**Title: Self-Report Measures of Physical Activity**

**Baecke Physical Activity Questionnaire (BPAQ), International Physical Activity Questionnaire (IPAQ), Physical Activity Scale for the Elderly (PASE), Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH)**

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**INTRODUCTION**

Many people with musculoskeletal (MSK) conditions can reduce their pain and improve their quality of life by being more physically active (1). Physical activity (PA) is internationally recommended as a core treatment for common MSK conditions such as osteoarthritis (OA) (2-5). However, people with MSK conditions are often less active than those without such conditions (6-8), with less than half of adult patients with OA meeting PA guidelines (9).

PA levels can be measured using objective methods such as accelerometry and pedometers or subjective methods such as self‐report measures. Use of self‐report PA measures is a popular approach as they are easy to use and are low cost (10). Two systematic reviews have evaluated the measurement properties of self-report PA measures in patients with OA (11,12), but to date, there is still no consensus regarding which self‐report PA measure is the most suitable for use in MSK populations.

This paper aims to summarise and critically assess the most widely used self-report PA measures in studies of common MSK conditions. The authors selected measures based on the following criteria: 1) administered by self-report, 2) most commonly cited for use in MSK populations (e.g. OA, low back pain (LBP), rheumatoid arthritis (RA), ankylosing spondylitis (AS), fibromyalgia (FM)) in the last 5 years, and 4) have evidence of psychometric data in MSK populations. A two-stage computerized literature search using Medline and Embase were performed. In the first search, medical subject headings for MSK conditions and MSK pain were used in conjunction with terms for exercise and PA to identify studies that used self‐report PA measures. A second search was then conducted to retrieve studies that evaluated measurement properties of the self‐report PA measures identified from the first search.

The measures reviewed below include the Baecke Physical Activity Questionnaire (BPAQ), the International Physical Activity Questionnaire (IPAQ) (3 versions), the Physical Activity Scale for the Elderly (PASE) and the Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH). Details on the content and structure of each measure are presented (number of items, recall period, response options, presence of translations, and adaptations) (see table 1). Information on cost and how to obtain the measures is also provided, where available. Important practical information is presented, including evidence for psychometric properties of each measure in common MSK populations (where available) (see table 2). A critical appraisal of each measure is provided and the review concludes with a summary and recommendations specific to the rheumatology community.

**BAECKE PHYSICAL ACTIVITY QUESTIONNAIRE (BPAQ)**

**Description**

**Purpose.** The BPAQ (13) is a self-report PA measure developed, originally, for use in epidemiological studies to assess levels of PA in young adults.

**Content or domains.** Self-reported responses across three domains are used to assess physical activity levels in a typical week: a) occupational physical activities (8 questions); b) sport (4 questions); c) leisure (4 questions); and total PA is the sum of all indices.

**Number of items.** 16 questions divided across 3 domains and summed for a total level of PA.

**Response options/scale**. Questions are scored on a five-point Likert scale ranging from ‘never’ to ‘always or very often’.

**Recall period for items.** Typical week

**Cost to use.** Free

**How to obtain.** Questionnaire and scoring available within the appendix of original article (13).

**Practical Application**

**Method of administration**. Self-administered.

**Scoring.** Each domain (occupation, sports, leisure) can receive a score from 1 through to 5, which is achieved through a scoring formula for that domain (see below). Within domains each question is also given a score from 1 through to 5 with the exception of questions asking main occupation and types of sports played. Total score is a sum of the scores for each domain and can range between 3 and 15 with a higher score corresponding to a higher PA level.

For the work domain, the respondent’s occupation is given a score of 1 (low activity), 3, (moderate activity) or 5 (high activity) based on work activity ratings from the Netherlands Nutrition Council. The overall work index is calculated using a formula: ((6 - Q2) + (Q1 + Q3 + Q4 + Q5 + Q6 + Q7 + Q8))/8.

For the sport domain, the first question involves calculating a “simple sports score” based on the respondent’s sport activity (a calculation of their two most frequently played sports). First it is determined what two sports the respondent plays most frequently. Sports are subdivided into three categories each of which has a value corresponding to intensity (average energy expenditure). Second, it is determined how frequently the respondent engages in the sport in hours per week, with different numbers of hours given a different value. Finally, it is determined how many months in the year the respondent plays their most frequently played sports. A value is given for different numbers of months per year. Once these three values are determined, the sport score is determined using the formula: ((value for intensity of most frequent sport)\*(value for weekly time of most frequent sport)\*(value for yearly proportion of most frequent sport))\*((value for intensity of second sport)\*(value for weekly time of second sport)\*(value for yearly proportion of second sport). Finally, an overall sport index can be calculated using the formula: (simple sport score + Q10 + Q11 + Q12)/4. For the leisure domain the overall leisure index is calculated using the formula: ((6 – Q13) + (Q14 + Q15 + Q16))/4.

**Score interpretation.** Scores cannot be interpreted in relation to other metrics of PA.

**Respondent time to complete.** Minimal burden. Quick to complete as all items are multiple choice.

**Administrative burden.** Time to administer is short and scoring can be done quickly by totalling scores for each index, and a total score summing all of these indices.

**Translations/adaptations.** There are no repositories of the BPAQ to identify all the translations, but the questionnaire has been used internationally in different populations with multiple languages including Japanese (14), Dutch (15), Persian (16), French (17), Flemish (18), Greek (19), Korean (20), and Portuguese (21).

**Psychometric Information**

**Floor and ceiling effects.** Not reported.

**Reliability.**

*Internal consistency.* Not reported in any studies

*Test-retest.* Intrasession intraclass correlation coefficient (ICC) 0.77 (95% confidence interval [95% CI] 0.65, 0.84) in patients with LBP (22). ICC 0.87 in adult women with hip disorders (14).

**Validity.** *Content/face validity.* Not reported in any studies

C*riterion validity.* Not reported in any studies.

*Construct validity.* Significant and fair correlation in people with LBP (rho 0.18) between BPAQ and number of steps and vector magnitude on Actigraph wGT3X-BT accelerometer (22). In adult females with hip disorders there was significant but low correlation (rho 0.30-0.49) across 3 measures of the BPAQ and a higher correlation between step counts and total score on BPAQ (rho 0.49) (14).

**Responsiveness.** Not reported in any studies.

**Minimum important difference.** Not reported in any studies.

**Generalisability.** Originally developed for epidemiological research and tested in a young Dutch male and female population (aged 32 years and under). Translation in multiple languages but its application in older populations and in MSK populations is limited.

**Use in clinical trials.** No randomised controlled trials (RCTs) in MSK populations that used the BPAQ questionnaire could be identified, only one protocol (23).

**Critical appraisal of overall value to the rheumatology community**

**Strengths.** Items are closed-response items that allow for easy completion and scoring. Scores can be broken down into three indices which allow for interpretations on how individuals are loading their PA. Total scores of the BPAQ appear to have adequate reliability (ICC>0.7).

**Caveats and cautions**. Limited to two studies of evidence in measurement properties in MSK populations, low correlations to objective measures. No evidence on sensitivity to changes/responsiveness. Scores cannot be interpreted in relation to recommended levels of PA.

**Clinical usability.** Quick and easy to administer and score. Individual scores across indices can be used to identify where individuals are most and least active (occupation, sport or leisure).

**Research usability.** No RCTs in MSK populations that used the BPAQ questionnaire could be identified, only one protocol (23). The BPAQ questionnaire was designed for use in epidemiological studies only. Several observational studies in MSK populations have used the BPAQ questionnaire (24-27).

**International Physical Activity Questionnaire (IPAQ)**

**Description**

**Purpose.** The purpose of the International Physical Activity Questionnaire (IPAQ) is to measure internationally comparable physical activity levels in adult populations (28). It was designed primarily for surveillance of PA at a population level, and has been predominantly used in studies of people with OA. It is not recommended for use as an outcome measure in small scale intervention studies.

**Content or domains.** The IPAQ is available for use with young and middle aged individuals (15-69 years) in Long (IPAQ-LF) and Short Forms (IPAQ-SF). There is also a short form version validated for use in older adults (IPAQ-E, 65+ years) (29).

*IPAQ-LF:* Covers five activity domains asked as separate sections. Namely, PA undertaken related to: a) work; b) transportation; c) housework; d) leisure time activities; and e) time spent sitting. The IPAQ-LF asks questions around the frequency (days) and duration (minutes) spent in each of these domains, with a focus on three types of activity; vigorous intensity, moderate intensity, and time spent walking (28).

*IPAQ-SF and IPAQ-E:* ask about the four specific activity types (vigorous intensity, moderate intensity, time spent walking and time spent sitting), undertaken during any work, transportation, housework, or leisure activity. Time spent sitting is asked as a separate question and used as an indicator of sedentary behaviour (see scoring manual, www.ipaq.ki.se).

**Number of items.**

*IPAQ-LF:* Has 27 items, however some can be skipped if the individual does not participate in any activities for a given domain (e.g. no work-related vigorous or moderate activities undertaken).

*IPAQ-SF:* Has six items, seven if the individual reports any time spent walking.

*IPAQ-E*: Covers the same items as the SF, but is presented as only four questions.

**Response options/scale.** All forms ask people completing the survey to indicate the number of days per week, and hours and minutes per day they spend doing the PA within each domain. Individuals may indicate they are not sure of the activity undertaken.

**Recall period for items.** Past week (last 7 days).

**Cost to use.** All versions are free to use and open access (www.ipaq.ki.se).

**How to obtain.** The IPAQ forms are freely available in multiple languages, either in pdf or word document format.

**Practical application**

**Method of administration**. The IPAQ-LF and IPAQ-SF are available as either telephone administered or self-administered. The IPAQ-E is only available in a self-administrated format.

**Scoring.** An English version of the scoring protocol for the LF and SF is freely available. The scoring protocol for the SF can be used to score the IPAQ-E. Automatic scoring templates and reports are available for select languages on the website.

Walking, moderate and vigorous scores are converted into METS (metabolic equivalent)-minute/week using the Ainsworth Compendium (30). An average MET score is based on time spent on each activity intensity then added together to make a total. This can then be converted into a categorical score of three categorical levels; low, moderate and high levels of activity. Definitions of these categories are outlined in the IPAQ scoring protocol.

*IPAQ-LF:* Provides separate domain specific scores for vigorous-intensity, moderate-intensity and walking within the 4 activity related domains (excluding sitting). Computation of the total scores for this form involves summation of the frequency (days) and duration (minutes), for all activities in all domains. Domain specific scores require summation of the scores of the different intensity activities within the specific domain. Activity specific sub-scores can also be calculated by summing the scores of the specific types across the domains.

*IPAQ-SF:* Provides separate scores for vigorous-intensity activity, moderate-intensity activity and walking. However, domain specific estimates cannot be calculated. Data for time sitting is not included in the summed score of PA, but should be reported and used to categorise activity into low, moderate or high levels (see the SF scoring protocol).

*IPAQ-E*: Scored similarly to the SF, however Hurtig-Wennlof and colleagues (29) suggest caution should be used when converting to MET due to lower metabolic rates in older adults. Rather min/day in each intensity can be reported.

**Score interpretation**. Scores are given in total METS-minute/week giving an estimate to energy expenditure in a week. Categorical score can be interpreted in terms of PA recommendations, those scoring low are below recommendations, moderate scores are meeting recommendations, and high scores are exceeding the recommendations.

**Respondent time to complete.** Time to complete has not been reported, however as the IPAQ-SF and IPAQ-E have less than 7 short response items, time to complete is minimal. The LF is longer to administer, although still takes a relatively short time to complete.

**Administrative burden**. Time to administer the questionnaires is very short as only a print out and a pen is required to complete. Scoring can be completed by hand or calculator, or on a simple spreadsheet. No additional equipment or software is required.

**Translations/adaptations.** There are currently 24 translated versions available (www.ipaq.ki.se), although not for all form types. The website includes a guide for translating the IPAQ into languages not currently available.

**Psychometric information**

**Floor and ceiling effects.** Not reported in any studies

**Reliability.**

*IPAQ-LF:*

Internal consistency: Not reported in any studies.

Test-retest: ICC=0.65 in patients with total hip replacement (THR) and/or total knee replacement (TKR) (31), ICC=0.83 in patients with AS (32), ICC=0.77 in females with FM (33), ICC= 0.37 in patients with LBP (25). Standard error of the measurement (SEM) =2668 METS-minute/week, minimal detectible change = 1115 METS-minute/week in patients with THR and/or TKR (31). Comparison across 12 countries ICC ranged from 0.96 to 0.46 (34). The IPAQ-LF has shown weak reliability for sedentary behaviour and moderate to vigorous activity in healthy older adult populations, therefore care should be taken when using it to classify PA levels in older populations (35).

*IPAQ-SF:*

Internal consistency: Not reported in any studies.

Test-retest: ICC=0.76 in patients with THR, ICC=0.87 in patients with TKA (36). ICC=0.51 in patients with THR and/or TKR (31). SEM=2487 METS-minute/week, minimal detectible change = 1039 METS-minute/week in patients with THA and/or TKA (31). Comparison across 12 countries ICC 0.88 to 0.32 (34). ICC=0.64, SEM=3532 METS-minute/week, smallest detectable change (SDC) =9791 METS-minute/week in patients with OA in a hip, knee, foot and hand OA sample (37).

*IPAQ-E:* Not reported in any studies

**Validity.**

*IPAQ-LF:*

Content/face: Not reported in any studies

Criterion: CSA accelerometers across 12 countries = 0.33 (34)

Construct: correlation to ActiGraph GT1M accelerometer = 0.43 in patients with THR and/or TKR (31), correlation to ActiGraph GT1M=0.38 in patients with AS (32), concordance correlation with SenseWear Pro Armband= 0.04 in females with FM (33), compared to Actigraph GT3X, individual overestimate in RA (38), correlation to Actigraph wGT3X-BT counts=0.33 in LBP (25); compared to the Actigraph older adult self-report had moderate correlations for moderate to vigorous PA (MVPA) (0.43-0.56) and 0.70 to 0.26 for SB, but they tended to underestimate both MVPA and sedentary behaviour (39)

*IPAQ-SF:*

Content/face: Not reported in any studies.

Criterion: Correlations to CSA accelerometers across 12 countries = 0.30 (34).

Construct: Correlation to ActiGraph GT1M accelerometers = 0.29 in patients with THR and/or TKR (31), correlation to PASE=0.61 in patients with hip OA (40), correlation to Sensewear activity monitor=0.40 in patients with RA (41). Correlation to PASE=0.56 in a hip, knee, foot and hand OA sample (37).

*IPAQ-E:*

Content/Face: Not reported in any studies

Criterion: activity domains positively correlated to ActiGraph GT1M=0.28 to 0.47 in older adults (29). A main effect for category (high, med, low) was observed with the high-sensitive serum C-reactive protein biomarker.

Construct: Not reported in any studies.

**Responsiveness.** Effect size (ES) = -0.14, standard responsiveness measure (SRM) = -0.21, responsiveness ratio (RR) = 0.12 in 6 in a hip, knee, foot and hand OA sample (37).

**Minimally important differences.** Not reported in any studies.

**Generalizability**. The IPAQ is designed as a population based measure. It is generic and designed to be used across all adults aged 18-65 (IPAQ-LF and SF), or 65+ (IPAQ-E), with or without clinical conditions (28). However, there are studies in certain populations that suggest it should be used cautiously with these groups.

**Use in clinical trials.** A number of RCTs have used the IPAQ-LF to assess and classify the level of PA in the study population (42) and IPAQ-SF (43-48).

**Critical appraisal of overall value to the rheumatology community**

**Strengths.** Scores for the SF and LF relate to weekly energy expenditure. Scores can be compared to recommended levels of PA or between different conditions. It has been translated into different languages, is easy to administer and quick to complete. The forms are open access, readily accessible and are free to use. The IPAQ-SF is widely used to research different MSK conditions and has been used in a range of OA and rheumatology studies. It covers activities across multiple domains including work, leisure and home life. The IPAQ-LF has more evidence for reliability and construct validity in relation to objective measures as compared to the IPAQ-SF or IPAQ-E. It was tested and developed in both high and low income countries (34).

**Caveats and cautions.** There is limited evidence of measurement properties in MSK populations for any of the forms, and there is no evidence in MSK populations for the IPAQ-E. All forms have low correlations to objective measures, and there is no evidence on sensitivity to changes/responsiveness. It is not recommended for use as an outcome measure for small intervention studies. Care should be taken when converting the IPAQ-E to METs (29). The IPAQ has not been validated for use in online studies.

**Clinical usability.** The questionnaires are quick and easy to administer and score, regardless of the form used. Individuals scores can be related to evidence for levels of PA that can lead to health benefits. The IPAQ-E reports good acceptance by older users (29). It may not be appropriate for use with certain patient populations.

**Research usability.** The forms can be self-completed or administered via telephone. They have been translated in different languages and can be used in different countries/languages with direct comparisons. The inclusion of the sitting activity scores in the IPAQ-SF can provide data on inactivity and sedentary behaviour in this population. The IPAQ-LF may be more applicable for research that requires more detailed assessments of PA.

While the IPAQ questionnaire has been used in several RCTs it was predominately designed for observational or population based studies. Several observational studies in MSK populations have used the IPAQ-LF (49) and the IPAQ-SF (45,50-54).

**Physical Activity Scale for the Elderly (PASE)**

**Description**

**Purpose.** The PASE was developed in the USA in a general older adult population and aims to measure self-reported PA in older adults in the previous week (55).

**Content or domains.** The PASE contains 3 subdomains; leisure activities, household activities and occupational work.

**Number of items.** 12 items. The leisure activities domain contains 5 items (sub domains), the household activities domain contains 6 items, and the occupational work domain contains a single item.

**Response options / scale.** PASE scores are calculated using both weights and frequency values for each of the 12 item activity types. Respondents report activities by a) providing categorical responses to the number of days per week and average hours per day (leisure activity domain) b) reporting if they have carried out an activity or not (items in the household activity domain) and, c) hours worked per week (occupational domain). Scale range is 0-400+ (higher scores indicate higher PA level).

**Recall period for items.** In the last week.

**Cost to use.** There is a cost for the scoring manual and cost per use of the questionnaire (contact www.healthcore.com for more details).

**How to obtain.** Questionnaire and scoring protocol available from www.healthcore.com

**Practical Application**

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| **Method of administration.** Self-administered or via telephone interview (recommended). |
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| **Scoring.** Scoring involves totaling the scores from the three activity domains and rounding to thenearest integer. PASE scores are calculated using both weights (intensity) and frequency valuesfor each of the 12 item activity types. However, each activity domain has a unique scoringmethod. The weighting of item activities was based on an algorithm derived using accelerometry,activity diary and global activity self-assessment (55, see scoring manual available fromwww.healthcore.com).For leisure activities, individuals respond with categorical responses to the number of days per week (never, seldom, sometimes, often) and average hours per day of activity (<1, 1-2, 2-4, 4>) of activities within each item subdomain. A “PASE activity time to hours per day conversion table” is then used to convert this categorical data into hours per day. Different item activities are assigned different weight scores which are then multiplied by the hours per day score for each item and totaled to give the domain sub-score. For household activities, individuals provide a binary response to whether they have carried out individual household activities in the last week which is then weighted by each sub domain item and totaled for the domain sub-score. Occupational hours worked is divided by 7 and given a weight score for the occupational domain sub-score. |
| **Score interpretation.** Higher PASE scores indicatehigher levels of physical activity. The PASE estimates PA, however, its scores are not directly interpretable in meaningful PA units. |
| **Respondent time to complete.** Self-administered or interviewer-administered versions can be completed in5-15 minutes. |
| **Administrative burden.** Administering time is 5-15 minutes. Time taken to score depends on the use of computer coding and is not provided in the literature.  |
| **Translations/adaptations:** Originally developed in English in USA. Has been translated into Dutch (56), Norwegian (57), Japanese (58), Chinese (59), German (60), Malaysian (61), Turkish (62), Italian (63) and Persian (64). It has been adapted for Mexican origin Latinos in South Western USA using an adapted scoring algorithm (65). It has also been adapted for Dutch populations by adding bicycling for transportation to the question about time spent walking (56). |

**Psychometric Information**

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| **Floor and ceiling effects:** Not specifically reported in any studies.  |
| **Reliability:** *Internal consistency:* Not reported in any studies*.*  *Test-retest*: ICC = 0.77 in patients with hip OA (40); 0.77 in men following TKR and  0.58 in women (66); 0.77 post THR (60); 0.68 in a hip, knee, foot and hand  OA sample (37). *Measurement error:* SEM of31, SDC of 87 in patients with hip OA (67); SEM of 32% and 35%, SDC of 89% and 97% in men and women respectively  following TKR (67); SEM of 23.0% post THR (60); SEM 46.7 and SDC of  129.6 in a hip, knee, foot and hand OA sample (37). |
| **Validity:** *Content/face:* Not reported in any studies. *Criterion/convergent:* PASE scores significantly correlated in expected directions with  performance in the 6-minute walk test, knee strength, knee pain frequency during  transfer, and perceived difficulty with physical functioning in older adults with knee pain and physical disability (68)*. Construct:* Correlation of total PASE score with accelerometer-based activity counts in patients with hip OA: 0.30 (p=0.089) and ranged from 0.20-0.38 for the different PA categories (67), correlation  with accelerometer 0.45 in men following TKA and 0.06 in women following TKR  (66), correlation with accelerometer 0.27 in patients following THR  (60). |
| **Responsiveness:** Effect size -0.16, Standard Response Measurement of -0.21 and Response Ratio of 0.09 in a hip, knee, foot and hand OA sample (37).  |
| **Minimally important differences:** Not reported in any studies.  |
| **Generalizability:** Developed in a USA population but has undergone translation and validation in multiple countries (some of these have been in MSK populations) (40, 60, 66). One study (65), has questioned the generalisability (weighting of items) in Mexican elderly Americans. **Use in clinical trials:** The measure has been used in multiple RCTs in OA populations (e.g. 43, 67, 69-76).  |
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**Critical appraisal of overall value to the rheumatology community**

**Strengths.**Designed specifically for older adults.Relatively quick to complete (5-15 minutes). Translated into multiple languages. Often used in OA studies.

**Caveats and cautions.**Mixed reliability results,large measurement error and poor responsiveness. Better suited to older adult populations.Weak correlations with objective measures of PA.Unable to discriminate between intensity of activity within individual subdomains (68). Cost associated with use.

**Clinical usability.**Relativelyquick and easy to administer but scoring maybe more time consuming and difficult in a consultation setting.Scores are not easily interpreted into meaningful units.

**Research usability.**Quick and easy to administer, so could be used in large studies including trials and observational studies (77-80). Validated in older adult populations with joint pain (e.g. OA populations). However, large measurement error and poor responsiveness properties suggest it is not useful in measuring change in PA.

**Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH)**

**Description**

**Purpose.** The SQUASH was developed in the Netherlands and aims to measure the habitual activities in a normal week over the “past months”(81).

**Content or domains.** The SQUASH contains 5 subdomains; a) commuting activities, b) activity at work or school, c) household activities, d) leisure time activities and d) sports.

**Number of items.** Up to 14 items, although not all need to be completed as each subdomain has a ‘Not applicable’ option as an item. The domains of commuting, work / school and household each have 2 items, the leisure time domain has 4 items, and the sports domain can include up to 4 sports activities indicated by the respondent.

**Response options / scale.** Individuals respond with the number of days per week and average time per day (hours and minutes) spent on each activity within each subdomain.

**Recall period for items.** An average week over the past months

**Cost to use.** Free

**How to obtain.** Questionnaire and scoring protocol published in Wendel-Vos et al (81).

**Practical Application**

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| **Method of administration.** Self-administered |
| **Scoring.** Scoring is completed by taking a sum of the time spent active in each domain in total minutes and multiplying them by their intensity scores (81).Activities are divided into 3 intensity categories based on Ainsworth’s compendium of physical activities, 2 to <4.0 METs (light), 4.0 to <6.5 METs (moderate), ≥6.5 METS (vigorous) (30, 82-83). Some studies have used different intensity categories for older adults: 2 to <3.0 METs (light), 3.0 to <5.0 METs (moderate), ≥5 METS (vigorous) (84). Activities with a MET score below 2 are not counted.  |
| **Score interpretation.** The SQUASH does not estimate energy expenditure but estimates habitual activity on an average week for individuals. Some studies have summed the number of days per week for moderate and vigorous activity lasting at least 30 minutes per week to evaluate adherence to American College of Sports Medicine and Dutch activity guidelines (85-86).  |
| **Respondent time to complete.** Less than 5 minutes |
| **Administrative burden.** Administering time is less than 5 minutes, but time taken to score could take relatively longer because intensity scores need to be assigned to activities, including open-ended sports questions.  |
| **Translations/adaptations.** Originally developed in Dutch (81). English version available but process for adaptation / translation not published. Has been translated into Turkish (87) and Japanese (88).  |

 **Psychometric Information**

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| **Floor and ceiling effects.** Not reported in any studies |
| **Reliability.** Internal consistency: Not reported in any studies.  Test-retest: ICC= 0.89 in patients with AS (32),  Spearman’s correlation=0.57 in patients with THR (84). |
| **Validity.** Content/face: Not reported in any studies.  Criterion: Not reported in any studies.  Construct: Correlation with accelerometer-based activity counts in patients with  AS: 0.35 (32), correlation to accelerometer parameters ranged= r=0.28-  0.49 in patients with knee OA (89),  correlations with accelerometer-based activity parameters= 0.20-0.67 in patients with  THR (84).  |
| **Responsiveness.** Not reported in any studies |
| **Minimally important differences.** Not reported in any studies |
| **Generalizability.** Developed in Dutch population and limited use to date in other countries. |
| **Use in clinical trials.** The measure has been used in RCTs investigating knee OA (aqua-cycling) (90) and RA (motivation and self-regulation for PA; combination therapies) (86, 91) **Critical appraisal of overall value to the rheumatology community** |

**Strengths.** Scores can be related to time spent physically active, allowing individuals to be categorized in relation to recommended levels of PA. Takes less than 5 minutes to complete. Opportunity to report any sporting activities in open-ended questions.

**Caveats and cautions.** Limited use among individuals with rheumatic and MSK conditions. Low correlations with objective measures of physical activity and mixed results on reliability. No evidence on sensitivity to changes/responsiveness and limited use in RCTs. Time intensive to score.

  **Clinical usability.** Quick and easy to administer but scoring maybe more time consuming and difficult in a consultation setting. Individual scores on weekly minutes of PA can be related to public health recommendations.

**Research usability.** Quick and easy to administer, so could be used in large studies. However, some psychometric properties not well established. Use of the measure in MSK conditions has involved mostly observational studies, including measurement during daily activities in patients with knee OA (89) and multiple studies focused on establishing the psychometric properties of the scale in different patient groups (32, 84, 85, 87, 88). Use in RCTs has been limited, with studies among patients with knee OA (90) and RA (86, 91).

**Summary / recommendations**

To our knowledge, no self-report measure of PA has been developed specifically for use in populations with MSK conditions. It is therefore important for clinicians and researchers to understand what options are available and how well commonly used measures reflect actual PA levels.

Four self-report PA measures were selected and reviewed based on their frequent use in MSK populations in the last 5 years and the identification of psychometric evidence properties in MSK populations. The authors acknowledge that other commonly used self-report measure such as the CHAMPS (92), the Minnesota Leisure Time Physical Activity Questionnaire (93) and the Yale Physical Activity Survey (94) could potentially be suitable for use in musculoskeletal populations, however they were not included in this review for two main reasons. Firstly, they are not commonly used in musculoskeletal research, and secondly, their psychometric evidence in musculoskeletal and older populations is lacking.

All of the measures included in this review were found to be quick and easy to complete. The majority of measures can also be scored relatively quickly (BPAQ, IPAQ forms, PASE). The SQUASH, however, features open response items to allow respondents to report any sports or physical activities that may not naturally fall into other subdomains, which can make scoring more difficult.

While it would be useful to use self-report PA measures to determine whether an individual or group are meeting current PA guidelines or allow clinically useful categorisation of PA level (e.g. inactive, low active, meeting recommendations), of all the measures included in this review, only the IPAQ and SQUASH allow for this. The impact of sedentary behaviour on MSK conditions has gained increasing interest in recent years (95-97), however of the measures included in this review, only the IPAQ forms assess sedentary time (sitting time). In addition, the SQUASH actually discounts low level activities (<2.0 METS), which may be particularly important to some MSK populations as they may only be able to perform low level activities. It is important that self-report PA measures record all levels of activity, otherwise they may be underestimating overall levels of PA.

The PASE and IPAQ-SF are currently the most commonly used measures in OA research and the BPAQ appears to be most frequently used in LBP research. Overall, psychometric evidence of all the measures identified is lacking in MSK populations (see table 2) and based on the evidence currently available, none of the measures demonstrated adequate measurement properties in terms of all components of reliability and validity. More studies have examined the measurement properties of the IPAQ-LF, yet the IPAQ-SF appears to be a more frequently used measure, possibly due to the reduced number of items and time to complete. There was a clear lack of evidence in terms of responsiveness for the measures in this review. The evidence for the PASE suggests poor responsiveness (37) and others have questioned its ability to detect change in PA levels (98).

In conclusion, as the measures included in this review lack evidence of their psychometric properties and responsiveness to change in MSK populations the authors suggest that caution should be taken when using self-reported PA measures. It is also important to note the wider limitations of all self-report measures i.e. potential for social desirability bias, recall bias, over and underestimation of activities/ misclassification of activities (99-100). Therefore, where possible, the use of objective measures of PA (e.g. accelerometry) should be considered. There is greater evidence of their validity and reliability (101) and they can objectively capture all dimensions of PA including time spent sedentary, which is known to detrimentally affect the general health and functional status of MSK populations (97). Further research is needed to investigate the measurement properties of commonly used self-report PA measures in MSK populations, to allow for informed recommendations and decisions on their use.

**AUTHOR CONTRIBUTIONS**

All authors drafted the article, revised it critically for important intellectual content, and approved the final version to be published.

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**CONFLICTS OF INTEREST**

None of the authors report any conflicts of interest.

**REFERENCES**

1. Arthritis Research UK. Providing physical activity interventions for people with musculoskeletal conditions. 2017. <https://www.versusarthritis.org/policy/policy-reports/providing-physical-activity/>.

2. Fernandes l, Hagen KB, Bijlsma JWJ, Andreassen O, Christensen P, Conaghan PG. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. Ann Rheum Dis. 2013;72:1125–1135. DOI:10.1136/annrheumdis-2012-202745.

3. McAlindon TE, Bannuru RR, Sullivan M, Arden N, Berenbaum F, Bierma-Zeinstra S, et al. OARSI guidelines for the non- surgical management of knee osteoarthritis. Osteoarthritis Cartilage 2014;22:363–88. DOI: <http://dx.doi.org/10.1016/j.joca.2014.01.003>.

4. National Institute for Health and Care Excellence. Osteoarthritis: care and management.

Clinical guideline [CG177]; 2014. https://www.nice.org.uk/guidance/cg177.

5. Kolasinski, SL, Neogi T, Hochberg MC, Oatis C, Guyatt G, Block J, et al. American

College of Rheumatology/Arthritis Foundation Guideline for the Management of

Osteoarthritis of the Hand, Hip, and Knee. Arthritis Care Res. 2020; 1–14. DOI:

10.1002/acr.24131.

6. Hernández-Hernández V, Ferraz-Amaro I, Díaz-González F. Influence of disease activity on the physical activity of rheumatoid arthritis patients. Rheumatology. 2014;53:722–31. DOI: 10.1093/rheumatology/ket422.

7. Swinnen TW, Scheers T, Lefevre J, Dankaerts W, Westhovens R, de Vlam K . Physical activity assessment in patients with axial spondyloarthritis compared to healthy controls: a technology-based approach. PLoS One 2014; 9(2):e85309. DOI: 10.1371/journal.pone.0085309.

8. Herbolsheimer F, Schaap LA, Edwards MH, Maggi S, Otero Á, Timmermans EJ, et al. Physical activity patterns among older adults with and without knee osteoarthritis in six European countries. Arthritis Care Res 2016;68:228–36. DOI: 10.1002/acr.22669.

9. Holden MA, Nicholls EE, Young J, Hay EM, Foster NE. Exercise and physical activity in older adults with knee pain: a mixed methods study. Rheumatology 2015;54:413–23. DOI: 10.1093/rheumatology/keu333.

10. Warren JM, Ekelund U, Besson H, Mezzani A, Geladas N, Vanhees L. Assessment of physical activity: a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. Eur J Cardiovasc Prev Rehabil. 2010;17:127–39. DOI: 10.1097/HJR.0b013e32832ed875.

11. Terwee C, Bouwmeester W, van Elsland S, de Vet H, Dekker J. Instruments to assess physical activity in patients with osteoarthritis of the hip or knee: a systematic review of measurement properties. Osteoarthritis Cartilage 2011;19:620–33. DOI: 10.1016/j.joca.2011.01.002.

12. Smith RD, Dziedzic KS, Quicke JG, Holden MA, McHugh GA, Healey EL. Identification and evaluation of self‐report physical activity instruments in adults with osteoarthritis: A systematic review. 2019; 71(2):237–251 DOI: https://doi.org/10.1002/acr.23787.

13. Baecke JA, Burema J, Frijters JE. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. Am J Clin Nutr. 1982;36(5):936-42. DOI: 10.1093/ajcn/36.5.936.

14. Ono R, Hirata S, Yamada M, Nishiyama T, Kurosaka M, Tamura Y. Reliability and validity of the Baecke physical activity questionnaire in adult women with hip disorders. BMC Musculoskelet Disord. 2007:8:61. DOI: 10.1186/1471-2474-8-61.

15. Vogels N, Westerterp KR, Posthumus DL, Rutters F, Westerterp-Plantenga MS. Daily physical activity counts vs structured activity counts in lean and overweight Dutch children. Physiol Behav. 2007;92(4):611-6. DOI: 10.1016/j.physbeh.2007.05.007.

16. Sadeghisani M, Dehghan Manshadi F, Azimi H, Montazeri A. Validity and Reliability of the Persian Version of Baecke Habitual Physical Activity Questionnaire in Healthy Subjects. Asian J Sports Med. 2016;7(3):e31778. DOI: 10.5812/asjsm.31778.

17. van der Waerden J, Nakamura A, Pryor L, Charles MA, El-Khoury F, Dargent-Molina P, et al. Domain-specific physical activity and sedentary behavior during pregnancy and postpartum depression risk in the French EDEN and ELFE cohorts. Prev Med. 2019;121:33-9. DOI: 10.1016/j.ypmed.2019.02.012.

18. Beunen GP, Philippaerts RM, Delvaux K, Thomis M, Claessens AL, Vanreusel B, et al.

Adolescent physical performance and adult physical activity in Flemish males. Am J Hum

Biol. 2001;13(2):173-9. DOI: 10.1002/1520-6300(200102/03)13:2<173::AID

AJHB1026>3.0.CO;2-M.

19. Kaspiris A, Zaphiropoulou C, Vasiliadis E. Range of variation of genu valgum and

association with anthropometric characteristics and physical activity: comparison between

children aged 3-9 years. J Pediatr Orthop B. 2013;22(4):296-305. DOI:

10.1097/BPB.0b013e328360f9a5.

20. Lee JY, Yun YH, Park EC, Seo HW, Shin HR, Choi KS. Reliability and Validity of the Modified Korean Version of Baecke Questionnaire on Physical Activity. Epidemiology and Health. 2004;26(2):20-31.

21. Bellafronte NT, Serafini RKK, Chiarello PG. Relationship between total physical activity

and physical activity domains with body composition and energy expenditure among

Brazilian adults. Am J Hum Biol. 2019:e23317. DOI: 10.1002/ajhb.23317.

22. Carvalho FA, Maher CG, Franco MR, Morelhão PK, Oliveira CB, Silva FG, et al. Fear of

movement is not associated with objective and subjective physical activity levels in

chronic nonspecific low back pain. Arch Phys Med Rehabil. 2017;98(1):96-104. DOI:

10.1016/j.apmr.2016.09.115.

23. Oliveira CB, Franco MR, Maher CG, Tiedemann A, Silva FG, Damato TM, et al. The efficacy of a multimodal physical activity intervention with supervised exercises, health coaching and an activity monitor on physical activity levels of patients with chronic, nonspecific low back pain (Physical Activity for Back Pain (PAyBACK) trial): study protocol for a randomised controlled trial. Trials. 2018:19(1):40. DOI: 10.1186/s13063-017-2436-z.

24. Bento TPF, Cornelio GP, Perrucini PO, Simeão SFAP, de Conti MHS, de Vitta A. Low

back pain in adolescents and association with sociodemographic factors, electronic devices,

physical activity and mental health. J Pediatr (Rio J). 2019;S0021-7557(19):30279-7. DOI:

10.1016/j.jped.2019.07.008.

25. Carvalho FA, Morelhão PK, Franco MR, Maher CG, Smeets RJEM, Oliveira CB, et al. Reliability and validity of two multidimensional self-reported physical activity questionnaires in people with chronic low back pain. Musculoskelet Sci Pract. 2017;27:65-70. DOI: 10.1016/j.msksp.2016.12.014.

26. Chimenti RL, Scholtes SA, Van Dillen LR. Activity characteristics and movement patterns

in people with and people without low back pain who participate in rotation-related sports. J

Sport Rehabil. 2013;22(3):161-9. DOI: 10.1123/jsr.22.3.161.

27. Handrakis JP, Friel K, Hoeffner F, Akinkunle O, Genova V, Isakov E, et al. Key

characteristics of low back pain and disability in college-aged adults: a pilot study. Arch Phys

Med Rehabil. 2012;93(7):1217-24. DOI: 10.1016/j.apmr.2012.02.013.

28. Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P. International physical activity questionnaire: 12-country reliability and validity. Med sci sports Exerc. 2003;195:3508-1381. DOI: 10.1249/01.MSS.0000078924.61453.FB.

29. Hurtig-Wennlöf A, Hagströmer M, Olsson L. The International Physical Activity Questionnaire modified for the elderly: aspects of validity and feasibility. Public Health Nutrition. 2010;13:1847-1854. DOI: 10.1017/S1368980010000157.

30. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ. Compendium of

physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc.

2000;32(9 Suppl):S498-504. DOI: 10.1097/00005768-200009001-00009.

31. Blikman T, Stevens M, Bulstra SK, Van Den Akker-Scheek I, Reininga IH. Reliability and validity of the Dutch version of the International Physical Activity Questionnaire in patients after total hip arthroplasty or total knee arthroplasty. Journal of Orthop Sport Phys. 2013;43:650-659. DOI: 10.2519/jospt.2013.4422.

32. Arends S, Hofman M, Kamsma YP, van der Veer E, Houtman PM, Kallenberg CG.Daily

physical activity in ankylosing spondylitis: validity and reliability of the IPAQ and SQUASH

and the relation with clinical assessments. Arthritis Res Ther. 2013;15(4):R99. DOI:

10.1186/ar4279.

33. Segura-Jimenez V, Munguia-Izquierdo D, Camiletti-Moiron D, Alvarez-Gallardo IC, Ortega FB, Ruiz JR, et al. Comparison of the International Physical Activity Questionnaire (IPAQ) with a multi-sensor armband accelerometer in women with fibromyalgia: the al-Andalus project. Clin Exp Rheumatol. 2013;31(6 Suppl 79):S94-101.

34. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381-1395. DOI: 10.1249/01.MSS.0000078924.61453.FB

35. Ryan DJ, Wullems JA, Stebbings GK, Morse CI, Stewart CE, Onambele-Pearson, G.L. Reliability and validity of the international physical activity questionnaire compared to calibrated accelerometer cut-off points in the quantification of sedentary behaviour and physical activity in older adults. PloS One, 2018;13(4):p.e0195712. DOI: 10.1371/journal.pone.0195712. eCollection 2018.

36. Naal FD, Impellizzeri FM, Leunig M. Which is the best activity rating scale for patients undergoing total joint arthroplasty? Clin Orthop Relat Res. 2009;467:958–65. DOI: 10.1007/s11999-008-0358-5.

37. Smith RD. Self-reported physical activity levels: measurement and assessment in community dwelling adults with or at risk of osteoarthritis. PhD thesis, Keele University, Keele. 2017.

38. Yu CA, Rouse PC, Van Zanten JJV, Ntoumanis N, Kitas GD, Duda JL. Subjective and

objective levels of physical activity and their association with cardiorespiratory fitness in

rheumatoid arthritis patients. Arthritis Res Ther. 2015;17(1):59. DOI:

10.1186/s13075-015-0584-7.

39. Cleland C, Ferguson S, Ellis G, Hunter RF. 2018. Validity of the International Physical Activity Questionnaire (IPAQ) for assessing moderate-to-vigorous physical activity and sedentary behaviour of older adults in the United Kingdom. BMC Medical Research Methodology. 2018;18(1):176. DOI: 10.1186/s12874-018-0642-3.

40. Svege I, Kolle E, Risberg M. Reliability and validity of the Physical Activity Scale for the

Elderly (PASE) in patients with hip osteoarthritis. BMC Musculoskelet Disord. 2012;13(1):26.

DOI: 10.1186/1471-2474-13-26.

41. Tierney M, Fraser A, Kennedy N. Criterion validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF) for use in patients with rheumatoid arthritis: comparison with the Sense Wear Armband. Physiotherapy. 2015;101(2):193-197. DOI: 10.1016/j.physio.2014.07.005.

42. Zacharia S, Taylor EL, Branscum PW, Cheney MK, Hofford CW, Crowson M. Effects of a

yoga intervention on adults with lower limb osteoarthritis: a randomized controlled trial.

American Journal of Health Studies. 2018;33(2);89-98.

43. Dziedzic KS, Healey EL, Porcheret M, Afolabi EK, Lewis M, Morden A, et al.

Implementing core NICE guidelines for osteoarthritis in primary care with a model

consultation (MOSAICS): a cluster randomised controlled trial. Osteoarthritis Cartilage.

2018;26(1):43–53. DOI: 10.1016/j.joca.2017.09.010.

44. Eichler S, Rabe S, Salzwedel A, Müller S, Stoll J, Tilgner N, et al. Effectiveness of an interactive telerehabilitation system with home-based exercise training in patients after total hip or knee replacement: study protocol for a multicenter, superiority, no-blinded randomized controlled trial. Trials. 2017;18(1):438. DOI: 10.1186/s13063-017-2173-3.

45. Gay C, Guiguet-Auclair C, Pereira B, Goldstein A, Bareyre L, Coste N. Efficacy of self

management exercise program with spa therapy for behavioral management of knee

osteoarthritis: research protocol for a quasi-randomized controlled trial (GEET one).

BMC Complementary and Alternative Medicine. 2018;18: 279. DOI: 10.1186/s12906-018

2339-x.

46. da Silva JMR, De Rezende MU, Spada TC, da Silva Francisco L, de Farias FES, da Silva CAC, et al. Educational program promoting regular physical exercise improves functional capacity and daily living physical activity in subjects with knee osteoarthritis. BMC Musculoskeletal Disorders. 2017;18(1):546. DOI:10.1186/s12891-017-1912-7.

47. Sit RWS, Chan KKW, Yip BHK, Zhang DD, Reeves KD, Chan YH, et al. Clinical effectiveness of patella mobilisation therapy versus a waiting list control for knee osteoarthritis: a protocol for a pragmatic randomised clinical trial. BMJ Open. 2018;8(3): p.e019103. DOI: 10.1370/afm.2320.

48. Vassão PG, de Souza MC, Silva BA, Junqueira RG, de Camargo MR, Dourado VZ. Photobiomodulation via a cluster device associated with a physical exercise program in the level of pain and muscle strength in middle-aged and older women with knee osteoarthritis: a randomized placebo-controlled trial. Lasers in Medical Science. 2019. DOI: 10.1007/s10103-019-02807-3.

49. Neto F, Queluz TT, Freire BFA. Physical activity and its association with quality of life in patients with osteoarthritis. Revista brasileira de reumatologia. 2011;51(6):544-549. DOI: http://dx.doi.org/10.1590/S0482-50042011000600002.

50. Magnusson K, Hagen KB, Østerås N, Nordsletten L, Natvig B, Haugen IK, Diabetes Is Associated With Increased Hand Pain in Erosive Hand Osteoarthritis: Data From a Population‐Based Study. Arthrit Care Res. 2015;67(2):187-195. DOI: 10.1002/acr.22460.

51. Lee SY, Ro HJ, Chung SG, Kang SH, Seo KM, Kim DK. Low skeletal muscle mass in the

lower limbs is independently associated to knee osteoarthritis. PLoS One.

2016;11:e0166385. DOI:10.1371/journal.pone.0166385.

52. Shim HY, Park M, Kim HJ, Kyung HS, Shin JY. Physical activity status by pain severity in

patients with knee osteoarthritis: a nationwide study in Korea. BMC Musculoskelet Disord.

2018;19(1):380. DOI:10.1186/s12891-018-2301-6.

53. Fu K, Makovey J, Metcalf B, Bennell KL, Zhang Y, Asher R, et al. Sleep Quality and Fatigue Are Associated with Pain Exacerbations of Hip Osteoarthritis: An Internet-based Case-crossover Study. J Rheumatol. 2019;(11):1524-1530. DOI: 10.3899/jrheum.181406.

54. Kilinç H, Karahan S, Atilla B, Kinikli Gİ. Can Fear of Movement, Depression and

Functional Performance be a Predictor of Physical Activity Level in Patients With Knee

Osteoarthritis? Arch Rheumatol. 2018;34(3):274–280.

DOI:10.5606/ArchRheumatol.2019.7160.

55. Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the

Elderly (PASE): development and evaluation. J Clin Epidemiol. 1993;46(2):153–62. DOI:

10.1016/0895-4356(93)90053-4.

56. Schult AJ, Schonten EG, Westerterp KR, Saris WHM. Validity of the Physical Activity

Scale for the Elderly (PASE): According to energy expenditure assessed by the doubly

labeled water method. J Clin Epidemiol. 1997;50(5):541–6. DOI:

10.1016/s08954356(97)00010-3.

57. Loland NW. Reliability of the physical activity scale for the elderly (PASE). Eur J Sport Sci. 2002;2(5):1–12. DOI: https://doi.org/10.1080/17461390200072504.

58. Hagiwara A, Ito N, Sawai K, Kazuma K. Validity and reliability of the Physical Activity

Scale for the Elderly (PASE) in Japanese elderly people. Geriatr Gerontol Int.

2008;8(3):143–51. DOI: 10.1111/j.1447-0594.2008.00463.x.

59. Ngai SPC, Cheung RTH, Lam PL, Chiu JKW, Fung EYH. Validation and reliability of the

Physical Activity Scale for the Elderly in Chinese populati on. J Rehabil Med.

2012;44(5):462–5. DOI: 10.2340/16501977-0953.

60. Casartelli NC, Bolszak S, Impellizzeri FM, Maffiuletti NA. Reproducibility and Validity of

the Physical Activity Scale for the Elderly (PASE) Questionnaire in Patients After Total Hip

Arthroplasty. Phys Ther. 2015;95(1):86-94. DOI: 10.2522/ptj.20130557.

61. Ismail N, Hairi F, Choo WY, Hairi NN, Peramalah D, Bulgiba A. The Physical Activity

Scale for the Elderly (PASE): Validity and reliability among community-dwelling older adults

in Malaysia. Asia-Pacific J Public Heal. 2015;27:62S-72S. DOI:10.1177/1010539515590179.

62. Ayvat E, Kilinç M, Kirdi N. The Turkish version of the physical activity scale for the elderly (PASE): Its cultural adaptation, validation, and reliability. Turkish J Med Sci. 2017;47(3):908–915. DOI: 10.3906/sag-1605-7.

63. Covotta A, Gagliardi M, Berardi A, Maggi G, Pierelli F, Mollica R, et al. Physical activity

scale for the elderly: Translation, cultural adaptation, and validation of the Italian version.

Curr Gerontol Geriatr Res. 2018. DOI: 10.1155/2018/8294568.

64. Keikavoosi-Arani L, Salehi L. Cultural adaptation and psychometric adequacy of the

Persian version of the physical activity scale for the elderly (P-PASE). BMC Res Notes.

2019;12(1):555. DOI: 10.1186/s13104-019-4591-7.

65. Siordia C. Alternative scoring for Physical Activity Scale for the Elderly (PASE).

Maturitas. 2012;72(4):379–82. DOI: 10.1016/j.maturitas.2012.05.009.

66. Bolszak S, Casartelli NC, Impellizzeri FM, Maffiuletti NA. Validity and reproducibility of

the Physical Activity Scale for the Elderly (PASE) questionnaire for the measurement of the

physical activity level in patients after total knee arthroplasty. BMC Musculoskelet Disord

2014;15(1):46. DOI: 10.1186/1471-2474-15-46.

67. Svege I, Nordsletten L, Fernandes L, Risberg MA. Exercise therapy may postpone total

pip replacement surgery in patients with hip osteoarthritis: a long-term follow-up of a

randomised trial. Ann Rheum Dis. 2015;74(1):164–9. DOI: 10.1136/annrheumdis-2013

203628.

68. Martin KA, Rejeski WJ, Miller ME, James MK, Ettinger Jr. WH, Messier SP. Validation of

the PASE in older adults with knee pain and physical disability. Med Sci Sports Exerc.

1999;31(5):627–33. DOI: 10.1097/00005768-199905000-00001.

69. Petrella RJ, Bartha C. Home based exercise therapy for older patients with knee

osteoarthritis: a randomized clinical trial. The Journal of Rheumatology. 2000;27(9):

2215-21.

70. Bossen D, Veenhof C, Dekker J, de Bakker D. The usability and preliminary

effectiveness of a web-based physical activity intervention in patients with knee and/or hip

osteoarthritis. BMC Med Inform Decis Mak. 2013;13(1):61. DOI:

http://www.biomedcentral.com/14726947/13/61.

71. Bennell KL, Ahamed Y, Jull G, Bryant C, Hunt MA, Forbes AB, et al. Physical Therapist

Delivered Pain Coping Skills Training and Exercise for Knee Osteoarthritis: Randomized

Controlled Trial. Arthrit Care Res. 2016 May;68(5):590–602. DOI: 10.1002/acr.22744.

72. Bennell KL, Campbell PK, Egerton T, Metcalf B, Kasza J, Forbes A, et al. Telephone

Coaching to Enhance a Home-Based Physical Activity Program for Knee Osteoarthritis: A

Randomized Clinical Trial. Arthrit Care Res. 2017;69(1):84–94. DOI: 10.1002/acr.22915.

73. Bade M, Struessel T, Dayton M, Foran J, Kim R, Miner T, et al. Early High-Intensity

Versus Low-Intensity Rehabilitation after Total Knee Arthroplasty: A Randomized Controlled

Trial HHS Public Access. Arthrit Care Res. 2017;69(9):1360–8. DOI: 10.1002/acr.23139.

74. Hinman RS, Lawford BJ, Campbell PK, Briggs AM, Gale J, Bills C, et al. Telephone-delivered exercise advice and behavior change support by physical therapists for people with knee osteoarthritis: protocol for the telecare randomized controlled trial. Physical Therapy. 2017; 97:524-536. DOI: 10.1093/ptj/pzx021.

75. Quicke JG, Foster NE, Ogollah RO, Croft PR, Holden MA. Relationship Between

Attitudes and Beliefs and Physical Activity in Older Adults With Knee Pain: Secondary

Analysis of a Randomized Controlled Trial. Arthritis Care Res. 2017;69(8):1192–200. DOI:

10.1002/acr.23104.

76. Allen KD, Arbeeva L, Callahan LF, Golightly YM, Goode AP, Heiderscheit BC, et al. Physical therapy vs internet-based exercise training for patients with knee osteoarthritis: results of a randomized controlled trial. Osteoarthritis Cartilage. 2018;26(3):383–96. DOI: 10.1016/j.joca.2017.12.008.

77. Dunlop, DD, Song J, Semanik PA, Sharma L, Chang RW. Physical activity levels and

functional performance in the osteoarthritis initiative: A graded relationship. Arthritis and

Rheumatism. 2011;63(1):127–136. DOI: 10.1002/art.27760.

78. Felson DT, Niu J, Yang T, Torner J, Lewis CE, Aliabadi P,Nevitt, M. C. Physical activity, alignment and knee osteoarthritis: Data from MOST and the OAI. Osteoarthritis Cartilage. 2013b; 21(6):789–795. DOI: 10.1016/j.joca.2013.03.001.

79. Fransen M, Su, Harmer A, Blyth FM, Naganathan V, Sambrook P, et al. A longitudinal study of knee pain in older men: Concord Health and Ageing in Men Project. Age Ageing. 2014;43(2):206-12. DOI: 10.1093/ageing/aft188.

80. Bindawas SM, Vennu V. Longitudinal effects of physical inactivity and obesity on gait speed in older adults with frequent knee pain: data from the Osteoarthritis Initiative. Int J Environ Res Public Health. 2015;12(2):1849-63. DOI: 10.3390/ijerph120201849.

81. Wendel-Vos GC, Schuit AJ, Saris WH, Kromhout D. Reproducibility and relative validity

of the short questionnaire to assess health-enhancing physical activity. J Clin Epidemiol.

2003;56(12):1163-1169. DOI: 10.1016/s0895-4356(03)00220-8

82. Ainsworth BE, Haskell WL, Leon AS, Jacobs DR Jr, Montoye HJ, Sallis JF. Compendium

of physical activities: classification of energy costs of human physical activities. Med Sci

Sports Exerc. 1993;25(1):71-80. DOI: 10.1249/00005768-199301000-00011.

83. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr, Tudor-Locke C, et al. Compendium of Physical Activities: a second update of codes and MET values. Med Sci Sports Exerc. 2011;43(8):1575-1581. DOI: 10.1249/MSS.0b013e31821ece12.

84. Wagenmakers R, van den Akker-Scheek I, Groothoff JW, Zijlstra W, Bulstra SK, Kootstra

JW. Reliability and validity of the short questionnaire to assess health-enhancing physical

activity (SQUASH) in patients after total hip arthroplasty. BMC Musculoskelet Disord.

2008;9:141. DOI: 10.1186/1471-2474-9-141.

85. de Hollander EL, Zwart L, de Vries SI, Wendel-Vos W. The SQUASH was a more valid tool than the OBiN for categorizing adults according to the Dutch physical activity and the combined guideline. J Clin Epidemiol. 2012;65(1):73-81. DOI: 10.1016/j.jclinepi.2011.05.005.

86. Konijn NP, van Tuyl LH, Boers M, et al. Effective Treatment for Rapid Improvement of

Both Disease Activity and Self-Reported Physical Activity in Early Rheumatoid Arthritis.

Arthrit Care Res. 2016;68(2):280-284. DOI: 10.1002/acr.22668.

87. Nicolaou M, Gademan MG, Snijder MB, Engelbert RHH, Dijkshoorn H, Terwee CB.

Validation of the SQUASH Physical Activity Questionnaire in a Multi-Ethnic Population: The

HELIUS Study. PLoS One. 2016;11(8):e0161066. DOI:

https://doi.org/10.1371/journal.pone.0161066

88. Makabe S, Makimoto K, Kikkawa T, Uozumi H, Ohnuma M, Kawamata T. Reliability and

validity of the Japanese version of the short questionnaire to assess health-enhancing

physical activity (SQUASH) scale in older adults. J Phys Ther Sci. 2015;27(2):517-522. DOI:

10.1589/jpts.27.517.

89. Verlaan L, Bolink SA, Van Laarhoven SN, Lipperts M, Heyligers IC, Grimm B. Accelerometer-based Physical Activity Monitoring in Patients with Knee Osteoarthritis: Objective and Ambulatory Assessment of Actual Physical Activity During Daily Life Circumstances. Open Biomed Eng J. 2015;9:157-163. DOI: 10.2174/1874120701509010157.

90. Rewald S, Mesters I, Lenssen AF, Emans PJ, Wijnen W, de Bie RA. Effect of aqua

cycling on pain and physical functioning compared with usual care in patients with knee

osteoarthritis: study protocol of a randomised controlled trial. BMC Musculoskelet Disord.

2016;17:88. DOI: 10.1186/s12891-016-0939-5.

91. Knittle K, De Gucht V, Hurkmans E, Peeters A, Ronday K, Maes S.Targeting motivation

and self-regulation to increase physical activity among patients with rheumatoid arthritis: a

randomised controlled trial. Clin Rheumatol. 2015;34(2):231-238. DOI: 10.1007/s10067-013

2425-x.

92. Stewart AL, Mills KM, KING AC, Haskell WL, Gillis D, Ritter PL. CHAMPS Physical Activity Questionnaire for Older Adults: outcomes for interventions Med Sci Sports Exerc. 2001; 33(7):1126–1141.

93. Taylor HLDR, Jacobs JR, Schucker B, Knudsen J, Leon AS, Debacker G. A questionnaire for the assessment of leisure time physical activities. J Chronic Dis. 1978; 31:741–755. DOI: 10.1016/0021-9681(78)90058-9.

94 [Dipietro L](https://www.ncbi.nlm.nih.gov/pubmed/?term=Dipietro%20L%5BAuthor%5D&cauthor=true&cauthor_uid=8492692), Caspersen CJ, [Ostfeld AM](https://www.ncbi.nlm.nih.gov/pubmed/?term=Ostfeld%20AM%5BAuthor%5D&cauthor=true&cauthor_uid=8492692), [Nadel ER](https://www.ncbi.nlm.nih.gov/pubmed/?term=Nadel%20ER%5BAuthor%5D&cauthor=true&cauthor_uid=8492692). A survey for assessing physical activity among older adults. Med Sci Sports Exerc. 1993;25(5):628-42.

95. Demmelmaier I, Åsenlöf P, Bergman P, Nordgren B, Opava CH. Pain rather than self-reported sedentary time explains variation in perceived health and activity limitation in persons with rheumatoid arthritis: a cross sectional study in Sweden. Rheumatol Int. 2017;37(6):923-930. DOI: 10.1007/s00296-016-3641-x.

96. Pinto D, Song J, Lee J, Chang RW, Semanik PA, Ehrlich-Jones LS. Association Between Sedentary Time and Quality of Life From the Osteoarthritis Initiative: Who Might Benefit Most From Treatment? Arch Phys Med Rehabil. 2017;98(12):2485-2490. DOI:10.1016/j.apmr.2017.06.004.

97. Sliepen M, Mauricio E, Lipperts M, Grimm B, Rosenbaum D. Objective assessment of

physical activity and sedentary behaviour in knee osteoarthritis patients - beyond daily steps

and total sedentary time. BMC Musculoskelet Disord. 2018;19(1):64. DOI:

10.1186/s12891-018-1980-3.

98. Quicke JG, Foster NE, Croft PR, Ogollah RO, Holden MA. Change in

physical activity level and clinical outcomes in older adults with knee pain: a secondary analysis from a randomised controlled trial. BMC Musculoskeletal Disorders. 2018;19:59. DOI: https://doi.org/10.1186/s12891-018-1968-z.

99. Adams SA, Matthews CE, Ebbeling CB, Moore CG, Cunningham JE, Fulton J, et al. The effect of social desirability and social approval on self-reports of physical activity. Am J Epidemiol. 2005;161(4):389–98. DOI: 10.1093/aje/kwi054.

100. Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay MA. Comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. Int J Behav Nutr Phys. 2008;5:56. DOI: 10.1186/1479-5868-5-56.

101. Westerterp, KR. Reliable assessment of physical activity in disease: an update on activity monitors. Current Opinion in Clinical Nutrition and Metabolic Care. 2014;17(5):401-406. DOI: 10.1097/MCO.0000000000000080.