This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

ORIGINAL ARTICLE

Arch Height Index Values in a Symptomatic Population

Megan E.R. Balsdon, MESc*

Michaela Khan, MSc*†

Dillon Richards, BSc‡

Colin E. Dombroski, PhD, CPed(C)*‡

*SoleScience Inc., Fowler Kennedy Sports Medicine Clinic, Western University, London, ON, Canada.
†Faculty of Health Sciences, School of Kinesiology, Western University, London, ON, Canada.
‡Faculty of Health Sciences, School of Physical Therapy, Western University, London, ON, Canada.

Corresponding author: Megan E.R. Balsdon, MESc, SoleScience Inc., Fowler Kennedy Sports Medicine Clinic, 3M Building, Western University, London, ON, Canada N6A 3K7. (E-mail: mbalsdon@uwo.ca)

Background: Normative studies on the Arch Height Index (AHI), Arch Rigidity Index (ARI), and
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

Arch stiffness have primarily focused on healthy populations, with little consideration of pathology. The purpose of this study was to create a normative sample of the aforementioned measurements in a pathological sample and to identify relationships between arch structure measurements and pathology.

**Methods:** AHI was obtained bilaterally at 10% and 90% weightbearing conditions using the Arch Height Index Measurement System (AHIMS). ARI and arch stiffness were calculated using AHI measurements. Dependent t-tests compared right and left, dominant and non-dominant, and injured and non-injured limbs. Measurements of the dominant foot were compared between sexes using independent t-tests. Relationships between arch stiffness and age, sex, and AHI were examined using the coefficient of determination ($R^2$). One-way ANOVAs were used to determine differences between arch structure measurements and number of pathologies or BMI.

**Results:** A total of 110 participants reported either one (n=55), two (n=38), or three or more (n=17) pathologies. Plantar fasciitis (n=31) and hallux valgus (n=28) were the most commonly reported primary concerns. AHI, ARI, and arch stiffness did not differ between limbs for any comparisons, nor between sexes. Between subgroups of BMI and number of pathologies, no differences exist in AHI or ARI; however, BMI was found to have an impact on AHI (10%WB) and arch stiffness ($p<.05$). Arch stiffness showed a weak relationship to AHI, where a higher AHI was associated with a stiffer arch ($R^2=0.06$).
Conclusions: Normative AHI, ARI and arch stiffness values were established in a pathological sample with a large incidence of plantar fasciitis and hallux valgus. Findings suggest relationships between arch stiffness and both BMI and arch height; however, few trends were noted in AHI and ARI. Determining relationships between arch structure and pathology is helpful for both clinicians and researchers.

Malleability and movement through the medial longitudinal arch (MLA), which lies between the head of the first metatarsal and the calcaneal tuberosity, enables shock absorption and stiff lever functions of the foot during gait\(^1\text{-}^6\). The MLA can be described using three different foot arch type classifications: low (pes planus); normal (pes rectus); and high (pes cavus).

Methods to clinically categorize foot arch types include: footprint parameters\(^1\text{-}^3\); posture-related scores\(^4\text{-}^5\); visual observation\(^6\); dimensional-related indices\(^7\text{-}^8\); and radiographs\(^9\). While radiographic measurement is considered the ‘gold standard’ for arch assessment\(^10\), x-rays may be challenging to access, require ionizing radiation, and cannot be used conveniently in a clinical setting. Developed by Williams and McClay (2000), the Arch Height Index (AHI) has been found to be a valid and reliable method to measure arch height when performed by single or multiple testers\(^7\). The AHI is the ratio of the dorsum height of the foot (measured at 50% of its total length) over the truncated foot length (distance from the most posterior aspect of the
calcaneeus to the first metatarsal phalangeal joint). Measures of the AHI have been further improved by the creation of the Arch Height Index Measuring System (AHMIS), for which intra-rater and inter-rater reliabilities are 0.94 and 0.99, respectively. Butler et al. (2008) found the mean AHI at 50% weightbearing to be 0.340±0.030 in 100 healthy recreational runners (50 females), which is in agreement with a study by Weimar and Shroyer (2013), who investigated the AHI of 79 college females (mean AHI: 0.340±0.032). However, these reports on AHI measurements are limited in that they have focused on pathology-free populations only.

Hegedus et al. (2010) were the first to investigate correlations of the AHI to self-reported lower extremity pain/dysfunction. No significant relationship was found between AHI and the Single Assessment Numeric Evaluation (self-reported scale relating timing and mechanism of lower extremity pain) or the Lower Extremity Functional Scale (self-reported ability to perform everyday tasks). However, this study was limited in that no specific diagnoses contributing to pain/dysfunction were reported. Rabbito et al. (2011) identified differences in seated AHI between runners with stage 1 posterior tibial tendon dysfunction, and authors suggested this anatomical difference may partially explain the progression of this condition. Thus, quantifying arch height measurements in pathological populations may be advantageous for clinicians to disentangle the effects of arch structure among certain populations and may help in the understanding of its role in pathology.

The ability of the foot to maintain its arch when weightbearing can be investigated using
the Arch Rigidity Index (ARI). The ARI is calculated by dividing standing AHI by seated AHI, with a value closer to 1.0 representing a stiffer arch\textsuperscript{16}. Previous studies have suggested pregnancy results in long lasting reductions in arch rigidity\textsuperscript{17}. Further, arch stiffness is a measure of deformation per unit load, and can be quantified in the foot using arch height index measures. One study has found that women demonstrate significantly greater arch flexibility than men, which may be related to an increase in ligamentous laxity\textsuperscript{18}. Given that greater arch flexibility has been associated with soft tissue injuries of the foot and ankle, women may be at an increased risk for injury\textsuperscript{19}; therefore, it is important to investigate arch rigidity or stiffness in the injured population.

The present study aimed to create a normative sample of AHI, ARI, and arch stiffness measurements in a pathological population and to identify relationships between arch structure measurements and pathology. If a relationship is found, clinicians can use these measures as a reliable way to better inform clinical decision making. It was hypothesized that a pathological population would show different arch structure measurement values compared to those previously reported for healthy populations. Additionally, it was hypothesized that individuals who experience three or more pathologies would show differences in arch structure measurements and larger variances compared to those who do not.
Methods

Participants were recruited from the SoleScience pedorthic clinic at the Fowler Kennedy Sports Medicine Clinic, Western University, Canada. Eligible patients reported an acute and/or chronic lower extremity injury (either unilateral or bilateral), were over 18 years of age, and were able to commute to the clinic. Participants were excluded if they were pregnant. Ethics was approved by the relevant research ethics board.

Participant demographics (age, height, weight, body mass index, dominant foot), including the number of pathologies and duration of symptoms were recorded. Foot dominance was determined by asking participants which leg they would prefer to kick a ball with. Pathology was diagnosed by an experienced, certified pedorthist (CD) and duration of symptoms was self-reported. All measurements (total foot length, truncated foot length, dorsum height) of the right and left foot were obtained by a single investigator (CD) using the well documented AHIMS procedure at both 10% and 90% weightbearing (WB) conditions\textsuperscript{11,12,20}. For the 10\% WB condition, participants were seated with their knees, hips and ankles relaxed at 90\(^\circ\). Measures for the 90\% WB condition were obtained from the stance leg while the participants used their contralateral foot to “toe-touch” weightbear for stability – a position that mimics the single leg stance position. Each participant was given identical instructions and the clinician visually observed the participant’s standing position to ensure consistency.

ARI (90\% WB AHI over 10\% WB AHI) and arch stiffness\textsuperscript{18} were also calculated from these
measurements. Arch stiffness was calculated assuming a 80% change in load between weightbearing conditions (80% change reflected the difference between 90% the body weight and the weight of the foot and shank):

\[
\text{Arch Stiffness} = \frac{0.80 \times \text{Bodyweight(kg)}}{\text{AHI (10% WB)} - \text{AHI (90% WB)}}
\]

The Shapiro-Wilk test was used to assess normality. Dependent t-tests were conducted to compare measurements between left and right, dominant and non-dominant, and injured and uninjured limbs. Participants who reported equal pain in both limbs were excluded from the injured versus uninjured limb analysis. Differences in sex were examined using independent t-tests for their dominant foot only. The relationships between age versus arch structure and between AHI versus arch stiffness were examined using a linear regression to determine the coefficient of determination \((R^2)\). One-way analysis of variance (ANOVA) was used to determine whether differences in arch measurements existed in subgroups based on number of pathologies or BMI. Post-hoc tests were conducted to report the average AHI, ARI, and arch stiffness for feet with the most commonly reported pathologies in the sample. Alpha value was set at 0.05 to define significance and all analyses were conducted in SPSS version 20 (SPSS, Inc., Chicago, Illinois).

**Results**

One hundred and ten participants (Table 1) voluntarily consented to participate in this study.
Participants were found to experience either one (n=55), two (n=38), or three or more (n=17) pathologies. Duration of pain/injury ranged from two weeks to three decades. Thirty-four different primary pathologies (i.e. the main reason the participant was seeking treatment) were reported. The most common primary pathologies were plantar fasciitis (n=31) and hallux valgus (n=28), followed by knee pain (n=7) and metatarsalgia (n=6). An additional 13 individuals reported hallux valgus as either their secondary or tertiary pathology, followed by four more individuals with plantar fasciitis, ten with metatarsalgia and three reporting knee pain. A total of 74 participants experienced greater pain in one limb compared to the other, and thus were included in analyses evaluating the injured versus non-injured limbs. All measures followed a normal distribution.

Means (±SDs) of 10% and 90% weightbearing (WB) foot measurements and the AHI are presented in Tables 2 and 3, respectively. Statistically significant differences were found between the right and left limbs and dominant and non-dominant limbs for truncated foot length and dorsum height, in both the 10% and 90% WB conditions (Table 2). Total foot length and AHI were not statistically different for either condition in all comparisons. Similarly, ARI and arch stiffness did not differ between limbs (Table 3).

Independent t-tests using the dominant foot for each participant showed no significant differences between males and females for 10% (p=.345) and 90% (p=.642) WB AHI, ARI (p=.556), or arch stiffness (p=.083).
Results for 10% and 90% weightbearing AHI, ARI and arch stiffness for subgroups of pathology and BMI are displayed in Table 4. Mean (±SDs) values are also included for the two most prevalent pathologies: plantar fasciitis (n=51 feet) and hallux valgus (n=56 feet) (Table 4). There were no statistically significant differences in BMI for 90% WB AHI (F(3,216)=2.500, p=.060), or ARI (F(3,216)=.108, p=.955); however, there was a significant difference in 10% WB AHI (F(3,216)=3.091, p=0.028) and arch stiffness between BMI groups (F(3,210)=3.915, p=.010). A Tukey post-hoc test revealed that the mean arch stiffness in the Healthy Weight group was statistically smaller than the Obese group (p=.025), whereas post-hoc tests for 10%WB AHI revealed the biggest difference between the Healthy Weight group and the Severely Obese group (p=.068). No statistically significant differences were found for number of pathology group means for 10% WB AHI (F(2,217)=.107, p=.898), 90% WB AHI (F(2,217)=.372, p=.690), ARI (F(2,217)=.871, p=.420) or arch stiffness (F(2,211)=0.154, p=.858).

There were no statistically significant relationships between age and either 90% WB AHI (p=.310; Figure 1a) or arch stiffness (p=.065; Figure 1b). There was a weak relationship between 90% WB AHI and arch stiffness (p=.113) where a higher AHI tended to correspond with a stiffer arch (R²=0.0632) (Figure 2).

Discussion

The purpose of the study was to measure arch height index (AHI), arch rigidity index (ARI), and arch stiffness in a pathological sample that focuses on creating a normative sample while
investigating the relationship between foot arch structure and pathology. The first aim was to determine if there were differences in AHI between right and left feet, dominant and non-dominant limbs, injured and uninjured limbs (where applicable), and between the dominant limb in males and females. No significant differences were found among these comparisons. Studies measuring AHI in an asymptomatic population found no significant differences between males and females,\textsuperscript{18,20} however, Zifchock et al. (2006) found a significantly higher AHI in dominant feet. Similarly, upon examining arch rigidity index (ARI), no significant differences were found using the same comparisons (gender, foot dominance, and injured limb). ARI has not been studied extensively in the literature; however, significant differences in ARI have been observed between males and females in an older population (~74 years old) using a 3D foot scanner\textsuperscript{21}.

In the present study, it was found that BMI was a factor in both arch stiffness and 10% WB AHI, where the mean arch stiffness in the healthy weight group was statistically smaller than the obese group, and the mean AHI at 10% WB was smaller in the healthy weight group compared to the severely obese group. This indicates that in a pathological sample, the arch was found to be both higher and stiffer in those with a larger BMI. It is understood among clinicians and researchers that there is a positive relationship between arch stiffness and a higher standing arch height, as arches that maintain their height during weightbearing tend to be stiffer than those that drop.\textsuperscript{18} This notion helps explain the trend seen among BMI groups
since AHI increased with increasing BMI, likely contributing to the increase in arch stiffness as well. The same trend of increased AHI with BMI was also observed in a recent study that measured AHI with a 3D foot scanner in a random sample of participants. Results from Zifchock et al. (2006) confirm a significant but weak relationship between arch height index and arch stiffness\textsuperscript{18}. Though the relationship showed a similar trend, the same correlation was not considered significant in the present study, which may be because 90% WB was used instead of 50% WB for the other studies\textsuperscript{18,22}, potentially leading to higher arch stiffness values and lower AHI values, in comparison. Arch stiffness was also evaluated between genders by Zifchock et al. (2006) in a non-injured sample of convenience in a university setting and found that male participants had significantly stiffer feet compared to females\textsuperscript{18}. This finding was not statistically significant in this pathological population; however, this study similarly showed a larger mean arch stiffness in males.

The mean standing AHI measured among this sample at 90% WB (0.323) was smaller than the previously reported values measured using the AHIMS in a healthy sample (0.340) at 50% bodyweight\textsuperscript{12,20}. The decrease in AHI is likely attributable to the increase in bodyweight from 50% to 90%. Standing AHI at 90% bodyweight reported in a study by Williams & McClay (2000) measured smaller (0.292) than the current study; however, the measurement was taken with hand-held calipers as opposed to the AHIMS\textsuperscript{7}. Previous studies that reported on normative AHI measures did not discuss ARI values; however, the present authors were able to calculate
ARI using the measured seated and standing AHI measurements included in those studies. ARI values were found to be 0.944 and 0.941 at 50% bodyweight \(^{12,20}\) and 0.81 at 90% bodyweight \(^{7}\), in comparison to 0.90 in the present study. Previous literature reporting normative values for AHI did so in asymptomatic populations, which may have contributed to the slight differences in AHI and ARI. Pathological participants were likely to be symptomatic at the time of data collection and were potentially protecting the foot by stiffening the intrinsic foot muscles, leading to a higher ARI compared to the value noted in the asymptomatic population.

It was hypothesized that the number of pathologies would be correlated to differences in AHI and/or ARI; however, this was not found to be the case. The present study was the first to examine a large pathological population, with thirty-four (34) different pathologies reported as the participants’ primary concern and main reason they were at the clinic seeking treatment. The two most common pathologies were plantar fasciitis and hallux valgus. An additional 13 individuals reported hallux valgus and four individuals reported plantar fasciitis as their secondary and tertiary pathologies. This means that more than one third of patients had hallux valgus, and slightly less than one third of patients had plantar fasciitis. The mean AHI for the group with hallux valgus was slightly lower than the mean AHI for the group as a whole, which aligns with the literature suggesting that flatfoot or collapse of the MLA has a causal correlation with hallux valgus\(^{23,24}\). Once study found that the arch height ratio (navicular height/foot length) was significantly lower in female university students with a hallux valgus angle greater
than 16 degrees\textsuperscript{25}. These authors were not able to comment on whether the decrease in arch height was the cause of the HV or the result of the deformation. Participants with plantar fasciitis had a slightly lower mean as well, but higher than the HV group, both were within one standard deviation from the mean of the group. Previous research indicates no direct correlation with either foot pronation or arch height in people with plantar fasciitis, likely because both pes planus and pes cavus feet are considered risk factors\textsuperscript{26,27}.

A previous study compared differences in AHI in runners with stage I posterior tibialis tendon dysfunction (PTTD) to healthy gender, height, and weight matched controls\textsuperscript{28}. Statistically significant differences were found in seated AHI (lower in PTTD group) but not in standing AHI or ARI. These results were determined using a between-subjects’ comparison, and measurements were taken at 50\% weightbearing. No additional studies have reported on AHI or ARI in a pathological population using the AHIMS; however, there have been reports on arch structure and its effect on injury prevalence. It was found that the MLA had no effect on the rates of ankle and knee injuries, reporting that the most commonly injured people had arch heights within a normal range \textsuperscript{29}. It is important to note that arch height was classified by navicular drop, which accounts for MLA mobility rather than static foot structure. With respect to foot function, Baumhauer et al.\textsuperscript{(1995)} found that the ratio of eversion-to-inversion strength was significantly larger in an injured compared to an uninjured cohort, with 67\% of the injured individuals with a ratio of 1.0 or greater, indicating a muscle imbalance. These individuals
exhibited a higher incidence of inversion ankle injuries\textsuperscript{30}. Unfortunately, this study did not comment on the static arch structure of the population.

A number of important considerations should be acknowledged. The present study did not include an asymptomatic control group since normative values have already been established for healthy populations. No scale was used to measure the exact percentage of the person’s weight on the single measured foot. However, the intention was to replicate a weightbearing condition that was closest to representing dynamic motion of the foot, especially more so than double legged standing (50% bodyweight). We did not take measurements while the foot was positioned with blocks at the heel and ball of the foot like previous studies\textsuperscript{12,18,20,28}, which would allow the midfoot to collapse completely. The authors felt that using blocks deforms the foot into a configuration that it is rarely seen functionally or during the activities of daily living, thus is unrealistic and clinically irrelevant to investigate. Additionally, a recent study compared the AHI using AHIMS at various weights and found the 50% bodyweight value on blocks versus force plate were no different\textsuperscript{31}. Lastly, although the AHI is only a static measurement, it is a simple, reliable, and accessible method to measure arch height in a clinic, and has been used abundantly in the literature in healthy populations prior to this study.
Conclusions

This study was the first to establish normative AHI values for a pathological population with a high incidence of hallux valgus and plantar fasciitis using the AHIMS. Differences between 10% and 90% weightbearing AHI values were noted for left and right, dominant and non-dominant, and injured and uninjured feet. Due to the large number of different pathologies between participants, no clear connections were found between pathological AHI or ARI and BMI, number of pathologies, or age. However, arch stiffness in the healthy weight group was statistically smaller than the obese group. A slight correlation between arch stiffness and AHI is suggestive that higher arched feet tend to be stiffer. Future investigations should focus on one injury, in its acute and/or chronic form, correlating AHI, ARI and arch stiffness with duration of the injury, while comparing these values to a control group.

Financial Disclosure: None reported.

Conflict of Interest: None reported.

References


10. Tong JWK, Kong PW: Association Between Foot Type and Lower Extremity Injuries:


Figure 1: The relationship of Arch Height Index (AHI) at 90% weightbearing (a) and arch stiffness (b) as a function of age and sex, with male and female values plotted separately. Values from both limbs are included.
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.
Figure 2: Arch Stiffness as a function of 90% WB Arch Height Index (AHI) across all participants. Values from both limbs are included.
Table 1: Participant Demographics.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Age</th>
<th>Height, cm</th>
<th>Weight, kg</th>
<th>BMI (kg/m²)</th>
<th>Dominant foot (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>57</td>
<td>51.7 ±17.7</td>
<td>162.8 ±5.2</td>
<td>73.3 ±16.5</td>
<td>26.8 ±5.3</td>
<td>95</td>
</tr>
<tr>
<td>Male</td>
<td>53</td>
<td>51.9 ±15.0</td>
<td>184.1 ±5.4</td>
<td>91.0 ±17.2</td>
<td>28.2 ±4.9</td>
<td>91</td>
</tr>
</tbody>
</table>

Table 2: Between-limb comparisons of foot measurements from the Arch Height Index Measurement System (n=110) for the 10% and 90% weightbearing conditions. Data are presented as mean ± SD, in cm.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Left</th>
<th>Right</th>
<th>p</th>
<th>Dominant</th>
<th>Non-dominant</th>
<th>p</th>
<th>Injured (n=74)</th>
<th>Uninjured (n=74)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% Weightbearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total foot length</td>
<td>25.3 ±1.9</td>
<td>25.3 ±1.9</td>
<td>.503</td>
<td>25.3 ±1.9</td>
<td>25.3 ±1.9</td>
<td>.503</td>
<td>25.2 ±1.8</td>
<td>25.2 ±1.8</td>
<td>.30</td>
</tr>
<tr>
<td>Truncated foot length</td>
<td>18.7 ±1.5</td>
<td>18.6 ±1.5</td>
<td>.00</td>
<td>18.6 ±1.5</td>
<td>18.7 ±1.5</td>
<td>.01</td>
<td>18.5 ±1.4</td>
<td>18.6 ±1.5</td>
<td>.34</td>
</tr>
<tr>
<td>Dorsum Height</td>
<td>6.7 ±.7</td>
<td>6.6 ±.7</td>
<td>.00</td>
<td>6.6 ±.7</td>
<td>6.7 ±.7</td>
<td>.00</td>
<td>6.6 ±.6</td>
<td>6.6 ±.7</td>
<td>.58</td>
</tr>
<tr>
<td>90% Weightbearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total foot length</td>
<td>25.8 ±1.9</td>
<td>25.8 ±1.9</td>
<td>.744</td>
<td>25.8 ±1.9</td>
<td>25.8 ±1.9</td>
<td>.706</td>
<td>25.7 ±1.9</td>
<td>25.7 ±1.9</td>
<td>.60</td>
</tr>
<tr>
<td>Truncated foot length</td>
<td>19.1 ±1.5</td>
<td>19.0 ±1.5</td>
<td>&lt;.00</td>
<td>19.0 ±1.5</td>
<td>19.1 ±1.5</td>
<td>&lt;.00</td>
<td>18.9 ±1.4</td>
<td>18.9 ±1.4</td>
<td>.64</td>
</tr>
<tr>
<td>Dorsum Height</td>
<td>6.2 ±.7</td>
<td>6.1 ±.7</td>
<td>&lt;.00</td>
<td>6.1 ±.7</td>
<td>6.2 ±.7</td>
<td>.00</td>
<td>6.1 ±.6</td>
<td>6.1 ±.7</td>
<td>.69</td>
</tr>
</tbody>
</table>
This Original Article has been reviewed, accepted for publication, and approved by the author. It has not been copyedited, proofread, or typeset and is not a final version.

Table 3: Between-limb comparisons of AHI, ARI, and Arch Stiffness. Data are presented as mean ± SD.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>All</th>
<th>Left</th>
<th>Right</th>
<th>p</th>
<th>Dominant</th>
<th>Non-dominant</th>
<th>p</th>
<th>Injured (n=74)</th>
<th>Uninjured (n=74)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHI (10% WB)</td>
<td>.35 ±</td>
<td>.358 ±</td>
<td>.356 ±</td>
<td>.16</td>
<td>.356 ±</td>
<td>.359 ±</td>
<td>.11</td>
<td>.357 ±</td>
<td>.357 ±</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>.033</td>
<td>.034</td>
<td>.031</td>
<td>.01</td>
<td>.030</td>
<td>.035</td>
<td>.06</td>
<td>.031</td>
<td>.036</td>
<td>2</td>
</tr>
<tr>
<td>AHI (90% WB)</td>
<td>.32 ±</td>
<td>.325 ±</td>
<td>.321 ±</td>
<td>.08</td>
<td>.322 ±</td>
<td>.324 ±</td>
<td>.22</td>
<td>.321 ±</td>
<td>.322 ±</td>
<td>.64</td>
</tr>
<tr>
<td></td>
<td>.034</td>
<td>.036</td>
<td>.032</td>
<td>.09</td>
<td>.032</td>
<td>.036</td>
<td>.1</td>
<td>.033</td>
<td>.037</td>
<td>9</td>
</tr>
<tr>
<td>ARI</td>
<td>.90 ±</td>
<td>.906 ±</td>
<td>.903 ±</td>
<td>.63</td>
<td>.905 ±</td>
<td>.904 ±</td>
<td>.83</td>
<td>.900 ±</td>
<td>.902 ±</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>.041</td>
<td>.040</td>
<td>.042</td>
<td>.07</td>
<td>.042</td>
<td>.039</td>
<td>.09</td>
<td>.042</td>
<td>.038</td>
<td>3</td>
</tr>
<tr>
<td>Arch Stiffness*</td>
<td>233 ±</td>
<td>2386 ±</td>
<td>2291 ±</td>
<td>.60</td>
<td>2355 ±</td>
<td>2323 ±</td>
<td>.86</td>
<td>2252 ±</td>
<td>2158 ±</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>141</td>
<td>1447</td>
<td>1382</td>
<td>.02</td>
<td>1402</td>
<td>1428</td>
<td>.1</td>
<td>1472</td>
<td>1091</td>
<td>0</td>
</tr>
</tbody>
</table>

*Values >10,000 were considered outliers and removed from analyses: n=107 for Left vs. Right and Dominant vs. Non-Dominant limbs, n=73 for Injured vs. Uninjured limbs
Table 4: AHI, ARI and Arch Stiffness by Pathology (number and type) and BMI groups. Data are presented as mean ± SD.

<table>
<thead>
<tr>
<th>No. Pathology</th>
<th>N</th>
<th>AHI (10%WB) (mean ± SD)</th>
<th>AHI (90%WB) (mean ± SD)</th>
<th>ARI (mean ± SD)</th>
<th>N</th>
<th>Arch Stiffness (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>110</td>
<td>.357 ± .033</td>
<td>.324 ± .033</td>
<td>.908 ± .036</td>
<td>108</td>
<td>2328 ± 1236</td>
</tr>
<tr>
<td>2</td>
<td>76</td>
<td>.356 ± .033</td>
<td>.320 ± .035</td>
<td>.900 ± .046</td>
<td>74</td>
<td>2399 ± 1685</td>
</tr>
<tr>
<td>3+</td>
<td>34</td>
<td>.359 ± .031</td>
<td>.325 ± .035</td>
<td>.905 ± .042</td>
<td>32</td>
<td>2236 ± 1313</td>
</tr>
<tr>
<td>Type of Pathology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantar Fasciitis</td>
<td>51</td>
<td>.355 ± .034</td>
<td>.320 ± .034</td>
<td>.904 ± .043</td>
<td>51</td>
<td>2504 ± 1611</td>
</tr>
<tr>
<td>Hallux Valgus</td>
<td>56</td>
<td>.352 ± .031</td>
<td>.316 ± .035</td>
<td>.897 ± .043</td>
<td>56</td>
<td>2320 ± 1644</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy Weight</td>
<td>82</td>
<td>.350 ± .029</td>
<td>.317 ± .033</td>
<td>.903 ± .041</td>
<td>80</td>
<td>1959 ± 1283*</td>
</tr>
<tr>
<td>Overweight</td>
<td>82</td>
<td>.360 ± .033</td>
<td>.326 ± .033</td>
<td>.906 ± .040</td>
<td>82</td>
<td>2460 ± 1516</td>
</tr>
<tr>
<td>Obese</td>
<td>52</td>
<td>.361 ± .037</td>
<td>.326 ± .035</td>
<td>.904 ± .044</td>
<td>48</td>
<td>2679 ± 1244*</td>
</tr>
<tr>
<td>Severely Obese</td>
<td>4</td>
<td>.391 ± .026</td>
<td>.355 ± .027</td>
<td>.907 ± .036</td>
<td>4</td>
<td>3361 ± 2106</td>
</tr>
</tbody>
</table>

* statistically significantly different (p<.05)