlation between the measurement attributes of the self-reported physical activity indicators in the Global Physical Activity Questionnaire (GPAQ), the International Physical Activity Questionnaire (IPAQ), and the European Health Survey Physical Activity Questionnaire (EHISPAQ) for 70 gym clients aged 18 to 70 years, and evaluate them simultaneously effective. The result of the study was all three questionnaires was significantly correlated. It was also found that there are five close correlations between GPAQ and IPAQ content indicators ($p < 0.05$) thus support the results of our study. The stronger correlation between GPAQ and VO₂Max compared to IPAQ and VO₂Max may also indicate that the household-related item in the IPAQ may not be necessarily relevant to young adults as they may not be yet responsible to household chores. Based on the finding, we recommend the use of the GPAQ over the use of IPAQ in this population.

To the best of our knowledge, our study is the first to ascertain the convergent validity between IPAQ and GPAQ in young adults who were predominantly active. We however acknowledge several limitations. First this study only based on a relatively small sample size thus may need to be confirmed with study with larger sample size. Another limitation is due to the use of self-report questionnaires. Some participants may have intentionally or unintentionally misreported. Future research is recommended to conduct with larger sample and various populations.

CONCLUSION

The present study indicates convergent validity between the GPAQ and IPAQ thus justify the use of the instruments in young adults population in Indonesia. We also found that GPAQ has a higher correlation with VO₂Max compared to the IPAQ and VO₂Max. We, therefore, recommend the use of the GPAQ compare to the IPAQ to measure physical activity in this population.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests in this study. All authors have been read and approved the manuscript for submission.

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