Physical Function Assessment of a Mayan Population Living With Osteoarthritis: The Importance of Considering Different Aspects of Functioning

Adalberto Loyola-Sanchez[1], Julie Richardson[2], Ingris Pelaez-Ballestas[3], Jose Alvarez-Nemegyei[4], John N Lavis[5,6,7,8,9,10], Michael G Wilson[5,6] and Seanne Wilkins[2]

[1]Cumming School of Medicine, University of Calgary, Calgary, AB, Canada. [2]School of Rehabilitation Science, McMaster University, Hamilton, ON, Canada. [3]Rheumatology Department, Hospital General de Mexico, Mexico City, Mexico. [4]Research Unit, Hospital Regional de Alta Especialidad de la Península de Yucatán, Mérida, Mexico. [5]McMaster Health Forum, McMaster University, Hamilton, ON, Canada. [6]Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, ON, Canada. [7]Department of Political Science, McMaster University, Hamilton, ON, Canada. [8]Program in Policy Decision-Making, McMaster University, Hamilton, ON, Canada. [9]Centre for Health Policy Analysis, McMaster University, Hamilton, ON, Canada. [10]Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Boston, MA, USA.

ABSTRACT:

OBJECTIVES: To assess the physical function of people living with osteoarthritis in a Maya-Yucateco rural community from 3 perspectives and explore factors associated with the presence of disability.

DESIGN: Physical function and social, physical, psychological, and behavioral factors were evaluated in all adults detected with hand, hip, and/or knee osteoarthritis (n = 144) through a Community-Oriented Program for the Control of Rheumatic Diseases–based census in the Mayan community of Chankom, Yucatán. All cases fulfilled the American College of Rheumatology criteria. Physical function was assessed from 3 perspectives: *hypothetical* or "what people think they can do" (Health Assessment Questionnaire-Disability Index [HAQ-DI]), *experimental* or "what people could do in standardized conditions" (6-minute walk test [6MWT] + the Functional Dexterity Test) and *enacted* or "what people actually do" (personal care, work, and leisure activities' self-report).

RESULTS: About 80% of participants reported "mild" disability (HAQ-DI ≤ 1) in the hypothetical function perspective, whereas average experimental function scores were low (6MWT: 206 m, Functional Dexterity Test: 64 seconds), and 78% of participants reported problems with enacted function (ie, work). Pain was significantly associated with disability in the hypothetical perspective (odds ratio [OR] = 3 [95% confidence interval [CI]: 1-4]); levels of wealth (β = 5 [95% CI: 1-9]) and muscle strength (β = 54 [95% CI: 20-87]) were significantly associated with functioning in the experimental perspective; and lower levels of self-efficacy (OR = 12 [95% CI: 6-27]) and physical activity (OR = 12 [95% CI: 6-27]) were significantly associated with work disability in the enacted function perspective.

CONCLUSIONS: People living with osteoarthritis in Chankom show important issues when assessing physical function at the experimental and enacted perspectives, which could have been overlooked if only the hypothetical perspective was considered. Different factors were associated with different physical function perspectives and all should be addressed to decrease disability in this community.

KEYWORDS: Osteoarthritis, disability evaluation, Mexico, population groups, indigenous populations

Introduction

Osteoarthritis (OA) is the most common type of joint disease worldwide; its prevalence is rapidly increasing with the aging population and it is considered a major source of disability.[1] The negative effects of chronic musculoskeletal (MSK) diseases, such as OA, on the physical function and quality of life of individuals are more severe in developing countries.[2] The disabling effects of OA are likely to be more pronounced in low socioeconomic areas within developing countries. Epidemiologic observations involving older adults show that the severity of disability is inversely associated with their socioeconomic position, and a population-based study found that socioeconomic factors were independently associated with the presence of disability in Chile.[3]

The prevalence of OA is estimated to be 10.5% in Mexico, making it the leading MSK disease in the country.[4] Osteoarthritis is also the leading cause of MSK pain in the Mexican State of Yucatán,[5] where there are many Maya-Yucateco rural indigenous communities. These communities are characterized by living in low socioeconomic conditions without access to adequate health services.[6] Therefore, the disabling effects of OA on people living in these Maya-Yucateco areas could be important, highlighting the need to assess this population's physical function.

The epidemiologic assessment of physical function in OA has been inconsistent and many measurement strategies have been used. Physical function in OA has been measured either through self-report of difficulty to do predefined activities,[7] execution of controlled standardized activities,[8] or self-report and observation of real-life activities' performance.[9] Glass[10] proposed a "conjugation of 3 tenses" of physical functioning: (a) the hypothetical or perceived "capacity" to do activities, (b) the experimental or "capability" for executing activities in controlled situations, and (c) the enacted or the actual "performance" of real-life activities.

Epidemiologic studies of OA have mainly focused on the hypothetical and experimental tenses of functioning.[7] Failing to consider the enacted tense means ignoring the context in which an individual wishes and needs to function.[10] In addition, assessing the enacted tense allows exploration of early function loss or "preclinical disability,"[11] as this is manifested by the emergence of compensatory strategies.

This study is part of a project aimed at developing a community-based rehabilitation program to decrease the disabling effects of MSK diseases in Chankom, a Mexican rural indigenous municipality located in Yucatán.[12] Understanding the disabling effects of OA in this low socioeconomic Mayan community through a complete evaluation of functioning, such as using the 3 tenses of functioning proposed by Glass, is essential to develop strategic interventions to decrease and prevent the disabling effects of this chronic disease. Consequently, our main objectives were to (a) assess the physical function of people living with OA in Chankom using Glass' 3 "functioning tenses" and (b) explore associations between known risk factors for OA progression and each of the functioning tenses assessed.

Methods

Study design

This was a 3-stage observational, cross-sectional, community-based study consisting of the following: (a) a survey, (b) a home-based assessment, and (c) a physiatry assessment. The first 2 stages were based on the Community-Oriented Program for the Control of Rheumatic Diseases (COPCORD) phase 1 methodology, as described elsewhere.[13] Briefly, trained community personnel applied a cross-culturally validated questionnaire[14] designed to detect MSK symptoms and other relevant clinical and socioeconomic variables to the adult population (≥18 years) of Chankom, following a census strategy. Two trained family physicians assessed all people who reported MSK symptoms during the survey at their homes. These assessments occurred within the same week in which the survey had been administered.

During the physiatry assessment, consenting participants identified with possible hand, hip, and/or knee OA were seen by a physiatrist for OA confirmation, physical function evaluation, and exploration of factors associated with OA progression. Assessments were conducted in the community with the help of local Mayan translators.

Setting

This study was conducted in the rural municipality of Chankom, located in the southeast of Yucatán, Mexico. Chankom has a total population of 4464 habitants from which 80% are considered to be living in poverty.[15] The survey and home-based assessment were conducted between June and November 2012, whereas the physiatry assessment was conducted between September and December 2012. The study was approved by the Hamilton Health Sciences/McMaster University Research Ethics Board (12-544) and the Hospital General de Mexico Research Ethics Board (DI/11/4044B/3/123).

Participants

Osteoarthritis diagnoses were confirmed following the American College of Rheumatology clinical criteria for hand OA[16] and radiological and clinical criteria for hip and knee OA.[17,18]

Physical function evaluations

Hypothetical functioning. Hypothetical function was evaluated using the Health Assessment Questionnaire-Disability Index (HAQ-DI) applied by trained local staff at participants' homes. The HAQ-DI has shown good psychometric properties when applied to people with OA[19] and was cross-culturally translated, adapted and validated for its use in the Maya-Yucateco population.[20] The HAQ-DI was scored following standard procedures and then transformed to an ordinal variable by grouping scores into 3 categories (mild, moderate, and severe disability) as previously reported.[21]

Experimental functioning. Experimental function was measured using the 6-minute walk test (6MWT) and the Functional Dexterity Test (FDT). The 6MWT measures the distance an individual can walk during 6 minutes on a hard, flat surface[22] and has demonstrated good test-retest reliability when used in people with hip and knee OA.[23] The test was executed on a flat corridor 30-m long using a mechanical road distance measuring wheel (the Measure Meter, Trumeter 5500; Imperial House, UK) and a timer. Participants wore their usual clothes and were instructed to walk at a comfortable pace, whereas a Mayan assistant provided verbal encouragement every 30 seconds.

The FDT evaluates the dexterity to do 3-jaw chuck precision grip, has shown good psychometric properties in the hand OA population,[24] and was applied following standardized procedures, described elsewhere.[25] Only results from the dominant hand were considered in the analysis.

Enacted functioning. Enacted function was evaluated through self-report of activities within 3 major areas of life. Participants described their main personal care, work and leisure activities and then were asked whether at that moment they were doing "ALL" activities in each area. Persons who answered affirmatively were asked whether they had modified the way and/or reduced the frequency in which they performed these activities. The answers were structured as 3 ordinal variables, "enacted personal care," "enacted work," and "enacted leisure," composed by 3 categories: ability (currently performs ALL activities without modification), preclinical disability (currently performs ALL activities but have modified and/or reduced frequency of performance in at least 1 activity), and disability (currently does not perform ALL activities).

Exploration of known factors for OA progression

Modifiable known factors associated with OA clinical progression in hand,[26] hip, and knee[7,27] OA populations were assessed and assigned to the following groups: social, physical, psychological, and behavioral.

Social factors. Participants' level of education and wealth were registered during the survey stage. Level of education was captured by years of education completed. Level of wealth was defined by the number and type of commodities owned by participants. Entertainment, electrodomestic appliances, communication, and transportation commodities were selected and classified by 2 people from the community according to their ability to differentiate levels of wealth within the community, resulting in a variable ranging from 0 "no commodities owned" to 14 "ownership of the highest-valued commodities."

Physical factors. We defined the number of comorbidities by the cumulative self-report of concurrent diseases explored from a predefined list.[14] Height and weight were measured during the survey application stage following the Lohman technique.[28] Weight was measured with a portable digital scale (Tanita Model 804, Tokyo, Japan), and height was measured with a portable ultrasonic digital stadiometer (ADE, Ultraschall/Messstab/MZ10020, Hamburg, Germany). We calculated participants' body mass index (BMI) using Quetelet formula.

We assessed participants' pain using the HAQ visual analogue scale (VAS). The original VAS format was changed to a 5-category ordinal scale to accommodate cultural customs.[14] Careful inspection and palpation techniques were used to register tender and swollen joints. Active and passive joint range of movement (ROM) was measured with a goniometer. Joint ROM values were further classified as "functional" or "not functional" using reported thresholds.[29]

Grip strength in the dominant hand was evaluated as kilograms of force using a hydraulic hand dynamometer (Jamar, Sammons Preston Rolyan, Bolingbrook, IL, USA). Hip flexion and knee extension strength were measured as kilograms of force using a handheld dynamometer (Lafayette Instrument Company, Lafayette, IN, USA), following the "make" technique[30] and averaging 3 trials executed with 1-minute rests between them. We constructed a "muscle strength" variable by summing all measurements and dividing them by body weight.[31]

Psychological factors. Anxiety and depression were assessed through self-report. We evaluated self-efficacy by asking participants about the amount of confidence they had to perform their personal care and work activities using a dichotomous scale ("none-to-little" and "sufficient-to-very-much") accommodating for cultural perceptions.

Behavioral factors. Level of aerobic physical activity was assessed using the Rapid Assessment of Physical Activity questionnaire part 1 (RAPA1). The validity of this instrument has been well established[32] and it has been translated to Mexican Spanish.

Statistical analyses

Mean values and standard deviations for continuous variables and frequencies for dichotomous/categorical variables were estimated. Confidence intervals were constructed using normal and binomial distributions. Student t and χ^2 tests were used to compare mean values and frequencies, respectively. Associations between groups of risk factors for OA progression (independent variables) and the functioning tenses assessed (dependent variables) were explored using linear (LR), logistic (LogR), and ordinal logistic (OLR) hierarchical stepwise regression. Subgroup analyses were conducted for the physical function assessment, dividing the population by age (below and equal or above the mean age), and for the modifiable factors' evaluation, dividing the population by sex.

Representatives from each group of independent variables were selected according to their plausibility, model contribution, and lack of redundancy after exploring bivariate correlations. The variable(s) selected were then ordered and entered to the final models using a stepwise approach following these premises: (1) hypothetical function is the result of an abstract estimation of what is possible to do; therefore, we followed this order of entry: psychological-physical-social-behavioral; (2) experimental function is a simulation of what can be objectively done in circumscribed conditions; hence, we followed this order of entry: physical-psychological-social-behavioral; and (3) enacted function is what is actually done under determined sociocultural contexts; consequently, we followed this order of entry: social-behavioral-physical-psychological. We followed this process to decrease the chance of introducing conditional associations among independent variables that could have affected the associations with dependent variables.

Regression models' assumptions were confirmed through score tests (OLR), residual plots, Shapiro and Wilk tests,
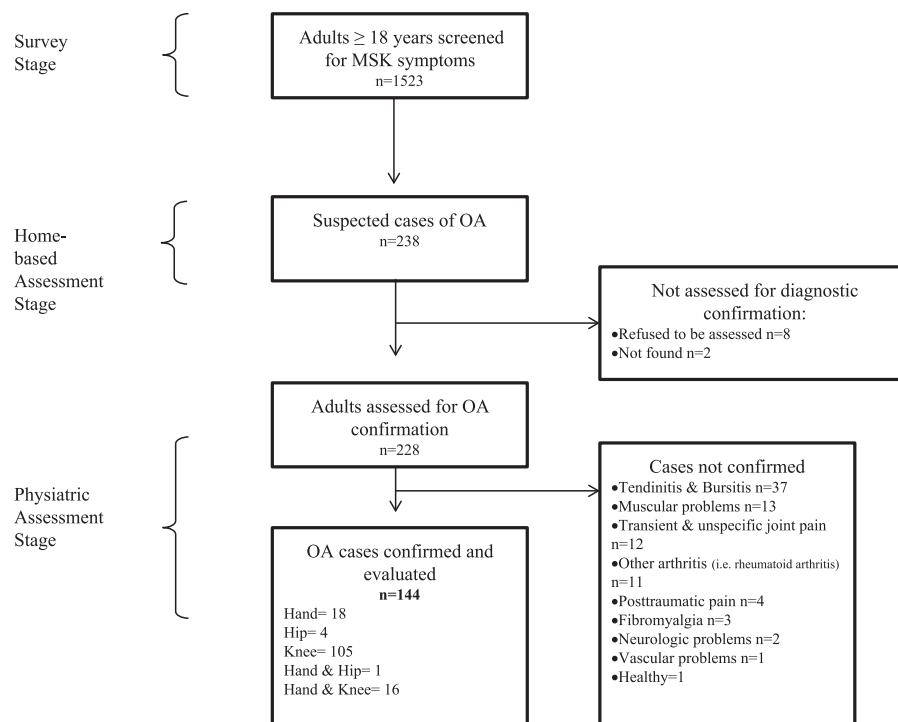
Figure 1. Study stages and participants' flowchart.

variance inflation factor (LR), and hat-squared statistics, Hosmer and Lemenshow tests, and the area under the curve (LogR). The variable "enacted personal care" was further reduced into 2 categories (presence or absence of functioning problems) due to the small number of cases observed in the disability category (n = 2). The RAPA1's 5 categories were condensed to 3 due to the small number of cases observed in the first 2.

Statistical significance was set to a $P \leq .01$ accounting for model over fitting. Analyses were conducted using STATA 12.1.

Results

In total, 228 adults with suspected OA (96%) consented to be assessed for diagnostic confirmation. The mean age and HAQ-DI scores significantly differed between persons who consented and persons who declined. The group who declined was on average younger (–11 years [95% CI: –2.7 to –19], $P = .009$) and with less disability (–0.46 HAQ-DI points [95% CI: –0.02 to –0.9], $P = .03$). Hand, hip, and/or knee OA was confirmed in 144 participants (63% [95% CI: 56 to 69]) and alternative diagnoses were established. The knee was the most commonly affected joint, followed by the hand, a combination of hand and knee, the hip, and a combination of hand and hip (see Figure 1). The mean age of the population was 62 years (SD = 12.6 years) and there were more women than men (56% vs 44%).

Physical function assessment

Table 1 shows the physical function assessment estimates for the entire population and by age. The HAQ-DI scores showed that 115 participants (80%) had mild disability. The mean distance walked during the 6MWT was 206 m, and the mean FDT score was 64 seconds. A total of 55 participants (38%) reported performance disability for work and 36 (25%) reported disability for performing leisure activities. In all, 52 (36%) and 49 (34%) participants reported preclinical disability for performing work and leisure activities, respectively. Participants ≥62 years old showed lower functioning levels than participants younger than 62 years in all the physical function evaluations.

Known modifiable factors for OA progression

Table 2 shows the descriptive estimates of all factors obtained for the whole population and by sex. The population's mean level of education was 2.3 years and the mean level of wealth score was 5. On average, participants reported 2 comorbidities and presented a median of 2 joints affected with OA. About 80% of participants reported some level of pain. Women had higher mean BMI than men, whereas men had higher mean muscle strength than women. Participants reported sufficient-to-very-much self-efficacy to perform personal care, work, and leisure activities in 81%, 49%, and 61% of the cases. Men were significantly more physically active than women.

Associations between modifiable factors for OA progression and physical function

Psychological, physical, and social factors were statistically significantly associated with the hypothetical function (HAQ-DI).

Table 1. Descriptive estimates for the physical function assessment.

FUNCTIONING TENSES	TOTAL	AGE	
	N = 144	<62Y	≥62Y
		N = 70	N = 74
Hypothetical			
HAQ-DI (%)			
Mild	115 (80)	67 (96)*	48 (65)*
Moderate	20 (14)	2 (3)*	18 (24)*
Severe	9 (6)	1 (1)*	8 (11)*
Experimental			
Mean 6MWT[a] (σ)	206 (76.9) miss = 2	239 (66)[l]	175 (77)[l] miss = 2
Mean FDT[b] (σ)	64 (32)	55 (28)[l]	73 (36)[l]
Enacted			
Personal care (%)			
Ability	94 (65)	56 (80)*	38 (51)*
Preclinical disability[c]	48 (34)	14 (20)*	34 (46)*
Disability	2 (1)	0 (0)*	2 (3)*
Work (%)			
Ability	37 (26)	26 (37)*	11 (15)*
Preclinical disability[c]	52 (36)	28 (40)*	24 (32)*
Disability	55 (38)	16 (23)*	39 (53)*
Leisure (%)			
Ability	46 (31)	28 (40)*	18 (24)*
Preclinical disability[c]	49 (34)	26 (37)*	23 (31)*
Disability	36 (25)	10 (14)*	26 (35)*
No leisure activities	13 (9)	6 (9)*	7 (9)*

Abbreviations: 6MWT: 6-minute walk test; HAQ-DI: Health Assessment Questionnaire-Disability Index; FDT: Functional Dexterity Test; miss: missing data; σ: standard deviation.
[a]Meters.
[b]Seconds obtained from the dominant hand, including penalizations for touching the board, supinating the wrist, and/or dropping the pegs.
[c]Reported modifications on the way and/or the frequency of activities' performance were always associated with the presence of osteoarthritis.
*$P < .01$ (χ^2); [l]$P < .01$ (t test).

Specifically, pain was associated with higher levels of disability, and subgroup analyses showed that physical activity level was associated with less disability in men, whereas higher self-efficacy and level of wealth were associated with less disability in women (see Table 3).

Physical, psychological, and social factors were statistically significantly associated with the experimental mobility function (6MWT). Specifically, higher levels of muscle strength, self-efficacy, and level of wealth were associated with greater distance walked (see Table 3).

Physical and psychological factors were statistically significantly associated with the experimental hand dexterity function (FDT). The significance of these hypotheses' tests remained after conducting a model re-estimation with the logarithmic transformation of FDT to eliminate residuals' heteroscedasticity and non-normality. We have not reported the estimates of the transformed model due to difficulty in interpreting unit changes (log seconds) in the dependent variable.

Behavioral, physical, and psychological factors were statistically significantly associated with personal care–enacted function. Specifically, higher levels of physical activity and self-efficacy were associated with fewer functional problems (see Table 3).

Table 2. Descriptive estimates for known factors associated with osteoarthritis progression.

RISK FACTORS	TOTAL (N = 144)	GENDER	
		MEN (N = 63)	WOMEN (N = 81)
Social			
Mean years of education (σ)	2.3 (2.5)	2.7 (2.6)	2 (2.4)
Mean level of wealth score[a] (σ)	5 (2.6)	5 (2.6)	5 (2.7)
Physical			
Mean number of comorbidities (σ)	2.14 (1.63)	2 (1.6)	2 (1.6)
Mean BMI (σ)	29 (5)	27 (4)[I]	31 (5)[I]
Pain intensity (%)			
Nothing	28 (19)	13 (21)	15 (19)
A little	27 (19)	10 (16)	17 (21)
Not very strong	28 (19)	14 (22)	14 (17)
Strong	49(34)	23 (36)	26 (32)
Very strong	12 (9)	3 (5)	9 (11)
Median number of joints affected	2	2	2
Functional range of motion in all joints (%)	125 (87)	50 (79)	75 (93)
Mean normalized muscle strength[b] (σ)	1.2 (0.3) miss = 3	1.4 (0.3)[I] miss = 1	1 (0.2)[I] miss = 2
Psychological			
Self-reported anxiety (%)	66 (46)	22 (35)	44 (54)
Self-reported depression (%)	55 (38)	21 (33)	34 (42)
Sufficient to very much self-efficacy, personal care (%)	117 (81)	51 (81)	66 (81)
Sufficient to very much self-efficacy, work (%)	70 (49)	26 (41)	44 (54)
Sufficient to very much self-efficacy, leisure (%)	80 (62) miss = 1	33 (62) miss = 1	47 (61)
Behavioral			
RAPA1 (%)			
SURL	23 (16)	7 (11)*	16 (20)*
UR	65 (45)	19 (30)*	46 (57)*
A	56 (39)	37 (59)*	19 (23)*

Abbreviations: BMI; body mass index; RAPA1: Rapid Assessment of Physical Function questionnaire part 1 (aerobic activity); SURL: sedentary to underactive regular light activities; UR: underactive regular; A: active; miss: missing values; σ: standard deviation.
[a]Owned entertainment, electrodomestic, communication, and transportation commodities, weighted by their market price and social utility.
[b]$\sum$ (muscle strength measurements)/body weight (kg force/kg weight).
*$P \le .001$ (χ^2); [I]$P \le .001$ (t test).

Behavioral and psychological factors were statistically significantly associated with work-enacted function. Specifically, higher levels of physical activity and self-efficacy were associated with a higher functional level (see Table 3).

Finally, the psychological factor self-efficacy was statistically significantly associated with leisure-enacted function. Higher levels of self-efficacy were also associated with a higher functional level (see Table 3).

Discussion

Principal findings

The experimental and enacted functions were considerably compromised in this population, overshadowing the "mild disability" observed during the hypothetical function evaluation. Although the HAQ-DI scores showed mainly mild levels of disability, participants' experimental function was low compared with that

Table 3. Regression models' estimates.

	ESTIMATES (95% CI)		
	TOTAL	MEN	WOMEN
Dependent variable			
HAQ-DI[a]			
Self-efficacy	0.7 (0.5–1.0)	1.2 (0.6–2.3)	0.5 (0.3–0.8)*
Pain	2.5 (1.4–4.4)*	1.8 (0.8–4.2)	4.0 (1.7–9.7)*
BMI	0.9 (0.8–1.0)	0.7 (0.5–1.0)	0.9 (0.8–1.1)
Muscle strength	0.1 (0.0–1.1)	0.1 (0.0–7.0)	0.1 (0.0–2.0)
Level of education	0.8 (0.6–1.1)	0.6 (0.3–1.2)	1.2 (0.7–1.9)
Level of wealth	0.8 (0.6–1.0)	0.8 (0.6–1.3)	0.7 (0.5–0.9)*
Level of physical activity[c]	0.3 (0.1–1.4)	0.0 (0.0–0.3)*	1.9 (0.2–22)
6MWT[b]			
Muscle strength	55 (22–89)*	38 (–18 to 94)	49 (–13 to 110)
Functional joint range of movement	30 (–2 to 61)	27 (–17 to 71)	37 (–20 to 95)
Self-efficacy	9 (4–15)*	10 (1–19)	10 (2–17)*
Level of education	4 (–1 to 8)	5 (–2 to 11)	3 (–4 to 10)
Level of wealth	6 (2–10)*	12 (5–18)*	3 (–2 to 9)
Level of physical activity[c]	15 (–18 to 48)	7 (–53 to 66)	16 (–28 to 59)
Personal care–enacted function[a]			
Level of education	0.9 (0.8–1.1)	0.9 (0.7–1.2)	0.9 (0.7–1.1)
Level of physical activity[b]	0.2 (0.1–0.5)*	0.1 (0.0–0.7)	0.2 (0.1–0.9)
Functional joint range of movement	0.3 (0.1–1.0)	0.2 (0.0–0.9)	0.9 (0.1–6.3)
Self-efficacy	0.2 (0.1–0.6)*	0.3 (0.1–1.7)	0.1 (0.0–0.5)*
Work enacted function[a]			
Level of wealth	1.1 (0.9–1.2)	0.9 (0.7–1.2)	1.1 (0.9–1.3)
Level of physical activity[c]	14 (3–55)*	>50(0–>50)	15 (2.7–83)*
Pain	0.8 (0.6–1.1)	0.8 (0.5–1.2)	0.8 (0.6–1.2)
Self-efficacy	12 (6–27)*	5.4 (1.4–20)*	14 (4.7–42)*
Leisure-enacted function[a]			
Level of wealth	1.1 (1.0–1.2)	1.0 (0.8–1.2)	1.2 (1.0–1.4)
Level of physical activity[d]	2.3 (0.8–6.3)	2.9 (0.4–21)	3.8 (0.9–15)
Pain	0.8 (0.6–1.1)	3 (0.4–23)	0.8 (0.6–1.1)
Self-efficacy	3.5 (1.8–7)*	4.2 (1.2–14)	3.4 (1.3–8.8)*

Abbreviations: 6MWT: 6-minute walk test; CI: confidence interval; HAQ-DI: Health Assessment Questionnaire-Disability Index.
[a]Prevalence Odds ratios obtained through ordinal logistic regression (HAQ-DI, work, and leisure-enacted function) or logistic regression (personal care–enacted function).
[b]Linear β coefficients obtained through linear regression.
[c]Sedentary to underactive regular (light activities) vs active.
[d]Sedentary to underactive regular (light activities) vs underactive regular.
*$P < .01$.

reported in the literature. For instance, the mean 6MWT scores (239 m) of the <62 years old subgroup were markedly reduced in comparison with other OA populations (400 m),[33] and their mean FDT scores (55 seconds) were considered as "nonfunctional."[25] In addition, most of the participants reported problems in performing their work and leisure activities. Considering that work is the central element of life in this population, the hypothetical function evaluation failed to capture this important aspect of disability.

All groups of factors previously linked with OA progression[7,26,27] were associated with 1 or more of the 3 functioning tenses explored. Increased levels of wealth were associated with increased mobility capability. Pain was associated with decreased capacity, whereas higher muscle strength was associated with increased mobility capability. High self-efficacy was associated with increased mobility capability and increased performance of personal care, work, and leisure activities. Higher levels of physical activity were associated with increased performance of work and leisure activities.

In women, lower levels of wealth were associated with lower capacity, which may be related to sex differences in nutritional intake.[34] Also, in women, low self-efficacy was associated with low capacity, probably due to catastrophizing.[35] Finally, in men, higher levels of physical activity were associated with increased capacity as previously reported.[36] Overall, these results show that a 1-dimensional evaluation of the concept of function is not enough to understand how a chronic illness, such as OA, may impact on people's lives. It is clear that a 3-perspective assessment of functioning produces better understanding of the disabling effects of an illness, providing more information to design interventions directed to ameliorate it.

Strengths and limitations

This study provides a community-based and theoretically driven physical function assessment of all people diagnosed with OA living in Chankom, confirming the comprehensiveness and applicability of findings to this community. Moreover, the strict methodology followed to identify and confirm OA cases increases the confidence of the associated estimates. Finally, involving local people in the development and execution of the study increases the validity of results.

The limitations of the study includes potential selection bias evidenced by the significant differences observed in the mean age and functional capacity between people who agreed and those who refused to be assessed for OA confirmation, which could have resulted in an overestimation of the presence and severity of disability. Moreover, the cross-sectional design of this study limits our causal inferences between the factors and the functioning tenses evaluated.

Implications for practice and policy

Our results underscore the importance of developing a multidimensional intervention considering gender and social, physical, psychological, and behavioral factors to decrease the disabling effects of OA in this community. There is also a need to create local and regional health policy changes addressing social, cultural, and economical barriers for the appropriate health care access of people living with OA in rural poor communities.

Implications for research

The results of this study contribute empirical value to the theoretical physical functioning tenses proposed by Glass,[10] as well as to the existence of the "preclinical disability" concept.[37] Our findings suggest that there is a difference between what people perceive they can do and what they actually do in real-life conditions. This difference is explained by contextual familial, cultural, and socioeconomic factors, which in real-life conditions act as barriers or as facilitators for the fulfillment of meaningful roles. Incorporating the concept of preclinical disability to the enacted function assessment confirmed the existence of a functioning gradient, which includes changes in frequency and/or modifications to performance before it is completely lost. It will be important to further explore these concepts around functioning in research conducted in other cultural contexts and for other chronic diseases.

Conclusions

People living with OA in Chankom present important capability and performance problems. Higher levels of wealth, muscle strength, self-efficacy, and physical activity were associated with better physical function, whereas pain was associated with more disability. A multidimensional intervention that considers gender differences is needed to address the disabling effects of OA in this community. Evaluating the concept of physical function from 3 different perspectives allowed the identification of problems that would not have been otherwise detected by following a traditional 1-dimensional approach to functioning evaluation.

Acknowledgements

Author Contributions

AL-S participated in the conception, design, data acquisition, analysis, and drafting of this manuscript. JR and IP-B participated in the conception, design, analysis, and drafting of this manuscript. JA-N, JL, MW, and SW participated in the design and drafting of this manuscript. All authors read and approved the final version of this manuscript.

REFERENCES

1. Wenham CY, Conaghan PG. New horizons in osteoarthritis. *Age Ageing.* 2013;42:272–278.
2. Chopra A, Abdel-Nasser A. Epidemiology of rheumatic musculoskeletal disorders in the developing world. *Baillieres Best Pract Res Clin Rheumatol.* 2008;22:583–604.

3. Zitko Melo P, Cabieses Valdes B. Socioeconomic determinants of disability in Chile. *Disabil Health J*. 2011;4:271–282.

4. Pelaez-Ballestas I, Sanin LH, Moreno-Montoya J, et al. Epidemiology of the rheumatic diseases in Mexico. A study of 5 regions based on the COPCORD methodology. *J Rheumatol Suppl*. 2011;86:S3–S8.

5. Alvarez-Nemegyei J, Pelaez-Ballestas I, Sanin LH, Cardiel MH, Ramirez-Angulo A, Goycochea-Robles MV. Prevalence of musculoskeletal pain and rheumatic diseases in the southeastern region of Mexico. A COPCORD-based community survey. *J Rheumatol Suppl*. 2011;86:S21–S25.

6. Leyva-Flores R, Infante-Xibille C, Gutierrez JP, Quintino-Perez F. [Persisting health and health access inequalities in Mexican indigenous population, 2006-2012]. *Salud Publica Mex*. 2013;55:S123–S128.

7. Chapple CM, Nicholson H, Baxter GD, Abbott JH. Patient characteristics that predict progression of knee osteoarthritis: a systematic review of prognostic studies. *Arthritis Care Res*. 2011;63:1115–1125.

8. Sharma L, Song J, Felson DT, Cahue S, Shamiyeh E, Dunlop DD. The role of knee alignment in disease progression and functional decline in knee osteoarthritis. *JAMA*. 2001;286:188–195.

9. Kjeken I, Dagfinrud H, Slatkowsky-Christensen B, et al. Activity limitations and participation restrictions in women with hand osteoarthritis: patients' descriptions and associations between dimensions of functioning. *Ann Rheum Dis*. 2005;64:1633–1638.

10. Glass TA. Conjugating the "tenses" of function: discordance among hypothetical, experimental, and enacted function in older adults. *Gerontologist*. 1998;38:101–112.

11. Fried LP, Bandeen-Roche K, Williamson JD, et al. Functional decline in older adults: expanding methods of ascertainment. *J Gerontol A Biol Sci Med Sci*. 1996;51:206–214.

12. Loyola-Sanchez A, Richardson J, Pelaez-Ballestas I, et al. Developing community based rehabilitation programs for musculoskeletal diseases in low-income areas of Mexico: the community- based rehabilitation for low income communities living with rheumatic diseases [CONCORD] protocol. *JMIR Res Protoc*. 2014;3:e57.

13. Darmawan J. Recommendations from the Community Oriented Program for Control of Rheumatic Disease for data collection for the measurement and monitoring of health in developing countries. *Clin Rheumatol*. 2007;26:853–857.

14. Pelaez-Ballestas I, Granados Y, Silvestre A, et al. Culture-sensitive adaptation and validation of the Community-Oriented Program for the Control of Rheumatic Diseases methodology for rheumatic disease in Latin American indigenous populations. *Rheumatol Int*. 2014;34:1299–1309.

15. SEDESOL. Informe Anual Sobre la Situación de Pobreza y Rezago Social: Chankom, Yucatán [Annual Inform on the poverty and social lag situation: Chankom, Yucatán] [in Spanish]. https://www.sedesol.gob.mx/work/models/SEDESOL/Informes_pobreza/2014/Municipios/Yucatan/Yucatan_017.pdf. Published 2010. Accessed April 20, 2014.

16. Altman R, Alarcon G, Appelrouth D, et al. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hand. *Arthritis Rheum*. 1990;33:1601–1610.

17. Altman R, Alarcon G, Appelrouth D, et al. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hip. *Arthritis Rheum*. 1991;34:505–514.

18. Altman R, Asch E, Bloch D, et al. Development of criteria for the classification and reporting of osteoarthritis. Classification of osteoarthritis of the knee. Diagnostic and Therapeutic Criteria Committee of the American Rheumatism Association. *Arthritis Rheum*. 1986;29:1039–1049.

19. Bruce B, Fries JF. The Stanford Health Assessment Questionnaire: a review of its history, issues, progress, and documentation. *J Rheumatol*. 2003;30:167–178.

20. Alvarez-Nemegyei J, Peláez-Ballestas I, Loyola-Sanchez A. Traducción y validación transcultural del instrumento Health Assessment Questionnaire al idioma Maya-Yucateco [Translation and cross-cultural validation of the Health Assessment Questionnaire to the Maya-Yucateco language] [in Spanish]. *Reumatol Clin*. 2013;9:C1–C17.

21. Bruce B, Fries JF. The Stanford Health Assessment Questionnaire: dimensions and practical applications. *Health Qual Life Outcomes*. 2003;1:20.

22. Balke B. A simple field test for the assessment of physical fitness. *Rep Civ Aeromed Res Inst US*. 1963;53:1–8.

23. Kennedy DM, Stratford PW, Wessel J, Gollish JD, Penney D. Assessing stability and change of four performance measures: a longitudinal study evaluating outcome following total hip and knee arthroplasty. *BMC Musculoskelet Disord*. 2005;6:3.

24. Schoneveld K, Wittink H, Takken T. Clinimetric evaluation of measurement tools used in hand therapy to assess activity and participation. *J Hand Ther*. 2009;22:221–235.

25. Aaron DH, Jansen CW. Development of the Functional Dexterity Test (FDT): construction, validity, reliability, and normative data. *J Hand Ther*. 2003;16:12–21.

26. Kalichman L, Hernandez-Molina G. Hand osteoarthritis: an epidemiological perspective. *Semin Arthritis Rheum*. 2010;39:465–476.

27. Dekker J, Van Dijk GM, Veenhof C. Risk factors for functional decline in osteoarthritis of the hip or knee. *Curr Opin Rheumatol*. 2009;21:520–524.

28. Lohman TG, Roche AF, Martorell R. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics; 1988.

29. Taboadela CH. *Goniometría: una herramienta para la evaluación de las incapacidades laborales*. Buenos Aires, Argentina: Asociart ART; 2007.

30. Burns SP, Spanier DE. Break-technique handheld dynamometry: relation between angular velocity and strength measurements. *Arch Phys Med Rehabil*. 2005;86:1420–1426.

31. Hurd WJ, Morrey BF, Kaufman KR. The effects of anthropometric scaling parameters on normalized muscle strength in uninjured baseball pitchers. *J Sport Rehabil*. 2011;20:311–320.

32. Topolski TD, LoGerfo J, Patrick DL, Williams B, Walwick J, Patrick MB. The Rapid Assessment of Physical Activity (RAPA) among older adults. *Prev Chronic Dis*. 2006;3:A118.

33. Jones A, Silva PG, Silva AC, et al. Impact of cane use on pain, function, general health and energy expenditure during gait in patients with knee osteoarthritis: a randomized controlled trial. *Ann Rheum Dis*. 2012;71:172–179.

34. Sharkey JR, Branch LG. Gender difference in physical performance, body composition and dietary intake in homebound elders. *J Women Aging*. 2004;16:71–90.

35. Keefe FJ, Lefebvre JC, Egert JR, Affleck G, Sullivan MJ, Caldwell DS. The relationship of gender to pain, pain behavior, and disability in osteoarthritis patients: the role of catastrophizing. *Pain*. 2000;87:325–334.

36. Strawbridge WJ, Camacho TC, Cohen RD, Kaplan GA. Gender differences in factors associated with change in physical functioning in old age: a 6-year longitudinal study. *Gerontologist*. 1993;33:603–609.

37. Fried LP, Bandeen-Roche K, Chaves PH, Johnson BA. Preclinical mobility disability predicts incident mobility disability in older women. *J Gerontol A Biol Sci Med Sci*. 2000;55:M43–M52.