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# Playing Football as a Risk Factor for Lower Leg Malalignment?—Comparing Lower Leg Axis of Male Adolescent Football Players and Referees

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**Abstract:** The prevalence of varus knee malalignment among junior and adult football players (FP) has proven to be higher compared to other sports. No causal relationship has yet been found, as genu varum can be assumed to be an independent risk factor for the development of knee osteoarthritis. The purpose of this study is to compare knee alignment measurements and sport-specific data of adolescent football players and referees (REF). Knee alignment was detected by measuring the intercondylar/intermalleolar distance (ICD/IMD) as well as the Hip–Knee–Ankle angle (HKA) using a standardized digital frontal-plane photograph. Anthropometric and sports-related data (training/match exposure, seasons actively played, etc.) were collected by means of questionnaires (Clinical trial registration number: DRKS00020446). A total of 28 male FP and 29 male adolescent REF were included in the survey. The mean age was 17.4 ± 0.7 years. The two groups did not differ significantly in age, height, weight, BMI, and overall football/refereeing exposure per week (FP vs. REF: 274 vs. 285 min/week, $p = 0.61$). The HKA of the FP was significantly lower (toward varus) than that of the REF (177.6° ± 2.4° vs. 179.0° ± 2.4°; $p < 0.001$). However, ICD did not significantly differ (FP: 17 ± 25 mm, REF: 13 ± 27 mm; $p = 0.55$). The football environment with frequent football exposure seems to have an influence on leg axis deviation in FP compared to REF. For prevention of knee osteoarthritis in FP, an advanced understanding of leg axis development in adolescent players is essential and, therefore, needs further research.

**Keywords:** bowlegs; varus knee alignment; knee malalignment; genu varum; junior football



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## 1. Introduction

Lower leg malalignment—next to other factors such as female sex, obesity, trauma, and sports activities—has been proven to be associated with osteoarthritis of the lower limb [1–6]. Due to the continuous increase in life expectancy, the rise in the mean age of society, and the resulting expected increase in osteoarthritis patients [7,8], it is precisely the popular sports that need to be scrutinized more closely. Especially professional FP, there seems to be at greater risk for knee osteoarthritis compared to athletes from other sports [9]. Among others, a history of knee injury has been proven to be one of the major attributable risk factors for developing knee osteoarthritis in professional football. However, even after adjustment for recognized risk factors, professional football per se appears to be a risk factor for knee osteoarthritis [2]. The specific factors for this fact still need to be identified. In addition to the increased prevalence of osteoarthritis, the prevalence of genu varum appears to be significantly increased for professional FP (55% to 63%) [10]. However, osteoarthritis is not the only possible consequence of lower extremity axis abnormalities. Genu varum also leads to an increased risk of anterior cruciate ligament injuries [11]. Football, as the most popular sport worldwide, has just recently come under suspicion for causing bowlegs as early as adolescence [12,13]. However, a causal relationship has yet to be proven. Abreu et al. assume that varization of the leg axis would be caused by repetitive microtrauma to the growth plates close to the knee joint. They have likewise thought of selection bias as a cause of the increased prevalence [14]. Witvrouw et al. suggested a soccer-specific muscle distribution imbalance as a possible explanation [15]. Finally, according to Asadi et al., the potential factors for the increased prevalence of bowlegs in football compared to other sports such as basketball, volleyball, or handball may be the increased strain from frequent cutting maneuvers as well as mechanical stress from soccer-specific movements such as shooting the ball [13,16].

To avoid further confounders, the authors decided to only include male subjects with an average body mass index (BMI). As Shohat et al. already showed, the prevalence of genu varus is significantly higher in males than in females. Furthermore, genu valgus is more prevalent in female, overweight, and obese subjects compared to those with normal BMI and underweight subjects [6]. Not only is sex a crucial factor for lower leg alignment but so is ethnicity. Tang et al. identified differences in Chinese and Caucasian subjects when comparing knee alignment [17,18].

To verify the above-mentioned hypotheses, further comparative studies are needed that include a control group with as many identical anthropometric characteristics as possible but differing in certain exposure factors. These requirements are fulfilled in football REF. They wear similar footwear, and move on the same terrain, but show a different pattern of movement and are not required to perform football-specific movements such as kicking or jumping. Referees are therefore very well suited as a control group to detect football-specific risk factors for the potential development of varus malalignment already in childhood and adolescence. Recent studies have shown that biomechanically movement sequences of the lower extremity in the frontal plane can be decisive for, i.a., knee joint injuries. Using the example of anterior cruciate ligament (ACL) rupture in professional men's football, video analysis showed that the knee joint is predominantly (81%) in a valgus position at the time of ACL rupture [19]. Although there is so far no video analysis on referees' injury mechanisms, different injury mechanisms and movements in the frontal plane must be assumed for REF and players due to the different running distances and game situations. In order to be able to make accurate statements, the age of the study population should therefore be chosen so that the sport practiced, in this case, football, was mainly practiced during the (pre-)pubertal growth spurt, which is considered the most sensitive phase for developing lower leg malalignment [13,20].

So, the aim of this study is to compare lower leg alignment and overall football exposure of male adolescent FP and REF to further detect risk factors for the development of a lower leg malalignment through sporting activity in childhood and adolescence.

## 2. Materials and Methods

*Design*—The presented survey is a comparative cross-sectional study. The subjects are composed of two groups, FP and REF. The design and methods of this study were previously approved by the local Ethics Committee (code: 19-1571-101) and the study was registered in the German Clinical Trials Register DRKS (Clinical trial registration number: DRKS00020446). Written consent concerning participation, measurement, data acquisition, and publication of the data was collected for each participant. In the case of minors, the participant was represented by their responsible legal guardians. A cross-sectional study design was chosen to analyze the anthropometric (e.g., sex, age) and sport-specific data (e.g., position on field, history of injury) by a questionnaire and to assess the lower leg alignment using an established intercondylar/intermalleolar distance (ICD/IMD) measurement technique [21,22] as well as a sonographic-assisted digital photograph for determining the Hip–Knee–Ankle angle (HKA). The written consent forms, study guidelines, and questionnaires were distributed to the subjects and in the case of underaged subjects to their legal guardians and were collected before the leg axis measurement. The questionnaire included information regarding participant characteristics (age, height, weight) as well as playing position, dominant leg, training and competition history, level of performance, and injury history.

*Study population*—Selection of participants was performed by quota sampling. The investigators were instructed to select the participants within the age range of 15 to 19 years as well as being equally distributed throughout every level of performance (amateur to professional level). Due to the study design, an a priori sample size calculation was not possible because there are no assumptions about the effect size and there was no primary end point with a comparison of two groups. The aim of the study was a initial estimation of the comparability of the two groups. Therefore, the authors aimed for n = 30 for each group, which provided good feasibility and still makes it possible for valid results. Since there are gender differences regarding the timing of the closure of the growth plates and leg axis alignment, only male subjects were selected to minimize confounding factors. The study population therefore consists of a series of male adolescent FP and male adolescent REF aged between 15 to 19 years, matched regarding age and BMI. The minimum age of 15 years was chosen because then at least an already-started growth plate closure of the lower extremities can be assumed and thus the length growth is almost completed [20]. The inclusion and exclusion criteria were defined as shown in Table 1.

**Table 1.** Inclusion and exclusion criteria of the study population.

| Inclusion Criterions | Exclusion Criterions |
|---|---|
| • outfield players (defenders, midfield, striker)<br>• active member of a football team registered in the Bavarian Football Association<br>• soccer/refereeing as the main practiced sport (largest percentage of training and playing time per week compared to the rest of individual sport activity)<br>• complete data set | • active member as referee of a football team registered in the Bavarian Football Association<br>• referees with no semi-professional or professional football exposure prior to their refereeing career (no more than 180 min training exposure per week during childhood and adolescence)<br>• current injury of the lower extremity<br>• chronic orthopedic disorder affecting the leg axis<br>• incomplete data set<br>• BMI > 30.0 kg/$m^2$<br>• goalkeepers |

Only outfield players were included in the FP study group, as goalkeepers present a different load and movement profile and therefore might limit the interpretation of the results. Most of the surveyed REF played football during childhood and early adolescence, but they must not have exceeded training exposure of more than 180 min per week at any point during that time; none of them had played since the beginning of their refereeing career. During recruitment, equal attention was paid to ensure that the average BMI of the two groups was similar and within the normal range, since, for example, overweight per se is already associated with a valgus leg axis and could therefore distort the results [6]. The REF all served as both head referee and linesman.

*Analysis of the leg axis*—The analysis of the leg axis was performed by measuring the ICD and IMD in a standing position. The athletes were asked to stand shoulder-width apart and then to move the legs toward each other with very small steps until either the malleoli or the condyles touched. This maneuver was rehearsed three times before each measurement to ensure a standardized and accurate procedure. The ICD and IMD (mm) were measured with a digital caliper. The technique was previously described and established in many studies [12,13,23,24]. Malalignment was defined according to Shohat et al. IMD values greater than 4 cm were defined as a pathological valgus leg axis and ICD values greater than 3 cm were defined as a pathological varus malalignment [6]. The second technique is the determination of the HKA by using a standardized sonographic-assisted digital anterior–posterior photograph. The accuracy of digital photographs for determining lower leg alignment has already been proven to be more than satisfying [25,26]. The method is based on the approach of Sheehy et al. and Schmitt et al. and was performed under precise standardized conditions [25,26]. The participant was positioned on level ground standing at a distance of 3 m from the camera. The camera (Apple® iPad Air 3rd generation, 8-megapixel front camera) stood on a tripod (Tripod Stativ 106 3D by Hama®), which was positioned at the participant's knee height in order to minimize the parallactic error. The participant was then asked to remain in a relaxed position with their weight equally distributed on both feet. The legs were then aligned to achieve orthograde positioning of the patellae, analogously to a full-leg radiography [27]. Then, the three joint points were defined: (1) Hip joint: First, the femoral head was sonographically detected in anterior–posterior direction with a portable ultrasound device (Butterfly iQ®) in standing position. The skin was marked at the point that showed the highest point of convexity of the femoral head on ultrasound. (2) Knee joint: The next step was palpatory detection of the knee joint gap both medially and laterally and application of an elastic band at this level. If palpation was difficult due to soft tissue mantle, detection was also sonographically assisted. A line was then drawn on the digital image from the medial to the lateral intersection of the rubber band with the background, and the midpoint of this line was determined as the knee joint center. (3) Ankle joint: center of the line connecting the bony prominences of the medial and lateral malleoli (see Figure 1). The HKA of the photograph was measured with an angle measuring application (Angle Meter 360, ©Alexey Kozlov). All examiners were instructed in the operation of the ultrasound device, sonographic detection of femoral head and knee joint gap, operation of camera, and measurement software, and had performed the measurement multiple times before the start of the study phase. The method was validated prior to the study. The inter-rater reliability, indicated as intraclass correlation coefficient, was 0.987 (95% confidence interval: 0.948–0.997), $p < 0.001$). For subjects with a BMI $\leq 30$ kg/m$^2$—which includes all subjects in this study—the HKA measured with a full-leg radiograph highly correlates with the HKA of the digital photograph (Pearson's r = 0.93; $p < 0.001$). Additionally, thigh circumference of the dominant and non-dominant leg was measured at the level of the midpoint of the line connecting the spina iliaca anterior superior and the lateral knee joint space using a measuring tape.

*Data analysis*—Statistical analysis was performed using SPSS® (Version 25, IBM, Armonk, NY, USA). Data are presented as mean ± SD including range. The comparison of the mean values of two groups was performed by the Student's *t*-test for independent samples. A probability ($p$) value of $\leq$0.05 was considered to be significant for each test. Graphical illustrations were generated with GraphPad Prism® (Version 5.01, GraphPad Software, La Jolla, CA, USA) and Microsoft PowerPoint 2013® (Microsoft Corporation, Redmond, WA, USA).

**Figure 1.** Determination of the Hip–Knee–Ankle angle via the photographic method. The center of the femoral head in anterior–posterior direction was marked on the skin for both sides. The Hip–Knee–Ankle angle was defined as the inner angle toward the body center line, as shown for the right leg. The declaration of consent for the publication of the photographic material was submitted in writing prior to the measurement.

## 3. Results

In total, N = 67 subjects were primarily selected for lower leg alignment measurement. Of those, ten subjects did not meet all inclusion criteria. Prior to statistical analysis, nine subjects had to be excluded due to an incomplete data set (missing information on dominant leg and/or training/match exposure), and one subject due to a BMI > 30.0 kg/$m^2$. The study population finally subjected to statistical analysis consists of n = 28 male adolescent FP and n = 29 male adolescent REF aged 15 to 19 years (mean: 17.4 ± 0.7 years). The anthropometric data (age, weight, height, and BMI) can be seen in Table 2. No significant differences were found between the two groups with regard to any of the attributes due to study group matching.

**Table 2.** Listing of anthropometric data of the football players (FP) and referees (REF). The mean values of both groups were compared using *t*-test. SD: standard deviation; kg: kilogram; cm: centimeter; BMI: body mass index.

| | | **FP** | **REF** | ***p* Value** |
|---|---|---|---|---|
| | **n** | **28** | **29** | |
| age (years) | mean ± SD<br>min–max | 17.4 ± 0.7<br>16–18 | 17.3 ± 1.0<br>15–19 | 0.73 |
| weight (kg) | mean ± SD<br>min–max | 72.2 ± 8.8<br>58.1–97.4 | 72.2 ± 9.4<br>58.3–101.7 | 0.998 |
| height (cm) | mean ± SD<br>min–max | 181.0 ± 6.2<br>168–197 | 179.6 ± 5.9<br>165–191 | 0.38 |
| BMI (kg/$m^2$) | mean ± SD<br>min–max | 22.0 ± 2.4<br>18.2–27.0 | 22.4 ± 2.6<br>17.4–30.0 | 0.61 |

*Football exposure*—Information on training and match exposure including seasons actively played can be taken from Table 3. The weekly overall football exposure times of both groups were comparably high (FP: 274 ± 72 min/week vs. REF: 285 ± 94 min/week; $p$ = 0.61). The FP's training exposure per week was significantly higher than that of the REF ($p$ = 0.006), but the REF's match exposure was again significantly higher than that of the FP ($p$ < 0.001). The FP started playing football clearly and significantly earlier than the REF (12 ± 2.4 seasons; $p$ < 0.001). The REF started their career on average 3.3 ± 1.6 years or seasons ago. Of the REF, 34.5% refereed junior football matches, 65.5% refereed adult football matches, and of those, 42.0% managed semi-professional and professional matches.

**Table 3.** Information on training and match exposure and actively seasons played of both football players (FP) and referees (REF). Mean values were compared using the Student's t-test.

| | | **FP** | **REF** | ***p* Value** |
|---|---|---|---|---|
| | **n** | **28** | **29** | |
| overall exposure per week (min) | mean ± SD | 274 ± 72 | 285 ± 94 | 0.61 |
| training exposure per week (min) | mean ± SD | **245 ± 76** | **182 ± 90** | **0.006** |
| match exposure (matches/season) (min/week) (1 match ≙ 90 min) | mean ± SD | **16.6 ± 7.8**<br>**29 ± 14** | **44.0 ± 21.9**<br>**76 ± 37** | **<0.001** |
| seasons actively played (n) | mean ± SD | **12.0 ± 2.4** | **3.3 ± 1.6** | **<0.001** |

*Knee alignment measurements*—The FP's overall HKA showed significantly lower (1.5° more toward varus) than that of the REF ($p$ < 0.001; see Figure 2 and Table 4). The same applies not only to the overall HKA measurements but also laterally separated for the dominant and non-dominant leg (dominant: $p$ = 0.031; non-dominant: $p$ = 0.015). The HKA of the dominant/non-dominant leg within the group of FP and REF did not differ significantly (FP: $p$ = 0.53; REF: $p$ = 0.65). The ICD/IMD did not differ significantly between the two groups ($p$ = 0.55; see Figure 3). Thigh circumference was higher in FP than in REF ($p$ < 0.001). Thigh circumference did not differ within the groups between the dominant and non-dominant leg (FP: $p$ = 0.42; REF: $p$ = 0.86).

**Table 4.** Knee alignment measurements indicated as intercondylar/intermalleolar distance (ICD/IMD; in mm) and Hip–Knee–Ankle angles (HKA; in degrees) of the football players (FP) and referees (REF). Mean values were compared using the Student's *t*-test. [1] $n_{FB}$ = 56; $n_{REF}$ = 58.

| | | **FP** | **REF** | ***p* Value** |
|---|---|---|---|---|
| | **n** | **28** | **29** | |
| ICD/IMD (mm) | mean ± SD | 17 ± 25 | 13 ± 27 | 0.55 |
| HKA overall (degree) | mean ± SD | **177.6 ± 2.4** [1] | **179.1 ± 2.4** [1] | **<0.001** |
| HKA dominant (degree) | mean ± SD | **177.8 ± 2.4** | **179.3 ± 2.5** | **0.031** |
| HKA nondominant (degree) | mean ± SD | **177.4 ± 2.4** | **179.0 ± 2.4** | **0.015** |
| Thigh circumference overall (cm) | mean ± SD | **51.9 ± 3.3** [1] | **49.5 ± 3.6** [1] | **<0.001** |

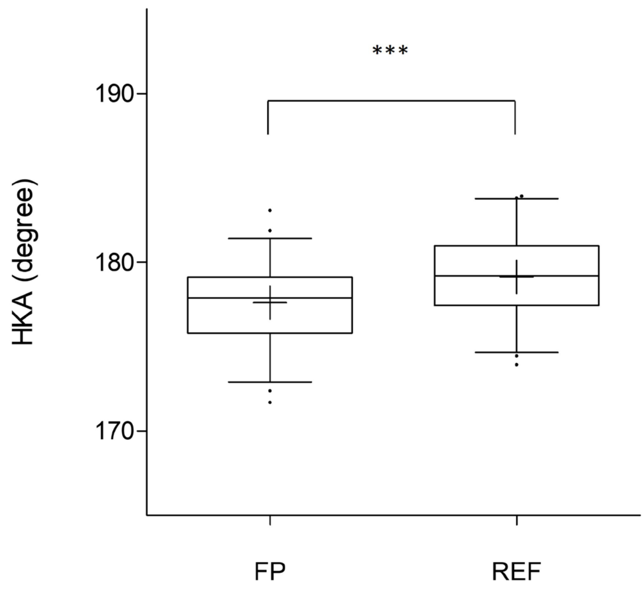


**Figure 2.** Hip–Knee–Ankle angle (HKA) measurements of football players (FP; n = 28) and referees (REF; n = 29), indicated in degrees. The line in the box shows the median, the plus marks the mean, the whiskers mark the 5th and 95th percentile, and the dots are single values that are off the 5th and 95th percentile, respectively. *** $p < 0.001$.

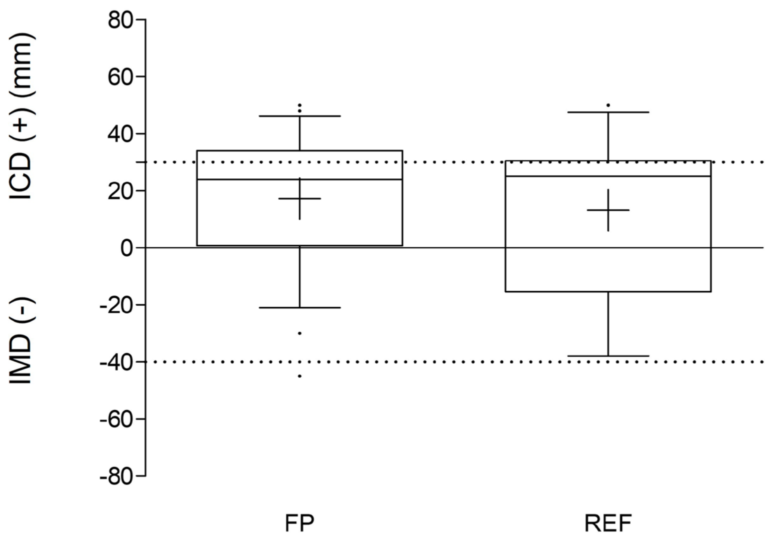


**Figure 3.** ICD/IMD measurement of all participants (nFP = 28; nREF = 29), indicated in millimeters (mm). The line in the box shows the median, the plus marks the mean, the whiskers mark the 5th and 95th percentile, and the dots are single values that are off the 5th and 95th percentile, respectively. The dotted lines mark the border to pathological varus/valgus values, defined by Shohat et al. [6]. IMD: Intermalleolar distance; ICD: Intercondylar distance; FP: football players; REF: referees.

## 4. Discussion

The aim of the presented study was the comparison of lower leg alignment and overall football exposure of male adolescent FP and REF to further detect risk factors for the development of a lower leg malalignment through sporting activity in childhood and adolescence.

The present study showed for the first time differences in lower leg alignment between two football-related populations, FP and REF. The FP's HKAs were significantly lower (1.5° more varus) than those of the REF, even if the ICD/IMD measurements did not differ significantly. This finding is of interest regarding the fact that the overall football respective refereeing exposure was comparable. However, the FP's training exposure is significantly higher than that of the REF (1.4-fold), whereas the match exposure of REF is higher than that of the FP (2.7-fold). With regard to training exposure, these findings need to be looked at in detail because not all training is the same. Of course, the type of training differs vastly between FP and REF. While FP have to improve—in addition to physical fitness, speed, and agility—tactical play, coordination, and ball handling by means of dribbling and shooting technique, the improvement of fitness and endurance takes a much higher priority for REF and, thus, takes up a higher proportion of the total training time [28]. Although the overall football exposure seems comparable between the study groups, FP show a significantly increased thigh circumference in comparison to the REF (see Table 4). This can be an expression of a higher training/match intensity and might be evidence of the muscular adaptation to the higher load profile and physical demands of the FP.

Although the ICD/IMD measurement, as an indirect method to determine lower leg alignment in the frontal plane, correlates quite well with the HKA of a full-leg radiography (r = 0.89) [22], this, of course, does not testify to sufficient measurement accuracy. Nevertheless, the authors chose this method because it is simple and quick to perform and does not require an excess of equipment. Due to the relatively small study population size, it is reasonable to assume that the measurement of ICD/IMD might not be an appropriate measurement method to detect significant differences. This would be supported by the high standard deviation of the results of both groups (ICDFP: 17 ± 25 mm; ICDREF: 13 ± 27 mm; $p = 0.55$). Since, due to the comparative study design, an indirect measurement method such as ICD/IMD does not seem to be sufficient for relatively small study groups, the standardized sonographic-assisted photographic measurement method was also used. This method does not require the use of ionizing radiation, which is not permitted for study purposes in children and adolescents for ethical reasons. Here again, the HKA of both groups differed significantly ($p < 0.001$). The reason why FP showed a HKA of 1.5° less than that of the REF can certainly not only be found in one aspect. The discussion here is helped above all by working out what characteristics distinguish FP from REF. First of all, most soccer players begin their careers at an early age, whereas referee training, here exemplified by the Bavarian Soccer Association, is only possible from the age of 14, i.e., after the onset of puberty [29]. That means that playing football per se not only might play a role in the varization of the leg axis, but it might be important at the pubertal developmental stage or growth phase when junior FP are practicing or playing football. Thaller et al. already assumed that excessive football exposure essentially during the prepubertal growth phase might be crucial for influencing lower leg alignment [13]. The results of the present study can support this thesis, as the surveyed FP had already been actively playing soccer for an average of 12 years by the age of 17 (see Tables 2 and 3). Asadi et al. concluded that football-specific movements such as cutting maneuvers or shooting for goal might be also responsible by applying specific mechanical loading on the growth plates that are near to the knee joint [16]. FP perform far more unpredictable running routes, as they have to quickly react to movements of the opponent or enter or avoid a duel. Compared to REF, this results in more frequent changes in direction and braking and acceleration, each accompanied by transverse or oblique forces acting on the lower extremity. Having in mind that the overall exposure time of FP and REF was similarly high, the FP's leg axis has shown more varus HKA than the REF's, and the FP's thigh circumference was significantly higher than that of the REF; these results corroborate the hypothesis that football-specific movement patterns that differ from those of REF might be a cause for a varization of junior FP's leg axis. Of course, further studies are needed to test this hypothesis further, but this study already provides initial arguments for answering the question of whether and how football leads to the varization of the leg axis as early as adolescence. If the influence of sporting activity on the varization of the leg axis is confirmed and estimated to a pathological extent, the authors' and further researchers' perspective is to take primary preventive measures such as developing training concepts that counteract the pathological development. At the moment, however, this is not yet possible due to a lack of evidence.

Despite all its strengths and unique data collection, the present study has some limitations, which should be considered in the interpretation of its results. The fact that some of the study population of REF had also played football before they began refereeing limits the interpretation of the results. REF have hardly, or not at all, been scientifically considered for a long time, but they have increasingly become the focus of sports medicine research in the past two decades, so that statements can also be made about physical demands, movement patterns, and injury patterns and incidence: Even though low-speed activities predominate during matches, high-speed running, as a percentage of total match distance, varies from 7% to 17% of the match and also include cutting maneuvers [28,30]. Injury patterns and incidence especially of the lower leg seem quite similar to those of amateurs [31,32] and professionals [33,34] FP [28,35,36]. However, the physical demands of at least, but not only, professional football REF, are more and more comparable to those of FP of the same level [26,34]. Recruiting REF who had no football exposure prior to their refereeing career was understandably only possible in exceptional cases. This explains the size of the study population, as recruitment was challenging due to matching the young age, BMI, and the REFs' limited football exposure. However, the presented comparison group of REF is nevertheless suitable for the study due to the similar stress profile and the comparable environment and exposure time (playing field, footwear, etc.). The chosen clinical methods of measurement of the leg axis in the frontal plane have their weaknesses in accuracy as well. However, for ethical reasons, the use of ionizing radiation is not possible. Still, the study nevertheless provides valid and reliable results.

## 5. Conclusions

This study provides for the first time a valid indication that football-specific movements and loading situations may influence lower leg alignment. Furthermore, the football environment with frequent football exposure during the week and the number of played seasons seems to have an impact on leg axis deviation in football players compared to REF. For prevention of knee osteoarthritis in FP, an advanced understanding of leg axis development in adolescent players is essential. In summary, to answer the question posed in the title, the results presented here support the hypothesis that playing football in adolescence is not necessarily a risk factor but does have an influence on the leg axis toward varus alignment. To further specify exactly which factors of playing football could be responsible for this influence, further studies are needed to detect the causing factors for leg axis development under the influence of sports activity.

**Author Contributions:** Conceptualization, C.M. and A.D.; methodology, M.K.; software, L.H.; validation, C.M. and L.A.; formal analysis, S.G.; investigation, A.D.; resources, V.A.; data curation, A.D.; writing—original draft preparation, C.M.; writing—review and editing, M.K. and W.K.; visualization, D.S.; supervision, W.K.; project administration, V.A.; funding acquisition, W.K. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the University of Regensburg, Germany (protocol code 19-1571-101; date of approval: 13 November 2019).

**Informed Consent Statement:** The authors confirm that any participant and additionally the participant's parents or legal guardians in case of underaged participants have given informed consent to participate in the research.

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author (CM). The data are not publicly available due to restrictions, as the information they contain could compromise the privacy of the research participants.

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