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Is the Human Activity Profile a useful measure in people with knee osteoarthritis?

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Abstract—This study evaluated the usefulness of the Human Activity Profile (HAP) in people with knee osteoarthritis (OA). People with OA (N = 226) completed the HAP and a battery of pain and physical function measures. Healthy elderly controls (N = 33) also completed the HAP, and 20 OA participants underwent repeat testing 2 to 7 days later. Test-retest reliability was excellent (intraclass correlation coefficients 0.96 and 0.95). The HAP was sensitive enough to detect differences in physical activity between people with (N = 33) and without OA (N = 33) ($p < 0.01$). When OA individuals were classified as impaired, moderately active, or active based on HAP score, differences in pain and physical function were detected ($p <$ 0.05). Correlations between HAP and commonly used pain and physical function measures were weak to moderate (r = 0.18–0.63, all $p < 0.01$), indicating that the HAP measures additional information not gained by other assessment tools. The HAP is a reliable measure, and it is sensitive enough to discriminate between people with and without knee OA, and within an OA cohort. The HAP appears to have greater applicability in osteoarthritic women than men.

Key words: disability, function, knee, osteoarthritis, pain, physical activity, reliability, sensitivity.

INTRODUCTION

Physical activity is linked to a variety of health benefits, including reductions in morbidity and mortality related to common chronic diseases (e.g., cardiovascular pathology, diabetes, osteoporosis, and cancer), as well as improvements in mental health, physical functioning, and weight control [1–5]. Chronic musculoskeletal conditions, of which osteoarthritis (OA) is the most prevalent [6], exacerbate a sedentary lifestyle, yet little research has been directed toward evaluating physical activity in this pathological population.

Knee OA is particularly prevalent in the elderly, affecting approximately one-third of people aged over 60 years [7]. It results in considerable knee pain and is one

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Abbreviations: AAS = adjusted activity score, BMI = body mass index, HAP = Human Activity Profile, ICC = intraclass correlation coefficient, MAS = maximal activity score, OA = osteoarthritis, ROM = range of motion, SEM = standard error of measurement, TUG = timed up and go, VAS = visual analog scale, WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.

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of the most frequent causes of disability in this age group [8]. Despite numerous studies demonstrating the safety and efficacy of exercise and physical activity for people with knee OA [9–12], clinical experience suggests that afflicted individuals remain largely inactive compared to their healthy counterparts. Impairments in quadriceps muscle strength, knee joint proprioception, balance, and cardiovascular fitness are evident in patients with knee OA [13–16]. Together with the presence of pain, these impairments may culminate in reduced performance during everyday functional tasks and locomotor activities. Ultimately, knee OA may limit overall physical activity levels, although this has not been well documented to date.

Physical activity levels are rarely measured in knee OA trials. This may be because accurate assessment of activity level is not easily accomplished. Instruments that provide direct measures of physical activity, such as accelerometers, are not readily available to the clinician and are not economical for use in large groups of people. In contrast, self-report activity questionnaires are inexpensive and convenient to administer, yet such questionnaires are infrequently used in studies of knee OA.

The Human Activity Profile (HAP) is a self-administered instrument available to measure physical activity. The HAP was originally developed by Daughton and colleagues [17] to measure quality of life achieved by patients in rehabilitation programs for chronic obstructive pulmonary disease. Validation studies in a group of pulmonary rehabilitation patients demonstrated a significant correlation with $\dot{V}O_{2max}$. The questionnaire has subsequently been used as a measure of physical activity in both healthy and impaired populations [18]. The HAP consists of 94 common daily activities listed in ascending order according to the energy required to perform them. A wide variety of activities is represented, including self-care tasks, personal/household work, entertainment/social activities, and independent exercise pursuits [18]. With regard to each of the listed activities, respondents are requested to indicate if (1) they are currently able to perform the activity (unassisted), (2) they have stopped performing the activity, or (3) they have never performed the activity.

While the HAP has been used to estimate activity levels in a variety of populations with different medical conditions [19–22], it has not been used in patients with knee joint OA specifically. Information about its reliability and sensitivity in this population is vital before such a measure could be used in evaluating outcome in clinical trials. Of particular importance is the capability of the HAP to detect differences in physical activity levels between people with and without knee OA, as well as its capacity to differentiate between people with knee OA. Presently, a plethora of outcome measures is available and recommended [23] for use in knee OA trials, such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), visual analog scales (VASs), and observed physical function measures. Use of multiple outcome measures in a clinical trial can be time-consuming for both the investigator and the participant. Thus, it is important that a physical activity measure such as the HAP, before it is incorporated into the test battery, also be proven to provide additional information not gained from other measurement tools typically used in knee OA.

The aims of this study were to (1) assess the test-retest reliability of the HAP in knee OA, (2) determine if differences in physical activity levels could be detected between those with and without knee OA with the use of the HAP, (3) correlate the HAP with measures of pain and physical function, and (4) determine if the HAP classification system can detect differences in pain and physical function in a large cohort with symptomatic knee OA.

METHODS

Participants

All participants were recruited from the community by way of advertisements in clubs and local media. Individuals with knee OA made up two cohorts recruited for research into the effectiveness of physiotherapy intervention. Participating were 226 individuals with knee OA aged over 50 years. Diagnosis of OA was confirmed by a rheumatologist based on the American College of Rheumatology clinical and radiological classification criteria [24]. Participants with OA were included if they had knee pain on most days of the previous month (average level >3 cm on a 10 cm VAS), demonstrated osteophytes on x-ray, and experienced pain and/or difficulty on getting up from sitting or climbing stairs. All were independent in activities of daily living and had a stable intake of nonsteroidal anti-inflammatory drugs over the previous 2 weeks. Exclusion criteria included physiotherapy treatment for the knee (previous 12 months), knee surgery (previous 3 months), body mass index (BMI) >38, past history of lower-limb joint replacement, Synvisc® or intra-articular steroid injection (previous 6 months), systemic arthritic condition, or severe medical condition precluding safe testing or participation in the physiotherapy trial.

For the purposes of comparing physical activity between people with and without knee OA, 33 control participants were recruited and matched to the first 33 OA participants tested with regard to age, gender, and BMI. Controls were excluded if they reported a history of lower-limb pathology or joint disorder, reported injury to or pain in either knee in the past year (for which treatment was sought, or which interfered with function), or displayed abnormality on physical examination of the knee (flexion range of motion [ROM] 125°, effusion, palpable warmth, ligamentous laxity). Because of ethical constraints, X rays to exclude radiographic OA were not performed.

The research was approved by the University of Melbourne Human Research Ethics Committee. All participants provided written informed consent.

Physical Activity

Physical activity was measured in both control and OA participants with the HAP. Two aggregate scores were calculated [18]: (1) maximal activity score (MAS), representing the highest oxygen-demanding activity the participant is still able to perform, and (2) adjusted activity score (AAS), derived by subtraction of the number of activities the participant is no longer able to perform from the value of the MAS, and reflective of an individual's typical daily physical activities. Each parameter was scored from 0 to 94, with higher scores representing greater physical activity. Physical activity of each participant was also classified based on the AAS [18] as (1) impaired (<53), (2) moderately active (53–74), or (3) active (>74). For example, a participant who records walking 1 mile nonstop (item 64) as the most strenuous activity they are still able to do and indicates that they have ceased performing three less strenuous activities than this (e.g., cleaning windows, climbing 36 steps nonstop, and painting) would obtain an MAS of 64 and an AAS of 61 and would be classified as moderately active.

To establish test-retest reliability, a subgroup of 20 participants with knee OA completed the HAP on a second occasion, between 2 and 7 days later.

Self-Reported Pain and Physical Function

Self-reported pain and physical function was assessed in the OA group only. The Likert version of the WOMAC was used for an evaluation of knee pain and physical function [25]. Aggregate scores were obtained for each dimension by a summation of the component item scores. Possible scores ranged from 0 to 20 for the pain dimension, and 0 to 68 for physical function, with higher scores indicating greater pain and disability. Average pain on movement and at rest, as well as average restriction to daily activities, over the past week were recorded with the use of a 10 cm horizontal VAS [26] marked in 1 cm increments, with higher scores indicating greater pain and restriction.

Observed Physical Function

Within the OA group, the following observed physical impairment measures were also performed.

Step Test

The step test is a validated and reliable functional, dynamic test of standing balance [27]. Individuals with knee OA have been shown to demonstrate significantly poorer dynamic balance with the step test, as compared to an elderly healthy population [13]. Participants were instructed to maintain balance on the symptomatic leg while stepping the contralateral limb on and off a 15 cm step as quickly as possible. The number of times the participant could place the foot up onto the step and return it to the floor over a 15 s interval was recorded. Participants performed the test with bare feet and with no hand support. The test was performed only once with two to three practice steps permitted prior to the test. If loss of balance occurred, the test was ceased and the number of completed steps up to that point was recorded.

Timed Up and Go (TUG) Test

The TUG test is a validated and reliable test of function in older individuals [28]. Individuals with knee OA take 21 percent more time to perform the TUG test than do healthy elderly individuals [29]. A stopwatch was used to time the participant rising from a standard arm chair, walking around a cone on the floor 3 m away, returning to the chair, and sitting down again. Participants performed the task at their own pace, once only. An explanation and demonstration were provided by the investigator, but no practice trials were given.

Walking Speed

Individuals with knee OA demonstrate significant reductions in walking speed, corresponding to only

69 percent of healthy elderly values [29]. In this study, walking was analyzed at a self-selected fast pace on a level surface, because this is a more reliable measure than a self-selected normal pace [30]. Participants walked in their own shoes along a 7.5 m walkway. Custom-made timing gates with infrared sensors attached to a stopwatch were used for the calculation of walking speed over the middle 2.5 m. Results were averaged over five trials.

STATISTICAL ANALYSIS

Data were analyzed with the Statistical Package for Social Sciences (SPSS, Inc.) and checked for normality and homogeneity of variance prior to analysis.

Data obtained from a subgroup of 20 participants with knee OA, measured on two occasions (2–7 days apart), were analyzed for a determination of test-retest reliability. Calculations included paired *t*-tests to compare the mean scores of tests 1 and 2, the intraclass correlation coefficient (ICC 3,1) to determine agreement, and the standard error of measurement (SEM) to assess the degree of absolute error.

HAP data were compared between the first 33 participants with knee OA tested and the matched control group (N = 33), with the use of Mann-Whitney *U*-tests and an alpha level of 0.05. Baseline comparability of the two groups was confirmed prior to analysis (with an independent *t*-test or chi-square tests). Individuals were characterized as impaired, moderately active, or active (based on the AAS), and proportions of each were compared between the OA and control groups with the chi-square statistic.

Univariate correlations were made between variables with the Spearman ρ coefficient in the entire OA cohort (N = 226). Variables that demonstrated significant correlations, together with age, gender, and BMI, were then subjected to forward stepwise multiple regression to evaluate independent predictors of the MAS and AAS.

Within the entire OA cohort (N = 226), pain and physical function scores were compared between those participants classified as impaired, moderately active, and active (based on the AAS). This comparison was performed with the use of a one-way analysis of variance, with age and gender as covariates.

RESULTS

Table 1 provides demographic information regarding the control and OA participants, as well as pain and physical function scores for the OA cohort.

Test-Retest Reliability in Knee OA

No significant difference was observed between mean scores on the two test administrations for the MAS or the AAS (both $p > 0.05$). The ICC (3,1) values were 0.96 for the MAS and 0.95 for the AAS. The SEM was 3 for both parameters of physical activity.

Table 1.
Characteristics of participants. Data are reported as mean ± standard deviation unless otherwise indicated.

Characteristics	Osteoarthritis Group (N = 226)	Control Group (N = 33)
Demographics		
Age (yr)	69 ± 8	68 ± 8
Height (m)	1.64 ± 0.09	1.67 ± 0.01
Weight (kg)	79.9 ± 12.8	76.7 ± 15.4
Body mass index (kg/m^2)	29.3 ± 4.2	27.5 ± 5.0
Gender	150 (66%) female	16 (48%) female
Tibiofemoral Disease Severity*	0 (6, 3%)	—
	I (33, 15%)	—
	II (24, 11%)	—
	III (133, 60%)	—
	IV (24, 11%)	—
Pain		
Symptom duration (yr)	9 ± 9	—
WOMAC (0–20)	8 ± 3	—
VAS: pain at rest (0–10 cm)	3 ± 2	—
VAS: pain on movement (0–10 cm)	5 ± 2	—
Self-Reported Physical Function		
WOMAC (0–68)	28 ± 10	—
VAS: restriction to activities (0–10 cm)	5 ± 2	—
Observed Physical Function		
Step test (N)	11 ± 3	—
TUG test (s)	12.6 ± 3.4	—
Walking speed (m/s)	1.3 ± 0.3	—

*Based on Kellgren & Lawrence grading system [Kellgren JH, Jeffrey MR, Ball J. The epidemiology of chronic rheumatism: atlas of standard radiographs. Vol. 2. Oxford: Blackwell Scientific; 1963.], where higher grades indicate more severe disease, and a grade 0 represents isolated patellofemoral disease. Note that radiographs were unavailable for 6 people.
WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index
TUG = timed up and go
VAS = visual analog scale

Comparison of Physical Activity Between People With and Without Knee OA

The OA subgroup and the control participants were well matched with regard to age, gender, and BMI (all $p > 0.05$). **Table 2** compares physical activity levels between the two groups. The MAS was similar between people with and without knee OA. However, differences were evident with regard to the AAS where, as a whole, the OA group was less physically active than the control group ($p < 0.01$). On further analysis, women with knee OA were less active than healthy women ($p < 0.001$); and, although men with OA demonstrated lower mean AAS scores than their healthy counterparts, this was not statistically significant. A significant association ($p < 0.01$) was observed between group and activity classification (as based on AAS), with only 20 percent of the OA group classified as active, compared with 49 percent of the control group.

Relationship Between Physical Activity Levels and Pain and Physical Function in Knee OA

Univariate correlations between the HAP scores and pain and physical function measures are shown in **Table 3**. All pain and physical function measures were significantly correlated with both the MAS and AAS. Participants with less pain and better physical function reported that they were able to perform more strenuous physical activities (i.e., higher MAS), as well as more "usual" physical activity (i.e., higher AAS), than those with greater pain and worse physical function. However, the strength of the associations was only low to moderate, with correlation coefficients ranging from 0.18 to 0.63. The results of the forward stepwise multiple regression (**Table 4**) demonstrated that the best independent predictors of the MAS were the TUG test, walking speed, and gender. Together, these three variables explained a total of 32 percent of the variance in MAS. For the AAS, the best independent predictors were walking speed, self-reported activity restriction (VAS), the TUG test, and the step test. These variables explained half the variance in the AAS.

Comparison of Pain and Physical Function Based on HAP Classification

Significant differences were observed in pain and physical function between the groups classified by the AAS as impaired, moderately active, and active (all $p < 0.05$). Those whose physical activity was classified as impaired had greater pain and worse physical function than the more active groups. The percentage differences in pain and physical function of the impaired and moderately active groups, compared to the active group, are plotted in the **Figure**.

DISCUSSION AND CONCLUSIONS

This preliminary investigation evaluated the value of the HAP as a measure of physical activity in people with knee OA. Overall, results of this study suggest that the HAP is a useful measure that may be incorporated into the test battery for studies of knee OA. The HAP is reliable and sufficiently sensitive to discriminate between people

Table 2.
Comparison of physical activity between people with and without knee osteoarthritis (OA). Data are presented as mean ± standard deviation unless otherwise indicated.

Physical Activity Measurements	OA Group (*N* = 33)	Control Group (*N* = 33)	*p*-Value
Maximal Activity Score (0–94)			
Entire cohort	76 ± 8	78 ± 8	0.27
Males only	78 ± 7	79 ± 10	0.76
Females only	73 ± 8	77 ± 6	0.13
Adjusted Activity Score (0–94)			
Entire cohort	62 ± 13	73 ± 11	0.001
Males only	67 ± 13	74 ± 12	0.09
Females only	57 ± 10	72 ± 9	<0.001
Proportions Classified* as			
Active	18%	49%	
Moderately active	58%	48%	0.006
Impaired	24%	3%	

*Based on adjusted activity score and compared with chi-square statistic.

with and without knee OA. Furthermore, classification of physical activity based on the HAP is also able to discriminate between individuals with knee OA, regarding measures of pain and physical function. While correlated with typically used measures of pain and physical function in knee OA, results indicate that such measures cannot be used to accurately predict physical activity levels. Thus, inclusion of the HAP in the test battery may be warranted for future studies of knee OA.

Table 3.
Univariate correlations between Human Activity Profile and pain and physical function measures in osteoarthritic cohort (*N* = 226).

Pain/Physical Function Measures	MAS (*r*)	AAS (*r*)
Pain		
WOMAC	–0.23*	–0.32*
VAS: pain at rest (cm)	–0.18†	–0.19†
VAS: pain on movement (cm)	–0.27†	–0.39†
Self-Reported Physical Function		
WOMAC	–0.23*	–0.39*
VAS (cm)	–0.27*	–0.48*
Observed Physical Function		
Step test (*N*)	0.34*	0.52*
TUG test (s)	–0.46*	–0.59*
Walking speed (m/s)	0.44*	0.63*

*$p < 0.001$
†$p < 0.01$
r = univariate correlates
MAS = maximal activity score
AAS = adjusted activity score
WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index
VAS = visual analog scale
TUG = timed up and go

Excellent test-retest reliability was demonstrated in people with knee OA when the HAP was completed on two occasions, separated by a 2- to 7-day interval. The absolute measurement error indicates the degree of difference required to detect genuine change resulting from an intervention or differences between groups of individuals. The measurement error observed in this study was small, with the SEM just 3 percent of the scale for the MAS and the AAS. Thus, from the present data, a difference of more than six points on both the MAS and the AAS would be required to demonstrate a significant difference or change greater than measurement error 95 percent of the time.

Other researchers have tested the reliability of the HAP in different patient populations. The developers of the HAP reported reliability coefficients for the MAS and AAS of 0.84 and 0.79, respectively [18]. These reliability coefficients were calculated from repeat measurements with a 16-day interval in a cohort of 29 healthy participants in a smoking cessation program. Farrell et al. demonstrated higher correlations (0.97 for both indices) in a group of elderly patients attending a chronic pain clinic [20]. These correlations were very similar to the ICC values found in our study. Thus, the HAP appears to be reliable in measuring activity levels in both healthy and impaired individuals.

Sensitivity to detect change is an essential feature of any measurement instrument. Our study has demonstrated the HAP to be sufficiently sensitive to discriminate between people with and without knee OA. Compared to the MAS, the AAS appears to be the most useful parameter for detecting change. This supports the suggested

Table 4.
Independent predictors of Human Activity Profile scores, as determined by forward stepwise multiple regression.

Independent Predictors	ß-Coefficient	Standard Error	*p*-Value	Variance Explained (%)
Maximal Activity Score				
TUG	–0.960	0.210	<0.001	27
Walking speed	7.910	2.880	<0.01	4
Gender*	–2.507	1.212	0.04	1
Total				32
Adjusted Activity Score				
Walking speed	13.280	3.599	<0.001	39
VAS: restriction	–1.455	0.291	<0.001	6
TUG test	–0.834	0.257	0.001	4
Step test	0.582	0.242	0.017	1
Total				50

*Gender: 1 = male, 2 = female. TUG = timed up and go VAS = visual analog scale

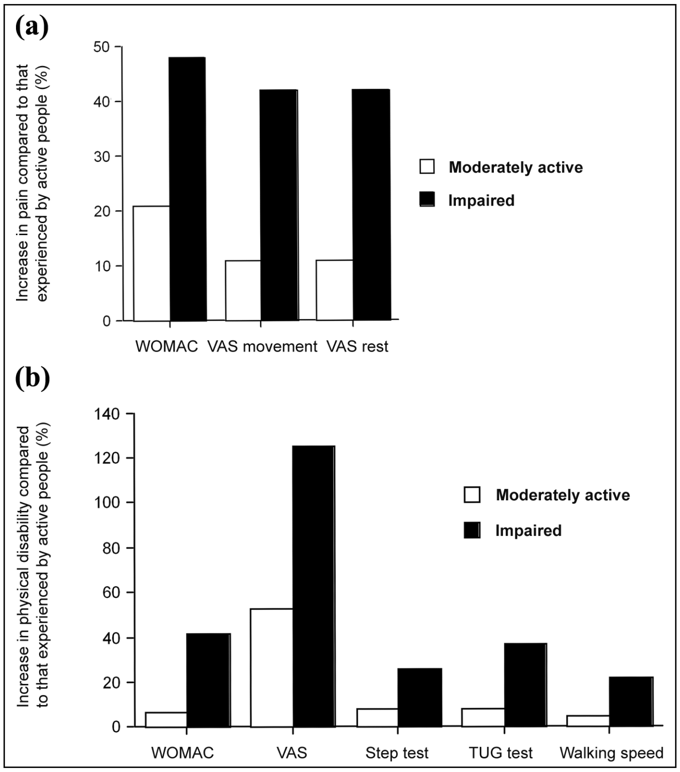

Figure.
Mean percentage difference in **(a)** pain and **(b)** physical function in OA participants classified as impaired or moderately active, compared to active individuals.

notion that the AAS may be more reactive to impairment than the MAS [18]. This parameter is perhaps also the most clinically relevant, because it provides a more stable estimate of an individual's daily (or usual) activities. In comparison, the MAS, which estimates the most strenuous physical activity a person is still able to perform (but not necessarily regularly), potentially can provide unrealistically high estimates of normal physical activity. Thus, the AAS helps correct the MAS for those individuals who occasionally perform one particular energy-intensive activity but who, because they have given up a number of activities that are less energy-intensive than their MAS, may lead more restricted lives in general. For example, a person who reports being able to walk 2 miles nonstop when absolutely necessary (thus achieving an MAS of 70), but no longer climbs steps or performs household chores (such as sweeping, vacuuming, or mowing the lawn), will achieve an AAS of no more than 62.

Furthermore, classification of physical activity, based on the AAS, is also sensitive enough to demonstrate differences between groups. Within the knee OA group, 24 percent of people were classified as impaired, compared to only 3 percent of healthy matched controls, while only 18 percent of the OA subgroup were classified as active, compared to 49 percent of the control group. Further analysis within the larger OA cohort demonstrated that the classification system is also sensitive enough to distinguish between people with knee OA. On the basis of pain and physical function measures, people classified as impaired demonstrated significantly higher levels of pain and lower levels of physical function, compared to the more active groups.

In our study, gender differences were evident, with women (both knee OA and control participants) tending to record lower scores with the HAP than their male counterparts. Although OA males recorded lower AAS scores than healthy males, the difference was not enough to reach statistical significance. This finding suggests that the HAP is less sensitive in males than females. The prevalence of symptomatic joint disease is greater in women than men [31], so it is perhaps not surprising that the HAP is better able to discriminate between women with and without knee OA, compared to men. To increase the applicability of the HAP as a measure of physical activity in males, one may have to modify and validate some of the listed activities in the future.

Although the HAP is unable to define actual physical impairment, the activity pattern within each classification describes an "impaired," "moderately active," or "active" lifestyle [18]. Those categorized as active by the HAP are participating in a notable amount of strenuous recreational activity, such as cycling, tennis, or jogging. Those categorized as moderately active are capable of maintaining the home, walking, and generally moving around freely at home and work. Those categorized as impaired are barely able to take care of grooming and basic household needs, and would not be taking care of heavy household chores or engaging in physical recreational activity.

The results of our study show that, while there is a correlation between physical activity levels and commonly used measures of pain and physical function, this correlation is only weak to moderate in strength. Even in a multiple regression, less than half the variance in HAP scores could be explained by a combination of measures. This suggests that the HAP does, in fact, assess a different dimension (activity levels and energy expenditure) than other recommended outcome measures and thus would not provide redundant information if included in a test battery for knee OA.

While this study has evaluated the sensitivity of the HAP, other aspects of validity require examination before the HAP can be conclusively recommended in studies of knee OA. Responsiveness of the HAP to intervention must be established in individuals with knee OA, specifically. In 80 healthy women aged 60 to 70 years, Hamdorf et al. demonstrated that a 6-month walking program can significantly increase the MAS and AAS [21]. These improvements in physical activity were associated with improvements in heart rate and cardiovascular fitness, providing some evidence for the validity of the HAP. Similar evaluations, however, are required in people with knee OA. Also useful would be a comparison of the HAP with other self-report physical activity questionnaires, such as the Physical Activity Scale for the Elderly [32], in order to establish concurrent validity.

Practical considerations are important for judgment of the usefulness of a questionnaire. Although the HAP assesses a large number of individual activities (94 in total), its simple format facilitates prompt completion (around 5 min); this is important if multiple outcome measures are to be administered. Furthermore, scoring the questionnaire is simple and requires no complex calculations. The scope of the questionnaire is diverse, covering a broad range of activities, which helps to minimize floor and ceiling effects. In our large cohort of 226 people with knee OA, only 1 participant scored the maximum value, and none the minimum.

Epidemiological research has demonstrated that physical inactivity and low physical fitness increase the risk of a range of public health problems, including cardiovascular disease, diabetes, and osteoporosis [1–5]. Thus, increasing activity levels is strongly recommended for improving health and well-being. Individuals with knee OA are at particular risk of inactivity. Treatment for knee OA should aim not only to reduce pain and disability but also to increase physical activity levels. We recommend that researchers consider including the HAP as a measure of physical activity in future studies of knee OA, particularly those involving women.

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