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# Driving Difficulties in Patients With Axial Spondyloarthritis: Results From the Scotland Registry for Ankylosing Spondylitis

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**Objective.** To describe the driving difficulties experienced by individuals with axial spondyloarthritis (SpA), and to characterize associated clinical and sociodemographic features and impact on work.

**Methods.** The Scotland Registry for Ankylosing Spondylitis (SIRAS) is a cohort study of patients with a clinical diagnosis of axial SpA. Baseline information was collected on clinical and patient-reported measures and work participation measures (using the Work Productivity and Activity Impairment Questionnaire: Specific Health Problem [WPAI:SHP]). Patient-rated difficulties with 9 driving tasks were used in a factor analysis, and relationships between driving difficulty and work participation were investigated.

**Results.** In total, 718 patients provided data for analysis, of which 642 (89%) had some difficulty with at least 1 driving task, and 72 (10%) had some difficulty with all 9 tasks. Three domains of driving difficulty were identified: dynamic driving scenarios, crossing traffic, and the physical act of driving. Chronic widespread pain, knee and back pain, fatigue, high disease activity, and anxiety/depression were significantly associated with reporting driving difficulties across all 3 domains, particularly the physical act of driving. After adjusting for sociodemographic, disease activity, physical and mental health, driving difficulties in each domain were associated with a 2–3 times increased likelihood of restricted work productivity and with an increased risk of sickness absence in the past 7 days.

**Conclusion.** Driving difficulties are common in individuals with axial SpA and impact on work, even after adjusting for clinical status. Improving understanding and awareness of driving disability will help direct advice and resources to enable individuals to remain independent and economically active.

## INTRODUCTION

Driving is a key functional ability that plays an integral role in daily life, facilitating access to shops and health care, social activities, and participation in work. Driving is a very common choice compared with other forms of transportation because it offers personal control and autonomy (1). This is particularly the case in sparsely populated areas, where the car provides the only opportunity for traveling long distances because of limited public transport options. Among people with reduced mobility, driving is often the only option to retain independent mobility (2). Not surprisingly, therefore, having to give up driving has been found to be associated with social isolation, restricted mobility, and depression (3,4).

Driving presents a unique set of challenges for those with musculoskeletal disease (5). In a recent cross-sectional survey of older drivers, Kandasamy et al (6) found that musculoskeletal health conditions were the most prevalent self-reported diagnoses and were associated with the greatest reduction in driving over the past year. Yet surprisingly, it has received little attention. The limited number of studies that we found predominantly focused on individuals with rheumatoid arthritis (RA) (7,8). The most common clinical manifestations of axial spondyloarthritis (SpA) affect the neck and spine, and yet, we know very little about how axial SpA impacts driving ability (9). Individuals with axial SpA are usually of working age when diagnosed and therefore live with functional impairment throughout their working life and into older

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**SIGNIFICANCE & INNOVATIONS**

- Driving difficulties are common in patients with axial spondyloarthritis and are associated with restricted work participation.
- There is a need for a standardized approach to assessing driving difficulties that focuses on the full range of issues.
- The characterization of specific driving difficulties domains forms a useful basis for developing practical solutions to support driving.

age. It is only by developing an understanding of which aspects of driving are affected in axial SpA, and the relationship between these and the clinical and sociodemographic features of axial SpA, that we may be able to develop appropriate solutions.

Furthermore, driving is important for participating in work. In the UK, of 26.5 million workers in England and Wales age 16–74 years, 16.7 million either drove themselves or car-shared to work (10). In rural areas, almost three-fourths of workers travel by car to work (10). In a snapshot of the UK government's Find a Job database, 1 in 5 jobs required the applicant to have a driving license (11). Equivalent data from the US show that an even greater number (115 million US workers [90%]) commute to work in their car, mostly (76%) alone (12). The ability to work is important to individuals with axial SpA, and we have recently identified that commuting to/from work can be a particular issue (13). However, to our knowledge, little is currently known about the prevalence of driving difficulties experienced by individuals with axial SpA, the nature of those difficulties, their association with sociodemographic and clinical features of the disease, and the impact of driving difficulties in work ability. We investigated these questions in a comprehensive countrywide register.

## PATIENTS AND METHODS

**Setting and patients.** The Scotland Registry for Ankylosing Spondylitis (SIRAS) is a disease register of patients with a clinical diagnosis of axial SpA in Scotland. The study protocol has been published elsewhere (14). Briefly, all patients seen in secondary care rheumatology departments in Scotland between October 2010 and October 2013 with a clinical diagnosis of ankylosing spondylitis were recruited. Clinical data were collated from medical records, and socioeconomic/lifestyle characteristics were determined by postal questionnaire. All individuals who had indicated in the baseline questionnaire that they currently drove a motor vehicle were included in the first part of the current analysis, and current drivers who were also in paid employment were included in the second part of the analysis.

**Measures.** *Clinical and sociodemographic factors.* Clinical measures collected from medical notes included Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) scores (15) and relevant medical history about peripheral joint disease and uveitis. For the purposes of this analysis, BASDAI scores were dichotomized to indicate either low (<4) or high (≥4) disease activity. This cutoff is consistent with guidelines from the UK National Institute for Health and Clinical Excellence for the use of tumor necrosis factor inhibition therapy. The baseline questionnaire collected information on pain experienced "for at least a day" during the past month and invited participants to indicate the site(s) on a 35-segment body manikin. From this, participants were classified as having the following: chronic widespread pain (coded according to the Manchester definition) (16); widespread pain (not chronic); or regional pain. Regional pain sites of particular interest included the knee, lower back, and mid-upper spine (cervical and thoracic). Information on fatigue was collected using the Chalder Fatigue Scale (a score ≥4 of 11 indicating moderate-severe fatigue) (17). Individuals' current experience of any anxiety or depression was assessed using a dichotomized score from the anxiety/depression domain (1 item) within the 3-level EuroQol 5-domain (EQ-5D-3L) questionnaire (18).

Sociodemographic information collected in the baseline questionnaire included the participant's age, sex, level of education, current employment status, and whether their paid employment involved mainly sedentary or physical work. The Scottish Index of Multiple Deprivation (SIMD) is a postcode-derived index comprised of indicators of deprivation across the domains of employment, income, health, education, skills and training, crime, housing, and geographic access to services (19). SIMD score was ranked by quintiles, where 1 = resident in most deprived area, and 5 = resident in most affluent area; these 5 values were reduced to 2 levels for subsequent analysis due to the distribution of participants, with scores of 1 and 2 representing those in the most deprived areas. Individuals were also classified according to their access to an urban area: living in an urban area (settlement ≥10,000 people); living within an average drive time of ≤30 minutes to an urban area (accessible); or living in a setting with an average drive time of >30 minutes to an urban area (rural).

*Driving difficulties.* Assessment of driving difficulty was informed by a list of specific driving tasks that are assessed by the Scottish Driving Assessment Service (Table 1). For each item on the list of 9 tasks, participants were asked to rate their ability to perform that task on a Likert scale from 0 (no difficulty) to 3 (severe difficulty). For descriptive purposes, we tabulated the proportion of current drivers who had any difficulty with each task (i.e., a score >0 on each task).

*Work absenteeism and presenteeism.* The Work Productivity and Activity Impairment Questionnaire: Specific Health Problem (WPAI:SHP) was used to assess whether individuals had missed any work due to their axial SpA in the past 7 days, as well as their percent impairment while working (0–100%, where 0% reflects no effect of axial SpA on work, and 100% reflects being completely prevented from working) due to their axial SpA (20).

**Table 1.** Frequency of having any difficulty with each driving task (n = 718)*

| | Value |
|---|---|
| Getting in or out of the motor vehicle | 515 (71.7) |
| Maneuvering the motor vehicle | 254 (35.4) |
| Sitting in the motor vehicle for long periods | 561 (78.1) |
| Turning right at traffic lights or across traffic | 205 (28.6) |
| Crossing major road or T-junctions | 213 (29.7) |
| Merging with fast moving traffic | 184 (25.6) |
| Going through roundabouts | 138 (19.2) |
| Making lane changes | 147 (20.5) |
| Driving through a congested high street | 130 (18.1) |

* Values are the number (%).

**Statistical analysis.** *Exploratory factor analysis.* An exploratory factor analysis was conducted using a polychoric correlation matrix of the ordinal driving difficulty scores for the 9 tasks. A principal axis factor extraction method was used, as this method does not require a normal distribution of item scores (21). As it was expected that identified factors may be correlated to some degree, identified factors were rotated using the oblique oblimin method, and factor loadings of >0.3 were considered meaningful (22,23). The number of extracted factors to retain was determined by inspecting eigenvalues of the factors on a scree plot in relation to those obtained by parallel analysis. Parallel analysis is a simulation method which compares the eigenvalues from the factor analysis to those generated by a simulated data set (21). This comparison gives an indication of the point at which extracted factors are potentially meaningful and at what point they become no more informative than random noise.

Using a regression-based method, factor scores were then generated for each individual for each identified factor. This method generates a factor score for each participant using the coefficients of each item on the factor, adjusted for correlations between items. This method is considered superior to generating a score based on simply multiplying item scores by their factor loadings, as it takes correlations between items into account (22,24).

*Regression analyses.* Due to the distribution of factor scores, scores were dichotomized based on an upper quartile cutoff to identify individuals with a high level of difficulty in each driving domain. The upper quartile cutoff was chosen in order to identify individuals who struggled the most with each driving domain. Associations between clinical and sociodemographic factors and the identified driving difficulty domains were investigated within all current drivers using univariate logistic regression.

Among current drivers who were in paid employment, we subsequently focused on relationships between domains of driving difficulty and work-related outcomes. We investigated 2 models for the relationships between each identified driving difficulty domain and presenteeism and absenteeism (any in past 7 days) using logistic regression. Due to the distribution of presenteeism scores, a dichotomized variable was generated in order to investigate relationships between each driving difficulty domain and the upper quartile of presenteeism scores (which, in our sample, was represented by scores ≥40% impairment). In the first model, we adjusted for all sociodemographic and clinical variables, with the exception of self-reported anxiety/depression (anxiety/depression item within the EQ-5D-3L questionnaire), and in the second, we included the self-reported anxiety/depression score. We chose to show both models, as it is not clear if anxiety and depression lies on the path between driving difficulties and work factors or is a confounding factor. SIRAS received ethical approval from the North of Scotland Research Ethics Service (reference: 09/S0802/7).

## RESULTS

**Participant characteristics.** Figure 1 illustrates the flow of SIRAS participants who were included in the current analyses. The mean ± SD age of current drivers who had complete data on the driving difficulty items and could therefore be included in the factor analysis was 52 ± 12 years, 23% were female, and 66% were either employed, a student, or worked full time (unpaid) in the home.

Full clinical and sociodemographic characteristics of the study sample of current drivers who had complete data on the

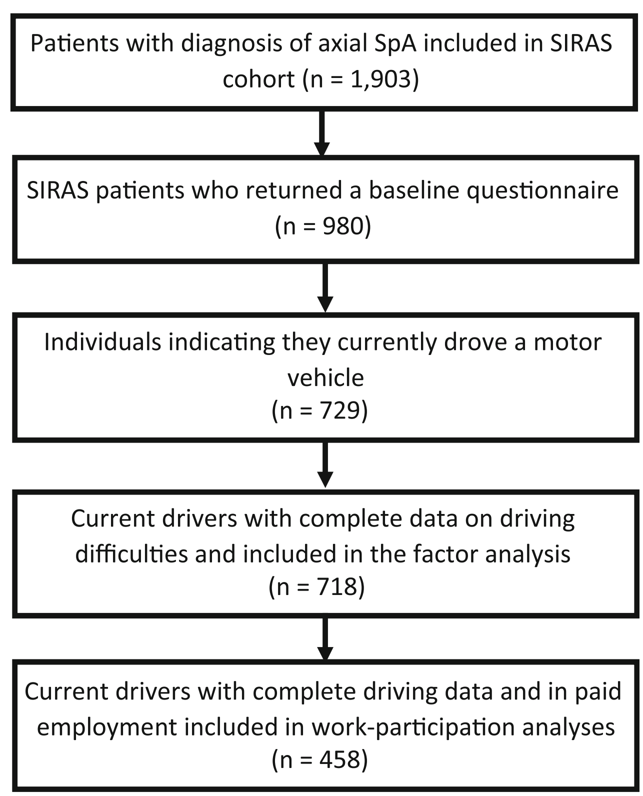


**Figure 1.** Flow chart of Scotland Registry for Ankylosing Spondylitis (SIRAS) participants included in the current analyses. SpA = spondyloarthritis.

**Table 2.** Sociodemographic characteristics of current drivers with axial spondyloarthritis (n = 718)*

| Characteristic | Value |
|---|---|
| Age, mean ± SD years | 52 ± 12 |
| Sex | |
| Male | 519 (72.3) |
| Female | 168 (23.4) |
| Missing | 31 (4.3) |
| Employment status | |
| Full-/part-time/student/full-time unpaid work at home | 470 (65.5) |
| Retired | 108 (15.0) |
| Retired early or unemployed due to health/seeking work | 134 (18.7) |
| Missing | 6 (0.8) |
| Job type | |
| Mainly desk/sedentary | 277 (38.6) |
| Mainly physical/labor intensive | 174 (24.2) |
| Not in paid employment | 256 (35.7) |
| Missing | 11 (1.5) |
| Education | |
| University/further degree | 184 (25.6) |
| Secondary school | 208 (29.0) |
| Apprenticeship | 88 (12.3) |
| Further education, college | 231 (32.2) |
| Missing | 7 (1.0) |
| Deprivation status | |
| 1, most deprived | 65 (9.1) |
| 2 | 100 (13.9) |
| 3 | 168 (23.4) |
| 4 | 188 (26.2) |
| 5, most affluent | 156 (21.7) |
| Missing | 41 (5.7) |
| Rural/urban status | |
| Large/other urban area | 341 (47.5) |
| Accessible small town or rural | 212 (29.5) |
| Remote small town or rural | 124 (17.3) |
| Missing | 41 (5.7) |

* Values are the number (%) unless indicated otherwise.

driving difficulty items are presented in Tables 2 and 3. In all, 718 of 729 current drivers had complete data on the driving difficulty items. Of the 718 current drivers who had complete data on driving difficulty items, 642 (89%) had some difficulty with at least 1 driving task, and 72 (10%) had some difficulty with all 9 tasks. The median number of difficulties (i.e., having any difficulty with each task) was 2 (interquartile range 1–4). Getting in/out of a car and sitting for long periods were the most frequently reported difficulties. The proportion of drivers with any difficulty in each of the driving tasks is presented in Table 1.

**Factor analysis.** The results from the parallel analysis indicated that 3 domains, which accounted for 84% of the variance in the factor model, should be retained (see Supplementary Figure 1, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.24595). Loadings between each driving item and the 3 domains are shown in Supplementary Table 1, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.24595.

These 3 domains appeared to reflect the following driving domains: dynamic driving scenarios (domain 1); crossing traffic (domain 2); and physical act (and comfort) of driving (domain 3). Correlations between the generated factor scores are provided in Supplementary Table 2, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.24595, and as expected, indicated that difficulties across the 3 domains were associated with one another.

**Characteristics associated with driving difficulty domains.** Next, the univariate relationships between the 3 identified domains of driving difficulty and clinical and sociodemographic characteristics were explored (Table 4). Some variations were shown. For example, patients with a history of peripheral joint disease were more likely to report difficulties crossing traffic and with the physical act of driving. In contrast, individuals with higher disease activity, regional, widespread, or chronic widespread pain, knee pain, lower back pain, mid-upper spinal pain, and moderate-severe fatigue were more likely to have difficulties with all 3 driving difficulty domains.

**Table 3.** Clinical characteristics of current drivers with axial spondyloarthritis (n = 718)*

| Characteristic | Value |
|---|---|
| Disease activity | |
| BASDAI score <4 | 338 (47.1) |
| BASDAI score ≥4 | 234 (32.6) |
| Missing | 146 (20.3) |
| Pain status | |
| No pain | 129 (18.0) |
| Regional or nonchronic widespread pain | 241 (33.6) |
| Chronic widespread pain | 343 (47.8) |
| Missing | 5 (0.7) |
| Fatigue | |
| CFS score <4 | 411 (57.2) |
| CFS score ≥4 | 290 (40.4) |
| Missing | 17 (2.4) |
| Knee pain | 220 (30.6) |
| Lower back pain | 415 (57.8) |
| Mid-upper spinal pain | 368 (51.3) |
| PJD | |
| No history of PJD | 304 (42.3) |
| History of PJD | 413 (57.5) |
| Missing | 1 (0.1) |
| Uveitis | |
| No history of uveitis | 396 (55.2) |
| History of uveitis | 239 (33.3) |
| Missing | 83 (11.6) |
| Anxiety/depression | |
| EQ-5D-3L level 1 (no anxiety/depression) | 451 (62.8) |
| EQ-5D-3L level 2–3 (any anxiety/depression) | 266 (37.1) |
| Missing | 1 (0.1) |

* Values are the number (%). BASDAI = Bath Ankylosing Spondylitis Disease Activity Index; CFS = Chalder Fatigue Scale; EQ-5D-3L = 3-level EuroQol 5-domain; PJD = peripheral joint disease.

**Table 4.** Univariate associations between clinical and sociodemographic characteristics and different driving difficulty domains*

| | Dynamic driving scenarios, domain 1† | Crossing traffic, domain 2† | Physical act of driving, domain 3† |
|---|---|---|---|
| Age, per year (n = 678) | 1.01 (0.99–1.02) | 1.02 (1.00–1.03) | 1.00 (0.99–1.01) |
| Sex (n = 687) | | | |
| Male | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Female | 1.40 (0.95–2.07) | 0.89 (0.59–1.34) | 1.94 (1.34–2.87) |
| Deprivation (n = 677) | | | |
| Category 3–5, least deprived | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Category 1–2, most deprived | 1.35 (0.91–2.01) | 1.63 (1.11–2.40) | 1.91 (1.32–2.78) |
| Rural/urban status (n = 677) | | | |
| Large/other urban area | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Accessible small town or rural | 1.21 (0.82–1.79) | 0.89 (0.59–1.32) | 0.75 (0.51–1.12) |
| Remote small town or rural | 0.94 (0.57–1.53) | 0.92 (0.57–1.48) | 1.12 (0.72–1.75) |
| Disease activity (n = 572) | | | |
| BASDAI score <4 | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| BASDAI score ≥4 | 1.48 (1.01–2.18) | 1.87 (1.27–2.75) | 4.67 (3.15–6.96) |
| Widespread body pain (n = 713) | | | |
| No pain | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Regional or widespread pain | 2.26 (1.20–4.26) | 1.99 (1.07–3.71) | 4.71 (1.95–11.36) |
| Chronic widespread pain | 4.04 (2.22–7.34) | 3.78 (2.11–6.78) | 14.48 (6.21–33.78) |
| Fatigue (n = 701) | | | |
| CFS score <4 | 1.00 Ref. | 1.00 (Ref.) | 1.00 (Ref.) |
| CFS score ≥4 | 2.76 (1.95–3.93) | 1.95 (1.39–2.76) | 5.26 (3.66–7.56) |
| Knee pain (n = 713) | | | |
| No knee pain | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Knee pain | 1.87 (1.32–2.67) | 1.75 (1.23–2.50) | 3.70 (2.61–5.24) |
| Lower back pain (n = 713) | | | |
| No lower back pain | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Lower back pain | 1.95 (1.36–2.80) | 1.70 (1.19–2.43) | 3.92 (2.65–5.79) |
| Mid-upper spinal pain (n = 713) | | | |
| No mid-upper spinal pain | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Mid-upper spinal pain | 2.20 (1.54–3.13) | 2.20 (1.54–3.13) | 2.96 (2.08–4.22) |
| PJD (n = 717) | | | |
| No history of PJD | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| History of PJD | 1.24 (0.87–1.74) | 1.65 (1.16–2.34) | 1.54 (1.09–2.16) |
| Uveitis (n = 635) | | | |
| No history of uveitis | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| History of uveitis | 1.46 (1.01–2.10) | 1.38 (0.96–1.99) | 1.09 (0.76–1.56) |
| EQ-5D-3L anxiety/depression score (n = 717) | | | |
| Level 1 (none) | 1.00 (Ref.) | 1.00 (Ref.) | 1.00 (Ref.) |
| Level 2–3 (some) | 2.28 (1.62–3.22) | 2.31 (1.64–3.27) | 4.83 (3.40–6.87) |

* Values are the odds ratio (95% confidence interval). BASDAI = Bath Ankylosing Spondylitis Disease Activity Index; CFS = Chalder Fatigue Scale; EQ-5D-3L = 3-level EuroQol 5-domain; PJD = peripheral joint disease; Ref. = reference.
† Worst quartile.

**Driving difficulties and work.** Participants who had retired early or who were unemployed due to their health were more likely to have difficulties with all 3 driving difficulty domains when compared with employed individuals (dynamic driving scenarios odds ratio [OR] 1.97 [95% confidence interval (95% CI) 1.30–3.00]; crossing traffic OR 2.65 [95% CI 1.75–4.01]; physical act of driving OR 3.81 [95% CI 2.54–5.71]). Individuals in paid employment who had predominantly physical or labor-intensive jobs were more likely than those who had sedentary jobs to have driving difficulties, in particular, with the physical act of driving (OR 1.76 [95% CI 1.11–2.79]). Individuals who had only completed secondary school or further college education were also more likely to have difficulty with the physical act of driving relative to those who had completed a university degree (OR 1.95 [95% CI 1.23–3.11] and OR 1.64 [95% CI 1.04–2.61], respectively).

Sixty-four percent of individuals in paid employment reported that work productivity was affected to some degree by their axial SpA, and 8% had missed some work in the past 7 days. Relationships between each driving difficulty domain and the upper quartile of presenteeism scores (>40% presenteeism) and any absenteeism are presented in Table 5. Individuals who had complete data (and who were therefore included in these models) did not consistently differ from those with missing data on most sociodemographic and clinical variables when we checked this using chi-square tests. However, those

**Table 5.** Relationships between each driving difficulty domain and work participation (presenteeism and absenteeism) due to axial spondyloarthritis, adjusted for clinical and sociodemographic factors*

| Driving difficulty domains | Presenteeism† | | Absenteeism‡ | |
|---|---|---|---|---|
| | Model 1 (n = 273)§ | Model 2 (n = 272)¶ | Model 1 (n = 220)§ | Model 2 (n = 220)¶ |
| Dynamic driving situations# | 2.81 (1.28–6.17) | 2.80 (1.26–6.25) | 4.03 (1.20–13.51) | 4.13 (1.14–15.04) |
| Crossing traffic# | 2.54 (1.18–5.50) | 2.48 (1.12–5.54) | 3.76 (1.20–11.79) | 3.83 (1.10–13.32) |
| Physical act of driving# | 2.31 (1.02–5.19) | 2.46 (1.06–5.72) | 2.89 (0.79–10.53) | 4.87 (1.19–19.95) |

* Values are the odds ratio (95% confidence interval).
† Worst quartile of presenteeism scores.
‡ Any in past 7 days due to ankylosing spondylitis.
§ Model 1 for each driving difficulty factor was adjusted for sex, age, education, level of deprivation, access to urban area, job type, Bath Ankylosing Spondylitis Disease Activity Index score, chronic widespread pain status, knee pain, lower back pain, mid-upper spinal pain, Chalder fatigue scale, peripheral joint disease, and uveitis.
¶ Model 2 for each driving difficulty factor was adjusted for Model 1 factors and the 3-level EuroQol 5-domain anxiety/depression score.
# Worst quartile.

with missing data were more likely to report any anxiety/depression (39%) than those without (28%), and a higher percentage of those without missing data in the presenteeism model had a history of peripheral joint involvement (57% versus 47%). These differences are unlikely to affect interpretation of models, in particular, as models were adjusted for these factors. After adjustment for sociodemographic and clinical characteristics, each of the identified driving difficulty domains was associated with work-related presenteeism and absenteeism due to axial SpA.

## DISCUSSION

Driving difficulties are common in patients with axial SpA and are associated with restricted work participation. Almost 90% of individuals reported difficulty with at least 1 driving task, and 10% reported some difficulty with all 9 tasks. We identified 3 specific domains of driving difficulty in axial SpA: dynamic driving scenarios; crossing traffic; and the physical act of driving. Chronic widespread pain, knee and back pain, fatigue, high disease activity, and anxiety/depression were associated with driving difficulties across all 3 domains, in particular, the physical act of driving. After adjusting for a range of clinical and sociodemographic factors, including disease activity, each driving difficulty domain was associated with a greater likelihood of work presenteeism and absenteeism. Those with a physically demanding job were more likely to report difficulties with the physical act of driving.

There are some limitations to consider when interpreting these findings. Within SIRAS, patients were identified based on clinical diagnosis. No formal criteria were applied (e.g., the Assessment of SpondyloArthritis international Society criteria) because these criteria are not routinely collected in clinic. Therefore, the proportion of SIRAS participants fulfilling them is not clear. However, these are classification criteria and are not intended to be used as diagnostic criteria. Thus, we argue that participants identified because of a clinical diagnosis are more closely representative of a real-world clinical population. We have identified factors associated with driving difficulties; however, we were unable to account for the full range of factors associated with impaired driving, for example, range of joint movement, strength, reaction time, and other comorbidities, such as neurologic conditions that may impair driving. The data collected for this research were cross-sectional, so causation cannot be inferred. While we demonstrated that individuals with driving difficulties were more likely to report sickness absence in the past 7 days, the numbers reporting absenteeism were small, and therefore we cannot determine the magnitude of effect with any certainty.

Most studies to date exploring driving difficulties in rheumatic disease have either tended to use very broad questions (e.g., do you have difficulties with driving) or focus only on physical aspects of driving (7). This study enables us to further define the concept of driving disability and determine which aspects of driving cause difficulties. The factors identified have content validity and match those identified in other studies regarding difficulties with the physical act of driving, dynamic driving scenarios, and crossing traffic (5,9,25). They also reflect the types of adaptations individuals with musculoskeletal conditions report making in order to keep driving (such as making detours to avoid certain routes that involve crossing traffic or dynamic driving situations, and choosing a car to improve the physical act and comfort of driving) (5,13,26). The study also suggests the importance of disease-associated factors such as pain, fatigue, disease activity, and anxiety/depression in specific driving difficulties. Our findings suggest that driving difficulties are complex, so tailored solutions might be needed for people with axial SpA to enable them to keep their mobility. This also offers opportunities for targeting patient-focused treatment.

The characterization of specific driving difficulties domains forms a useful basis for developing practical solutions to support driving. In a recent review, Cammarata et al (8) identified a series of environmental factors that influenced driving in individuals with arthritis (including RA, ankylosing spondylitis, systemic lupus erythematosus, osteoarthritis, and gout). The driving domains identified in this study map onto a number of these environmental factors, which reflect opportunities for targeting patient-focused treatment. For example, difficulties getting in/out of a car maps onto products and technology (car features and modifications) and features of the natural environment (accessible car parking). Difficulties with dynamic driving situation relate to support and relationships (driving with a passenger) and attitudes (route avoidance and use [or not] of driving aids).

In keeping with studies in other musculoskeletal conditions, we have shown that disease activity, widespread pain, back pain, and fatigue are associated with driving difficulties (7,9). However, we have additionally demonstrated that these features were associated with driving difficulties across all 3 domains, especially the physical act and comfort of driving. Holden et al reported that neck pain had a significant impact on driving in individuals with axial SpA (9), particularly in driving scenarios that involved merging with traffic and crossing junctions, and some participants indicated that they were completely dependent on a passenger in order to safely undertake these maneuvers. Similarly, in a study of driving difficulties in patients referred to a Chronic Pain Rehabilitation Service (not specifically with arthritis), Fan et al (26) found that the main factors limiting driving were pain, fatigue, and limited joint mobility/stiffness. Patients with pain (predominantly neck and back pain) reported difficulties with the physical act and comfort of driving (sitting/getting in and out of a car) and dynamic driving scenarios, e.g., shoulder checks and merging with traffic.

Several medications commonly prescribed for pain, including opioids and anticonvulsants, have been associated with various measures of impaired driving performance (27). We recently found that side effects of opiates were a problem for those with axial SpA operating machinery and driving as part of their job (13). While clinical guidelines aim to reduce the use of opioids for chronic pain (28,29), they are commonly prescribed to people with musculoskeletal conditions (30,31). It is therefore important for clinicians to acknowledge the importance of driving and work participation and to consider the risks and benefits of strategies to manage pain.

Our findings, however, also support the observation that patterns of driving difficulties appear to differ across different rheumatic diseases. In studies of driving difficulties in RA, where peripheral disease involvement predominates, particularly in the hand and wrist, individuals have tended to report more problems with starting the car, turning keys, etc. (7,25). It should be acknowledged that only a small number of individuals had peripheral joint involvement in this study, but similar problems were not reported. However, knee pain was associated with difficulties in the physical act of driving, e.g., getting in and out of the car and sitting for long periods.

Our findings highlight the importance of driving for work participation among people with axial SpA. Work participation is an outcome of prime importance to individuals with axial SpA, specifically in terms of self-identity, providing social interactions, as well as enabling financial security (13). It is not perhaps surprising that if someone is struggling to get to and from work or carry out their job that involves driving, then this will adversely affect their ability to attend work and productivity while at work. We have recently reported that individuals with axial SpA find commuting to work challenging and have problems with accessing workplaces, e.g., suitable car parking spaces (13). The few studies exploring the relationship between work participation and rheumatic disease have not specifically explored driving, rather they have examined overall transport mobility (combining driving difficulties with use of other forms of transport) (32,33) or overall difficulties commuting to work (34,35). Albers et al (32) found that increasing age, impaired function, and work disability in patients with a recent diagnosis of RA were associated with reduced transport mobility (defined as being transported either by others, driving, or use of public transport). Allaire et al (34) and Lacaille et al (35) found that commuting difficulty was an independent predictor of work disability in RA; however, in these studies, driving difficulty was not specifically explored, and commuting difficulty was dependent upon whether or not participants reported physical difficulty getting to and from work.

We found no differences in reported driving difficulties between rural and urban dwellers. Given the car-dependent nature of rural living, this is perhaps surprising. However, the number of study participants in this study living in a remote small town or rural areas who currently drove was small (n = 124), which may have limited our statistical power to find an association. Most current drivers were urban dwellers. Furthermore, the driving questions were weighted toward urban driving scenarios, which were not necessarily as relevant to rural driving. It is also possible that individuals who had experienced significant driving difficulties in the past had made an active decision to stop working or to live in more accessible urban areas before this study.

Driving is a challenging topic to study among patients. We, like others researching driving difficulty, previously encountered concerns that participants felt vulnerable in proactively reporting problems with driving to their clinicians for fear of being reported or losing their driving license (5). Researchers need to approach this topic sensitively with people with rheumatic and musculoskeletal conditions and encourage them to be open and honest if we are to better understand the extent of the problem and develop appropriate interventions.

In conclusion, driving difficulties are common in patients with axial SpA and, after adjusting for a range of clinical and sociodemographic factors, are adversely associated with work participation. Improving understanding and awareness of driving disability in axial SpA will help direct advice and resources to enable patients to remain independent and economically active. Clinicians need to be enablers rather than arbiters of driving so that patients feel able to seek help. We suggest that future studies adopt a standardized approach to assessing driving difficulties that focuses on the full range of issues and outcomes, including work, to enable comparison across studies. It is also important to examine driving difficulties among people with different musculoskeletal conditions separately, as they may differ by condition.

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## AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Hollick had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
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## ROLE OF THE STUDY SPONSOR

AbbVie and Pfizer had no role in the study design or in the collection, analysis, or interpretation of the data, the writing of the manuscript, or the decision to submit the manuscript for publication. Publication of this article was not contingent upon approval by AbbVie or by Pfizer.

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