

The effect of distance to exercise facilities and sociodemographic factors on pain and function among rheumatology patients

Chi Chi Lau^{1*}, Levi Bonnell², Bradley J. Tompkins³, Dawid Czarny⁴, Amanda G. Kennedy⁵

¹Division of Rheumatology and Clinical Immunology, Department of Medicine, Robert Larner, MD College of Medicine at the University of Vermont and University of Vermont Medical Center, Burlington, VT, USA

²STS Research and Analytic Center, The Society of Thoracic Surgeons, Chicago, IL, USA

³Quality Program, Department of Medicine, Robert Larner, MD College of Medicine at the University of Vermont and University of Vermont Medical Center, Burlington, VT, USA

⁴Department of Internal Medicine, University at Buffalo, Buffalo, New York, USA

⁵Quality Program, Department of Medicine, Robert Larner, MD College of Medicine at the University of Vermont and University of Vermont Medical Center, Burlington, VT, USA

*Author for correspondence:
Email: chichi.lau@uvmhealth.org

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Abstract

Clinical features are known to influence pain in patients, but demographic characteristics have been less studied. The aim of this cross-sectional study was to evaluate the relationship of distance to exercise facilities and other demographic factors to the pain and function score, RAPID3 (Routine Assessment of Patient Index Data) in a large rheumatology practice.

The study data were extracted from an academic medical center electronic health record for established adult rheumatology outpatients. Multivariate linear regression quantified the relationship between the RAPID3 and age, sex, race, insurance status, rheumatologic condition (inflammatory or not), and geocoded distance from residential address to the closest indoor exercise facility. The mean RAPID3 differed significantly between subgroups for categorical variables ($P < 0.001$) in the 4,937 patients studied. In the adjusted multivariate regression model, an increase in 5 kilometers between patient residence and the nearest exercise facility, was associated with a rise in the RAPID3 by 0.13 ($P = 0.04$). RAPID3 also rose if the patient was a current smoker ($\beta = 3.4$, $P < 0.001$). There was a significant decrease in RAPID3 for men ($\beta = -1.1$, $P < 0.001$), those of white race ($\beta = -1.2$, $P = 0.008$), advancing age ($\beta = -0.05$ unit/year, $P < 0.001$), those with inflammatory rheumatologic conditions ($\beta = -2.3$, $P < 0.001$), and commercial insurance ($\beta = -2.6$, $P < 0.001$).

Patients who are current smokers, female, non-white, younger, have non-commercial insurance, primarily noninflammatory rheumatologic conditions, and who reside further from exercise facilities, do worse as measured by the RAPID3. These factors should be considered when optimizing therapies for the rheumatology patient population.

Keywords: Built environment, Health geography, Sociodemographics, Chronic pain

Key Messages

- Living further from exercise facilities may negatively affect pain and function in rheumatology patients.
- Smokers, females, those with non-commercial insurance and noninflammatory rheumatologic conditions also do worse.

Introduction

Chronic pain is a burden on the United States (US) healthcare system and is the most important factor affecting outcome in rheumatologic conditions [1,2]. Each year the number of patients diagnosed with arthritis has increased, with the projection that, by the year 2040, an estimated 78 million or 26% of the adults in the US will have a diagnosis of arthritis [2]. In 2010–2012, 22.7 million US adults had an arthritis-attributable activity limitation which is projected to increase to 34.6 million or 11.4% of adults by 2040 [2].

The use of pharmaceutical agents alone is inadequate to improve pain and function in most rheumatologic conditions. An integrative approach that includes exercise has been proposed [3,4], which multiple studies have shown to be beneficial for inflammatory and noninflammatory rheumatologic conditions [5–8]. The American College of Rheumatology has recommended exercise as adjunctive therapy in their guidelines for the management of Osteoarthritis (OA) and Rheumatoid Arthritis (RA) [9,10].

Positive associations have been shown between proximity to an exercise facility and level of physical activity [11–14]. Geographic locale may therefore affect patient health outcomes. One study found that for patients with chronic lower back pain, every 1-kilometer increase in distance from a physical activity facility decreased the probability of adherence to the adaptive physical activity program by 8% [15]. No studies have investigated the effect of proximity to exercise facilities on pain and function in the rheumatology patient population. Vermont (VT) is the second least populated state in the US [16], and so its rurality and lack of public transportation between countryside residences to amenities inside towns and cities, may limit access to exercise facilities.

The RAPID3 (Routine Assessment of Patient Index Data) has been approved by the American College of Rheumatology for assessment of rheumatoid arthritis and has been found to parallel accepted measures of disease activity in numerous other rheumatologic conditions, including osteoarthritis, spondyloarthropathies, systemic lupus, gout, psoriatic arthritis, fibromyalgia, and vasculitis [17–20]. The RAPID3 is calculated based on answers to questions regarding a patient's ability to perform activities of daily living and level of pain, and so this index can be an important measure of general health quality regardless of diagnosis. Patients followed at the University of Vermont Medical Center (UVMCC) Rheumatology Clinic are assessed at each visit using the RAPID3.

The goal of this study was to explore for associations between distance to indoor exercise facilities and other sociodemographic factors to pain and function as measured by the RAPID3 in rheumatology patients from the rural state of VT and northeast New York (NY) state.

Methods

Due to the retrospective nature of the study, the University of Vermont Institutional Review Board (IRB) waived the need of obtaining informed consent. The study adheres to the principles outlined in the Declaration of Helsinki. The University of Vermont Committee on Human Research approved this study (IRB#00000863).

Study design and population

This was an observational cross-sectional study. Inclusion criteria were established patients 18 years and older who had at least one follow-up visit in the rheumatology clinic at UVMCC between March 2016 and October 2019 with a RAPID3 and diagnoses documented at the time of each encounter. Retrospective data were extracted from UVMCC's electronic health record (EHR) (Epic Systems Corporation, Verona, WI). The geographic catchment area for UVMCC is the state of VT and six counties in northeastern NY. Patients were excluded if they did not reside in the catchment area, or if their home address was a post office box rather than a street address.

Dependent variable

The primary outcome was the RAPID3, an index calculated from a questionnaire comprised of the Health Assessment Questionnaire (HAQ), and visual analog scales for pain severity, and patient global assessment (**Supplemental Figure S1**). Each component is scored 0–10, then summed to provide the RAPID3 score (range 0–30) [21,22]. All follow-up rheumatology patients regardless of diagnosis completed the RAPID3 prior to meeting with the provider on the day of the encounter, then the RAPID3 was entered into the EHR by the staff. A higher RAPID3 score indicates worse pain and function. Disease severity is defined as near remission if the score is 1–3, low severity if 4–6, moderate severity if 7–12, and high severity if 13–30 [23].

Independent variables

Sociodemographic characteristics extracted from the EHR included age at the time of the encounter, sex, race (white or non-white), smoking status (current or not), and insurance (or payer) status. Insurance status was categorized as commercial (private insurances), or non-commercial (Medicaid, Medicare, self-pay/uninsured, Veterans Administration, workman's compensation, or state sponsored).

Distance to indoor exercise facilities- Exercise facilities were defined as a gym or recreational center, yoga studio, or physical therapy sites. The 2018 Dun and Bradstreet database was used to identify exercise facilities (Dun & Bradstreet Corp., Milburn, New Jersey). We used geocoding which transformed an address or place name to a location on the earth's surface. Patient home addresses were geocoded using ArcGIS Business Analyst (ESRI Inc., Redlands, CA). A driving network was created using VT e-911 and NY street data. Origin-destination (OD) cost matrix methods were used to calculate all possible routes, identified the nearest exercise facility to the patient's residence, and ultimately calculated a driving distance in kilometers (km) for each address. RAPID3 scores on the rheumatology visit date closest in time to the facility database creation were chosen for the analysis.

Rheumatology diagnoses- Encounter diagnosis for each established patient was categorized as an inflammatory or noninflammatory condition according to accepted conventions [24]. Inflammatory conditions referred to diseases characterized by soft tissue, joint, or systemic inflammation due to autoimmune or metabolic disorders [22]. Non-inflammatory conditions were those resulting from degenerative processes causing mechanical or structural defects, such as osteoarthritis [23] or chronic pain such as fibromyalgia [25]. In this study, if a patient had more than one diagnosis at the time of the encounter, and one was an inflammatory condition, the encounter diagnosis was categorized as inflammatory.

Statistical analysis

RAPID3 scores were compared between variable subgroups by the two sample t-test. Simple linear regression was used to test unadjusted associations between the RAPID3 and age, gender, race, smoking status, insurance status, rheumatologic condition, and distance from patient residence to the closest exercise facility. A separate linear regression correlating the RAPID3 with distance from patient residence to nearest exercise facility according to facility type was also performed and the facility showing a significant association was used in a multivariable model. Multivariable linear regression was

performed on variables that were statistically significant ($P < 0.05$) in the unadjusted analyses. Analyses were conducted using Stata 16.1 (Stata Corporation, College Station, TX), with $P < 0.05$ required for statistical significance. The variance inflation factor showed no collinearity between the independent variables. All tests were two-tailed.

Results

Of the original cohort of 6,512 patients, 1,575 patients were excluded due to missing data for relevant variables, resulting in a sample size of 4,937 patients for the final analysis (**Supplemental Figure S2**). The mean age was 59 years, mostly women (68%), white (96%), and not current smokers (88%) (**Table 1**). Payer type was nearly evenly divided between commercial (or private) insurance (49%) and non-commercial insurance (51%). Over 66% of the study population had inflammatory conditions, of which rheumatoid arthritis (28%), spondyloarthropathies (22%), and crystalline arthropathies (10%) comprised 60% (**Supplemental Table S1**).

Over 80% of non-inflammatory diagnoses included osteoarthritis (51%), fibromyalgia (18%), and degenerative disc disease or degenerative joint disease of the spine (14%) (**Supplemental Table S1**). The median number of clinic visits per patient over the 2.5-year study period was 4 for the entire group, 4 for those with inflammatory conditions, and 3 for the non-inflammatory group.

Most patients lived closest to physical therapy or gym facilities, while a small percentage lived closest to yoga studios (**Table 1**). The median distance to the nearest exercise facility was 3.9 km, with the middle 50% of distances ranging from 1.4 km to nearly 10 km. Eighty four percent of study patients resided in VT, and the rest in upstate NY. There were 507 exercise facilities used for geocoding.

The mean RAPID3 was significantly higher in females, non-whites, current smokers, those with non-commercial insurance, and non-inflammatory conditions which meant these groups had more pain and disability (**Table 1**). All independent variables significantly predicted the RAPID3 in univariate and multivariable regression

Table 1. Characteristics of the rheumatology patient population (N = 4,937).

				RAPID3, mean (SD) ^a
Age (years), mean (SD)	59	(15)	---	---
Sex, n (%)				
Female	3,361	(68)	10.2	(6.7)
Male	1,576	(32)	8.8	(6.7)
Race, n (%)				
White	4,739	(96)	9.7	(6.7)
Non-white	198	(4)	11.4	(7.4)
Smoking status, n (%)				
Current smoker	571	(12)	13.4	(6.8)
Not a current smoker	4,366	(88)	9.3	(6.6)
Payerb type, n (%)				
Commercial	2,426	(49)	8.7	(6.4)
Non-commercial	2,511	(51)	10.8	(6.9)
Conditionc type, n (%)				
Inflammatory	3,278	(66)	8.9	(6.7)
Non-inflammatory	1,659	(34)	11.4	(6.5)
State of residence, n (%)				
Vermont	4,158	(84)		
New York (northeast)	779	(16)		
Patients residing closest to each type of exercise facility, n (%)				
Physical Therapy	2,359	(48)		
Gym/fitness center	2,077	(42)		
Yoga studio	501	(10)		
Distance ^d (km), median (IQR)	3.9	(1.4-9.9)		

SD: Standard Deviation

^aRAPID3 scores differed significantly between subgroups for each characteristic variable by the two-sample t test ($P < 0.001$).

^bCommercial payer is private insurance; Non-commercial payers are Medicare (80.5%), Medicaid (18.0%), State sponsored insurance, Veterans Administration, workman's compensation or self-pay/ uninsured (1.5%)

^cCondition type refers to inflammatory or non-inflammatory rheumatologic diagnoses (Supplemental Table S1)

^dDistance to nearest exercise facility (physical therapy, yoga, or gym sites) from patient residence; IQR: Interquartile Range

models which included distance to the nearest exercise facility (**Table 2**). In the adjusted model, for each 5 km increase in distance between patient residence and the nearest exercise facility, the RAPID3 rose by 0.13 ($P=0.04$). There was a direct relationship between smoking and RAPID3 where current smoking status was associated with an increase in RAPID3 by 3.4 ($P<0.001$). There was an inverse relationship between RAPID3 and male gender ($\beta=-1.1$, $P<0.001$), advancing age ($\beta=-0.05$ unit/year, $P<0.001$), white race ($\beta=-1.2$, $P=0.008$), patients with commercial insurance ($\beta=-2.6$, $P<0.001$), and patients with inflammatory rheumatologic conditions ($\beta=-2.3$, $P<0.001$), implying these groups did better in terms of pain and function.

Univariable regression analysis looking at the RAPID3 in relation to distance to each of the three types of exercise facilities showed a significant positive correlation between distance to the nearest exercise site that was physical therapy, but not to yoga studios or gym facilities (**Table 3**). A multivariable regression model limited to patients living closest to physical therapy locations, continued to show a significant positive relationship between distance to physical therapy site and RAPID3 ($\beta=0.22$ RAPID3 unit/5 km; $P=0.02$). The coefficient estimates for all demographic variables, except for race, were significant in the regression models whether distance to nearest exercise facility of any type (**Table 2**) or distance to nearest facility that was physical therapy was used (**Table 3**).

Table 2. There is a significant association between demographic factors and pain and function as measured by RAPID3 in the rheumatology cohort (N=4,937).

Independent Variables	Univariable model ^a			Multivariable model ^b		
	Coefficient	95% CI	P	Coefficient	95% CI	P
Age	-0.02	-0.035, -0.010	<0.001	-0.05	-0.059, -0.032	<0.001
Male	-1.44	-1.84, -1.04	<0.001	-1.12	-1.50, -0.74	<0.001
White race	-1.71	-2.67, -0.76	<0.001	-1.24	-2.15, -0.33	0.008
Current smoker	4.09	3.51, 4.66	<0.001	3.44	2.87, 4.00	<0.001
Commercial payer	-2.16	-2.53, -1.79	<0.001	-2.66	-3.06, -2.26	<0.001
Inflammatory condition	-2.48	-2.87, -2.09	<0.001	-2.25	-2.62, -1.87	<0.001
Distance to nearest exercise facility ^c	0.15	0.02, 0.28	0.021	0.13	0.005, 0.25	0.041

CI: Confidence Interval

^aSimple univariate linear regression was used to test unadjusted associations with RAPID3.

^bMultiple linear regression was performed using variables that were statistically significant ($P<0.05$) in the univariable model. Coefficient of determination $R^2=0.11$

^cDistance in 5 km increments

Table 3. RAPID3 is significantly associated with residential distance from the nearest exercise facility that is a physical therapy site.

Independent Variables	Univariable model ^a			Multivariable model ^b		
	Coefficient	95% CI	P	Coefficient	95% CI	P
Distance to nearest site is a yoga facility, n=501	-0.18	-0.72, 0.37	0.52			
Distance to nearest site is a gym facility, n=2077	0.10	-0.08, 0.29	0.27			
Distance to nearest site is a physical therapy facility, n=2359	0.23	0.03, 0.42	0.021	0.22	0.04, 0.40	0.018
Age				-0.04	-0.058, -0.019	<0.001
Male				-0.87	-1.42, -0.33	0.002
White race				-1.14	-2.54, 0.26	0.112
Current smoker				3.47	2.71, 4.22	<0.001
Commercial payer				-2.72	-3.29, -2.14	<0.001
Inflammatory condition				-2.44	-2.97, -1.91	<0.001

CI: Confidence Interval

Distances by 5 km increments

^aSimple univariate linear regression was used to test unadjusted associations with RAPID3; see results in Table 1 for age, sex, race, smoking and insurance status, and inflammatory condition.

^bMultiple linear regression was performed using variables that were statistically significant ($P<0.05$) in the univariable model. Coefficient of determination $R^2=0.12$

Discussion

This study is the first to report an association between geographic proximity to exercise facilities and pain and function for a population with defined rheumatologic diagnoses. We observed a significant increase in the RAPID3 for rheumatology patients the further they lived from the nearest exercise facility. This was especially true for those patients who lived near a physical therapy site as the closest exercise facility.

The use of the RAPID3 as a measure of pain and function for the general rheumatology population is unique, but justified based on the broad applicability of its questions regarding daily functions. Hence the RAPID3 has been reported to reflect disease severity in multiple rheumatologic conditions [17–20] and correlating with more formal disease specific scoring methods.

Although the observed increase in RAPID3 by 0.13 units/5 km from the closest exercise facility is small, this translates to a rise in the RAPID3 by 2.6 units if the patient lived 100 km (62 miles) from such a facility (4 units for physical therapy sites) which approaches the clinically meaningful change of 3.8/30 RAPID3 units reported for rheumatoid arthritis patients [21]. Vermont is one of the most rural states in the US, but not the least densely populated. For other states in the US (like Alaska or Montana) with lower population density [26] the distances between residences and facilities can be vast lending more relevance to our results. Decreased physical access to exercise facilities could result in decreased opportunity for exercise to lessen pain. Other studies have supported this hypothesis by showing decreased physical activity the further away individuals resided from an exercise facility [11,12]. An alternative explanation for our findings would be that those patients with more pain would be less motivated to travel long distances to an exercise facility, therefore pain would be the limiting factor rather than distance. Distance to exercise facility may reflect the socioeconomic class of the patient depending on where they lived, which could influence their health status and access to healthcare [27].

This is the first study to report on multiple sociodemographic factors in relation to the RAPID3 for a broad spectrum of rheumatologic conditions in a large practice. Current smokers comprised only 12% of the study population, but they have higher RAPID3's than non-smokers with a mean RAPID3 score of 13.4 (high severity). A patient's RAPID3 could increase by greater than 3 points if they smoked, which is expected given the multiple negative effects smoking has on general health [28,29]. Increasing age was associated with a small decline in RAPID3 which differs from the findings of epidemiologic studies looking at chronic pain in the US, possibly due to better management of pain in more mature individuals in this study cohort compared with the general population. Women, non-whites, and those with non-commercial insurance fared worse with increased RAPID3, which is consistent with other studies looking at factors affecting chronic pain and function [30,31], and may reflect disparities in healthcare.

The group with noninflammatory conditions, whose most common diagnoses were osteoarthritis and fibromyalgia, was associated with higher RAPID3's compared to those patients with inflammatory conditions (comprised mostly of rheumatoid arthritis and the spondyloarthropathies). Our observation supports the findings of others who reported higher RAPID3's in osteoarthritis versus rheumatoid arthritis patients [32,33]. Although inflammatory arthritides are associated with more rapid joint destruction than the

noninflammatory conditions, the inflammatory conditions have a wider range of effective pharmaceuticals for treatment [5,34–36]. One study reported significantly lower RAPID3 scores in rheumatoid arthritis patients compared with osteoarthritis patients after 6 months of rheumatology management, thereby reflecting the superiority of rheumatoid arthritis therapies [33]. Despite classifying patients with both inflammatory and noninflammatory diagnoses as “inflammatory”, the “inflammatory” group still did better with lower RAPID3 scores, which may be a testament to the effectiveness of the medications used.

The main limitation of this study was its observational nature and the lack of evidence for causality, which means geographic proximity to exercise facilities could not be equated with actual participation in exercise. Our findings apply to relatively rural states like Vermont, but may not in more populated regions. Although the model proposed in this paper is statistically significant, the independent variables account for only 11% of the RAPID3 (coefficient of determination $R^2 = 0.11$, **Table 2**); there are certainly other variables affecting the RAPID3 that warrant additional study. The demographic factors associated with the RAPID3 in our population may indirectly reflect more significant influences such as socioeconomic status, healthcare access, and comorbid nonrheumatologic conditions.

The strengths of this study were the large size of the cohort, with inclusion of all rheumatology patients regardless of diagnosis, and so the results reflect findings from a “real life” clinical practice. The RAPID3 is a subjective index completed by the patient and therefore lacks the objectivity of a lab test, or physical finding, but this study and others have shown that the RAPID3 is an informative score readily attainable in clinical practice, and applicable to multiple rheumatologic conditions, thus demonstrating its usefulness for epidemiologic and outcome studies [28,37–39].

Future work could track patient activity using wearable movement devices and correlate that data with patient questionnaires regarding use of an exercise facility and residential distance from the facility. Insurance databases and billing records could be used to identify participation in physical therapy and associate that information with socioeconomic and insurance coverage status.

Conclusion

The functional wellbeing of rheumatology patients may be affected by sociodemographic factors along with their rheumatologic condition as shown in this cross-sectional study. Patients who are female, active smokers, non-white, with non-commercial insurance, who live further away from exercise facilities, and who have primarily noninflammatory rheumatologic conditions tend to do worse when measured by the RAPID3. These associations should encourage further investigations into health disparities affecting the rheumatology patient population.

Data Availability Statement

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Author Contributions Statement

CC.L. and A.G.K. designed the study. CC.L. and D.C. wrote the manuscript with input from all authors. L.N.B. performed the geocoding. CC.L., L.N.B., and B.J.T. analyzed the data. All authors reviewed the manuscript.

Conflicts of Interest Statement

The authors declare no conflicts of interest.

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