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LONG-TERM TRENDS IN ARTHRITIC PAIN AND LOW BACK PAIN ACCORDING TO POPULATION-BASED SURVEYS IN THE USA

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ABSTRACT

The prevalence of pain of multiple aetiologies in the global population is high, places a large burden on public health systems, and is costly to individuals and society. Yet, despite the wealth of data on pain, the research has some significant core limitations, namely: most studies are cross-sectional and geographically localised. There is, therefore, a dearth of long-term and geospatial research on pain in order to address the cost and burden thereof to society. Long-running, nationally representative, population-based surveys offer a potential source of such data on musculoskeletal pain. This thesis addresses the epidemiology of musculoskeletal pain in the United States from 1996 to 2018, using nationally representative health survey data. I evaluated temporal trajectories and geospatial trends, as well as associations between demographic- and lifestyle-related factors frequently associated with pain (namely, age, sex, socioeconomic status, BMI, and physical activity), over the full 23-year timeframe. Furthermore, population-based data are unavailable in South Africa over large timeframes, as they are in the US. Therefore, understanding US surveys, and corresponding musculoskeletal pain trends, will help to address the use of surveys in South Africa, and assist in planning allocation of resources.

Data were obtained from three long-running population-based surveys from the US: the Behavioural Risk Factor Surveillance System (BRFSS), the National Health Interview Survey (NHIS), and the National Health and Nutrition Examination Survey (NHANES) (Continuous). Between the three surveys, I was able to analyse long-running data on two types of common musculoskeletal pain: arthritic pain, and low back pain. After searching survey questionnaires for relevant questions, I downloaded and cleaned the corresponding data, and then created design objects to account for complex survey design. I made use of descriptive data to plot prevalence statistics across time, and US geo-space. I calculated annual growth rates for temporal prevalence data, and applied geospatial correlations to geospatial prevalence data. I assessed associations between musculoskeletal pain and demographic, and lifestyle factors, respectively, using Generalised Linear Models. All data cleaning, design object creation, and analyses were done in the R statistical environment, and the research is entirely reproducible and available on GitHub (https://github.com/AnneIoannides).

In addressing temporal trends of musculoskeletal pain (Chapter Three), I showed that the temporal prevalence trajectories of arthritic pain and low back pain in the US have remained

stable over the last 23 years. Approximately 25 to 30% of US residents have some kind of arthritic pain, while approximately 30% have low back pain. Although the prevalence may have remained constant, the absolute number of people with musculoskeletal pain increased by between 10 and 27.5 million people, depending on musculoskeletal pain type, by the end of the 23-year timeframe due to population growth and population aging. The temporal trajectories of both arthritic pain and low back pain were also constant within age groups, in males and females, and in employment groups; with the exception of a small increase in arthritic pain in the unemployed group. The temporal analysis also highlighted the consistency of both arthritic pain and low back pain prevalences in the respective demographic groups. Across the 23-year timeframe, females had more musculoskeletal pain than males, and unemployed people had more musculoskeletal pain than employed people. Furthermore, each group of increasing age had more arthritic pain than younger groups, consistently across time. Low back pain was slightly more prevalence in each increasing age group in young adults only, and was stable thereafter, consistently across time.

Geospatial heterogeneity existed in musculoskeletal pain, both by state and region (Chapter Four). I found a geospatial association between state residence and arthritic pain, where states closer together had similar arthritic pain prevalences. Furthermore, the same states appeared at the upper and lower limits of prevalence data across time. Appalachia and the Mississippi Valley were identified as arthritic pain hotspots, and states consistently at the upper prevalence limit included West Virginia, Kentucky, Alabama, Mississippi, Tennessee, Arkansas, and Michigan. Conversely, consistently at the lower prevalence limit were Hawaii, California, Arizona, Utah, Texas, Minnesota, and the District of Columbia. These spatial trends remained true across time, not only in the overall population, but also within various age groups, and in both males and females. US region-specific geospatial trends showed that the Midwest had significantly more reports of arthritic pain compared to the Northeast, South, and West, both nationally and within males and females. Age-specific analyses, however, were inconclusive. Likewise, regional analyses for low back pain were also inconclusive, and suggest that the geospatial trends for low back pain may be more randomly dispersed, or that regions are too large to yield a significant trend; however, a state-specific analysis to confirm this potential finding is recommended.

Demographic- and lifestyle-related factors and their potential relationship with musculoskeletal pain were addressed in Chapters Five, and Six, respectively. There was a significant, long-running association between arthritic pain and older age, where reports of arthritic pain increased progressively as age did. Arthritic pain increased from approximately 3% to 15% in 18- to 24-year olds, to approximately 47% to 60% in those aged 70 years and above, depending on arthritic pain type and survey. Low back pain, however, was already high in young adults (between 16% and 26%), increased only until adults were approximately in their thirties, and was then stable across middle- and older-adulthood (20% to 37%).

Female sex was associated with increased reports of all musculoskeletal pain types in the US across time. The prevalence of arthritic pain amongst females (23% to 38%), depending on arthritic pain type and survey) was always significantly higher than males (16% to 27%) ($P < 0.001$). I also evaluated the joint sites at which participants reported arthritic pain by age-sex divided demographic groups. All groups had high prevalences of pain, aching or stiffness in the knees. Young females reported more hip joint symptoms than age-matched males, young males reported more shoulder symptoms than age-matched females, and older people reported more joint symptoms in their hands and fingers than younger people. The prevalence of low back pain was also significantly higher in females (prevalence between 27% and 33%) than in males (prevalence between 23% and 30%) ($P < 0.001$).

Low socioeconomic status (by employment status, education level, and annual household income bracket) was significantly associated with arthritic pain throughout the study timeframe ($P < 0.05$ across years, with only a few minor exceptions due to smaller samples in module years or very small population demographic groups, demonstrated by wide confidence intervals). Low socioeconomic status (by employment status) was also significantly associated with low back pain over the whole study timeframe ($P < 0.001$). Lifestyle-related analyses indicated that increased BMI was significantly associated with musculoskeletal pain across time ($P < 0.001$ for painful arthropathies; $P < 0.001$ for low back pain). Physical inactivity was also statistically significantly associated with painful arthropathies ($P < 0.05$, except for four years, where the relationship was not significant) and low back pain ($P \leq 0.003$), consistently across time too.

My findings have shown, for the first time, the epidemiology of musculoskeletal pain on a national level, over a 23-year timeframe, using the same consistent measurement tools. I showed

the stable trajectory of musculoskeletal pain prevalence in the US population nationally, as well as within particular demographic groups. I have also shown the geospatial distribution and trends of musculoskeletal pain, and have shown (in the case of arthritic pain) that the geospatial distribution is consistent over time. Furthermore, my findings demonstrated that there is a long-running association between musculoskeletal pain with demographic- and lifestyle-related factors. This research, therefore, highlights areas where public health interventions for musculoskeletal pain may be aimed through targeting groups at greater risk for developing musculoskeletal pain by demographic group, lifestyle, or place of residence. It also offers clear trajectories that could be used to predict costs to public health systems. Finally, this thesis demonstrates a potential new methodology of studying pain in the population, through the use of population-based survey data.