

Community and Environmental Factors and Arthritis Outcomes

Joanne M. Jordan, MD, MPH; Leigh F. Callahan, PhD

Great strides have been made in the past century in preventing disease and reducing early mortality, but disparities in health between and within countries are still pervasive.¹⁻³ The National Institutes of Health defines disparities broadly as “differences in the incidence, prevalence, mortality, and burden of diseases and other adverse health conditions that exist among specific population groups in the United States.”⁴

The national health care research agenda places high priority on reducing disparities in health outcomes among persons of different socioeconomic and racial/ethnic groups through examining the mechanisms for disparities and proposing prevention strategies.⁵ There is now an increasing interest in more explicit investigations of the complex issues regarding disparities and health outcomes. The urgency of understanding the effects of external forces at multiple levels including individuals and their behaviors, communities and environments, and social policies was made vividly apparent in the wake of Hurricane Katrina. The same could be illustrated in how we reacted to the fall 2007 California wildfires. We cannot deny that place can have a significant impact on outcomes regardless of an individual's resources. We also cannot deny that there are racial and ethnic differences in communities in the US.

The association between lower levels of individual socioeconomic status and poorer health outcomes has been documented for centuries in various parts of the developed world.⁶⁻⁹ Associations between lower socioeconomic status and increased prevalence of disease, morbidity, and mortality in persons with arthritis and rheumatic conditions have been demonstrated in a number of population-based and clinical studies.¹⁰⁻¹³ The role of individual socioeconomic status has been studied examining variables such as formal education level, income, occupation, and home ownership. Health outcomes have been shown to be associated with the socioeconomic environment of an individual's neighborhood,¹⁴⁻¹⁶ independent of the individual's socioeconomic status.¹⁵⁻¹⁷ Although there is

a long tradition of public health research relating community factors to patterns of health and disease,^{18,19} this has traditionally been in the context of hygiene, clean water, and the presence/eradication of infectious disease-bearing vectors. Increasingly, research findings are beginning to focus on the upstream determinants related to the community in the context of chronic diseases. These include place of residence, work environment, or wider social and economic policies. These community variables often are described as “social context,” a catch-all phrase referring to the spectrum of societal factors that may not be directly

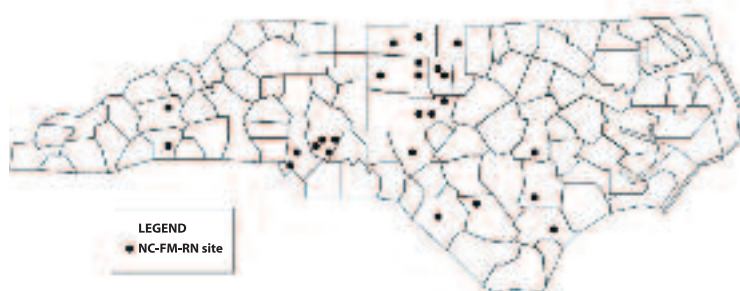
“In preliminary data from the Johnston County Osteoarthritis Project, we observed higher blood lead levels were associated with knee osteoarthritis severity in men and women...”

measured at the individual level. The socioeconomic context of communities may affect characteristics of the social, service, and physical environments to which all residents are exposed regardless of their own socioeconomic position^{20,21} and may have a greater negative impact on those with fewer individual resources.^{22,23}

Joanne M. Jordan, MD, MPH, is an associate professor of medicine and orthopaedics, chief of the Division of Rheumatology, Allergy, and Immunology, and director of the Thurston Arthritis Research Center at The University of North Carolina at Chapel Hill. She can be reached at Joanne_Jordan@med.unc.edu or 3300 Doc J. Thurston, Jr Building, CB#7280, Chapel Hill, NC 27599.

Leigh F. Callahan, PhD, is an associate professor of medicine, orthopaedics, and social medicine at the Thurston Arthritis Research Center, the University of North Carolina at Chapel Hill.

Figure 1.
Map of the 25 North Carolina Family Medicine Research Network (NC-FM-RN) Sites



We at the Thurston Arthritis Research Center at the University of North Carolina also have been very interested in the role of individuals' community and socioeconomic environments on health outcomes in people with arthritis throughout the state of North Carolina. We have examined the associations of community poverty level with arthritis prevalence and health status.^{24,25} (L. F. Callahan, T. Mielenz, B. Schoster, et al, unpublished data, 2007; L. F. Callahan, J. Schreffler, T. Mielenz, et al, unpublished data, 2007) We have also embarked on a novel research agenda that examines one particular aspect of the environment—chronic environmental metal exposures—in relationship to osteoarthritis in Johnston County, the site of a longitudinal community-based research study of racial/ethnic disparities in osteoarthritis and disability outcomes between African Americans and whites.²⁶

Community Poverty Level and Health Outcomes in North Carolina

In one study using patients from the North Carolina Family Medicine Research Network, a research consortium of 25 family medicine sites in rural, urban, and suburban practices across the state²⁷ (see Figure 1), we observed that white patients with low educational attainment (defined as less than a high school degree) and who lived in high poverty areas (defined for the block group using the 2000 Census as the percentage of the population in households with income below the poverty level) had 1.56 times the odds of reporting arthritis compared to white patients with higher educational attainment who lived in low poverty areas. African-American patients with low education living in an area with high poverty levels were more than twice as likely to report arthritis compared to African-American patients with high education levels living in low poverty areas. (L. F. Callahan, T. Mielenz, B. Schoster, et al, unpublished data, 2007)

We have also examined associations between education and census-based community-level measures of socioeconomic status in 4565 whites and African Americans in the Research Network. We used health-related quality of life assessed by the SF-12v2 Physical Component Summary and Mental Component Summary and 3 Centers for Disease Control and Prevention health-related quality of life measures to summarize

the impacts of the environments.^{28,29} Analyses also were conducted on subgroups of arthritis and cardiovascular disease patients. In whites, all 5 health-related quality of life outcomes had significant and meaningful associations for those with the lowest education and poorer outcomes; and 4 outcomes associated high community poverty level with poorer status. Four outcomes had associations with poorer status for the lowest education and high community poverty levels in the African-American group. Arthritis and cardiovascular disease subgroup analyses showed parallel findings. (L. F. Callahan, J. Schreffler, T. Mielenz, et al, unpublished data, 2007) These

findings indicate that even using crude environmental measures, community level variables are important.

Environmental Exposures as Potential Explanations of Community and Social Determinants of Outcome

What could explain geographic, socioeconomic, and community variation in arthritis outcomes? One potential explanation is environmental exposures to harmful substances in areas that are economically depressed. Many of the rheumatic illnesses such as systemic sclerosis, systemic lupus erythematosus, and rheumatoid arthritis are autoimmune in nature with both genetic and environmental components. Environmental exposures in relationship to autoimmune conditions have usually been examined in response to report of a cluster of affected persons surrounding an environmental pollution source or a common occupational exposure.³⁰⁻³⁴ Such exposures have included organic solvents, petroleum products, mercury, and silica dust,³⁵⁻³⁷ all of which can affect the immune system. However, interest in the role of *routine* environmental exposures, including those from childhood or throughout the lifecourse, is gaining traction. There is concern that routine environmental exposures could act as “triggers” to induce or maintain an autoimmune response or poor health outcome in individuals not exposed to overt environmental disasters. These include risk factors such as prior infections and tobacco and hormone use.^{38,39} Since some of these hypotheses are preliminary, their penetration into clinical practice has not yet widely occurred; nonetheless, the impact of treating these exposures as potentially modifiable targets for primary and secondary prevention could be significant.

Examination of environmental causes of nonautoimmune musculoskeletal conditions such as osteoarthritis has been limited. Some occupations, particularly those requiring heavy physical labor or repetitive knee bending, are more likely to be associated with osteoarthritis presumably through their physical demands and the biomechanical loads they entail.⁴⁰ Dietary intake and use of hormones and tobacco have also been examined in relationship to osteoarthritis⁴¹⁻⁴⁵ but few other environmental exposures have been examined.

We have recently begun examination of metal exposures, many of which occurred throughout the lifetime, and

osteoarthritis using data from the Johnston County Osteoarthritis Project, a longitudinal community-based research study of racial/ethnic disparities in osteoarthritis and disability outcomes between African Americans and whites.²⁶

Environmental Metal Exposures as Potential Risk Factors for Osteoarthritis

Heavy metals are ubiquitous, and exposure through drinking water, contaminated food, pesticides, and other means is widespread in our society⁴⁶⁻⁵¹ and remains a significant public health problem particularly in high-risk sociodemographic groups and certain geographic locations.^{46,51} The varied and sometimes subtle health effects of low-level, chronic exposures to multiple elements such as lead, mercury, arsenic, and cadmium have only recently been recognized.⁵²⁻⁶¹ Many metals are divalent or trivalent cations with a tropism for bone and the potential to bind to negatively charged components of proteoglycans in cartilage.^{55,62-65} Yet little attention has been directed at the possible roles of these metals in relationship to osteoarthritis, a condition accompanied by profound disruption in both bone and cartilage.⁶⁶⁻⁶⁹

Lead and Osteoarthritis

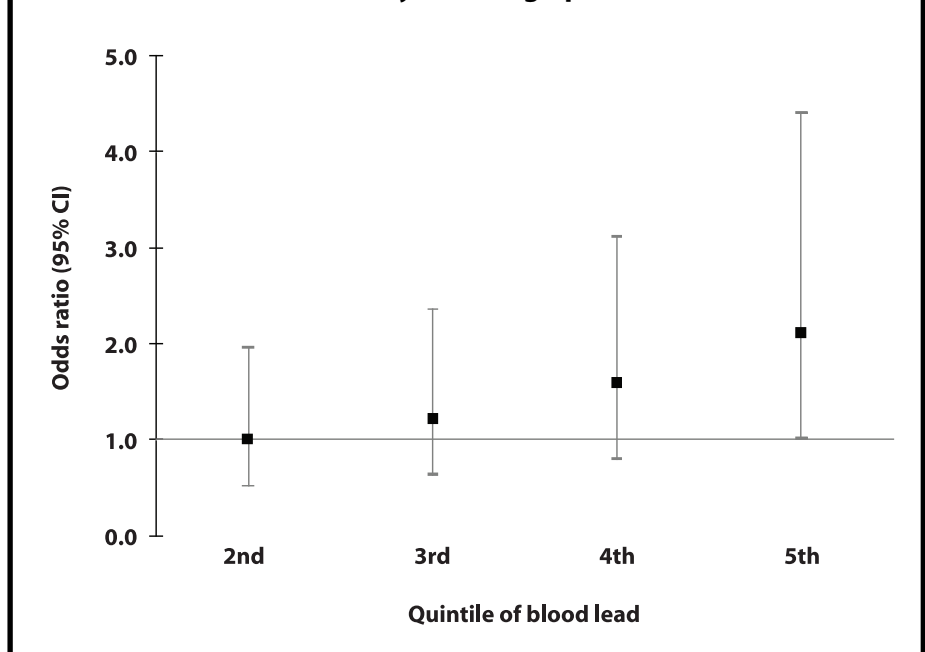
Approximately 95% of total body lead burden in adults is stored in bone with accumulation occurring into the 7th decade. Bone lead is released into blood chronically, making bone a target tissue for lead toxicity and an endogenous source of persistent lead toxicity particularly after menopause.⁷⁰⁻⁷³ Lead affects bone formation and resorption, and recent data suggest that lead affects cartilage as well.⁷⁴ In preliminary data from the Johnston County Osteoarthritis Project, we observed higher blood lead levels were associated with knee osteoarthritis severity in men and women (see Figure 2) and with serum and urine osteoarthritis biomarkers in women with possible racial differences in effect.^{75,76}

Selenium and Osteoarthritis

One potentially protective environmental exposure is selenium. Selenium is an essential trace element and a required cofactor for glutathione peroxidase and antioxidant defense against free radicals and peroxide.^{77,79} It has been evaluated for its protective role in cardiovascular disease, cancer, and other conditions of aging.^{77,79} Animals with selenium deficiency have irregular

bone formation, decreased bone strength, and abnormalities in types I and II collagen in cartilage.⁸⁰⁻⁸² In areas of China and eastern Asia where selenium levels in the soil are among the lowest in the world, low selenium, among other risk factors, has been associated with Kashin-Beck Disease, an endemic, early onset osteoarthropathy. Early intervention regarding deficiency in this environmental factor has decreased the incidence of this disease.^{83,84} Selenium levels may be low in the southeastern

Figure 2.
Blood Lead Levels and Severity of Radiographic Knee Osteoarthritis



United States as well,⁸⁵ leading us to investigate the role of selenium in osteoarthritis. Interestingly, preliminary data showed that those with low selenium levels, measured in toenails, were more likely to have knee osteoarthritis and more severe knee osteoarthritis,⁸⁶ and women with low selenium were more likely to have hip osteoarthritis. (J. M. Jordan, F. Fang, J. B. Renner, et al, unpublished data, 2007).

These results are compelling in that they suggest there may be modifiable environmental factors that could influence the onset and progression of osteoarthritis with the potential for intervention. We suspect these factors interact with genetic and other risk factor susceptibility, and future studies of these issues are planned.

Examination of the role of both individual and community social determinants of health outcomes in arthritis and rheumatic conditions is overdue. Future studies will be needed to verify cross-sectional associations longitudinally and to tease out explanatory factors behind observations. Arthritis and autoimmune conditions are areas in need of further research in the role of environmental exposures in etiology and maintenance of disease. The possibility that environmental exposures could contribute to these conditions and to ethnic disparities in these conditions would likely lead to changes in clinical practice and public policy. **NCMJ**

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