Pain and falls and fractures in community-dwelling older men

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Abstract

Background: pain may reduce stability and increase falls and subsequent fractures in older men.

Objectives: to examine the association between joint pain and any pain with falls, hip and non-spine fractures in older community-dwelling men.

Design: a cohort study.

Setting and Participants: analyses included 5,993 community-dwelling men aged ≥65 years from the MrOS cohort.

Measurements: pain at hip, knee and elsewhere (any) was assessed by self-report. Men reported falls via questionnaires mailed 3× per year during the year following the baseline visit. Fractures were verified centrally. Mean follow-up time for fractures was 9.7 (SD 3.1) years. Logistic regression models estimated likelihood of falls and proportional hazards models estimated risk of fractures. Models were adjusted for age, BMI, race, smoking, alcohol use, medications use, co-morbidities and arthritis; fracture models additionally adjusted for bone mineral density.

Results: one quarter (25%, n = 1,519) reported ≥1 fall; 710 reported ≥2 falls in the year after baseline. In multivariate models, baseline pain at hip, knee or any pain increased likelihood of ≥1 fall and ≥2 falls over the following year. For example, knee pain increased likelihood of ≥1 fall (odds ratio, OR 1.44; 95% confidence interval, CI 1.25–1.65) and ≥2 falls (OR 1.75; 95% CI 1.46–2.10). During follow-up, 936 (15.6%) men suffered a non-spine fracture (n = 217, 3.6% hip). In multivariate models, baseline pain was not associated with incident hip or non-spine fractures.

Conclusions: any pain, knee pain and hip pain were each strong independent risk factors for falls in older men. Increased risk of falls did not translate into an increased risk of fractures.

Keywords: pain, fall, fracture, cohort, MrOS, older people

Introduction

Studies have shown that almost 30% of the American population over 65 years of age will fall each year [1]. Of these, 20–30% sustain moderate to severe injuries, straining costs of the healthcare system [1, 2]. Fractures are a leading cause of morbidity in the old [3]; in 2002, treatment of osteoporotic fractures suffered by the male population in the USA cost $3.2 billion, or 18% of total costs associated with osteoporosis [4]. The increased incidence of fractures with age has no single causative factor but is due to a combination of weakening bone structure, increased falls and altered nature of falls [5].

An association between pain and future falls has been well established for both chronic and acute pain [6–14]. Location of pain has in multiple studies been shown to be of importance; however, there have been conflicting reports concerning pain at the knee, especially with regards to recurrent falls [11]. The underlying mechanisms are controversial but postural instability and cognitive distraction or
impairment caused by either the pain itself or the associated depressive symptoms have been suggested.

Despite the well-established association between pain and future falls, it remains unclear whether this translates into an increased risk of fractures. Pain has in multiple studies shown to both increase and decrease bone mineral density (BMD) [15–18]. It is unclear whether increased BMD associated with pain is protective of fractures as the remodelling might lead to lower shock resistance [18–22]. A single study has examined the association between pain and future vertebral fractures in post-menopausal women, finding sufferers of low back pain to be at higher risk [23]. Patients suffering from knee osteoarthritis have in a single study been found to have increased risk of fractures even after adjusting for falls [6]. Given the availability of self-reported pain in a clinical setting, pain could be an important readily available independent risk factor for falls and fractures. The aim of the present study was to look for a possible association between self-reported hip, knee or any pain with future falls or hip or non-spine fractures in older community-dwelling men.

Methods

MrOS study

MrOS is a multicentre, prospective study of healthy ageing focusing on osteoporosis and fractures in older men. Design, measures and recruitment methods have been described previously [24, 25]. Briefly, 5,994 community-dwelling men aged 65 years or older were recruited by targeted mailing, advertisements and media outreach to local communities from March 2000 to April 2002 at six clinical sites (Birmingham, AL; Minneapolis, MN; Palo Alto, CA; Monongahela Valley near Pittsburgh, PA; Portland, OR; and San Diego, CA, USA). Local institutional review boards approved study protocol, and all participants provided written informed consent. Primary inclusion criteria were ability to walk unassisted, the absence of bilateral hip replacements, ability to provide self-reported clinical experiences and willingness to visit a clinical site for physical measurements.

Measurements

Pain

We assessed pain using self-administered questionnaires. Any pain was determined by a SF-12 questionnaire question that has shown to be both valid and reliable in similar settings [26, 27]: ‘During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?’. Pain was rated on a 5-step scale (not at all, a little bit, moderately, quite a bit and extremely), with ‘any pain’ defined as pain that was moderate or greater. This cut-off point was used as pain of lesser intensity is unlikely to impact a participant’s daily life. Hip pain was queried with the question: ‘In the past 12 months, have you had pain in or around either hip joint, including the buttock, groin or either side of the upper thigh, on most days for at least 1 month? Do not include pain from the lower back’. Participants were dichotomously classified. A similar question was asked for knee pain substituting ‘knee joint’ for ‘hip joint’.

Bone mineral density

BMD at the total hip and femoral neck was obtained using DXA scans (model QDR 4500; Hologic, Waltham, MA, USA). Extensive quality assurance protocols were used throughout, including central training and certification of technicians and regular phantom DXA scans within and across centres [25].

Falls and fractures

Participants were queried about incident falls and fractures quarterly by mail, with response rates exceeding 99%. All fractures were centrally verified by a physician adjudicator using medical records. Hip and non-spine fractures were analysed. Men were followed for fractures from baseline until 25 January 2013; mean follow-up time was 9.7 (SD 3.06) years. We defined a participant with ‘any fall’ as someone who reported at least one fall in the year after baseline, and ‘2+ falls’ as someone who reported 2+ falls in the year after baseline.

Other measurements

Demographic characteristics included age, race/ethnicity, smoking, alcohol consumption and pre-existing diseases (questions were designed as ‘have you ever been told you have X disease by a physician?’). Participants were asked to bring all prescription medications they had taken daily or almost daily for at least 1 month to the clinic visit. If a participant forgot to bring one or more medications, clinic staff obtained this information by telephone or at a return visit. All medications were verified by pill bottle examination and matched to its ingredient(s) based on the Iowa Drug Information Service (IDIS) Drug Vocabulary (College of Pharmacy, University of Iowa, Iowa City, IA, USA) [28].

Body weight (balance beam or digital scale) and height (stadiometer) as well as physical performance measurements (timed 6 m walk, chair rise and grip strength) were collected at clinic visit. The frailty definition was derived from the one used in the Cardiovascular Health Study and has been used in prior analysis of the MrOS cohort. A man was considered frail if three or more of the following five criteria were present: shrinking/sarcopenia (lowest 20% of appendicular lean mass, adjusted for height and total body fat), low activity (lowest 20% of Physical Activity for the Elderly score), weakness (lowest 20% in grip strength by BMI), slowness (slowest 20% 6 m walking speed by height) or low energy (self-reported). Men with one or two criteria were considered intermediate.

Statistical analysis

Difference in baseline characteristics between participants with or without pain was assessed using t-tests for normally
distributed continuous variables, Mann–Whitney U test for skewed continuous variables and χ² tests for categorical variables (P < 0.05). Time to event risk of hip and non-spine fractures was estimated using proportional hazard models. Likelihood of falls was estimated from logistic regression models.

Models used in the analysis were unadjusted; adjusted for age, BMI and clinical site (base model); and multivariate models adjusted for relevant covariates with two different models for physical performance status. All final multivariate models include age, BMI, clinical site, race/ethnicity, smoking, alcohol consumption, number of pain medications, number of other medications, number of co-morbidities and site-specific arthritis (knee, hip or any). Fracture models additionally included femoral neck BMD. Participants missing covariates were excluded from the specific multivariate models.

Of the 5,994 men in MrOS, 1 was excluded prior to data analysis due to missing pain data, 2 for missing BMI, 97 for missing falls data and 111 men for missing data for 2+ falls. This left 5,894 in the ‘any falls’ base model, 5,880 in the ‘2+ falls’ base model and 5,991 in the fracture base model.

Final multivariate adjusted models included 5,550 for any falls, 5,536 for 2+ falls and 5,628 for both hip and non-spine fractures.

Statistical analysis was performed using SAS v 9.x (SAS Institute Inc, Cary, NC, USA).

Results

Participants

Of 5,993 subjects with pain data, 1,218 (20.3%) reported any pain, 1,453 (24.2%) reported hip pain and 1,964 (32.8%) reported knee pain at baseline. Of 1,218 who reported any pain, 338 (27.8%) did not report either hip or knee pain. When stratifying by pain categories, there was a significant difference between pain and no pain groups for most covariates (Table 1). Those who reported pain (either any or at the hip or knee) were older (except those reporting knee pain), more likely to smoke, consumed less alcohol and had worse physical performance as well as were more likely to be frail. Those reporting pain used more medication and were also more likely to suffer from co-morbidities, especially arthritis. Mean femoral neck BMD was significantly higher for those reporting pain at knee or hip, but not for those reporting any pain. Those reporting any pain or knee pain were more likely to take bisphosphonates.

Falls

During first year of follow-up, 1,519 (25.3%) men reported any falls and 710 (11.8%) men reported 2+ falls. In unadjusted logistic regression models, men reporting any pain, knee pain and hip pain were more likely to have any falls or 2+ falls in the year after baseline than men without pain (Table 2). Adjustment for age, clinic and BMI as well as full multivariate adjustment attenuated associations, but results remained significant. The largest odds ratio for falls was seen for any pain and lowest for hip pain.

Fractures

During follow-up over a mean of 9.7 years, 936 (15.6%) men experienced a non-spine fracture and 217 (3.6%) a hip fracture. The most common locations of first non-spine fractures were ribs (n = 187, 19.98% of non-spine fractures), hip fractures (any site) (n = 186, 19.87%) and ankle (n = 85, 9.08%). In unadjusted models, men reporting any pain were more likely to experience hip or non-spine fracture during follow-up (Table 3). After adjustment for age, BMI and clinic site, this association was attenuated, but remained significant. In fully adjusted models, this was further attenuated and no longer significant. Neither hip nor knee pain was associated with hip or non-spine fractures in any models.

Discussion

Any pain, i.e. moderate or greater, was the strongest risk factor for future falls among the three pain variables analysed, with a modest association for hip pain. The increased odds ratios were not explained by age, BMI or clinical study site. Associations were attenuated when controlling for covariates, including physical performance, but significance was retained for all categories of pain. Thus, association between pain and falls was independent of physical performance, medical conditions, analgesic and other medication use.

Any pain being more strongly related to falls than hip pain or knee pain may be due to differences in how these categories of pain were assessed. For any pain, participants rated how pain interfered with their work over the past for weeks on a scale (which was dichotomised for analysis), while for the hip and knee pain questions, participants were asked about the presence of pain, aching or stiffness over the past 12 months without rating severity. This difference could have resulted in differing severities of pain being included in the any pain versus the hip and knee pain definitions. Both Arden et al. [6] and Eggermont et al. [29] reported that fall risk increased as pain intensity increased, emphasizing the importance of pain intensity. Additionally, those with higher pain intensity might be more likely to remember and subsequently report a fall. While all three pain locations are likely to compromise gait and consequent balance, it is likely that any pain, as the only category including back pain, effected gait the most.

We found no association between hip or knee pain and future hip or non-spine fractures in unadjusted models. We did find a moderate association between any pain and hip and non-spine fractures after adjusting for age, BMI and clinical site of recruitment, but there was no significant association in fully adjusted multivariate models. This finding contradicts reports by Arden et al. [6] who reported an increased risk of both hip and non-spine fractures for those reporting knee pain.
There are several plausible explanations why an increased risk of falls did not translate into an increased risk of fractures. (i) Even though we found an increased risk of falls, these falls were not of a 'character' that would result in fractures. It is possible that those who fell managed to brace themselves or the resultant force would be in a direction in which a fracture

### Table 1. Characteristics of MrOS participants by any pain, hip pain or knee pain

<table>
<thead>
<tr>
<th></th>
<th>No any pain (n = 4,775)</th>
<th>Any pain (n = 1,218)</th>
<th>P values</th>
<th>No hip pain (n = 1,433)</th>
<th>Hip pain (n = 1,042)</th>
<th>P values</th>
<th>No knee pain (n = 1,964)</th>
<th>Knee pain (n = 1,164)</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age [years], mean (SD)</strong></td>
<td>73.5 (5.8)</td>
<td>74.4 (6.1)</td>
<td>&lt;0.001</td>
<td>73.6 (5.8)</td>
<td>74.0 (6.0)</td>
<td>0.02</td>
<td>73.6 (5.8)</td>
<td>73.8 (5.9)</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>4,257 (89.2)</td>
<td>1,104 (90.6)</td>
<td>0.13</td>
<td>4,055 (89.3)</td>
<td>1,306 (89.9)</td>
<td>0.54</td>
<td>3,605 (89.5)</td>
<td>1,757 (89.5)</td>
<td>0.99</td>
</tr>
<tr>
<td><strong>History of falls, %</strong></td>
<td>1,371 (28.7)</td>
<td>272 (22.3)</td>
<td>&lt;0.001</td>
<td>1,299 (28.6)</td>
<td>344 (23.7)</td>
<td>&lt;0.001</td>
<td>1,255 (31.2)</td>
<td>388 (19.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Smoking, %</strong></td>
<td>&gt;25</td>
<td>747 (15.6)</td>
<td>291 (23.9)</td>
<td>747 (16.5)</td>
<td>291 (20.0)</td>
<td>0.58</td>
<td>449 (22.9)</td>
<td>0.01</td>
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</tr>
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<td><strong>Frailty status</strong></td>
<td>14 drinks per week</td>
<td>1,569 (32.9)</td>
<td>551 (45.4)</td>
<td>&lt;0.001</td>
<td>1,541 (34.0)</td>
<td>579 (39.9)</td>
<td>&lt;0.001</td>
<td>1,374 (34.1)</td>
<td>746 (38.1)</td>
</tr>
<tr>
<td><strong>Physical performance</strong></td>
<td>1,20 drinks per week</td>
<td>2,622 (55.0)</td>
<td>546 (44.9)</td>
<td>&lt;0.001</td>
<td>2,463 (54.3)</td>
<td>705 (48.6)</td>
<td>&lt;0.001</td>
<td>2,176 (54.1)</td>
<td>992 (50.6)</td>
</tr>
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<td><strong>History of falls, %</strong></td>
<td>2,587 (53.5)</td>
<td>551 (45.4)</td>
<td>&lt;0.001</td>
<td>2,541 (53.0)</td>
<td>731 (50.3)</td>
<td>&lt;0.001</td>
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**Notes:**
- BMI: Body mass index.
- COPD: Chronic obstructive pulmonary disease.

### Additional Notes
- There are several plausible explanations why an increased risk of falls did not translate into an increased risk of fractures.
- Despite finding an increased risk of falls, these falls were not of a 'character' that would result in fractures. It is possible that those who fell managed to brace themselves or the resultant force would be in a direction in which a fracture would not occur.
was unlikely. As no standard data were collected concerning nature of the falls or activity at time of falling, it is not possible to assess this. ii) The pain-induced inflammation that we hypothesised may lower strength of bones through bone remodelling might not have translated into an altered BMD. The level of inflammation associated with lower intensity pain might not be sufficient to cause the altered BMD reported in other studies [18–20]. No information regarding duration of pain was collected; it is possible that pain and subsequent inflammation had not been present in participants long enough to translate into lowered bone strength. (iii) It is possible that pain status changed during the follow-up, that is, some of those reporting no pain at baseline may have developed pain in subsequent years or vice versa. However, analyses that truncated follow-up at 5 years were similar to analyses with full follow-up sequent years or vice versa. However, analyses that truncated follow-up did not significantly alter our findings. Other limitations of our study are lack of pain intensity measurements, lack of pain duration measurements, possible

\[ \text{Table 2. Risk of falls by pain category in older men} \]

\[
\begin{array}{|c|c|c|}
\hline
\text{Any pain} & \text{Any falls} & 2^+ \text{ falls} \\
\hline
\text{Unadjusted, OR (95% CI)} & 2.02 (1.76–2.31) & 2.57 (2.17–3.04) \\
\text{Base model adjusted, OR (95% CI)}^a & 1.92 (1.67–2.20) & 2.39 (2.01–2.84) \\
\text{Multivariate adjusted, OR (95% CI)}^b & 1.65 (1.42–1.92) & 2.00 (1.65–2.41) \\
\text{Multivariate and physical performance, OR (95% CI)}^c & 1.55 (1.32–1.81) & 1.79 (1.47–2.19) \\
\text{Multivariate and frailty, OR (95% CI)}^d & 1.53 (1.31–1.78) & 1.82 (1.50–2.21) \\
\hline
\text{Hip pain} & & \\
\text{Unadjusted, OR (95% CI)} & 1.48 (1.50–1.69) & 1.72 (1.45–2.03) \\
\text{Base model adjusted, OR (95% CI)}^a & 1.43 (1.25–1.64) & 1.64 (1.38–1.95) \\
\text{Multivariate adjusted, OR (95% CI)}^b & 1.30 (1.12–1.50) & 1.46 (1.21–1.76) \\
\text{Multivariate and physical performance, OR (95% CI)}^c & 1.24 (1.06–1.43) & 1.37 (1.13–1.67) \\
\text{Multivariate and frailty, OR (95% CI)}^d & 1.27 (1.10–1.47) & 1.43 (1.19–1.73) \\
\hline
\text{Knee pain} & & \\
\text{Unadjusted, OR (95% CI)} & 1.62 (1.43–1.83) & 2.00 (1.71–2.35) \\
\text{Base model adjusted, OR (95% CI)}^a & 1.58 (1.39–1.79) & 1.93 (1.63–2.27) \\
\text{Multivariate adjusted, OR (95% CI)}^b & 1.44 (1.25–1.65) & 1.75 (1.46–2.10) \\
\text{Multivariate and physical performance, OR (95% CI)}^c & 1.36 (1.18–1.57) & 1.65 (1.37–1.99) \\
\text{Multivariate and frailty, OR (95% CI)}^d & 1.41 (1.23–1.62) & 1.72 (1.43–2.06) \\
\hline
\end{array}
\]

\[ ^a \text{Age, BMI and clinical site of recruitment.} \]
\[ ^b \text{Age, BMI, clinical site of recruitment, race, smoking, alcohol, analgesics, meds, co-morbidities and arthritis}. \]
\[ ^c \text{Age, BMI, clinical site of recruitment, race, smoking, alcohol, analgesics, meds, co-morbidities, arthritis, walking speed, grip strength and ability to rise from chair.} \]
\[ ^d \text{Age, BMI, clinical site of recruitment, race, smoking, alcohol, analgesics, meds, co-morbidities, arthritis and frailty.} \]

\[ \text{Table 3. Risk of fractures by pain category in older men} \]

\[
\begin{array}{|c|c|c|}
\hline
\text{Any pain} & \text{Hip fractures} & \text{Non-spine fractures} \\
\hline
\text{Unadjusted, HR (95% CI)} & 1.35 (0.99–1.84) & 1.16 (0.98–1.37) \\
\text{Base model, HR (95% CI)}^a & 1.42 (1.04–1.94) & 1.31 (1.12–1.53) \\
\text{Multivariate adjusted, HR (95% CI)}^b & 1.16 (0.82–1.63) & 1.18 (0.99–1.40) \\
\text{Multivariate and physical performance, OR (95% CI)}^c & 1.00 (0.69–1.45) & 1.11 (0.92–1.32) \\
\text{Multivariate and frailty, OR (95% CI)}^d & 1.01 (0.71–1.44) & 1.09 (0.91–1.30) \\
\hline
\text{Hip pain} & & \\
\text{Unadjusted, HR (95% CI)} & 1.09 (0.80–1.49) & 1.11 (0.95–1.31) \\
\text{Base model, HR (95% CI)}^a & 1.08 (0.80–1.47) & 1.15 (1.00–1.34) \\
\text{Multivariate adjusted, HR (95% CI)}^b & 1.04 (0.75–1.46) & 1.16 (0.99–1.36) \\
\text{Multivariate and physical performance, OR (95% CI)}^c & 0.98 (0.69–1.39) & 1.18 (1.00–1.39) \\
\text{Multivariate and frailty, OR (95% CI)}^d & 0.95 (0.68–1.33) & 1.13 (0.96–1.33) \\
\hline
\text{Knee pain} & & \\
\text{Unadjusted, HR (95% CI)} & 1.21 (0.91–1.60) & 1.05 (0.90–1.22) \\
\text{Base model, HR (95% CI)}^a & 1.19 (0.90–1.58) & 1.09 (0.95–1.25) \\
\text{Multivariate adjusted, HR (95% CI)}^b & 1.17 (0.86–1.59) & 1.10 (0.95–1.28) \\
\text{Multivariate and physical performance, OR (95% CI)}^c & 1.10 (0.80–1.52) & 1.06 (0.91–1.24) \\
\text{Multivariate and frailty, OR (95% CI)}^d & 1.11 (0.81–1.52) & 1.07 (0.92–1.25) \\
\hline
\end{array}
\]

\[ ^a \text{Age, BMI and clinical site of recruitment.} \]
\[ ^b \text{Age, BMI, clinical site of recruitment, race, smoking, alcohol, analgesics, meds, co-morbidities, arthritis and femoral neck BMD}. \]
\[ ^c \text{Age, BMI, clinical site of recruitment, race, smoking, alcohol, analgesics, meds, co-morbidities, arthritis, femoral neck BMD, walking speed, grip strength and ability to rise from chair.} \]
\[ ^d \text{Age, BMI, clinical site of recruitment, race, smoking, alcohol, analgesics, meds, co-morbidities, arthritis and femoral neck BMD}. \]

\[ \text{iv) Non-spine fractures are a heterogeneous group and risk factors for fracture in different skeletal locations likely differ [30]. We found no association between pain and non-spine fractures, nor with hip fractures—the most clinically important type of fracture.} \]

\[ \text{The strengths of our study are the large, well-characterised cohort with a high rate of follow-up and centralised verification of fractures. A limitation of our study is time between assessment of pain and incidence of fracture; however, truncating follow-up did not significantly alter our findings.} \]
under-reporting of falls and limited data concerning use of non-prescription medications, specifically analgesics. The MrOS cohort consists mainly of white, community-dwelling, relatively healthy men, which might reduce generalisability of these findings. In summary, we confirmed that complaints of pain, whether at knee, hip or any site, were associated with significantly increased risk of future falls in older men. We did not find an association between pain and fractures. Future studies should account for intensity of pain at all locations, pain duration and use of non-prescription analgesics. Datasets with repeated measures of pain over time such that pain assessments are available in closer temporal proximity to subsequent fractures may shed more light on the association between pain and fractures.

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**Key points**

- Self-reported pain is readily available and has the potential to increase risk of falls as well as fractures.
- In several studies, self-reported pain at hip, knee or elsewhere was an independent risk factor for falls in older men.
- Self-reported pain was not associated with an increased risk of fractures in community-dwelling men.

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**Conflicts of interest**

None declared.

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**References**

Domains of importance to the quality of life of older people from two Swiss regions

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Abstract

Background: quality of life (QoL) is a subjective perception whose components may vary in importance between individuals. Little is known about which domains of QoL older people deem most important.

Objective: this study investigated in community-dwelling older people the relationships between the importance given to domains defining their QoL and socioeconomic, demographic and health status.

Methods: data were compiled from older people enrolled in the Lc65+ cohort study and two additional, population-based, stratified random samples (n = 5,300). Principal components analysis (PCA) was used to determine the underlying domains among 28 items that participants defined as important to their QoL. The components extracted were used as dependent variables in multiple linear regression models to explore their associations with socioeconomic, demographic and health status.

Results: PCA identified seven domains that older persons considered important to their QoL. In order of importance (highest to lowest): feeling of safety, health and mobility, autonomy, close entourage, material resources, esteem and recognition, and social and cultural life. A total of six and five domains of importance were significantly associated with education and age, respectively.

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