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Measures of Physical Performance Capture the Excess Disability Associated With Hip Pain or Knee Pain in Older Persons

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Background. Hip pain (HP) and knee pain (KP) may specifically affect function and performance; few studies investigate the functional impact of HP or KP in the same population.

Methods. Population-based sample of older individuals living in the Chianti area (Tuscany, Italy) (1998–2000); 1006 persons (564 women and 442 men) were included in this analysis; 11.9% reported HP and 22.4% reported KP in the past 4 weeks. Self-reported disability and lower extremity performance, measured by 400-m walk test and by the short physical performance battery (SPPB, including standing balance, chair raising, and 4-m walk test), were compared in participants reporting HP or KP versus those free of these conditions; the relationship of HP or KP with performance and self-reported disability was studied, adjusting for age, sex, hip or knee flexibility, muscle strength, multiple joint pain, major medical conditions, and depression.

Results. Participants reporting HP were more likely to report disability in shopping, cutting toenails, carrying a shopping bag, and using public transportation; those with KP reported more disability in cutting toenails and carrying a shopping bag. Participants reporting HP or KP had significantly lower SPPB scores. Adjusting by SPPB, pain no longer predicted self-reported disability, except for "HP—carrying a shopping bag."

Conclusions. In our cohort of older persons, those with HP reported disability in a wider range of activities than those with KP. Physical performance measured by SPPB was impaired in both conditions. Reduced lower extremity performance captures the excess disability associated with either HP or KP.

Key Words: Hip pain—Knee pain—Older persons—Performance—Disability.

JOINT pain is highly prevalent in older persons and may have a strong detrimental effect on performance and function (1,2). Indeed, lower extremity joint pain is often regarded as an important determinant of disability and poor physical performance in older persons. On the other hand, while the relationship between joint pain, lower extremity performance, and self-reported disability has been investigated in clinical studies, little information exists in populations (2). In particular, few epidemiological surveys addressed hip- and knee-related disability in the same cohort, and the pathway form joint pain to lower extremity performance and to disability has not been fully explored (3–5).

The InCHIANTI study, a population-based study focused on the disablement process in older persons, provides a unique opportunity to address this question. In fact, InCHIANTI collected data on joint pain, physical performance, and self-reported disability from a representative cohort of persons with different health status and functional level. Using data from the InCHIANTI study, we previously found reports of hip pain (HP) by 11.9% (120/1006) and of knee pain (KP) by 22.3% (222/1006) of the study population (6). In the same cohort, we studied the effects of back pain (BP) on self-reported disability in basic and instrumental activities of daily living (ADLs) and on lower extremity performance, demonstrating that physical performance captured the association of BP with self-reported disability in specific tasks (7). Along this line of investigation, we hypothesized that both HP and KP would be specifically associated with poor physical performance and with reports of task-specific disability in older persons and that lower extremity performance would modulate these associations.

Materials and Methods

A detailed description of the InCHIANTI study design is reported elsewhere (8). Briefly, a representative cohort of persons aged 65 or older was selected from the registries of *Greve in Chianti* (rural area) and *Bagno a Ripoli* (urban area near Florence) by a multistage sampling method. In 1998, baseline data collection (1998–2000) included a structured home interview, instrumental and laboratory tests, a standardized examination by a geriatrician, and the administration of physical tests by a trained physiotherapist. Of the initial sample (1299 persons enrolled), 17 men and 22 women died or moved away. Among potentially eligible participants, 91.6% (1154/1260) answered to the home interview. Some participants did not receive either the functional or the clinical assessment. Thus, the final population with all available data analyzed in this report included 1006 participants, 564 women and 442 men, aged 75.2 ± 7.1 years; participation rate was 80% (1006/1260). Dropouts were fairly distributed across age and gender classes, with the lowest participation rate in women of 85+.

Selected Variables

Presence of HP or KP was ascertained by two separate questions: "Ha avuto dolore all'anca/ginocchio nelle ultime 4 settimane?" (Over the past 4 weeks, did you ever experience hip/knee pain?) (6).

Participants who reported HP were administered the pain section of the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) (9), and their global WOMAC pain score (WPS; range 0–20) was calculated. A similar approach was used to grade KP. Pain-related use of nonsteroid anti-inflammatory drugs (NSAIDs) or analgesic drugs in the past 2 weeks was also recorded.

To collect information on falls, participants were asked if, in the past 12 months, they had experienced one or more falls, defined as an incident resulting in the participant coming unexpectedly to the ground. The answer was coded as positive or negative.

Disability

Self-reported disability was assessed by a 20-item questionnaire (10,11), including five basic ADLs (walking across small room, bathing, dressing, toileting, and transferring); and more complex activities, such as walking outdoors, climbing or descending stairs, walking 400 m, going shopping, carrying a shopping bag, performing light and heavy household chores, cooking own meal, eating, cutting toenails, using the toilet, rising arms overhead, manual dexterity (handling small objects), doing own laundry, and using public transportation. For the purpose of this analysis, participants who reported the need for another person's help in any of the previously mentioned activities were classified as disabled for that specific activity.

Lower Extremity Performance

The 400-m walk test and the short physical performance battery (SPPB) were used to assess lower extremity physical performance. For the 400-m walk test, participants were invited to walk for 400 m (20 laps of 20 m) as fast as possible to complete the task without stopping. Verbal encouragement to maintain pace was given, and the participant was told the number of laps completed at each lap. Although participants were asked to complete the task at once, a maximum of two standing rests were permitted for less than 2 minutes each. The use of assistive devices (e.g., canes, walkers) was allowed. Participants were excluded from the 400-m walk test if they had any of the following conditions: severe electrocardiographic abnormality, systolic blood pressure more than 180 mmHg, diastolic blood pressure more than 100 mmHg, resting heart rate less than 40 or more than 135 beats per minute, myocardial infarction, episodes of angina in the past 3 months, severe dementia, or poor visual acuity. Total time to perform the test was measured by a photocell-based system, and the mean velocity (meters/second) was used in the analysis (8).

The SPPB score is derived from the performance in three objective tests: usual walking speed over 4 m, five timed repeated chair rises, and standing balance (SB) (12). Each test is scored from 0 to 4, and the sum of three scores gives a total score ranging from 0 to 12 (12 = best). SPPB score has been shown to be associated with higher risk of incident disability and mortality in older persons (13,14). In tests of SB, participants attempted to maintain the side-by-side, semitandem, and tandem positions for 10 seconds and were scored 1 if they could hold the side-by-side but not the semitandem stand for 10 seconds, 2 if they held the semitandem stand for 10 seconds but were unable to hold the full-tandem stand for more than 2 seconds, 3 if they held the full-tandem stand for 3–9 seconds, and 4 if they held the full-tandem stand for 10 seconds. The 4-m walk test was scored based on quartiles: 1, more than 5.7 seconds (≤0.43 m/second); 2, 4.1–5.6 seconds (0.44–0.60 m/second); 3, 3.2–4.0 seconds (0.61–0.77 m/second); and 4, less than or equal to 3.1 seconds (≥ 0.78 m/second). Participants who could successfully stand up from a chair with their arms folded were asked to stand up and sit down five times as quickly as possible. Scores for the repeated chair stands were based on quartiles: 1, more than 16.7 seconds; 2, 16.6–13.7 seconds; 3, 13.6–11.2 seconds; and 4, less than or equal to 11.1 seconds (15).

Potential Confounders

Hip flexion, extension, extrarotation, adduction, abduction range of motion (ROM), and knee flexion and extension ROM were measured with a goniometer using a standard protocol (16).

Lower extremity isometric muscle strength was assessed bilaterally in eight lower extremity muscle groups using a handheld dynamometer (Nicholas Manual Muscle Tester; Fred Sammons, Inc., Burr Ridge, IL). All measures of lower extremity muscle strength were highly correlated (Pearson correlation coefficients from .87 to .92) (17). Therefore, right knee extension torque was used in this analysis as a marker of lower extremity muscle strength (6).

The diagnosis of major medical condition was ascertained combining information from medical history, physical examination, laboratory tests, and clinical records by preset algorithms; for our analysis, we included hypertension, peripheral artery diseases, stroke, and cardiovascular disease (8).

Pain in other joints included KP or HP, BP, and foot pain (FP). For BP, participants were asked how often they had experienced BP over the past year; given the high prevalence and the low clinical impact of sporadic BP, participants were considered as having BP if they reported pain from very often to almost always in the past year (6). Participants were also asked if they had experienced FP in the past month. Finally, the Center for Epidemiologic Studies-Depression scale (CES-D) was used to investigate on depressive symptoms (18).

Statistical Analysis

Data are reported as means ± *SD* or as percentages. Statistical analysis was performed using the STATA 7.1 software (19) and carried out following a two-step strategy separately for HP and KP. Age- and sex-adjusted associations according to the presence versus absence of HP (or KP) were tested for disability in selected ADLs and in performance tests of lower extremity function using logistic or linear regression models, as appropriate. Subsequently, significant associations of HP or KP with self-reported disability were further adjusted for SPPB to test the hypothesis that the deleterious effects of pain on lower extremity performance explain, in large part, the excess disability found in individuals with HP or KP compared with those free of these conditions. Type I error was set at 0.05.

Results

Table 1 summarizes the main characteristics of the study participants according to HP or KP. The WPS and use of drugs were similar for HP and KP (6). Both HP and KP were associated with increased risk of pain in other joints (6): among persons with HP, 84% (103/122) had also pain in another site (KP, BP, or FP), and among those with KP, 69% (157/226) reported pain in at least another site (HP, BP, or FP). Participants with HP or KP were significantly more likely to report one or more falls in the past year than those free of these conditions.

Table 2 shows the association of HP and KP, respectively, with disability in specific ADLs. Independent of age and sex, participants with HP were significantly more likely to report need of help from another person for shopping, cutting toenails, carrying a shopping bag, and using public transportation than those without HP. Participants with KP were significantly more likely to report disability in cutting toenails and in carrying a shopping bag.

Table 3 shows the relationship between HP or KP and physical performance. Walking speed in the 400-m task was not associated with pain in either joint. On the contrary, SPPB scores were significantly lower in participants with HP or KP. Considering SPPB subscores, repeated chair stand and 4-m usual paced walk were significantly impaired in both conditions, whereas SB was significantly more impaired in HP but not in KP.

Interestingly, the additional risk of disability and reduced lower extremity performance conferred by HP or KP alone were not significantly lower than those conferred by reporting pain in both joints (Table 4).

The relationship between HP or KP and disability is shown in Table 5. Models are presented adjusted only for age and sex; adjusted for age, sex, and SPPB score; and fully adjusted for multiple potential confounders, including age, gender, SPPB score, hip or knee flexibility, lower extremity muscle strength, CES-D score, pain in other joints, and presence of major clinical conditions. The age- and sex-adjusted associations “HP or KP—cutting toenails,” “HP—going shopping,” and “HP—using public transportation”

Table 1. Characteristics of InCHIANTI Study Participants Aged 65 and Older According to the Presence *vs* Absence of HP or KP

	HP			KP		
	Yes (*n* = 120)	No (*n* = 886)	*p**	Yes (*n* = 225)	No (*n* = 781)	*p**
Age (years) ($M \pm SD$)	75.2 ± 7.2	75.2 ± 7.1	.999	75.4 ± 6.9	75.2 ± 7.2	.577
Sex (% females)	76.2	53.4	<.001	74.3	50.9	<.001
WOMAC pain score ($M \pm SD$)	5.7 ± 3.6	—	—	5.7 ± 3.6	—	—
Use of NSAIDs or analgesic drugs (%)	19.7	—	—	14.6	—	—
Back pain (%)	60.8	27.5	<.001	48.9	26.5	<.001
HP (%)	—	—	—	32.0	6.1	<.001
KP (%)	60.0	17.3	<.001	—	—	—
Foot pain (%)	30.8	16.4	.007	30.7	14.5	<.001
Past year history of falls (%)	32.5	21.1	.027	30.7	20.1	.010

Notes: HP = hip pain; KP = knee pain; NSAIDs = nonsteroid anti-inflammatory drugs; WOMAC = Western Ontario and McMaster University Osteoarthritis Index.
*Age and sex adjusted.

Table 2. Self-reported Disability in Activities of Daily Living Among InCHIANTI Study Participants Aged 65 and Older According to the Presence *vs* Absence of HP or KP (*n* = 1006)

	HP			KP		
	Yes (*n* = 120)	No (*n* = 886)	*p**	Yes (*n* = 225)	No (*n* = 781)	*p**
Personal care						
Washing hands and face (%)	2.5	2.3	.901	1.8	2.5	.406
Taking a bath (%)	11.6	10.9	.826	10.2	11.2	.355
Dressing or undressing (%)	5.7	5.3	.638	5.8	5.2	.638
Eating (%)	0.8	1.9	.469	1.8	2.3	.678
Using the toilet (%)	3.3	3.6	.897	2.2	3.9	.156
Cutting toenails (%)	31.7	18.8	.002	29.6	17.7	.001
Mobility						
Going to or rising from bed (%)	3.3	3.8	.863	4.0	3.7	.815
Indoor mobility (%)	2.5	4.1	.384	4.4	3.8	.747
Outdoor mobility (%)	10.7	6.4	.095	7.5	6.7	.888
Climbing or descending stairs (%)	7.4	6.2	.631	7.1	6.1	.865
Walking 400 m (%)	13.1	8.8	.148	8.8	9.4	.339
Going shopping (%)	16.8	10.3	.023	13.0	10.5	.512
Using public transport (%)	24.8	17.0	.047	22.2	16.6	.254
Housekeeping and IADL						
Light household chores (%)	6.8	8.1	.924	7.8	8.0	.681
Heavy household chores (%)	21.7	17.1	.182	21.2	16.6	.168
Arms overhead (%)	0.8	3.0	.190	2.2	2.9	.432
Manual dexterity (%)	6.6	5.5	.670	6.6	5.3	0,665
Carrying shopping bag (%)	28.7	13.6	<.001	22.7	13.3	.007
Laundry (%)	9.6	11.5	.892	11.5	11.1	.474

Notes: HP = hip pain; IADL = instrumental activities of daily living; KP = knee pain.
*Age and sex adjusted.

were substantially attenuated and no longer significant after adjustment for SPPB. On the contrary, introducing SPPB as a covariate did not affect the relationship "HP—carrying a shopping bag" that remained statistically significant. In the fully adjusted model, which included measures of specific joint flexibility, lower extremity muscle strength, reports of pain in other joints, major medical conditions, and depression, the relationship "HP—carrying a shopping bag" was further attenuated and became no longer significant.

Finally, we repeated the fully adjusted analysis separately for the hip and the knee, considering the three components of the SPPB rather than the SPPB score. The final model for the hip identified a set of variables independently related to task-specific disability, whereas the association with HP was lost for all tasks. Independent predictors of disability in "cutting toenails" were age (p = .000), limiting medical conditions (p = .023), hip flexion ROM (p = .002), SB (p = .000), and 4-m walk test (p = .011), whereas the association with repeated chair stand was not significant (p = .186). For "going shopping," age (p = .005), limiting medical conditions (p = .023), repeated chair stand (p = .000), and 4-m walk test (p = .002) were significantly related to disability, whereas the association with balance was not significant (p = .246). Independent predictors of disability in "using public transportation" included age (p = .000), depression (p = .025), hip extrarotation ROM (p = .013), repeated chair stand (p = .009), 4-m walk test (p = .005), and balance (p = .029). For "carrying a shopping bag," age (p = .001), female gender (p = .020), limiting medical conditions (p = .000), depression (p = .027), pain in other joints (p = .006), hip extrarotation ROM (p = .0024), repeated chair stand (p = .000), and 4-m walk test (p = .003) were significantly related to disability, whereas SB was not (p = .103).

Table 3. Lower Extremity Performance Measures Among InCHIANTI Study Participants Aged 65 and Older According to the Presence *vs* Absence of HP or KP (*n* = 1006)

	HP			KP		
	Yes (*n* = 120)	No (*n* = 886)	*p**	Yes (*n* = 225)	No (*n* = 781)	*p**
Walking speed 400 m (m/sec) ($M \pm SD$)	1.3 ± 0.6	1.3 ± 0.3	.369	1.2 ± 0.4	1.3 ± 0.4	.193
SPPB score ($M \pm SD$)	8.7 ± 3.3	9.8 ± 3.1	.001	8.9 ± 3.3	9.9 ± 3.1	.001
4 m usual paced walk (score) ($M \pm SD$)	3.1 ± 1.0	3.4 ± 1.0	.003	3.2 ± 1.1	3.4 ± 1.0	.011
Repeated chair stand (score) ($M \pm SD$)	2.6 ± 1.4	3.1 ± 1.3	.002	2.6 ± 1.4	3.1 ± 1.3	.001
Standing balance (score) ($M \pm SD$)	3.0 ± 1.4	3.3 ± 1.2	.005	3.1 ± 1.3	3.3 ± 1.2	.106

Notes: HP = hip pain; KP = knee pain; SPPB = short physical performance battery.
*Age and sex adjusted.

Table 4. Self-reported Disability and Lower Extremity Performance Measures in Participants with Both HP and KP *vs* Participants With HP Only and *vs* Participants With KP Only

	HP + KP (n = 72)	HP Only (n = 48)	KP Only (n = 153)	HP + KP *vs* HP Only, p*	HP + KP *vs* KP Only, p*
Self-reported disability					
Personal care					
Washing hands and face (%)	27.4	20.4	13.1	.529	.227
Taking a bath (%)	95.9	14.6	10.4	.980	.613
Dressing or undressing (%)	54.9	61.2	58.8	.646	.589
Eating (%)	0	20.4	0	.705	n.a.
Using the toilet (%)	27.4	40.8	19.6	.737	.576
Cutting toenails (%)	35.2	26.5	27.0	.064	.048
Mobility					
Going to or rising from bed (%)	27.4	40.8	45.7	.897	.717
Indoor mobility (%)	27.4	20.4	5.2	.761	.576
Outdoor mobility (%)	68.5	16.3	78.4	.594	.747
Climbing or descending stairs (%)	54.8	10.2	78.4	.858	.833
Walking 400 m (%)	82.2	20.4	91.5	.352	.803
Going shopping (%)	12.7	22.3	13.2	.501	.549
Using public transport (%)	24.6	25.0	21.0	.483	.238
Housekeeping and IADL					
Light household chores (%)	43.5	10.4	93.9	.799	.782
Heavy household chores (%)	17.1	28.9	23.1	.618	.917
Arms overhead (%)	13.7	0	26.1	.999	.714
Manual dexterity (%)	68.5	61.2	65.3	.707	.462
Carrying shopping bag (%)	28.8	28.6	19.7	.733	.033
Laundry (%)	86.9	11.1	12.9	.475	.938
Performance					
400-m walk (m/sec) ($M \pm SD$)	1.2 ± 0.5	1.4 ± 0.7	1.2 ± 0.4	.277	.867
SPPB (score) ($M \pm SD$)	8.9 ± 3.2	8.5 ± 3.5	9.0 ± 3.4	.342	.279
4 m usual paced walk (score) ($M \pm SD$)	3.1 ± 1.0	3.1 ± 1.1	3.2 ± 1.1	.487	.121
Repeated chair stand (score) ($M \pm SD$)	2.6 ± 1.5	2.7 ± 1.4	2.7 ± 1.4	.329	.359
Standing balance (score) ($M \pm SD$)	3.2 ± 1.3	2.7 ± 1.5	3.1 ± 1.4	.154	.778

Notes: HP = hip pain; KP = knee pain; n.a. = not applicable; SPPB = short physical performance battery.
*Age and sex adjusted.

As to the knee, the final model identified a set of variables independently related to task-specific disability, whereas the association with KP was also lost for all tasks. For "cutting toenails," age (p = .000), limiting medical conditions (p = .022), knee flexion ROM (p = .026), knee extension ROM (p = .045), SB (p = .000), and 4-m walk test (p = .001) were

Table 5. Task-Specific Disability in HP and KP Adjusted for Age and Sex, Further Adjusted for SPPB Score, and Further Adjusted for Multiple Potential Confounders

	HP		KP	
	OR (95% CI)	p	OR (95% CI)	p
Shopping				
Adjusted for age and sex	2.0 (1.1–3.6)	.023	1.3 (0.8–2.1)	.512
Adjusted for age, sex, and SPPB score	1.2 (0.6–2.3)	.652	0.8 (0.4–1.7)	.577
Fully adjusted model*	2.3 (0.8–6.8)	.125	0.8 (0.3–1.9)	.562
Using public transport				
Adjusted for age and sex	1.6 (1.0–2.5)	.047	1.4 (0.9–2.2)	.254
Adjusted for age, sex, and SPPB score	1.1 (0.4–2.7)	.838	0.9 (0.5–1.7)	.779
Fully adjusted model*	1.2 (0.5–2.7)	.637	0.8 (0.4–1.7)	.589
Carrying shopping bags				
Adjusted for age and sex	2.7 (1.6–4.4)	<.001	1.8 (1.2–2.8)	.007
Adjusted for age, sex, and SPPB score	2.7 (1.5–4.8)	<.001	1.5 (0.9–2.5)	.111
Fully adjusted model*	2.0 (0.9–4.3)	.067	1.3 (0.7–2.4)	.408
Cutting toenails				
Adjusted for age and sex	2.1 (1.3–3.4)	.002	2.0 (1.4–2.9)	.001
Adjusted for age, sex, and SPPB score	1.7 (1.0–3.0)	.065	1.6 (1.0–2.5)	.051
Fully adjusted model*	2.1 (0.8–5.3)	.113	1.4 (0.8–2.3)	.263

Notes: HP = hip pain; KP = knee pain; OR = odds ratio; SPPB = short physical performance battery.
*The fully adjusted model also included age, sex, SPPB, hip or knee flexibility, lower extremity muscle strength (knee extension torque), pain in other joints, medical conditions (chronic heart failure, coronary artery disease, stroke, and peripheral artery disease), and depression (Center for Epidemiologic Studies-Depression scale score).

independently related to disability, whereas the association with repeated chair stand was not significant (p = .001). For "going shopping," age (p = .001), female gender (p = .030), limiting medical conditions (p = .000), knee flexion ROM (p = .027), knee extension ROM (p = .046), repeated chair stand (p = .000), and 4-m walk test (p = .001) were significantly related to disability, whereas SB was not (p = .534). Independent predictors of disability in "using public transportation" were age (p = .000), depression (p = .020), repeated chair stand (p = .012), 4-m walk test (p = .017), and balance (p = .001). For "carrying a shopping bag," age (p = .000), female gender (p = .026), limiting medical conditions (p = .000), depression (p = .019), pain in other joints (p = .000), hip extrarotation ROM (p = .0024), repeated chair stand (p = .008), and 4-m walk test (p = .001) were significantly related to disability, whereas reduced SB was not (p = .152).

Discussion

Lower extremity joint pain is often reported as the main determinant of restrictions in mobility by older persons (20), but the precise mechanisms by which hip and knee joint problems affect performance and disability are not yet fully investigated (21,22). Self-report questionnaires and performance measures represent two methods for assessing physical function, and both assessments are necessary to obtain a complete picture of the functional consequences of osteoarthritis (OA) (2). Indeed, history of arthritis (23) and BP (7,24) affects negatively the rate of decline of lower extremity performance with age, but it is not clear whether and how such effects of pain on performance may translate into the loss of autonomy in daily living activities.

In this study, we found that neither HP nor KP was significantly correlated with self-reported functional limitations in basic ADLs, but both conditions were associated with higher risk of reporting limitations in several physically demanding activities, such as cutting toenails, carrying a shopping bag, and, only for HP, shopping and using public transportation. Our findings are in agreement with studies showing that lower extremity pain is associated with physical function deterioration (25) and that lower musculoskeletal impairment affects instrumental rather than basic ADLs (26). Furthermore, lower extremity pain, along with muscle weakness, may cause buckling of the affected limb (27) and a lateral shift of the center of gravity toward the painful joint while walking (28), and we confirmed that both conditions were associated with higher risk of reporting one or more falls in the past year (3).

We also found that only participants affected by HP reported excess disability in shopping and using public transportation. These differences in disability reports between KP and HP were somewhat surprising since pain characteristics, such as average WOMAC total score, average pain intensity, and percentage of participants reporting morning stiffness, were quite similar in participants affected by KP or HP, and, for both conditions, the activities that elicited more severe pain were climbing or descending stairs and walking (6). On the other hand, we did not investigate on pain frequency that may be relevant to this issue. In the literature, patients with hip OA tend to report poorer physical function and role than those with knee OA (29), and hip but not knee OA was associated with ADL disability in an Italian elderly cohort (30). Furthermore, in the Framingham study, previous hip fracture was associated with more disability in instrumental ADLs than knee OA (31).

We then explored the relationship between HP or KP and our chosen set of performance measures. In our sample, both HP and KP were significantly associated with lower SPPB scores, whereas neither condition was associated with different walking speed in the 400-m task. This finding was not totally unexpected. Indeed, both measures investigate lower mobility performance, but the 400-m walk test was designed to test fitness and aerobic capacity and may have been affected by a wide variety of clinical factors other than joint pain, such as conditions affecting endurance and exercise tolerance (32). In fact, the 400-m walk test has showed only moderate correlation to SPPB, with the strongest relationship with the 4-m walk test (33). However, the two measures are not identical: it has been argued that the ability to walk over a short distance (a typical mobility task) implies partially different requirements than that of prolonged self-paced walking, eventually with the aid of an assistive device (33), and we believe that this may explain the apparently contradictory finding of HP or KP being significantly related to the 4-m walk test but not to the 400-m test in our study cohort. On the other hand, the association of either HP or KP with the SPPB was expected and particularly interesting since many studies have shown that low SPPB scores in older persons predict multiple adverse health outcomes, including incident ADL disability, nursing home admission, and mortality (15,17). Indeed, recent evidence suggests that chronic pain, per se, is associated with a risk of reduced physical performance that may be reverted with pain relief (34).

Interestingly, but in contrast with previous literature, we found that the level of lower extremity performance deterioration was not significantly better in person, with only HP or KP compared with persons with pain in both joints (35). This discrepancy is difficult to explain and may suggest the existence of a threshold beyond which the excess risk of disability is not increased. On the other hand, we must acknowledge that subdividing our cohort in four subgroups (HP or KP alone, pain in both joints, and no pain in either HP or KP) led to relatively small numbers of participants per group, thus reducing the statistical power of this specific analysis.

Exploring the single three components of the SPPB, we found that performance in 4-m walking and rising from a chair were significantly impaired in persons with HP as well as in those with KP, whereas SB was significantly impaired in participants with HP but not in those with KP. This difference may be explained by the specific characteristics of postural control in the elderly people (9): in younger individuals, "ankle strategy," that is activating ankle muscles first as an anticipatory adjustment to stabilize posture, is preferentially used to respond to external balance perturbations, whereas elderly people generally adopt a "hip strategy," which may reasonably be impaired in the presence of HP. In a cohort of persons aged 55 and older, impaired balance was independently associated with poor lower extremity strength and HP (36) and impaired control of the trunk and hip movements during postural adjustments (particularly the ability to initiate and control a hip strategy) may also explain reduced balance in elders with BP (37). These findings suggest that HP of whatever cause, rather than hip structural changes "per se," may influence balance control, possibly by pain-induced reflex inhibition of the thigh and gluteal muscles, and this mechanism may be particularly relevant to older persons who preferably use hip rather than ankle strategy to maintain balance. Indeed, HP may lead to loss of hip extension with anterior shift of the center of gravity (38), and in older persons with hip OA, reduced lower extremity performance was associated with increased activity aimed at controlling balance, measured as increased center point of force velocity (39), and with frequent near-falls (40). From the clinical point of view, our findings suggest that routine testing and eventual treatment of balance problems may be particularly relevant to older patients with HP.

When we introduced the SPPB score into the analysis of the relationship between joint pain and self-reported disability in specific tasks, we found the relationship between disability and either HP or KP was attenuated and no longer significant, except for disability in "carrying a shopping bag" that remained significantly related to HP. A previous analysis on the same cohort of the relationship between disability reported by persons with BP and their lower extremity physical performance showed similar findings: measures of physical performance could modulate disability in specific activities associated to BP, again with the exception of carrying a shopping bag (7). In the fully adjusted model, this relationship was attenuated and no more significant, suggesting that other key factors play a relevant role in this association, including joint flexibility and, possibly, weight bearing–related pain increase.

Since we found an impairment in SB associated with HP but not with KP, we had hypothesized that SB would be particularly relevant to the higher risk of disability reported only by persons with HP in the tasks of "going shopping" and "using public transportation." On the contrary, when we performed an exploratory analysis, we found that all three test scores were independently related to disability in all activities considered, except "going shopping" and "carrying a shopping bag," where were not related to SB, and "cutting toenails," which was not related to repeated chair stand. Although a comprehensive analysis of the determinants of disability in this population goes far beyond the aims of this study, in this exploratory analysis, we also noticed that specific ROM impairment was independently associated to disability in all tasks except for "going shopping" for the hip and for "using public transportation" for the knee. Thus, joint-specific flexibility was an independent factor attenuating the relationship between HP or KP and task-specific disability, whereas the general measure of lower extremity strength we used in the fully adjusted model (knee extension torque) was not an independent predictor of task-specific disability, probably because it was not sufficiently specific.

Disability in older persons is a multidimensional construct, and the relevance of reduced performance to task-specific disability was somehow expected (34,41). Recently, a Finnish study shows that in hip OA, performance measures are better predictors of physical function than pain (42). However, beyond these results, our findings suggest that lower extremity performance measures—SPPB score—can almost completely capture the excess disability associated with either HP or KP. Furthermore, SPPB score was significantly related to task-specific disability independent not only of age, sex, reported pain in other joints, depression, and major medical conditions but also of impairments in lower extremity strength and in flexibility of the painful joint. As previously underlined by Guccione, "*the pathway from disease to disability is not inexorable. At each junction, . . . proper medical care and timely rehabilitation can eliminate or blunt the impact of disease on impairment, of impairment on function limitations and of function limitations on disability*" (43). Thus, including the SPPB in the assessment of patients with lower extremity pain reporting disability and expanding the focus of their rehabilitation plan from specific joint treatment to balance and mobility training may substantially improve their functional outcome.

This study has several limitations. First, our data did not utilize the OMERACT–OARSI criteria (44). While the standard questions to assess HP or KP investigate on frequent pain in the past month (pain on most days of the month), we enquired about pain anytime in the month, thus relying on a somewhat broader and probably less specific criterion. Furthermore, we assessed pain severity but not pain frequency. As to pain management, we verified that in our cohort, both HP and KP were associated with higher reports of NSAIDs and analgesic intake in the previous 2 weeks (6), but we did not ask about the interference of medication intake on pain frequency or intensity. Furthermore, if the proportion of participants with HP or KP reporting drug intake was significantly higher compared with those without pain, it was much lower than that reported in studies performed in the United States or in the United Kingdom (1,21). These data probably reflect different views regarding drug prescription and intake, both from the practitioner's and from the patient's perspective that may be relevant to actual pain management and pain functional impact, but we did not investigate these issues in our analysis. Another limitation of our study is that the question investigating HP and KP did not record neither the affected side nor whether the joint involvement was bilateral, and this may have attenuated the associations of joint pain with measures of physical performance and function. Finally, based on the data collected, we cannot exclude the possibility of radiated pain or radicular pain, although we could verify a specific joint-related ROM impairment associated with joint pain in our cohort (6).

In conclusion, we found that in our sample, HP and KP were associated with higher reports of limitations in several physically demanding abilities, such as cutting toenails, carrying a shopping bag, and, only for HP, shopping and using public transportation. Neither HP nor KP was associated with impairment in the 400-m walk test. Either condition was associated with lower SPPB scores, although SB was impaired in HP but not in KP. Except for disability in carrying a shopping bag in those with HP, reduced performance in the SPPB modulated the relationship between task-specific disability and joint pain in our population, independently of other potentially confounding factors including specific joint flexibility and lower extremity muscle strength. From a clinical perspective, these results suggest that the clinical assessment of patients with HP or KP should be completed with an evaluation of their lower extremity performance and that widening the focus of rehabilitation from specific joint impairment to mobility and balance may substantially modify the trajectory from lower extremity pain to disability.

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References

1. Dawson J, Linsell L, Zondervan K, et al. Epidemiology of hip and knee pain and its impact on overall health status in older adults. *Rheumatology*. 2004;43:497–504.
2. Stratford PW, Kennedy DM, Woodhouse LJ. Performance measures provide assessments of pain and function in people with advanced osteoarthritis of the hip or the knee. *Phys Ther*. 2006;86:1489–1496.
3. Leveille SG, Bean J, Bandeen-Roche K, Jones R, Hochberg M, Guralnik JM. Musculoskeletal pain and risk for falls in older disabled women living in the community. *J Am Geriatr Soc*. 2002;50(4):671–678.
4. Takahashi T, Ishida K, Yamamoto H, et al. Modification of the functional reach test: analysis of lateral and anterior functional reach in community-dwelling older people. *Arch Gerontol Geriatr*. 2006; 42(2):167–173.
5. Yagci N, Cavlak U, Aslan UB, Akdag B. Relationship between balance performance and musculoskeletal pain in lower body comparison healthy middle aged and older adults. *Arch Gerontol Geriatr*. 2007;45(1):109–119.
6. Cecchi F, Mannoni A, Benvenuti E, et al. Epidemiology of hip and knee pain in a representative cohort of Italian persons aged 65 and older: the InCHIANTI Study. *Osteoarthritis Cartilage*. 2008;16(9):1039–1046.
7. Di Iorio A, Abate M, Guralnik JM, et al. From chronic low back pain to disability. A multifactorial mediated pathway: the InCHIANTI study. *Spine*. 2007;32:809–815.
8. Ferrucci L, Bandinelli S, Benvenuti E, et al. Subsystems contributing to the decline in ability to walk: bridging the gap between epidemiology and geriatric practice in the InCHIANTI study. *J Am Geriatr Soc*. 2000;48:1618–1625.
9. Bellamy N. *WOMAC Osteoarthritis Index. A User's Guide*. London, Ontario, Canada; 1996.
10. Cecchi F, Debolini PL, Molino Lova R, et al. Epidemiology of back pain in a representative cohort of Italian persons aged 65 and older: the InCHIANTI Study. *Spine*. 2006;31:1149–1155.
11. Heikkinen E, Waters WE. *The Elderly in Eleven Countries—A Sociomedical Survey*. Copenhagen, Denmark: WHO; 1989.
12. Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *J Gerontol A Biol Sci Med Sci*. 2000;55:M221–M231.
13. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*. 1994;49:M85–M94.
14. Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med*. 1995;332:556–561.
15. Rossiter-Fornoff JE, Wolf SL, Wolfson LI, Buchner DM. Related articles, links a cross-sectional validation study of the FICSIT common data base static balance measures. Frailty and injuries: cooperative studies of intervention techniques. *J Gerontol A Biol Sci Med Sci*. 1995;50:M291–M297.
16. Kendal FP, McCreary EK. *Muscle Testing and Function*. Baltimore, MD: Williams & Wilkins; 1983.
17. Lauretani F, Russo CR, Bandinelli S, et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. *J Appl Physiol*. 2003;95:1851–1860.
18. Bellamy N, Buchnan WW, Goldsmith CH, et al. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J. Rheumatol*. 1988;15:1833–1840.
19. Ettinger WH, Fried LP, Harris T, Shemanski L, Schulz R, Robbins J. Self-reported causes of physical disability in older people: the Cardiovascular Health Study. CHS Collaborative Research Group. *J Am Geriatr Soc*. 1994;42:1035–1044.
20. O'Reilly SC, Muir KR, Doherty M. Knee pain and disability in the Nottingham community: association with poor health status and psychological distress. *Br J Rheumatol*. 1998;37:870–873.
21. Lamb SE, Guralnik JM, Buchner DM, et al. Factors that modify the association between knee pain and mobility limitation in older women: the Women's Health and Aging Study. *Ann Rheum Dis*. 2000;59:331–337.
22. Kimberly YZ, Forrest KY, Zmuda JM, Cauley JA. Correlates of decline in lower extremity performance in older women: a 10-year follow-up study. *J Gerontol A Biol Sci Med Sci*. 2006;61:1194–1200.
23. Carrington Reid M, Williams CS, Gill TM. Back pain and decline in lower extremity physical function among community dwelling older persons. *J Gerontol A Biol Sci Med Sci*. 2005;60:793–797.
24. Salaffi F, Cavalieri F, Nolli M, Ferraccioli G. Analysis of disability in knee osteoarthritis. Relationship with age and psychological variables but not with radiographic score. *J Rheumatol*. 1991;18:1581–1586.

25. Jette AM, Branch LG, Berlin J. Musculoskeletal impairment and physical disablement among the aged. *J Gerontol*. 1990;45: M203–M208.
26. Pavol MJ, Owings TM, Foley KT, Grabiner MD. Influence of lower extremity strength of healthy older adults on the outcome of an induced trip. *J Am Geriatr Soc*. 2002;50(2):256–262.
27. Maquet P. *Biomechanics of the Hip*. Berlin, Germany: Springer Verlag; 1985.
28. Salaffi F, Carotti M, Grassi W. Health-related quality of life in patients with hip or knee osteoarthritis: comparison of generic and disease specific instruments. *Clin Rheumatol*. 2005;24:29–37.
29. Mannoni A, Briganti MP, Di Bari M, et al. Epidemiological profile of symptomatic osteoarthritis in older adults: a population based study in Dicomano, Italy. *Ann Rheum Dis*. 2003;62:576–578.
30. Guccione AA, Felson DT, Anderson JJ, et al. The effects of specific medical conditions on the functional limitations of elders in the Framingham study. *Am J Public Health*. 1994;84:351–358.
31. Newman AB, Simonsick EM, Naydeck BL, et al. Association of long-distance corridor walk performance with mortality, cardiovascular disease, mobility limitation, and disability. *JAMA*. 2006;295(17): 2018–2026.
32. Sayers SP, Guralnik JM, Newman AB, Brach JS, Fielding RA. Concordance and discordance between two measures of lower extremity function: 400 meter self-paced walk and SPPB. *Aging Clin Exp Res*. 2006;18(2):100–106.
33. Bryant LL, Grigsby J, Swenson C, Scarbro S, Baxter J. Chronic pain increases the risk of decreasing physical performance in older adults: the San Luis Valley Health and Aging Study. *J Gerontol A Biol Sci Med Sci*. 2007;62:989–996.
34. Peat G, Thomas E, Wilkie R, Croft P. Multiple joint pain and lower extremity disability in middle and old age. *Disabil Rehabil*. 2006; 28(24):1543–1549.
35. Satariano WA, DeLorenze GN, Reed D, Schneider EL. Imbalance in an older population: an epidemiological analysis. *J Aging Health*. 1996;8:334–358.
36. Mok NW, Brauer SG, Hodges PW. Hip strategy for balance control in quiet standing is reduced in people with low back pain. *Spine*. 2004;29:E107–E112.
37. Arokoski JP, Leinonen V, Arokoski MH, Aalto H, Valtonen H. Postural control in male patients with hip osteoarthritis. *Gait Posture*. 2006;23:45–50.
38. Arnold CM, Faulkner RA. The history of falls and the association of the timed up and go test to falls and near-falls in older adults with hip osteoarthritis. *BMC Geriatr*. 2007;7:17.
39. Kerrigan DC, Lee LW, Collins JJ, Riley PO, Lipsitz LA. Reduced hip extension during walking: healthy elderly and fallers versus young adults. *Arch Phys Med Rehabil*. 2001;82(1):26–30.
40. Fried LP, Young Y, Rubin G, Bandeen-Roche K. WHAS II Collaborative Research Group. Self-reported preclinical disability identifies older women with early declines in performance and early disease. *J Clin Epidemiol*. 2001;54(9):889–901.
41. Juhakoski R, Tenhonen S, Anttonen T, Kauppinen T, Arokoski JP. Factors affecting self-reported pain and physical function in patients with hip osteoarthritis. *Arch Phys Med Rehabil*. 2008;89(6):1066–1073.
42. Guccione AA. Arthritis and the process of disablement. *Phys Ther*. 1994;74:408–414.
43. Pham T, van der Heijde D, Altman RD, et al. OMERACT-OARSI initiative: Osteoarthritis Research Society International set of responder criteria for osteoarthritis clinical trials revisited. *Osteoarthritis Cartilage*. 2004;12(5):389–399.

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