

# Prevalence of Achilles Tendinopathy and Associated Selected Intrinsic Risk Factors among Nigerian Footballers

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## SUMMARY

**Background.** Achilles tendinopathy (AT) is a major foot and ankle overuse injury which has been reported to be prevalent in running and jumping sporting activities, especially football which has witnessed increased participation in recent times. However, there are no epidemiological data on tendinopathy in footballers in Nigeria. The aim of this study was to determine the prevalence of Achilles tendinopathy and associated intrinsic risk factors among Nigerian footballers.

**Methods.** Participants were 151 registered football players recruited from various football clubs in Lagos State, Nigeria. Selected intrinsic factors of age, gender, body mass index (BMI), random blood glucose and bilateral ankle dorsiflexion and plantarflexion were evaluated. AT was determined with the Royal London Hospital Test and ultrasonography. Principal Component Analysis (PCA) was used to determine the association between AT and selected intrinsic risk factors and significance set at  $p < 0.05$ .

**Results.** The prevalence of AT was 15.9%. There were significant associations between elevated BMI ( $p = 0.027$ ), left ankle dorsiflexion ( $p = 0.035$ ) and right ankle plantarflexion ( $p = 0.008$ ) with Achilles tendinopathy. No significant association ( $p > 0.05$ ) was found between Achilles tendinopathy and blood glucose level.

**Conclusions.** Elevated body mass index, reduced ankle dorsiflexion and plantarflexion are risk factors for Achilles tendinopathy.

## KEY WORDS

Prevalence; Achilles tendinopathy; intrinsic risk factors; Nigerian footballers.

## INTRODUCTION

Exposure of the Achilles tendon to excessive mechanical loadings during vigorous exercises such as running and jumping result in tendinopathy and subsequent tendon rupture (1). A prevalence of 21% was reported for Achilles tendinopathy among recreational sports (2) participants in Nigeria (3). The aetiology of Achilles tendinopathy has been reported to be multi-factorial, which could be due to intrinsic and extrinsic factors (4). The intrinsic factors include intra-tendinous degeneration, aging, genetic factors, diabetes, body mass index (BMI) and kinematics and biomechanical abnormalities such as limited range of motion (ROM) and leg length discrepancy (4, 5). Some of the extrinsic

factors on the other hand are training frequency, trauma, training errors and mechanical overload which all play some role in the development of Achilles tendinopathy (6).

Overweight and obesity as determined by the body mass index (BMI), has been on the increase over the years and it has been reported that both may be associated with poorer fitness in terms of strength and endurance (7, 8). This results in lower levels of neuromuscular control including balance and coordination, which could place those with elevated BMI at greater risk for injury (1). A systematic review on running related musculoskeletal injuries found that Achilles tendinopathy presented as the second highest injury incidence at 9.1-10.9% (7) Saunders *et al.* (9) reported a

prevalence of 23.3% Achilles tendon rupture in footballers among the Danish population in a retrospective study. With increase in football participation in Nigeria, an upsurge in the incidence of injuries has been reported with an overall injury incidence of 113.4 and time-loss incidence of 15.6 injuries/1000 match-hours. Several lower limb injuries such as ankle injuries, anterior cruciate ligament (ACL) ruptures and Achilles tendon injuries have been associated with restricted ankle dorsiflexion range of motion (ROM) (10). A few studies have analyzed whether football-specific adaptations would occur in the ankle and hip rotation ROMs despite the fact that restricted scores have been considered as primary risk factors for some of the most common injuries in football, such as ankle sprains and knee osteoarthritis respectively (11). A study reported that restricted ankle dorsiflexion ROM increases injury risk significantly by modifying lower-limb stiffness and landing forces after a vertical jump (12). It was reported also that the maintenance of blood glucose (energy) balance is an important factor in reduction of injury risk because it ensures optimal performance among athletes (13).

Achilles tendinopathy presents with symptoms of pain, swelling, and impaired function during sporting activities and activities of daily living (4). It is quite detrimental to an athlete's career because it is associated with factors such as psychological discomfort, poor quality of life, time, and productivity loss (14). It has also been associated with functional limitations generally and ankle dorsiflexion has been reportedly reduced as well (12, 15).

The quest to identify injury risk factors in sports has been ongoing in the world of sports medicine (10). Currently, there are no documented epidemiological data on Achilles tendinopathy and its associated risk factors among footballers in Nigeria hence the need for this study.

## MATERIALS AND METHODS

This study was a cross sectional analytical survey that involved one hundred and fifty-one (151) amateur football players who were recruited by convenience from various clubs across Lagos, Nigeria. Participants who had played football actively in the last 6 months and currently engaged in full training and match responsibilities at the time of the study were included. Ethical approval was sought and obtained from the institutional Health Research and Ethics Committee and informed consent sought and obtained from the participants after duly explaining the study procedure to them. The consent of the coaches was sought for participants who were under the age of 18 years. This study conformed to the ethical standards of MLTJ (Muscle, Ligaments and Tendons Journal) (16). All anthropometric

measurements were taken at the beginning of the study: age, gender, height, and weight of each participant were recorded using the self-administered questionnaire.

Royal London Hospital test was performed on each participant while lying in a prone position on a plinth/flat surface as previously described (17). Participants were positioned prone on a plinth with their ankles hanging relaxed just over the edge of the plinth, the portion of the Achilles tendon which was maximally tender to palpation was identified. Then the participant was asked to actively dorsiflex the ankle while the tender part of the tendon was palpated again. However, this time in maximal dorsiflexion, participants with Achilles tendinopathy reported a substantial decrease or absence of pain when the palpation technique is repeated in dorsiflexion.

## Ultrasonography

Diagnostic Ultrasound Machine XARIO 200 was used for imaging in gray scale with a 5-12 MHz 50 mm linear array transducer as previously described (18). The Achilles tendon of all participants who were positive to the Royal London Hospital test were assessed in prone position with the feet hanging over a plinth. A specialist performed all imaging in the sagittal and axial planes (supero-inferiorly and medio-laterally) along the length of the Achilles tendon. The hypoechoic region and/or focal thickening in both planes were noted. Color Doppler was used to note areas of neovascularization.

## Blood Glucose Evaluation

This was taken in a sitting position, the fingertip of the pollex cleaned with moist cotton wool and lightly pricked with a lancet, a drop of blood was dropped from the pricked region on a test strip and then inserted into the meter. The bleeding area was cleaned with a dry cotton wool. And the sugar level was read off and recorded in millimole per liter (mmol/L).

## Ankle Range of Motion

The range of motion for plantarflexion and dorsiflexion for each participant was taken by asking the participant to lie supine or sit in a chair and extend their knee on an even/flat surface. A universal goniometer was placed one degree below the lateral malleolus with the stationary arm parallel to the metatarsals of the foot and the movable arm moved as participants actively flexed and extended their ankles. This measurement was repeated three times and the average score was recorded. All measurements were recorded in degrees. An ROM less than 17° was regarded as restricted (19).

### Statistical Analysis

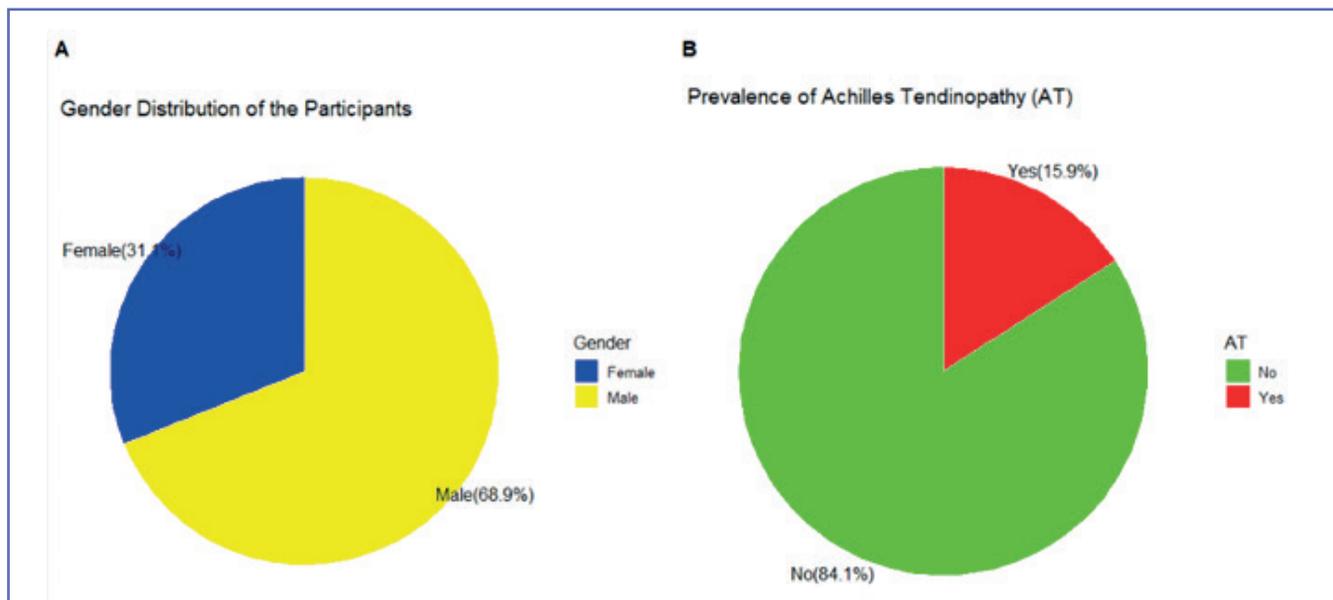
All data was analyzed using descriptive statistics of mean, standard error, percentages, pie-charts, and bar charts. Normality of the data was evaluated using Shapiro-Wilk normality test. Independent student's t-test and Wilcoxon rank-sum test were performed for parametric and non-parametric data to establish statistically significant variables using "ggplot2" and "ggpbur" packages. Principal Component Analysis (PCA) was used to determine the association between Achilles tendinopathy, body mass index and ankle dorsiflexion and plantarflexion. The dataset was randomly partitioned into 80%, 20% for training and testing data. Training data (121 individuals, 6 variables). Testing data (30 individuals, 6 variables). The PCA was conducted on training data. The output of training PCA (selected principal components) was run in logistic regression. The accuracy of logistic regression model in the prediction of Achilles tendinopathy in both training data and testing data were computed and compared. "FactoMineR" and "factoextra R" packages were used to do CPA analysis while "nnet" R package was employed for the analysis of logistic regression. Data was analyzed and plotted using R statistical computing software version 4.0.2 (20) in RSTUDIO environment. Level of significance for all inferential statistics was set at  $p \leq 0.05$ .

### RESULTS

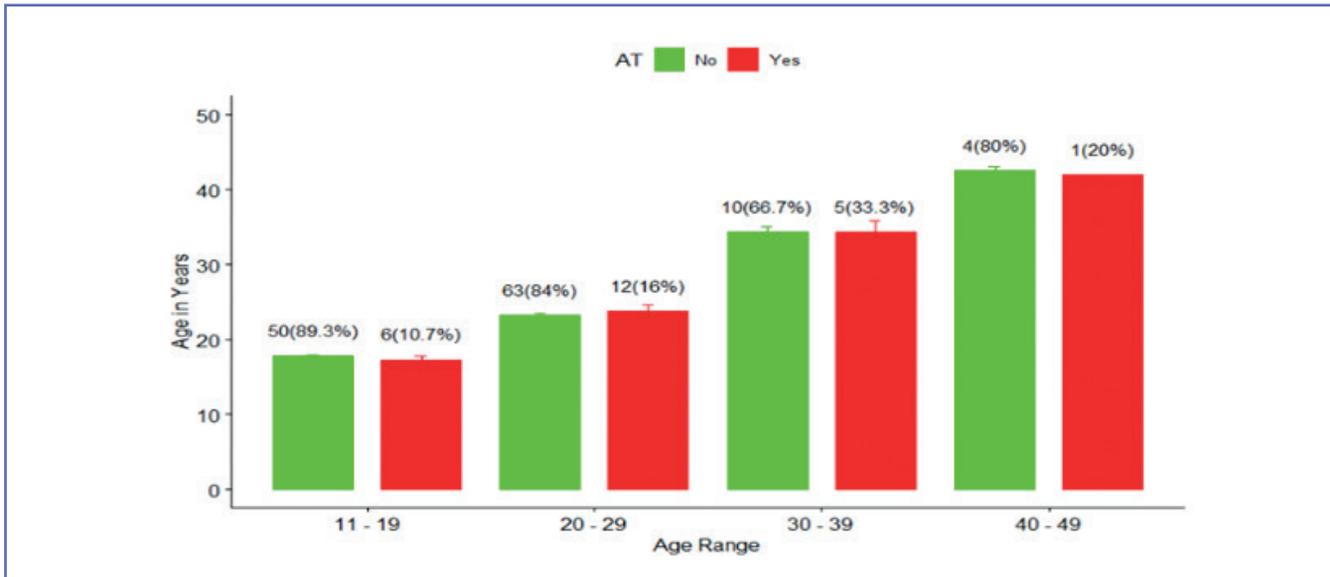
A total of one hundred and fifty-one (151) amateur football players were assessed. One hundred and four (104)

which represent 68.9% of the participants were males and forty-seven (47) (31.1%) were females (**figure 1 A**). The Median (Interquartile range) of age (years), height (m), weight (Kg) and BMI (Kg/m<sup>2</sup>) are 21(19-25), 1.72 (1.65-1.78), 63.8 (57-71) and 21.6 (19.7-23.3) respectively. The characteristics of the participants are seen in **table I**, while **table II** shows the distribution of Achilles tendinopathy. The prevalence of Achilles tendinopathy was 15.9% (**figure 1 B**). Twenty-four (24) participants tested positive to Royal London Hospital Test while one hundred and twenty-seven (127) were negative. The age distribution of all the participants is described in **figure 2**. The central tendencies of Age Range of the participants without Achilles Tendinopathy were 18 (17-19), 23 (21-25), 34.3 (0.79) and 42.5 (0.65) while for participants with Achilles Tendinopathy, they were 17.33 (0.56), 23.83 (0.81), 34.44 (1.54) and 42 (0); for Age Range 11-19, 20-29, 30-39 and 40-49, respectively. Where Mdn (Q1-Q3) = Median (Interquartile range) and M (SE) = Mean (Standard Error).

Using Wilcoxon rank sum test and independent t-test in the comparison of middle values of participants with and without Achilles tendinopathy. There were significant differences in the body mass index (BMI) ( $p = 0.005$ , **figure 3 B**), right ankle dorsiflexion (Rom RD), right ankle plantarflexion (Rom RP), left ankle dorsiflexion (Rom LD) and left ankle plantarflexion (Rom LP) (all  $p < 0.05$ ) as seen in **figure 4 A**, **figure 4 B**, **figure 4 C** and **figure 4 D**, respectively. There were no significant differences in Age, Blood Glucose and Parity (all  $p > 0.05$ ) as shown in **figure 3 A**, **figure 3 C**



**Figure 1.** Gender Distribution and Prevalence of Achilles Tendinopathy.



**Figure 2.** Age distribution of Participants with and without Achilles Tendinopathy.

and **figure 3 D** accordingly. Principal Component Analysis (PCA) was conducted to see the association of BMI, Rom RD, Rom RP, Rom LD, and Rom LP with Achilles tendinopathy. The principal was used to extract three (3) components. Components with eigenvalues (variances) of less than 1 were not retained for extraction (20, 21). The eigenvalue for each principal component were 2.15, 1.19 and 1.07 for PC1, PC2 and PC3 principal component, respectively. The percentage total explained variances by each component were 35.8, 19.8 and 17.8, respectively. The three principal components accounted for 73.4% of total explained variations (**table III**). The eigenvectors (rotation matrix) showed

**Table I.** Characteristics of the Participants.

Age	21 (19-25)
Parity	0 (0-0)
Height (m)	1.72 (1.65-1.78)
Weight (Kg)	63.8 (57.0-71.0)
BMI (Kg/m <sup>2</sup> )	21.6 (19.7-23.3)
Blood Sugar (mmol/L)	4.99 (0.06)
Rom RD (°)	19 (17.5-21)
Rom RP (°)	23 (20-26)
Rom LD (°)	20 (19-21)
Rom LP (°)	24 (21-26)

ROM – Range of Motion, RD – Right Dorsiflexion, RP – Right Plantarflexion, LD – Left Dorsiflexion, LP – Left Plantarflexion, the values are in Median (Q1-Q3) and Mean (SE).

**Table II.** Distribution of Achilles Tendinopathy.

Gender (Male, Female)	23 (95.8%), 1 (4.2%)
Type (Mid-Portion, Insertional)	12 (50%), 12 (50%)
Affected Leg (Right, Left, Both)	16 (66.7%), 6 (25%), 2 (8.3%)
BMI (Underweight, Normal, Overweight, Obese)	1 (4.2%), 16 (66.7%), 2 (16.7%), 3 (12.5%)
Right Dorsiflexion (Stiffness, Normal, Hyperflexion)	13 (54.2%), 10 (41.7%), 1 (4.2%)
Right Plantarflexion (Stiffness, Normal, Hyperflexion)	10 (41.7%), 12 (50%), 2 (8.3%)
Left Dorsiflexion (Stiffness, Normal, Hyperflexion)	24 (100%), 0 (0%), 0 (0%)
Left Plantarflexion (Stiffness, Normal, Hyperflexion)	24 (100%), 0 (0%), 0 (0%)
Blood Sugar (Hypoglycemic, Normal, Hyperglycemic)	0 (0%), 24 (100%), 0 (0%)

ROM – Range of Motion, RD – Right Dorsiflexion, RP – Right Plantarflexion, LD – Left Dorsiflexion, LP – Left Plantarflexion, the values are in Median (Q1-Q3) and Mean (SE).

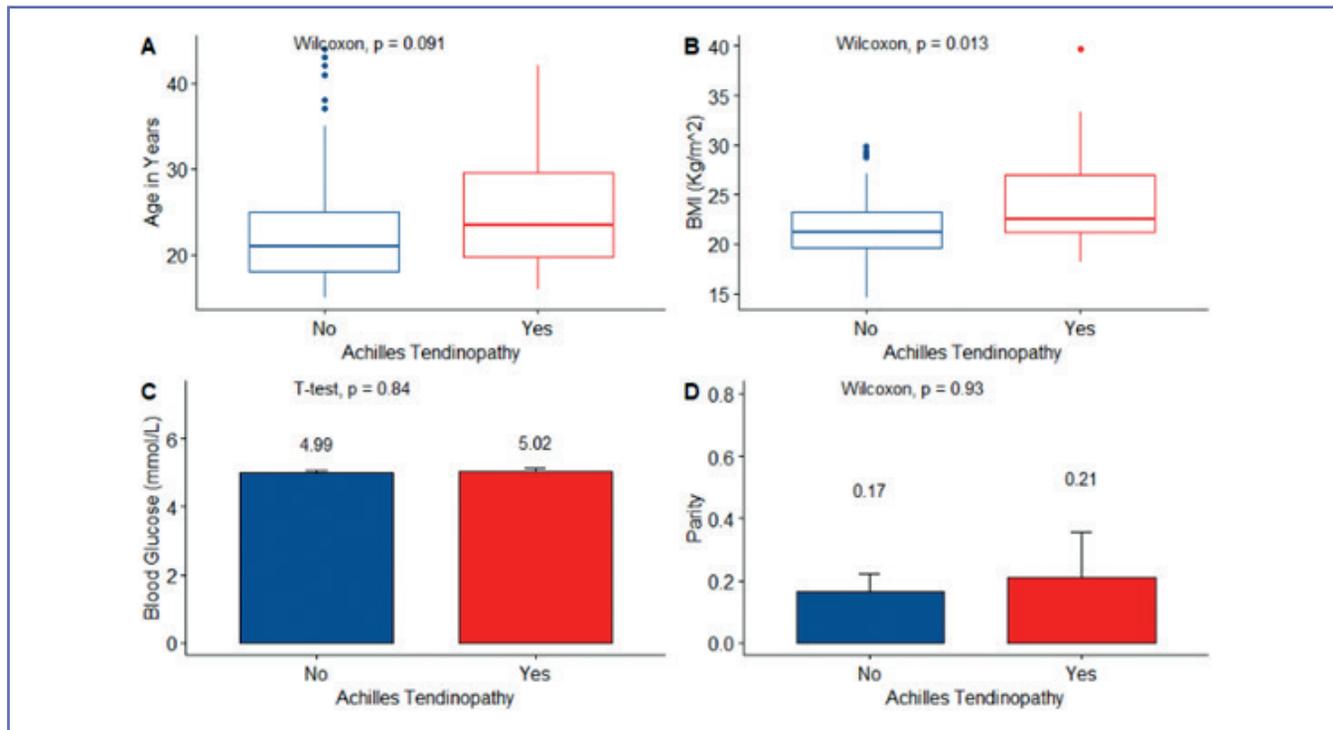


Figure 3. Profiles of Achilles Tendinopathy (ATs) in Age (A), BMI (B), Blood Glucose (C) and Parity (D) of the participants.

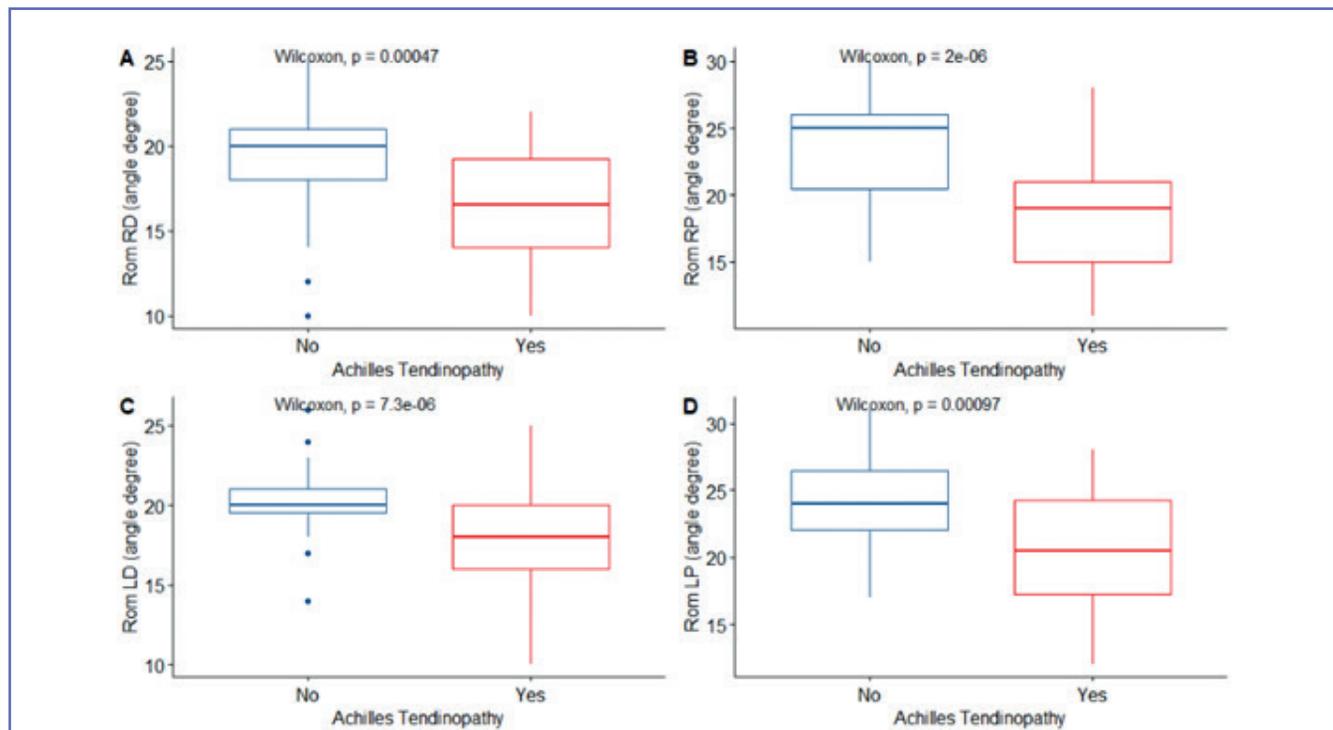


Figure 4. Profiles of Ankle Kinematics.

**Table III.** Principal Component Analysis Eigenvalues and Eigenvectors.

	PC1	PC2	PC3	PC4	PC5	PC6
<b>Normalized Eigenvalues</b>	2.15	1.19	1.07	0.86	0.6	0.14
<b>Total Variance Explained (%)</b>	35.8	19.8	17.8	14.3	10	2.3
<b>Cumulative of Variance Explained (%)</b>	35.8	55.6	73.4	87.7	97.7	1
	<b>Eigenvectors</b>					
	PC1	PC2	PC3	PC4	PC5	PC6
<b>BMI</b>	- 0.124	<b>- 0.532**</b>	- 0.381	0.744	- 0.036	0.037
<b>Glucose</b>	- 0.031	- 0.317	<b>- 0.728**</b>	- 0.6	0.095	- 0.007
<b>Rom RD</b>	<b>0.483**</b>	- 0.513	0.309	- 0.088	0.212	- 0.596
<b>Rom RP</b>	<b>0.576**</b>	- 0.267	0.102	- 0.095	- 0.473	0.594
<b>Rom LD</b>	<b>0.489**</b>	0.268	- 0.202	0.19	0.727	0.291
<b>Rom LP</b>	<b>0.424**</b>	<b>0.459</b>	<b>- 0.422</b>	0.184	- 0.439	- 0.453

the correlation between the raw variables and transformed variables. Allowing the correlation coefficient  $r \geq 0.4$ . The first principal component (PC1) explained the greatest proportion of variance and related with four variables of Rom RD, Rom RP, Rom LD, and Rom LP. The second principal component (PC2) is associated with BMI alone. While the third principal component (PC3) is only associated with Blood Glucose Level (**table III**). **Figure 5 A** is a two-dimensional biplot of principal component analysis of the participants. The component scores of each individual and the variables loadings were displayed. Although, three principal components were considered in this study, but the first two principal components were plotted for easy illustration and visualization (22). The participants were clustered into group of "Yes" and "No" to Achilles tendinopathy, **figure 5 A**. **Figure 5 B** is a factor Map that showed the quality of representation of the variables in PC1 and PC2. Blood Glucose was low in quality, BMI, Rom LD, and Rom LP were moderate and Rom RD and Rom RP were high in quality of representation, **figure 5 B**. **Table IV** shows contingency tables (confusion matrices) of logistic regression model of retained principal components. The model accuracies for training and testing data were 87.6% and 90% respectively. The difference in the accuracies were not statistically significant ( $p = 1.000$ ). Also, using logistic regression analysis on the whole dataset, there was a significant association between Achilles tendinopathy and the body mass index (BMI)  $p = 0.024$ , right plantarflexion  $p = 0.008$  and left dorsiflexion  $p = 0.038$  (**table V**). As regards the random blood glucose, one hundred and forty-five (97.9%) of the participants had normal blood glucose level (random and after meal), two (1.4%) had low blood glucose level and one (0.7%) participant was hyperglycemic. There was no signif-

icant association between Achilles tendinopathy and blood glucose level of the football players ( $p = 0.7464$ ) as all the participants with AT had normal glucose levels. However, the third principal component (PC3) is only associated with Blood Glucose Level (**table III**).

## DISCUSSION

Epidemiological evidence of tendon pathology among sportspersons in Nigeria is very limited even though the importance of this knowledge, coupled with identifying associated risk factors cannot be over emphasized. This was a cross-sectional study to determine the prevalence of Achilles tendinopathy and its association with some selected intrinsic risk factors among Nigerian footballers. This knowledge is pertinent even as a prior study had reported the dominance of intrinsic factors over extrinsic factors in the aetiology of tendinopathy (23). There is presently no epidemiological data on tendinopathy among footballers in Nigeria, this study has therefore provided preliminary data as well as identified intrinsic factors which will enable preventive measures to mitigate their effects on tendons.

The prevalence of Achilles tendinopathy (AT) in this study was 15.9% while the findings by Docking *et al.* (15) reported a prevalence of 21.5% among Australian male professional football players. The prevalence of AT in this study was lower than what was reported in a similar study on recreational athletes in Nigeria (1). The lower prevalence reported in this study could be due to the relatively small sample size, thus studies with much larger sample sizes are advocated. Our findings also showed that half (50%) of the footballers had midportion AT while the other half presented with the insertional type (**table II**), thus both were equally prevalent.

**Table IV.** Confusion Matrix of PCA Performance.

PCA Model Prediction	Training Data		PCA Model Prediction	Testing Data	
	No	Yes		No	Yes
No	97	12	No	25	1
Yes	3	9	Yes	2	2

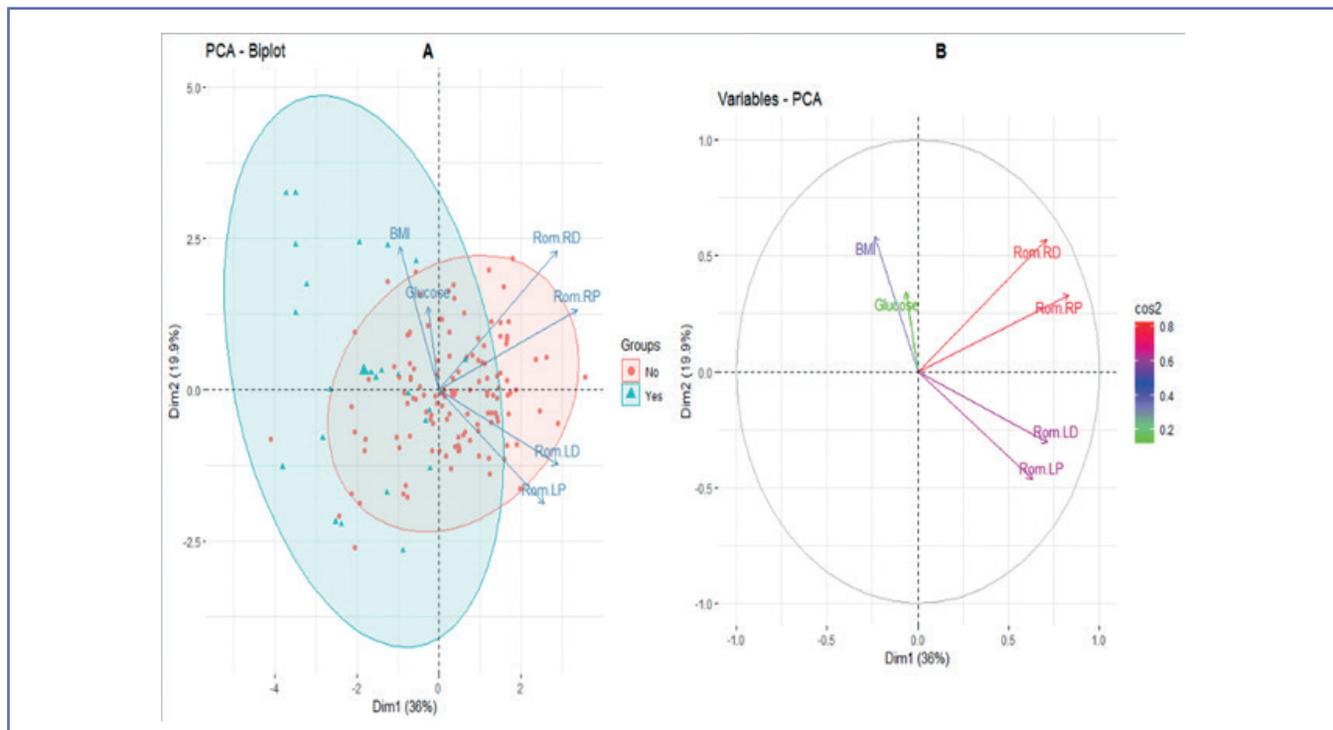
Accuracy = 87.6% (95% CI; 80.38%-92.89%)	Accuracy = 90% (95% CI; 73.47%-97.89%)
Error rate = 12.4%	Error rate = 10%
Fisher's Exact, p value = 1, Odds ratio = 0.79 (95% CI; 0.14-3.08)	

Our results showed that 96% of the participants with AT were males while only one was female. This was not unexpected as the hormone estrogen has been documented to protect pre-menopausal women from central fat accumulation which is one of the symptoms of metabolic syndrome (24). A prior study had reported metabolic syndrome as a risk factor for Achilles tendon pathology in men because men usually have less total body fat but more central/intra-abdominal adipose tissue, whereas women have more total fat mainly in the gluteal/femoral and subcutaneous depots with

a reduction in central adiposity. The reduced central adiposity in women therefore may serve as a preventive factor against tendon damage in pre-menopausal women (25). As seen in the age distribution of the participants in this study, all the female footballers are at the pre-menopausal stage.

### The epidemiology of tendon injuries

Ruptures and tendinopathy have highlighted the association between BMI or adiposity and the risk of pathology (26).



**Figure 5.** (A) Biplot of Principal Component Analysis (PCA). (B) Factor Map of Variables. The quality of representation of Blood Glucose is low. BMI, Rom LD, and Rom LP provided moderate representation and Rom RD and Rom RP exhibited high quality goodness of fit in Achilles tendinopathy.

There are conflicting reports from prior studies on BMI as a significant risk factor for AT and most of the cohort studies found no significant association while a few linked obesity, and overweight with higher risks of developing AT (27, 28). Our findings reported a significant association between body mass index (BMI) and Achilles tendinopathy which agrees with previous findings even as the principal component analysis (PCA) also showed that the difference in BMI between participants with and without AT was statistically substantial ( $p = 0.013$ ).

One study in the review by Franceschi *et al.* (29) identified a potential interaction between age and obesity with degenerative tendon changes. Those with dyslipidemia and fat deposition in the Achilles tendon may be at risk for developing tendon pain. Another systematic review found that elevated adiposity was frequently associated with general tendon injuries (30). It was however noted from our findings that majority of the participants with Achilles tendinopathy had normal BMI (16; 67%) so the underlying factor responsible for the significance appears to be beyond the body weight. It has been shown from prior studies that tendon disease is also prevalent in individuals with increased fat mass and greater waist/hip ratio despite having normal body weight. These group of individuals categorized as metabolically obese but of normal weight account for about 5 to 45% of the population (24, 31). This underscores the role of central obesity in tendinopathy and calls for further studies to investigate body composition as risk factor for AT.

Prior studies had reported restricted ankle motion, especially dorsiflexion in professional footballers (5, 32). This has been attributed to structural adaptations and was thought to be protective against injury by reducing excessive movements to which the joint is subjected. However, as far back as 1982, (33) it had been suggested that stiffness of the ankle joint in soccer players is a predisposing factor for muscle rupture and tendinitis which agrees with the findings of our study as 54% of the participants with AT had reduced Ankle

dorsiflexion while 42% had reduced Ankle plantarflexion in the dominant limbs. For the left lower limbs, all the participants, even those without AT were seen to have both dorsiflexion and plantarflexion stiffness. As seen in **figure 4**, all the profiles of Ankle kinematics were significantly ( $p < 0.05$ ) associated with Achilles tendinopathy. However, logistic regression analysis identified right ankle dorsiflexion, left ankle plantarflexion and BMI as being significantly ( $p < 0.05$ ) associated with Achilles tendinopathy (**table V**). These findings corroborate the report of structural adaptation of the soft tissues resulting in stiffness and underscores the need for preventive ankle stretching/flexibility exercises for football players even as some studies also reported that restricted ROM scores are primary risk factors for some of the most common football injuries (34, 35).

Diabetes has been identified as a major intrinsic factor for the development of Achilles tendinopathy even as recent systematic reviews have clearly demonstrated that patients with high cholesterol and diabetes are at significantly higher risk of developing tendinopathy (36). In our study, we found no association between Achilles tendinopathy and the blood glucose levels which is not consistent with the findings of the studies by Jarvinen *et al.* (37), and Bondi *et al.* (38) who reported that intrinsic risk factors for the development of Achilles tendinopathy included systemic diseases such as diabetes mellitus and elevated BMI. However, in the PCA factor map of variables (**figure 5 B**), it is seen that the quality of representation of blood glucose is low which implies that though it had no significant association in this study, it is still a factor to consider as a risk factor for AT. A prior study had actually advocated further investigations into the influence of hormones on tendon structure and metabolism (39). In addition, it is seen from our results that all the participants (100%) with Achilles tendinopathy had normal glucose profile. This could be due to the role of genetic and racial factors as prior reports were from studies conducted among Caucasians.

**Table V.** Association between Achilles Tendinopathy and Selected Variables Using Logistic Regression.

Parameters	Beta	Odds Ratio (OR)	95% OR	P value
Age	0.0004	1.0001	1-10.0012	0.9937
BMI	0.2548	1.2902	0.78-2.13	0.024**
Blood Glucose	- 0.1505	0.8603	0.64-1.16	0.7464
Rom RD	- 0.002	0.9980	0.99-1.002	0.999
Rom RP	- 0.3086	0.7345	0.40-1.35	0.008**
Rom LD	- 0.3826	0.6821	0.32-1.44	0.038**
Rom LP	- 0.0491	0.9521	0.87-1.05	0.688

ROM – Range of Motion, RD – Right Dorsiflexion, RP – Right Plantarflexion, LD – Left Dorsiflexion, LP – Left Plantarflexion.

## Limitations of Study

This was a preliminary study and so the sample size was limited, a much larger sample size would have allowed for a more generalized application of the findings. Also, the role of body composition in Achilles tendinopathy was not determined. Further studies with a larger sample size and to determine the roles of body composition and genetic factors are advocated.

## CONCLUSIONS

It was concluded that elevated body mass index and restricted ankle joint mobility were significant predisposing risk factors for Achilles tendinopathy among Nigerian footballers.

## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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