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A Comparative Study on Foot Morphology between Different Sports of Inter University Level Players

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Abstract: The purpose of this study is to compare on Foot Morphology Between Different Sports of Inter University Level Players, such as badminton, basketball, volleyball, football, cricket, and athletics in Uttar Pradesh, India. A total of 120 male players (20 from each sport) participating in different sports at university level were selected for the present study. The age category of students was between the range of 18 to 22 years. Comprehending the distinct anatomical modifications exhibited by these athletes can offer valuable perspectives on the needs of individual sports and facilitate the creation of footwear and training regimens tailored to various sports. A variety of foot metrics, including Length (Foot Length, Ball of Foot Length, Outside Ball of Foot, Toe Length, Heel to Medial/Lateral Malleolus), were measured and analysed as part of the research. The findings showed that athletes from various sports had significantly diverse foot morphologies, indicating that each sport's particular physical demands result in different adaptations in the structure of the foot. When compared to other sports, football had the most significant variances across a number of parameters, suggesting that football players have distinct foot morphological traits. Specific foot measurements in basketball, badminton, and athletics were notably different from those in other sports.

Keywords: Foot morphology, Players, Inter University, Different sports.

Introduction

The human body relies heavily on its feet for stability and movement. It is the end of a limb that supports weight and permits movement. The human foot has more structural differences than most other regions of the body. The foot's shape and dimensions change as it grows. Large variances exist in the normal population at

various ages, particularly in the features of the medial longitudinal arch (Kulthanan et al., 2004).

Understanding foot morphology in athletes is critical for improving performance and reducing sports injuries. Foot shape has a substantial impact on biomechanics, including balance, agility, and overall athletic performance. This comparative study examines foot morphology among inter-university level athletes from two different sports, with the goal of identifying characteristics that may contribute to sport-specific adaptations and requirements.

Foot morphology includes a variety of parameters such as foot length, width, arch height, and unique features such as heel width and thickness. These factors are critical in defining an athlete's biomechanical efficiency and injury risk (Nigg, 2010). For example, athletes with higher arches may thrive in sports that require agility and quick changes in direction, whereas those with lower arches may display advantages in endurance-related activities (Hofman et al., 2018).

Foot morphology can have a major impact on performance outcomes in sports like football and basketball, which include running, jumping, and rapid changes in direction (Wagner et al., 2020). Understanding how foot structure changes between players in these sports can shed light on biomechanical adjustments that improve movement efficiency and reduce injury risk.

Methodology

The current study included 120 male players (20 from each sport) who competed in several inter university sports. The students ages ranged from 18 to 22.

For the study, the scholar created an ink pad for foot imprinting on A4 paper. Subjects were instructed to stand with both feet on the ground, and both leg imprints were obtained. As a result, both legs on the ground, left and right, were used for the investigation.

Result and findings

Table- 1 showed that the Length (Foot Length, Ball of Foot Length, Outside Ball of Foot, Toe Length, Heel to Medial/Lateral Malleolus) multiple comparison through Post Hoc Test (LSD)

| Multiple Comparisons | | | | | | | | |
|----------------------|-------------|-------------|-----------------------|----------------|------|-------------------------|-------------|--|
| LSD | | | | | | | | |
| Dependent Variable | (I) SPOR TS | (J) SPORT S | Mean Difference (I-J) | Standard Error | Sig. | 95% Confidence Interval | | |
| | | | | | | Lower Bound | Upper Bound | |
| | | | | | | | | |

| | | | | | | | | |
|---------------------|------------|------------|----------|-------|--------|--------|-------|-------|
| foot length(R) | Athletics | Badminton | .6400 | .3995 | .399 | .102 | -.151 | 1.431 |
| | | Basketball | .8350* | .3995 | .399 | .039 | .044 | 1.626 |
| | | Cricket | .1800 | .3995 | .653 | -.611 | .971 | |
| | | Football | -.6200 | .3995 | .123 | -1.411 | .171 | |
| | | Volleyball | .5200 | .3995 | .196 | -.271 | 1.311 | |
| | Badminton | Athletics | -.6400 | .3995 | .112 | -1.431 | .151 | |
| | | Basketball | .1950 | .3995 | .626 | -.596 | .986 | |
| | | Cricket | -.4600 | .3995 | .252 | -1.251 | .331 | |
| | | Football | -1.2600* | .3995 | .002 | -2.051 | -.469 | |
| | | Volleyball | -.1200 | .3995 | .764 | -.911 | .671 | |
| | Basketball | Athletics | -.8350* | .3995 | .039 | -1.626 | -.044 | |
| | | Badminton | -.1950 | .3995 | .626 | -.986 | .596 | |
| | | Cricket | -.6550 | .3995 | .104 | -1.446 | .136 | |
| | | Football | -1.4550* | .3995 | .000 | -2.246 | -.664 | |
| | | Volleyball | -.3150 | .3995 | .432 | -1.106 | .476 | |
| | Cricket | Athletics | -.1800 | .3995 | .653 | -.971 | .611 | |
| | | Badminton | .4600 | .3995 | .252 | -.331 | 1.251 | |
| | | Basketball | .6550 | .3995 | .104 | -.136 | 1.446 | |
| | | Football | -.8000* | .3995 | .048 | -1.591 | -.009 | |
| | | Volleyball | .3400 | .3995 | .397 | -.451 | 1.131 | |
| | Football | Athletics | .6200 | .3995 | .123 | -.171 | 1.411 | |
| | | Badminton | 1.2600* | .3995 | .002 | .469 | 2.051 | |
| | | Basketball | 1.4550* | .3995 | .000 | .664 | 2.246 | |
| | | Cricket | .8000* | .3995 | .048 | .009 | 1.591 | |
| | | Volleyball | 1.1400* | .3995 | .005 | .349 | 1.931 | |
| | Volleyball | Athletics | -.5200 | .3995 | .196 | -1.311 | .271 | |
| | | Badminton | .1200 | .3995 | .764 | -.671 | .911 | |
| | | Basketball | .3150 | .3995 | .432 | -.476 | 1.106 | |
| Cricket | | -.3400 | .3995 | .397 | -1.131 | .451 | | |
| Football | | -1.1400* | .3995 | .005 | -1.931 | -.349 | | |
| ball of foot length | Athletics | Badminton | .2850 | .3003 | .345 | -.310 | .880 | |
| | | Basketball | .4200 | .3003 | .165 | -.175 | 1.015 | |
| | | Cricket | -.0850 | .3003 | .778 | -.680 | .510 | |
| | | Football | -.7100* | .3003 | .020 | -1.305 | -.115 | |
| | | Volleyball | .0900 | .3003 | .765 | -.505 | .685 | |
| | Badminton | Athletics | -.2850 | .3003 | .345 | -.880 | .310 | |
| | | Basketball | .1350 | .3003 | .654 | -.460 | .730 | |

| | | | | | | | | |
|------------|----------------------|------------|------------|-------|-------|--------|-------|-------|
| | | Cricket | -.3700 | .3003 | .220 | -.965 | .225 | |
| | | Football | -.9950* | .3003 | .001 | -1.590 | -.400 | |
| | | Volleyball | -.1950 | .3003 | .517 | -.790 | .400 | |
| | Basketball | Athletics | -.4200 | .3003 | .165 | -1.015 | .175 | |
| | | Badminton | -.1350 | .3003 | .654 | -.730 | .460 | |
| | | Cricket | -.5050 | .3003 | .095 | -1.100 | .090 | |
| | | Football | -1.1300* | .3003 | .000 | -1.725 | -.535 | |
| | | Volleyball | -.3300 | .3003 | .274 | -.925 | .265 | |
| | Cricket | Athletics | .0850 | .3003 | .778 | -.510 | .680 | |
| | | Badminton | .3700 | .3003 | .220 | -.225 | .965 | |
| | | Basketball | .5050 | .3003 | .095 | -.090 | 1.100 | |
| | | Football | -.6250* | .3003 | .040 | -1.220 | -.030 | |
| | | Volleyball | .1750 | .3003 | .561 | -.420 | .770 | |
| | Football | Athletics | .7100* | .3003 | .020 | .115 | 1.305 | |
| | | Badminton | .9950* | .3003 | .001 | .400 | 1.590 | |
| | | Basketball | 1.1300* | .3003 | .000 | .535 | 1.725 | |
| | | Cricket | .6250* | .3003 | .040 | .030 | 1.220 | |
| | | Volleyball | .8000* | .3003 | .009 | .205 | 1.395 | |
| | Volleyball | Athletics | -.0900 | .3003 | .765 | -.685 | .505 | |
| | | Badminton | .1950 | .3003 | .517 | -.400 | .790 | |
| | | Basketball | .3300 | .3003 | .274 | -.265 | .925 | |
| | | Cricket | -.1750 | .3003 | .561 | -.770 | .420 | |
| | | Football | -.8000* | .3003 | .009 | -1.395 | -.205 | |
| | outside ball of foot | Athletics | Badminton | .2400 | .3478 | .492 | -.449 | .929 |
| | | | Basketball | .5650 | .3478 | .107 | -.124 | 1.254 |
| Cricket | | | .2950 | .3478 | .398 | -.394 | .984 | |
| Football | | | -.1550 | .3478 | .657 | -.844 | .534 | |
| Volleyball | | | .3950 | .3478 | .258 | -.294 | 1.084 | |
| Badminton | | Athletics | -.2400 | .3478 | .492 | -.929 | .449 | |
| | | Basketball | .3250 | .3478 | .352 | -.364 | 1.014 | |
| | | Cricket | .0550 | .3478 | .875 | -.634 | .744 | |
| | | Football | -.3950 | .3478 | .258 | -1.084 | .294 | |
| | | Volleyball | .1550 | .3478 | .657 | -.534 | .844 | |
| Basketball | | Athletics | -.5650 | .3478 | .107 | -1.254 | .124 | |
| | | Badminton | -.3250 | .3478 | .352 | -1.014 | .364 | |
| | | Cricket | -.2700 | .3478 | .439 | -.959 | .419 | |
| | | Football | -.7200* | .3478 | .041 | -1.409 | -.031 | |
| | | Volleyball | -.1700 | .3478 | .626 | -.859 | .519 | |
| Cricket | | Athletics | -.2950 | .3478 | .398 | -.984 | .394 | |
| | | Badminton | -.0550 | .3478 | .875 | -.744 | .634 | |
| | | Basketball | .2700 | .3478 | .439 | -.419 | .959 | |

| | | | | | | | |
|------------|------------|------------|---------|-------|--------|--------|-------|
| | | Football | -.4500 | .3478 | .198 | -1.139 | .239 |
| | | Volleyball | .1000 | .3478 | .774 | -.589 | .789 |
| | Football | Athletics | .1550 | .3478 | .657 | -.534 | .844 |
| | | Badminton | .3950 | .3478 | .258 | -.294 | 1.084 |
| | | Basketball | .7200* | .3478 | .041 | .031 | 1.409 |
| | | Cricket | .4500 | .3478 | .198 | -.239 | 1.139 |
| | | Volleyball | .5500 | .3478 | .117 | -.139 | 1.239 |
| | Volleyball | Athletics | -.3950 | .3478 | .258 | -1.084 | .294 |
| | | Badminton | -.1550 | .3478 | .657 | -.844 | .534 |
| | | Basketball | .1700 | .3478 | .626 | -.519 | .859 |
| Cricket | | -.1000 | .3478 | .774 | -.789 | .589 | |
| Football | | -.5500 | .3478 | .117 | -1.239 | .139 | |
| toe length | Athletics | Badminton | .3500 | .1936 | .073 | -.033 | .733 |
| | | Basketball | .2550 | .1936 | .190 | -.128 | .638 |
| | | Cricket | .1000 | .1936 | .606 | -.283 | .483 |
| | | Football | -.2200 | .1936 | .258 | -.603 | .163 |
| | | Volleyball | .3000 | .1936 | .124 | -.083 | .683 |
| | Badminton | Athletics | -.3500 | .1936 | .073 | -.733 | .033 |
| | | Basketball | -.0950 | .1936 | .625 | -.478 | .288 |
| | | Cricket | -.2500 | .1936 | .199 | -.633 | .133 |
| | | Football | -.5700* | .1936 | .004 | -.953 | -.187 |
| | | Volleyball | -.0500 | .1936 | .797 | -.433 | .333 |
| | Basketball | Athletics | -.2550 | .1936 | .190 | -.638 | .128 |
| | | Badminton | .0950 | .1936 | .625 | -.288 | .478 |
| | | Cricket | -.1550 | .1936 | .425 | -.538 | .228 |
| | | Football | -.4750* | .1936 | .016 | -.858 | -.092 |
| | | Volleyball | .0450 | .1936 | .817 | -.338 | .428 |
| | Cricket | Athletics | -.1000 | .1936 | .606 | -.483 | .283 |
| | | Badminton | .2500 | .1936 | .199 | -.133 | .633 |
| | | Basketball | .1550 | .1936 | .425 | -.228 | .538 |
| | | Football | -.3200 | .1936 | .101 | -.703 | .063 |
| | | Volleyball | .2000 | .1936 | .304 | -.183 | .583 |
| | Football | Athletics | .2200 | .1936 | .258 | -.163 | .603 |
| | | Badminton | .5700* | .1936 | .004 | .187 | .953 |
| | | Basketball | .4750* | .1936 | .016 | .092 | .858 |
| | | Cricket | .3200 | .1936 | .101 | -.063 | .703 |
| | | Volleyball | .5200* | .1936 | .008 | .137 | .903 |
| | Volleyball | Athletics | -.3000 | .1936 | .124 | -.683 | .083 |
| | | Badminton | .0500 | .1936 | .797 | -.333 | .433 |
| | | Basketball | -.0450 | .1936 | .817 | -.428 | .338 |
| | | Cricket | -.2000 | .1936 | .304 | -.583 | .183 |

| | | | | | | | |
|--|------------|------------|---------|-------|--------|--------|-------|
| | | Football | -.5200* | .1936 | .008 | -.903 | -.137 |
| heel to medial/lateral malleolus | Athletics | Badminton | .3350 | .2404 | .166 | -.141 | .811 |
| | | Basketball | .6900* | .2404 | .005 | .214 | 1.166 |
| | | Cricket | .5550* | .2404 | .023 | .079 | 1.031 |
| | | Football | .8950* | .2404 | .000 | .419 | 1.371 |
| | | Volleyball | .5500* | .2404 | .024 | .074 | 1.026 |
| | Badminton | Athletics | -.3350 | .2404 | .166 | -.811 | .141 |
| | | Basketball | .3550 | .2404 | .143 | -.121 | .831 |
| | | Cricket | .2200 | .2404 | .362 | -.256 | .696 |
| | | Football | .5600* | .2404 | .022 | .084 | 1.036 |
| | | Volleyball | .2150 | .2404 | .373 | -.261 | .691 |
| | Basketball | Athletics | -.6900* | .2404 | .005 | -1.166 | -.214 |
| | | Badminton | -.3550 | .2404 | .143 | -.831 | .121 |
| | | Cricket | -.1350 | .2404 | .576 | -.611 | .341 |
| | | Football | .2050 | .2404 | .396 | -.271 | .681 |
| | | Volleyball | -.1400 | .2404 | .561 | -.616 | .336 |
| | Cricket | Athletics | -.5550* | .2404 | .023 | -1.031 | -.079 |
| | | Badminton | -.2200 | .2404 | .362 | -.696 | .256 |
| | | Basketball | .1350 | .2404 | .576 | -.341 | .611 |
| | | Football | .3400 | .2404 | .160 | -.136 | .816 |
| | | Volleyball | -.0050 | .2404 | .983 | -.481 | .471 |
| | Football | Athletics | -.8950* | .2404 | .000 | -1.371 | -.419 |
| | | Badminton | -.5600* | .2404 | .022 | -1.036 | -.084 |
| | | Basketball | -.2050 | .2404 | .396 | -.681 | .271 |
| | | Cricket | -.3400 | .2404 | .160 | -.816 | .136 |
| | | Volleyball | -.3450 | .2404 | .154 | -.821 | .131 |
| Volleyball | Athletics | -.5500* | .2404 | .024 | -1.026 | -.074 | |
| | Badminton | -.2150 | .2404 | .373 | -.691 | .261 | |
| | Basketball | .1400 | .2404 | .561 | -.336 | .616 | |
| | Cricket | .0050 | .2404 | .983 | -.471 | .481 | |
| | Football | .3450 | .2404 | .154 | -.131 | .821 | |

Results and Discussion

Multiple comparisons using the LSD approach show substantial differences in foot morphological profiles among players from a variety of sports, including athletics, badminton, basketball, cricket, football, and volleyball. Measurements of foot length, ball of foot length, outer ball of foot length, toe length, and heel to medial/lateral malleolus length reveal these disparities.

Foot Length (R)

1. The study found that basketball players have considerably longer right feet than athletics players, with a mean difference of 0.835 ($p = 0.039$).
2. Badminton players have substantially shorter feet than football players, with an average difference of -1.260 ($p = 0.002$).
3. Basketball players have much shorter feet than football players, with an average difference of -1.455 ($p = 0.000$).
4. Cricketers have much shorter feet than football players, with an average difference of -0.800 ($p = 0.048$).
5. Football players have significantly longer feet than volleyball players, with an average difference of 1.140 ($p = 0.005$).

According to these findings, football players had longer feet than athletes from other sports, particularly badminton, basketball, and cricket. This could be due to football's unique physical and biomechanical demands, which may influence foot growth.

Ball of Foot Length (R):

1. Football players have considerably shorter ball of foot lengths than athletics players, with an average difference of -0.710 ($p = 0.020$).
2. Football players have significantly shorter ball of foot lengths than badminton players, with an average difference of -0.995 ($p = 0.001$).
3. Football players had significantly shorter ball of foot lengths than basketball players, with an average difference of -1.130 ($p = 0.000$).
4. Football players had considerably shorter ball of foot lengths than cricketers, with an average difference of -0.625 ($p = 0.040$).
5. Football players had considerably larger ball of foot lengths than volleyball players, with an average difference of 0.800 ($p = 0.009$).

These findings suggest that football players had shorter ball of foot lengths than athletes in other sports, with the exception of volleyball. This trait could be related to the distinct foot mechanics necessary in football.

Outside Ball of Foot Length (R):

Significant differences in outside ball of foot length are observed between:

Basketball players had considerably shorter outside ball of foot lengths than football players, with an average difference of -0.720 ($p = 0.041$).

This research emphasizes football players' different foot structure in comparison to basketball players.

Toe Length(R):

There are significant variances in toe length between:

1. Football players have considerably longer toes than badminton players, with an average difference of 0.570 ($p = 0.004$).

2. Football players have considerably longer toes than basketball players, with an average difference of 0.475 ($p = 0.016$).
3. Football players have considerably longer toes than badminton players, with an average difference of 0.570 ($p = 0.004$).
4. Football players have considerably longer toes than basketball players, with an average difference of 0.475 ($p = 0.016$).
5. Football players have considerably longer toes than volleyball players, with an average difference of 0.520 ($p = 0.008$).

The statistics show that football players had longer toes than athletes in other sports, which could be owing to the unique demands of football that promote this morphological characteristic.

Length from heel to medial or lateral malleolus (R)

Significant variances in heel-medial/lateral malleolus length include:

1. Basketball players have considerably longer heel to medial/lateral malleolus lengths than athletes, with a mean difference of 0.690 ($p = 0.005$).
2. Cricketers have considerably longer heel-to-medial/lateral malleolus lengths than athletics, with a mean difference of 0.555 ($p=0.023$).
3. Football players have considerably longer heel to medial/lateral malleolus distances than athletes, with a mean difference of 0.895 ($p = 0.000$).
4. Volleyball players have considerably longer heel-to-medial/lateral malleolus lengths than athletes, with a mean difference of 0.550 ($p=0.024$).
5. Football players have considerably longer heel-to-medial/lateral malleolus lengths than badminton players, with a mean difference of 0.560 ($p=0.022$).

These results show that, in comparison to athletes in other sports, football players generally had longer heel to medial/lateral malleolus lengths, which may be due to the unique functional adaptations needed for football.

Conclusion:

Multiple comparisons demonstrate considerable differences in foot shape between players from different sports. Football players have unique foot traits, such as longer foot lengths, shorter ball of foot lengths, longer outside ball of foot lengths, longer toes, and longer heel to medial/lateral malleolus lengths. These variances are most likely the result of football's specific biomechanical and physical demands, which alter foot shape. Understanding these distinctions can provide insights into the individual needs and adaptations of players in other sports, resulting in better training, performance, and injury prevention techniques.

There were notable variations in the different foot morphology measurements between the sports. When compared to other sports, football had the most significant variances across a number of parameters, suggesting that

football players have distinct foot morphological traits. Specific foot measurements in basketball, badminton, and athletics were notably different from those in other sports.

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