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# The Short Questionnaire to Assess Health-Enhancing Physical Activity in Syrian Adults' Populations

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## SUMMARY

Background: To date, no studies have evaluated the reliability and/or validity of methods for measuring physical activity (PA) in free-living conditions within the Syrian population.
Methods: This study compared estimates of PA and sedentary behavior (SB) obtained from the ActiGraph WGT3X-TB (AG) accelerometer and the Short Questionnaire to Assess Health Enhancing Physical Activity (SQUASH). Forty-five adults (13 men and 32 women, mean age 36.9 ±8.3 years) completed the SQUASH twice, with a 45-day interval between administrations. Time spent in low, moderate, vigorous, and moderate-vigorous PA (MVPA) was calculated using the SQUASH and AG accelerometer data. Reliability was assessed by calculating the Spearman correlation coefficient between the PA items scores. Bland-Altman analysis was also performed. The validity of the SQUASH was determined using the AG accelerometer as the reference method.
Results: PA levels were systematically higher when measured by the SQUASH compared to the AG accelerometer. The Spearman's correlation coefficient for the overall SQUASH reproducibility was 0.64. The Spearman's correlation coefficient between the calculated total activity score from the SQUASH and the AG accelerometer was 0.31, indicating moderate reliability and validity of the SQUASH.
Conclusion: Given its simplicity, brevity, ease of use, and low cost, the SQUASH appears to be a suitable method for monitoring PA in Syrian adults. Further strengthening of the validity scores may be possible by providing more detailed information on the types of activities included in the questionnaire.

*Keywords: Accelerometer, Self-report, Measurements, Reliability, Validity.*

## INTRODUCTION

Several urgent calls to action have been issued to address the global physical activity (PA) and sedentary behavior (SB) issues [1]. Enhancing PA among the population is crucial, as compelling evidence suggests that higher levels of PA are associated with better health outcomes [2]. Regular PA is essential to achieving and maintaining good health [3]. Low levels of PA are linked to an increased risk of morbidity and mortality [4,5]. Measuring PA can be challenging due to its diverse nature [6]. Therefore, an efficient and accurate tool for measuring PA in populations is essential. Physical activity is assessed using both objective measures like accelerometers and nonobjective measures based on self-report questionnaires [7]. At the population level, PA is often determined based on self-reported questionnaires [8,9]. Self-report questionnaires remain the most commonly used tool for assessing PA on a practical scale, although epidemiological studies often use questionnaires to determine PA levels [10]. The questionnaire is an inexpensive and useful method in categorizing subjects in low or high levels PA [11]. The Short Questionnaire to Assess Health Enhancing Physical Activity (SQUASH) is an example of such a questionnaire. SQUASH measures the activity score, a combination of intensity and duration of PA per week, and total minutes of activity per week [12]. The SQUASH is structured to facilitate comparisons with national and international PA recommendations [13].

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The questionnaire includes questions about various activities such as commuting, gardening, odd jobs, sports, work activities, household chores, and leisure time. SQUASH is used by various research institutes and government agencies to monitor the PA behavior of youth and adult populations and adherence with PA guidelines [2,11,13].

Validation of PA measures is crucial to accurately assess and monitor the progress of PA interventions [14]. The accelerometer is often used as the gold standard method for assessing the validity of PA self-report questionnaires [15,16].

The purpose of this study was to determine the test reliability and validity of SQUASH in measuring self-reported habitual PA in a Syrian adult population using an ActiGraph WGT3X-BT accelerometer measurement device. While our previous work on using accelerometer to Assess Physical Activity Behavior in Syrian Adults in comparison with WHO recommendations reported that 1.5% of women and 6.7% of men, accumulate 150 minutes per week of MVPA with 10 minutes bouts [17]. Therefore, we expected that SQUASH would be relatively reliable in this population

## MATERIAL AND METHODS

### Study design, procedure and participants

Fifty-two adults (15 men and 37 women) were recruited from various workplaces within the Syrian Atomic Energy Commission (SAEC) in Damascus, Syria. Participants were selected according to the following inclusion criteria: (a) age range of 18-60 years; (b) willingness to wear accelerometers for seven days during free-living activities and sleeping; and (c) ability to complete surveys in Arabic. Participants signed written informed consent forms to participate in the study. The SAEC human ethics committee approved the study protocol, which was conducted in accordance with the Helsinki Declaration of the World Medical Association. The final sample consisted of 45 participants (13 men and 32 women) who met the inclusion criteria and had complete data on objectively assessed physical activity (PA), height, and weight. No technical errors were encountered during accelerometer registrations. Participants were required to wear the accelerometer for at least four days with a minimum of 600 minutes of valid daily monitor wear. The study involved three visits to the participants' workplaces. During the first visit, trained research assistants conducted measurements of anthropometric parameters. Body weight was measured using electronic scales (Seca, Model: 7671321004; Germany) with an accuracy confirmed by using known masses (20 kg). Height was measured to the nearest 0.5 cm using a wall-mounted stadiometer (Seca, Model: 225 1721009; Germany). Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. A demographic questionnaire was administered to collect information on sex, age, marital status, education levels, and smoking status. Participants were asked to wear the ActiGraph accelerometer on their left hip with an adjustable elastic belt for seven days. Seven days after the first visit, participants returned the accelerometers and completed the SQUASH-1 questionnaire. The third visit occurred 45 days later, during which the SQUASH-2 questionnaire was completed.

### Accelerometer processing

The material requirements for the study included the ActiGraph (AG) (WGT3X-BT, Pensacola. FL. 32502 USA) accelerometer, a small, lightweight, tri-axial activity monitor that provides data on physical activity (PA), including activity counts, energy expenditure (kcal), steps, and activity intensity (METs) [18]. Participants wore a single AG accelerometer unit over their left hip, attached to an elasticized waistband, for all waking hours during a 24-hour period over seven days. Participants were instructed to remove the device before engaging in aquatic activities such as swimming, bathing, and showering. The AG accelerometer data were processed using the Actilife software and exported to Microsoft Excel format. Within Microsoft Excel, mean minutes of PA, including light, moderate, and vigorous, as well as sedentary behavior (SB) were calculated per day. The daily average was then multiplied by seven to create a weekly total activity score [19].

### Short Questionnaire to Assess Health Enhancing Physical Activity (SQUASH)

The SQUASH was selected to evaluate the physical activity (PA) behavior of the study population.. For activities at work and household, the intensity was pre-defined into two categories: light or intense [20]. The total minutes of activity were calculated for each question by multiplying frequency (days/week) by duration (min/day) while the missing answers were not considered the farther calculation. The total minutes of PA per week were calculated by aggregating the total minutes of PA reported in the SQUASH.

To assess the reproducibility of the SQUASH over time, 45 subjects completed the questionnaire in a randomised order on two separate occasions, with a 45-day interval between the first and second measurements. This time period was chosen to avoid recall bias while preventing significant changes in PA levels. The validity of the self-reported PA questionnaire was assessed by correlating the SQUASH total scores with the AG accelerometer results [12,21].

### Diagnosis Criteria

Cutoff points for intensity categories were based on the PA guideline [21]. Based on the reported effort in the SQUASH activities were given an intensity score (ranging from 1 to 9). For example; walking and odd jobs activities received an intensity score of 1, 2, or 3 based on reported effort being low, moderate, or vigorous activity, respectively. For gardening and bicycling these intensity scores were 4, 5, and 6, respectively. The scores for light and intense activity at work and household are 2 and 5, respectively [21].

### Statistical analysis

Participants with both SQUASH and AG accelerometer data were included in the present analysis. All statistical analyses were performed using the Statistical Package for Social Science (SPSS) for Windows (Version 17.0.1, 2001, SPSS Inc., Chicago, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were represented by frequency and percentage. Statistical significance was set at $p < 0.05$ or corresponding p-value in all tests.

Spearman's rho correlations were used to evaluate relationships between change scores of self-reported (SQUASH) and objective measurement (AG accelerometer) of PA. To examine differences between pre and post levels of PA, Wilcoxon signed rank tests were used. Effect sizes (r) of the differences between the baseline, an effect size of r = 0.0 to 0.30 was considered a negligible effect, 0.30 to 0.50 small effect, 0.50 to 0.70 moderate effect, 0.70 to 0.90 high effect, and 0.90 to 1.00 a large effect [21]. Summary data is reported as mean (SD) and statistical significance was assumed at $p < 0.05$.

## RESULTS

### Baseline characteristics of study participants

Demographic characteristics of the study populations are presented in Table 1. Of the 45 individuals who participated in the study, (n=32; 71.1%) were female and (n=13; 28.9%) were male. The mean age of the participants in the study group was 36.9±8.3 years, with 42.6±5.3 years for men and 34.6±8.2 years for women. The mean BMI was 26.6±4.7 kg/m$^2$, with 28.2±3.3 kg/m$^2$ for men and 26.0±5.1 kg/m2 for women. The majority of the total sample of the participants were aged 30–45 years (n = 27; 60.0%), married (n = 30; 66.7%); overweight/obese (n = 28; 62.2%), with high school level education (secondary school or higher) (n = 38; 84.5%); and non-smokers (n = 23; 51.1%) (Table 1).

*Table 1. Descriptive demographic characteristics of the study participants.*

| Variables | Subcategory | Total sample | Men | Women |
|---|---|---|---|---|
| | | **N=45** | **N=13 (28.9%)** | **N=32 (71.1%)** |
| **Age (years)** | Mean (±SD) | 36.9±8.3 | 42.6±5.3 | 34.6±8.2 |
| **Age group (n, %)*** | 18-29 | 10 (22.2) | 0 (0.0) | 10 (31.3) |
| | 30-45 | 27 (60.0) | 8 (61.5) | 19 (59.4) |
| | >45 | 8 (17.8) | 5 (38.5) | 3 (9.4) |
| **Marital status (n, %)** | Single | 15 (33.3) | 2 (15.4) | 13 (40.6) |
| | Married | 30 (66.7) | 11 (84.6) | 19 (59.4) |
| **BMI (Kg/m²)** | Mean (±SD) | 26.6±4.7 | 28.2±3.3 | 26.0±5.1 |
| **BMI Category (n, %)*** | Normal Weight | 17 (37.8) | 2 (15.4) | 15 (46.9) |
| | Overweight/Obese | 28 (62.2) | 11 (84.6) | 17 (53.1) |
| **Educational level (n, %)*** | < Secondary School | 7 (15.6) | 3 (23.1) | 4 (12.5) |
| | Secondary School | 8 (17.8) | 5 (38.5) | 3 (9.4) |
| | > Secondary School | 30 (66.7) | 5 (38.5) | 25 (78.1) |
| **Smoking status (n, %)*** | Yes | 22 (48.9) | 10 (76.9) | 12 (37.5) |
| | No | 23 (51.1) | 3 (23.1) | 20 (62.5) |

** Significant deference exists between men and women at p<0.05*

## Measurements of PA and Test–retest reliability

All descriptive statistics for SQUASH-1 and SQUASH-2 are presented in Table 2. Of the reported time (SQUASH-1), 14% was spent during leisure-time activities (walking, cycling, gardening, odd jobs and sports), 60% during household activities (light and intense) and 25% at work (light and intense). Almost no time (less than 1.5%) was spent on commuting activities (walking and cycling) (Table 2).

The Spearman's correlation coefficient for the total activity score was 0.64. For the other, separate questions the Spearman's correlation coefficient ranged from - 0.08 to 0.84. Reliability for commuting bicycling activities could not be measured. Intense commuting by walking was least reliable (r=-0.08), while, light activities at work were most reliable (r=0.84) (Table 2).

Bland and Altman analysis for the total activity score showed significant differences between the two SQUASH assessments, with the most observations staying at the 0 – 1.96 SD range and within the 95% limits of agreement (Figure 1). The limits of agreement for estimated total activities that derived from SQUASH-1 vs SQUASH-2. MVPA that derived from SQUASH, with upper and lower 95% LOA of -5624.5 to 5677.7 min/week at 2 SD (Figure 1).

Significant ($p < 0.074$) inter-method agreement was demonstrated between SQUASH-1 and SQUASH-2 estimates. Correlations between the SQUASH-1 with SQUASH-2 were R2 = 0.004, and p=0.651.

## Validity of the SQUASH

Assessment of physical activity (PA) using the SQUASH revealed significantly higher total PA minutes across all intensity levels compared to the AG accelerometer. Moderate and vigorous intensity PA durations were consistently higher when assessed by the SQUASH than by the AG accelerometer (Table 3). The SQUASH reported an average of 3409 ± 1102 minutes of total weekly activity, while the AG accelerometer recorded 1395 ± 436 minutes of total weekly activity. Predominantly, both the SQUASH (78%) and the AG accelerometer (83%) indicated that most of the time was spent in low-intensity activities. The Spearman's correlation coefficient between the total activity scores derived from the SQUASH and AG accelerometer was 0.31 (95% CI ranging from 1690 to 2336, as shown in Table 3).

*Table 2. Test–retest reliability of SQUASH-SF based on Spearman-rank correlation coefficients (n = 45)*

| Item | Minutes/week | Activity score | Activity score | Reliability |
|---|---|---|---|---|
| | SQUASH-1 | SQUASH-1 | SQUASH-2 | R Spearman |
| | n= 45 | n = 45 | n = 45 | n = 45 |
| **All items together** | 3415 (1095) | 7973 (3516) | 8000 (3699) | 0.64** |
| **Commuting** | | | | |
| **Walking** | 46 (54) | 100 (125) | 113 (176) | 0.35* |
| **Cycling** | 0 (0) | 0 (0) | 0 (0) | - |
| **Leisure time** | | | | |
| **Walking** | 163 (251) | 342 (523) | 450 (649) | -0.08 |
| **Cycling** | 1 (9) | 7 (45) | 23 (157) | -0.02 |
| **Gardening** | 63 (325) | 313 (1623) | 255 (1149) | 0.83** |
| **Odd jobs** | 207 (666) | 340 (1030) | 193 (704) | 0.24 |
| **Sports** | 29 (75) | 112 (335) | 205 (682) | 0.60** |
| **Activities at work** | | | | |
| **Light** | 661 (801) | 1321 (1601) | 1584 (2004) | 0.84** |
| **Intense** | 214 (337) | 1071 (1687) | 808 (1121) | 0.26 |
| **Household activities** | | | | |
| **Light** | 1937 (407) | 3873 (814) | 4040 (833) | 0.19 |
| **Intense** | 101 (466) | 506 (2327) | 167 (917) | 0.65** |

*Minutes per week spent in different categories of physical activity (mean ± SD), activity scores from the dual measurements (mean ± SD) and reliability of the total activity scores, as well as reliability of the scores on separate questions of the SQUASH (Spearman correlation coefficient). *p<0.05, **p<0.01.*

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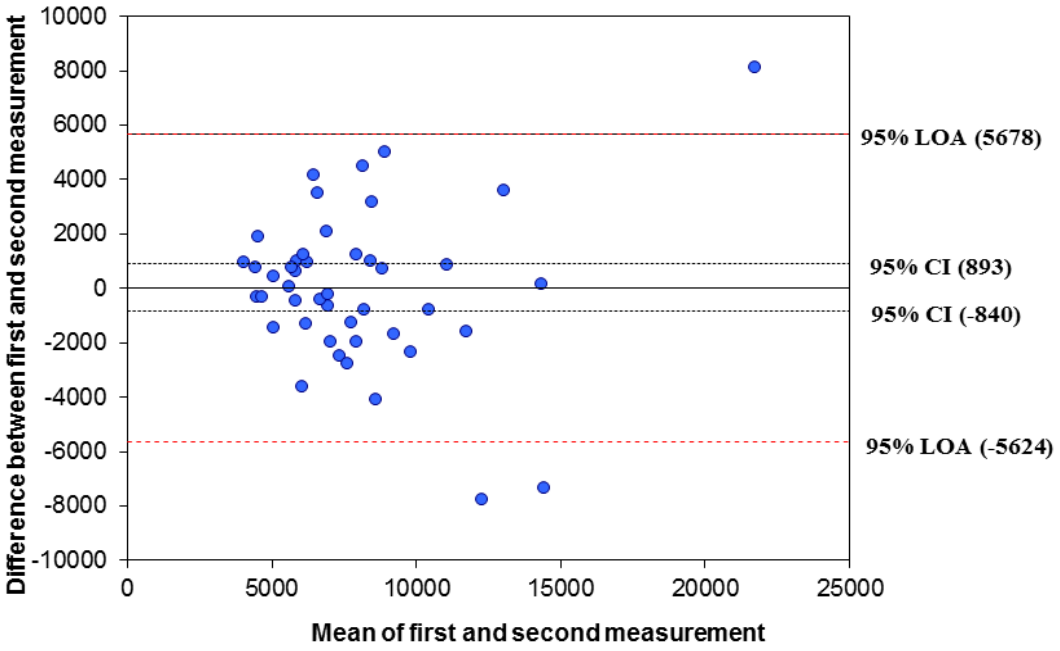
*Figure 1. Bland and Altman graph with the limits of agreement (LOA).*




*The difference between total activity scores on the first and second SQUASH plotted against their mean for each patient, together with 95% confidence interval (CI) and the 95% LOA.*

*Activity score = minutes x intensity.*

*Table 3. Physical activity levels based on SQUASH -SF and ActiGraph results (n = 45)*

| | SQUASH-1 (n=45) | ActiGraph (n=45) | d | SE d | 95% CI | rSpear-man |
|---|---|---|---|---|---|---|
| **Total** | 3409 ± 1102 | 1395 ± 436 | 2013 ± 1076 | 160 | 1690 - 2336 | 0.31* |
| **Low intensity** | 2667 ± 920 | 1155 ± 372 | 1511 ± 955 | 142 | 1224 - 1798 | 0.01 |
| **Moderate intensity** | 388 ± 573 | 235 ± 106 | 153 ± 526 | 78 | -5 - 311 | 0.46** |
| **Vigorous intensity** | 354 ± 550 | 5 ± 6 | 349 ± 551 | 82 | 183 - 514 | -0.03 |

*All times are expressed as minutes of activity per week (mean ± SD).*

*d = mean difference between time spent in physical activity as assessed by the first administered SQUASH (SQUASH-1) and the Actigraph.*

*SE d = standard error of the mean difference. 95% CI = 95% confidence interval of the mean difference between the two measurements.*

However, the Bland and Altman analysis demonstrated poor agreement between the two methods in calculating total PA, with an R value of 0.741 and p-value of 0.000. The 95% limits of agreement (LOA) ranged from -94.8 to 4121.3 minutes per week at 2 standard deviations (Figure 2).

Figure 3 illustrates the distribution of weekly minutes of moderate-equivalent PA from self-reported data and AG accelerometer measurements.

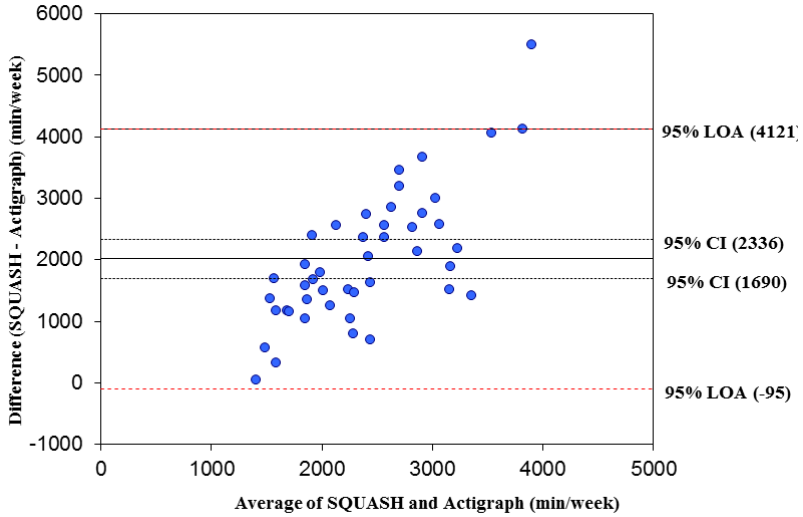
Both distributions show a wide variation in physical activity levels within the sample, with the majority exhibiting low activity levels and a smaller

proportion engaging in higher levels of activity. The AG accelerometer data showed a broader range of values compared to self-reported activity. Ideally, a bell-shaped curve would represent a normally distributed dataset. When comparing tertiles of activity scores with activity counts, the exact agreement was 48%, and the weighted kappa value was 0.20 (Figure 3).

## DISCUSSION

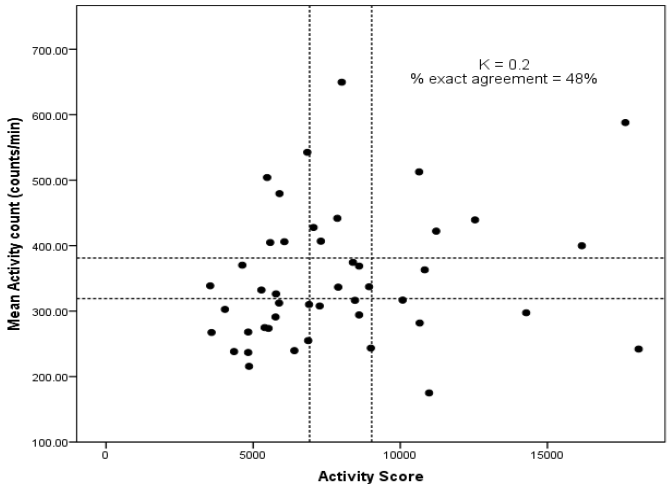
The primary objective of this study was to assess the reliability and validity of the SQUASH questionnaire in measuring physical activity (PA) and sedentary behavior (SB) among Syrian adults aged 18-60 years, using the AG accelerometer as the comparison method. The AG accelerometer is considered one of the most reliable tools for comparing subjective methods like the SQUASH [23,24]. We evaluated the measurement properties of the SQUASH as a more detailed self-report method for assessing PA behavior. Questionnaires have been recommended as a reliable and valid approach for assessing PA levels in the general adult population [11,13]. However, the SQUASH cut-off points appear to be higher, leading to an overestimation of PA levels compared to the AG accelerometer. This finding supports the well-

*Figure 2. Bland and Altman graph with the limits of agreement (LOA).*




*The difference between total minutes of physical activity per week as assessed by mean of the SQUAH and the Actigraph, plotted against their mean for each patient, together with 95% confidence interval (CI) and the 95% LOA.*

*Figure 3. Tertiles (dotted lines) of the activity score per week (SQUAH) and the mean activity counts per minutes (Actigraph).*



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documented observation that the SQUASH and other PA questionnaires tend to overestimate PA levels [25-27].

## Reliability of the SQUASH

The Spearman correlation for overall (all items together) reliability of the SQUASH in our assessment was 0.64. Therefore, the reproducibility is comparable to other PA questionnaires. The correlation coefficient we determined in this validation experiment of SQUASH is within the range of correlation coefficient indicating in the literatures [11,28,29]. Therefore, the correlation coefficient in our study can be considered as reasonable and acceptable. However, the reproducibility of PA questionnaires has been determined in adults in many countries in the past. Most of the researchers found that kappa values varying from 0.47-0.89 [11,28,29]. This result may be explained by the real differences in the PA levels from week to week, overestimation of the real PA attribute to an incorrect perception of activity, misunderstanding of the questions that led to measurement error in both questionnaire surveys, and/or the inability to correctly recall all activities performed when completing the surveys [27,30].

## Validity of the SQUASH

The main finding of the present study is that the agreement between self-reported physical activity (PA) using the SQUASH questionnaire and objectively assessed PA using the ActiGraph (AG) accelerometer was small (r=0.31). To the best of our knowledge, this is the first study to examine the validity of the SQUASH in a Syrian population using AG accelerometer measurements. Therefore, we are unable to directly compare our data to others in similar populations.

Previous studies have reported Spearman's correlation coefficients ranging from 0.31 to 0.45 based on the validity of other PA questionnaires [25,27]. The SQUASH total scores were reported to be somewhat better, with correlations of 0.45 in healthy adults and 0.35 in patients [11,21]. In a review assessing the validity of seven PA questionnaires in adults, the correlation with accelerometer total counts ranged from 0.34 to 0.89 [13,31]. However, it has been suggested that the correlation between total PA assessed by a questionnaire and total accelerometer counts should be at least 0.50 to demonstrate construct validity [32]. Based on these guidelines, the SQUASH did not reach the standard for construct validity in Syrian adults.

Our finding is consistent with the recommendation by Cleland et al. who suggested that self-reported physical activity in general was not sufficiently accurate for individual assessment. These study results have important implications for how PA is being assessed and reported among the population in Syria. The present findings suggest that the SQUASH may not be appropriate for assessing minutes of PA in Syrian adult populations.

## Clinical Implications and Future Directions

These findings have potential important clinical implications, as PA measurement using self-reports has been suggested for use in healthcare settings for risk assessment [33,34]. To improve the validity of questionnaires in adult populations, it may be possible to strengthen the validity scores by providing more detailed examples of the types of activities adults may do [35,36]. This may enhance their ability to accurately recall their activities during the 7-day reporting period.

Some potential sources of information errors could arise in PA records. Despite these limitations, the SQUASH is a suitable tool for monitoring and assessing PA behavior in Syrian adults and could provide useful PA information for international comparisons. The results showed moderate reliability and validity of the questionnaire, which is in agreement with data published in review papers [9,37-39].

## Strengths of the study

The strength of our study is that we used objectively measured PA data (AG accelerometer), and were able to compare it with subjective data (SQUASH). To our best knowledge, this study is the first to validate the SQUASH to the Arabic language. We detected moderate correlation between PA estimated by AG accelerometer and SQUASH. As well as a moderate test-retest reliability for most of the SQUASH items. In this study we used the AG accelerometer as reference method, thereby enhancing the criterion validity of the research.

## Limitations of the study

This study has several limitations that should be considered when interpreting the results.

Small Sample Size: The study population was relatively small, which may limit the generalizability of the findings.

Healthy Adult Participants: Only healthy adults were recruited for the study. Therefore, the results cannot be extrapolated to other populations such as young people or older adults.

Lack of Gold Standard Comparison: Estimates of sedentary behaviour (SB) and physical activity (PA) were not compared with a gold standard method like doubly labeled water, which is considered the most accurate technique for measuring energy expenditure.

Limited Generalisability: The generalisation of the results is limited to a similar study population. Comparisons of PA and SB using these methods with

other study samples could provide inaccurate results.

Higher Education Level: Although the researchers tried to cover a large socioeconomic range, the participants had a higher than average education level compared to the general Syrian population. Physical activity in people from higher socioeconomic groups is more accurately recalled [40,41].

Variation Between Questionnaires: Several participants varied in their responses between questionnaires. Some questions may be regarded as easier or more difficult to respond to, and this should be taken into consideration when testing the validity of a question or questionnaire.

Reliability Affected by Interview Interval: Previous research has shown that reliability can be affected by the interval between the two interviews [42].

In conclusion, while this study provides valuable insights into the physical activity and sedentary behavior patterns of healthy Syrian adults, the limitations mentioned above should be considered when interpreting the findings and designing future research in this area.

## CONCLUSION

The current study marks the first validation of an international standardized physical activity (PA) questionnaire for Syrian adults. The study aimed to assess the reliability and validity of the SQUASH in monitoring PA levels. The results indicate that the SQUASH has moderate reliability and validity in determining minutes of PA. Despite this, the SQUASH was found to be a suitable method for monitoring PA in Syrian adults. Future validation studies should consider using doubly labeled water as a criterion for employment in surveillance.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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