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Racial Differences in Foot Disorders and Foot Type: The Johnston County Osteoarthritis Project

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Abstract

Objective—To describe racial differences in the frequency of structural foot disorders and pes planus, and cavus foot types in a large cohort of African American and Caucasian men and women 50+ years old.

Methods—Of 1,695 Johnston County Osteoarthritis Project participants evaluated for foot disorders/type in 2006–2010, four with lower extremity amputation were excluded, leaving 1,691 available for analyses (mean age 69 years, mean body mass index [BMI] 31.5 kg/m², 68% women, 31% African American). The most common foot disorders/types were identified using a validated foot examination. Each foot disorder/type was compared by race using logistic regression, controlling for age, BMI, and gender. Effect modification between race (African American versus Caucasian) and age, BMI (categorized as ≥30 [obese] or <30 kg/m² [non-obese]), gender, and education were examined.

Results—Hallux valgus (64%), hammer toes (35%), overlapping toes (34%), and pes planus (23%) were common. Compared to Caucasians, African Americans were almost 3 times more likely to have pes planus and were nearly 5 times less likely to have Taylor's bunions or pes cavus. Among the non-obese, African Americans were more likely than Caucasians to have hallux valgus (adjusted odds ratio [aOR] = 2.01, 95% confidence interval [CI] = 1.39–2.92), hammer toes (aOR = 2.64, 95% CI = 1.88–3.70), and overlapping toes (aOR = 1.53, 95% CI = 1.09–2.13).

Conclusions—Foot disorders are common among adults 50 years of age or older and differ by race. Future research is needed to determine the etiology of foot problems, especially those with racial differences, in order to inform prevention approaches.

Keywords

foot; race/ethnicity; epidemiology

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Introduction

Foot disorders are highly prevalent conditions, and evidence suggests that foot problems are significant independent predictors of disability and falls [1–3]. Presence of foot disorders are more likely to occur with increasing age [4], and the prevalence of hallux valgus differs by gender [5–7], possibly due to factors such as age, weight or shoe wear with non-supportive components or high-stress biomechanics [7, 8]. Other personal characteristics, such as race, may be also associated with foot disorders or certain foot types (pes planus or cavus). Clinical observations suggest that hallux valgus and pes planus are more prevalent in African Americans than Caucasians [5]. However, few studies of foot disorders and conditions in the general population have been published to confirm these clinical findings [5, 7].

The purpose of the present study was to examine racial differences in the frequency of foot disorders and foot types in African American and Caucasian men and women in a large community-based sample. The frequency of foot disorders/foot types by race was further assessed to determine whether it varied by age, body mass index (BMI), gender, and education, as a proxy for socioeconomic status.

Methods

Study Participants

This cross-sectional sample was composed of participants enrolled in the Johnston County Osteoarthritis Project, an ongoing, community-based study of the occurrence of osteoarthritis in African American and Caucasian residents in a rural county in North Carolina. During 1991–1997, this study enrolled civilian, non-institutionalized adults 45 years of age and older who resided in six townships in Johnston County [9]. This cohort was enriched with additional Johnston County residents 45+ years of age during 2003–2004. During a follow-up visit (November 2006–November 2010), 1,695 participants (who had aged to at least 50 years by this visit) completed clinical examinations of the foot. Four participants were excluded due to lower extremity amputation, and thus, data for 1,691 participants were available for analyses.

Foot Conditions and Disorders

Foot disorders/types were assessed using a validated foot examination with visual and palpation criteria to assess specific foot disorders [10, 11]. The two major sections to the foot examination were: 1) questions about foot pain (pain, aching or stiffness), a history of foot fracture, heel pain in past 3 months, foot pain while standing, and 2) a physical examination of each foot for the specific foot disorders of interest. The foot examination was performed by a trained clinical examiner and classified structural deformities, such as hallux valgus, hammer or claw toes, Morton's neuroma, Tailor's bunion, overlapping toes, and hallux rigidus, and conditions, such as pes planus and pes cavus, as present or absent.

Participant Characteristics

Race (African American or Caucasian) was based on self-report by the study participant. The following participant characteristics were examined as potential covariates in our analyses as they may be associated with foot conditions or disorders: age (continuous variable in years); BMI (continuous variable calculated as weight in kilograms/height in meters squared); gender, and education (categorized as <12 years versus ≥12 years of school). Height without shoes was measured using a calibrated stadiometer in inches and converted to meters, and weight was measured in pounds using a balance beam scale and converted to kilograms.

Statistical Methods

The frequency of each foot disorder/type was calculated. Chi-square statistics for categorical variables and t-test statistics for continuous variables were used to compare age, BMI, gender, and education with each foot disorder/type by race. Logistic regression was used to compare each of these foot disorders/types by race, controlling for age, BMI, gender, and education, and odds ratios and 95% confidence intervals were calculated. Effect measure modification was evaluated between race (African American versus Caucasian) and categories of participant characteristics as follows: age dichotomized at the mean (> 69 years versus ≤ 69 years), BMI in groups of obese (≥ 30 kg/m²) versus non-obese (<30 kg/m²), gender (women versus men), and education (<12 years versus ≥ 12 years of school). In models that indicated interactions at p-values <0.10, the appropriate sub-groups were examined, and odds ratios and 95% confidence intervals were calculated separately for each sub-group. All statistical computations were performed using SAS version 9.2 software (SAS Institute, Cary, NC).

Results

Of the 1,691 participants in this study, 31.2% were African American, over two-thirds were women, and over three-quarters had completed at least 12 years of education (see Table 1). The average age was 69 years with standard deviation (SD) of 9 years (age range 50–95 years). One BMI value was considered implausible, and this participant was removed from any BMI analyses, leaving an average BMI of 31.5 kg/m² (SD of 7.2) for 1,690 participants (BMI range = 12.6–78.1 kg/m²). Compared to Caucasians, African Americans were slightly younger with a higher BMI on average, were more likely to be women, and were less likely to have completed ≥ 12 years of school (Table 1).

As seen in Table 2, the most common structural foot disorder was hallux valgus, followed by hammer toes, overlapping toes, Morton's neuroma, Taylor's bunions, plantar fasciitis, and claw toes. The most common foot type was pes planus. Hallux valgus, hammer toes, and pes planus were more common in African Americans than Caucasians, and Taylor's bunions and pes cavus were more common in Caucasians than African Americans (Table 2). After the regression models accounted for the effects of age, gender, BMI, and education (see Table 2), pes planus was nearly 3 times more common in African Americans than Caucasians with an adjusted odds ratio (aOR) of 2.94, (95% confidence interval [CI] = 2.31–3.75). African Americans were approximately 5 times less likely to have Taylor's bunions (aOR = 0.18, 95% CI = 0.09–0.37) and 4 times less likely to have pes cavus (aOR=0.28, 95% CI = 0.13–0.59) than Caucasians in similarly adjusted models.

Statistically significant interactions were observed between race and BMI for hallux valgus, hammer toes, and overlapping toes. Among participants who were not obese (BMI <30 kg/m²), African Americans were approximately 2 times more likely than Caucasians to have hallux valgus (aOR = 2.01, 95% CI = 1.39–2.92), 2.6 times more likely to have hammer toes (aOR = 2.64, 95% CI = 1.88–3.70), and 1.5 times more likely to have overlapping toes (aOR = 1.53, 95% CI = 1.09–2.13). Among obese (BMI ≥ 30 kg/m²) participants, frequency of hallux valgus (aOR = 1.33, 95% CI = 0.98–1.80), hammer toes (aOR = 1.12, 95% CI = 0.83–1.51), and overlapping toes (aOR=0.94, 95% CI = 0.70–1.28) did not differ significantly by race.

Discussion

Structural foot disorders and pes planus were common in this community-based study of adults 50 years of age and older. Compared to the other three community- or population-based studies of structural foot disorders/types of which we are aware, the frequencies of

hammer toes [5, 12], claw toes [5], pes planus [5], pes cavus [5], and plantar fasciitis [5] were similar to those observed in our study. In the present study, hallux valgus (64%) was more common compared to older samples from the Feet First Study (37%) [5] and population-based MOBILIZE Boston Study of older adults (46%) [7]. In addition overlapping toes (34%) were twice as common compared to the Feet First Study (16%) [5]. Tailor's bunions (6%) were less common in the present study compared to the Feet First Study (13%) [5]. Variation in the frequency of these foot disorders across cohorts may be related to differences in population characteristics, such as age (e.g., Feet First Study [5] participants were 65+ years of age and MOBILIZE Boston Study [7] participants were 70+ years old compared to our cohort of persons aged 50 years and older), BMI, race or other extrinsic factors such as shoe wear or occupational history. As the relation of these variables to foot disorders is not known except in clinical samples, possible differences in cohorts should be considered and these factors further evaluated. The high frequency of foot disorders in these cohorts suggest that they are of important public health concern, especially since they may contribute to more serious adverse outcomes common for older adults (i.e., falls, decreased physical activity, functional limitations, decreased quality of life) [1, 13, 14].

In this study, the racial differences for the frequency of structural foot disorders and certain foot types, specifically with hallux valgus, hammer toes, and pes planus, occurred more commonly among African Americans than Caucasians, while Tailor's bunion and pes cavus presented more frequently among Caucasians than African Americans. The Feet First study also reported that hallux valgus and pes planus were more common in African Americans than Caucasians [5]. We did not observe any significant interaction between race and gender in the present study, however Nguyen et al. [7] reported that non-White race was associated with hallux valgus among men only in the MOBILIZE Boston study of older adults. In our study, the higher odds of hallux valgus, hammer toes, and overlapping toes among African Americans compared to Caucasians was statistically significant among participants whose BMI was less than 30 kg/m², but was less apparent among obese participants (BMI ≥ 30 kg/m²). The effects of obesity may mask a racial discrepancy in the frequency of hallux valgus, hammer toes, and overlapping toes, and thus, the results among the non-obese participants may provide a more accurate picture of the racial difference. The important interaction between race and obesity groups suggests that the effect of obesity may supersede the effects of unknown factors that may be responsible for the racial disparities in having these foot disorders, thereby equalizing the frequency of these disorders in obese African Americans and Caucasians. Interestingly, non-obese African Americans had the highest frequency of hallux valgus, hammer toes, and overlapping toes compared to all other subgroups (obese African Americans and non-obese and obese Caucasians), as shown in Table 2. The reason for the higher frequency of these foot disorders in non-obese African Americans is not known and warrants further exploration, particularly examining occupational factors and shoe wear history.

An important strength of this study is that the foot examinations were conducted using a validated foot evaluation tool for specific, common foot disorders. Additionally, the study is community-based and includes large numbers of African American and Caucasian men and women, thus allowing for racial comparisons in a sample that may be more representative of adults 50 years of age and older than those in clinic-based studies. To date and to our knowledge, this is the largest study that has assessed the relation between common foot disorders or types and race. Our study is limited by several factors, however. Foot radiographs, which are useful for confirming the presence of structural disorders like hallux valgus, were not obtained in this study. Foot biomechanics data, which may confirm pes planus/ cavus foot types and pronatory/supinatory foot movement patterns, were collected but not fully analyzed at the time of this report and will be examined in future studies.

Information on possible genetic influences, effects from various shoe wear worn at different ages across the lifespan, multi-joint osteoarthritis, and occupational factors were not considered in these analyses. However, these aspects that might affect the relation between foot disorders and race are planned to be the topics of future studies as these data become available since they may help explain racial differences that we observed in this study.

In conclusion, the frequency of structural foot disorders and pes planus among adults 50 years of age and older is high, and in our community-based sample, certain foot disorders/types differed by race. Future research is needed to determine the etiology of these structural foot disorders/types in order to help explain the racial differences observed in this study. Understanding the origin of these foot disorders/types and their differences by race may inform prevention efforts as well as early intervention approaches, especially in important population subgroups.

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Significance and Innovations

- Structural foot disorders are an important public health concern because they are common among adults 50+ years old and they may contribute to more serious adverse outcomes, such as falls and disability.
- Racial differences in the frequency of foot disorders and certain foot types are apparent, particularly among the non-obese.

Table 1

Characteristics of Study Participants from the Johnston County Osteoarthritis Project attending Foot Examination 2006–2010, by Race.

	Total Sample N=1,691	African Americans N=528 (31.2%)	Caucasians N=1,163 (68.8%)	p-value*
Age: mean (\pm SD)	68.6 (9.1)	67.3 (9.2)	69.2 (9.0)	<0.01
Body Mass Index: mean (\pm SD)	31.5 (7.2)	33.3 (8.6)	30.6 (6.3)	<0.01
Women, n (%)	1,142 (67.5)	383 (72.5)	759 (65.3)	<0.01
12 years of Education, n (%)	1,314 (77.7)	368 (69.7)	946 (81.3)	<0.01

* Chi-square p-values for categorical variables and t-test p-values for continuous variables.

Table 2

Frequency of Foot Disorders or Foot Conditions by Race and adjusted Odds Ratios and 95% Confidence Intervals for Main Effects and for BMI subgroups, Johnston County Osteoarthritis Project Participants Attending Foot Examination Between 2006 and 2010.

	Total Sample N=1,691	African Americans N=528 (31.2%)	Caucasians N=1,163 (68.8%)	Unadjusted Odds Ratio (95% Confidence Interval	Adjusted* Odds Ratio (95% Confidence Interval
Hallux Valgus, n/N (%)	1088/1691 (64.3)	371/528 (70.3)	717/1163 (61.7)	1.47 (1.18–1.83)	-
Non-obese, n/N (%)	535/818 (62.3)	149/198 (75.3)	386/620 (62.3)	-	2.01 (1.39–2.92) †
Obese, n/N (%)	553/872 (63.4)	222/330 (67.3)	331/542 (61.1)	-	1.33 (0.98–1.80) †
Hammer Toes, n/N (%)	597/1691 (35.3)	219/528 (41.5)	378/1163 (32.5)	1.47 (1.19–1.82)	-
Non-obese, n/N (%)	292/818 (35.7)	103/198 (52.0)	189/620 (30.5)	-	2.64 (1.88–3.70) †
Obese, n/N (%)	305/872 (34.9)	116/330 (35.2)	189/542 (34.9)	-	1.12 (0.83–1.51) †
Overlapping Toes n/N (%)	578/1691 (34.2)	190/528 (36.0)	388/1163 (33.4)	1.12 (0.91–1.39)	-
Non-obese, n/N (%)	296/818 (36.2)	85/198 (42.9)	211/620 (34.0)	-	1.53 (1.09–2.13) †
Obese, n/N (%)	282/872 (32.3)	105/330 (31.8)	177/542 (32.7)	-	0.94 (0.70–1.28) †
Pes Planus n/N (%)	391/1691 (23.1)	202/528 (38.3)	189/1163 (16.3)	3.19 (2.53–4.04)	2.94 (2.31–3.75)
Morton's Neuroma n/N (%)	160/1691 (9.5)	55/528 (10.4)	105/1163 (9.0)	1.17 (0.83–1.65)	1.03 (0.72–1.47)
Tailor's Bunions n/N (%)	106/1691 (6.3)	8/528 (1.5)	98/1163 (8.4)	0.17 (0.08–0.35)	0.18 (0.09–0.37)
Plantar Fasciitis n/N (%)	89/1691 (5.3)	31/528 (5.9)	58/1163 (5.0)	1.19 (0.76–1.89)	0.98 (0.62–1.57)
Pes Cavus n/N (%)	79/1691 (4.7)	8/528 (1.5)	71/1163 (6.1)	0.24 (0.11–0.50)	0.28 (0.13–0.59)
Claw Toes n/N (%)	55/1691 (3.3)	21/528 (4.0)	34/1163 (2.9)	1.38 (0.79–2.39)	1.57 (0.89–2.78)

* Adjusted for age, gender, body mass index, and education; reference = Caucasian.

† Adjusted for age, gender, and education; statistically significant ($p < 0.10$) interaction of race and body mass index (non-obese vs. obese). P-value for statistically significant interactions: hallux valgus=0.06, hammer toes=0.06, and overlapping toes=0.01.