

Association between Running Activity and Pronated Foot Posture in East Java Puslatda Athletes

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Abstract

Background: Athlete begins intense exercise at a young age when the musculoskeletal system is still immature, thus it has the potential to cause specific changes in body. A more pronated foot have a greater mobility in both lateral medial plane and vertical plane. Hyperpronated foot allegedly can increase injury risk because it will cause a great moment of force and instability. The research aimed to determine correlation between running activity and pronated foot posture, and to obtain foot posture description of East Java puslatda athletes during running activity in their exercise.

Methods: The research employed cross sectional design using 75 athletes, consisting of 43 athletes who run more than 20 km per week and 32 athletes who run less than 20 km per week. The research variables were running activity obtained from questionnaire and foot posture obtained from the Foot Posture Index examination. The study protocol was approved by the ethics committees of Dr. Soetomo Teaching Hospital (Surabaya, Indonesia).

Results: The subjects' demographic data characteristics based on age and exercise duration showed no difference between the two sample groups. On the other hand, the research found a significant difference between age ($p = 0.001$) and body mass index ($p = 0.049$). There was no significant correlation between running activity and pronated foot posture, with $p = 0.293$.

Conclusion: The study found that running activity more than 20 km per week had no correlation with pronated foot percentage. Pronated foot posture was commonly found in the sample group with running activity more than 20 km per week, but it was not statistically significant.

Keywords: athlete, foot postur index, pronated foot posture, running.

Introduction

Athlete begins intense exercise at a young age when the musculoskeletal system is still immature, thus it has the potential to cause specific changes in body. Athlete's foot morphology may be associated with a variety of sports. Some data suggest that specific exercise and

repetitive movements in certain sports can affect foot arch index¹. In his study in 1323 professional athletes, found an increased risk of flat foot and splay foot occurrences in the endurance runner group².

A research conducted in General Practice Department of Groningen University and Rehabilitation Department of Utrechtsi University, Netherland, from September 2007-April 2009 found 23.7% of sport injury incidence per 1000 patients, with 27.8 prevalence per 1000 patients³. Running-related injuries comes second after soccer injuries, and lower extremity injury occurs three times more often than upper extremity³. Moreover, a study conducted in 2010 by Indonesia Ministry of Youth and Sports found 78 of 84 athletes had injuries.

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92% of injuries occurred during exercise and most of them were lower extremity .

Researcher and clinician must pay attention to sport injury prevention and intervention ⁴. One of proactive efforts in injury prevention is by performing screening process to detect athlete's injury risk ⁵. Lower extremity injury could be affected by a huge biomechanical stress while running and a varied foot posture ^{4,6,7}. Foot morphology is an important factor that determines correlation between ground reaction force and lower extremity rotation axis ⁴. A more pronated foot have a bigger mobility, both in lateral medial and vertical planes. A hyperpronated foot allegedly can increase injury risk because it has the potential to cause a great moment of force and instability ⁵. Various techniques have been used to assess foot posture, including visual observation, footprint evaluation, foot arch index, to measure heel position in frontal plane and navicular tuberosity position ⁷. Foot Posture Index is a quick and convenient visual measurement method to determine normal or abnormal foot posture classification (pronation, supination or normal), based on visually-observed six foot posture criteria ^{7,8}.

The research aimed to determine correlation between running activity and pronated foot posture, and to obtain foot posture description of East Java puslatda athletes during running exercise. Foot posture description is one of the information to estimate injury risk, therefore

it could increase athletes, coaches and doctors caution against possible injury threats.

Method

The research was conducted at Sport Clinic of Dr. Soetomo General Hospital, Surabaya, Indonesia, using East Java puslatda athletes who followed screening process from April to September 2013. The subjects met inclusion criteria (subjects who practiced a lot of running activities and less running activities) and exclusion criteria (aged less than 18, foot deformities such as syndactyly, polydactyly, terminal phocomelia, sport injuries, subject cannot stand relax and stack weight on both legs e.g. in pain condition), and signed informed consent. The study protocol was approved by the ethics committees of Dr. Soetomo Teaching Hospital (Surabaya, Indonesia).

The research is an observational analytic with cross sectional study design using 75 subjects, consisting of 43 subjects in the group that did a lot of running activity and 32 subjects in the group that did less running activity. The physical examinations included anthropometric and foot examinations, including inspection, palpation, examination of ankle and toe range motion, joint laxity and Foot Posture Index measurement. The process of data analysis was conducted using SPSS 13 software (SPSS, Inc., Chicago, IL). The obtained data were then statistically analyzed using logistic regression.

Results

Table 1. Logistic regression analysis on pronated posture-related factors (bivariate)

| Variabel | B | Harga p | R ² |
|-------------------|-------|---------|----------------|
| Sex | 0,782 | 0,126 | 0,043 |
| Age | 0,036 | 0,532 | 0,007 |
| BMI | 0,069 | 0,931 | 0,00 |
| Exercise duration | 0,095 | 0,149 | 0,039 |
| Running activity | 0,507 | 0,293 | 0,20 |

R²was obtained from Nagelkerke

Table 2. Logistic regression analysis on pronated posture-related factors (multivariate)

| Variables | B | p | R2 |
|-------------------|---------|-------|-------|
| Sex | 1,267 | 0,032 | 0,132 |
| Age | - 0,039 | 0,696 | |
| BMI | 0,089 | 0,923 | |
| Exercise duration | 0,080 | 0,237 | |
| Running activity | 1,048 | 0,062 | |

R²was obtained from Nagelkerke

Table 3. Logistic regression analysis on pronated posture-related factors in male subjects

| Variables | B | p | R2 |
|-------------------|---------|---------|-------|
| Exercise duration | 0,508 | 0,008 * | 0,275 |
| Age | - 0,328 | 0,024 * | |
| BMI | - 0,764 | 0,481 | |
| Running activity | 0,304 | 0,658 | |

R²was obtained from Nagelkerke

Table 4. Logistic regression analysis on pronated posture-related factors in female subjects

| Variables | B | p | R ² |
|-------------------|---------|-------|----------------|
| Exercise duration | 0,077 | 0,512 | 0,363 |
| Age | - 0,209 | 0,230 | |
| BMI | 19,596 | 1,0 | |
| Running activity | 22,285 | 0,99 | |

R²was obtained from Nagelkerke

The study had a sample of 75 subjects, consisting of 43 subjects in the sample group that did a lot of running activity and 32 subjects in the group that did less running activity. The average subjects' age in the group that did a lot of running activity was 22.8 with age range between 18.0-33.9, while the average subjects' age in the group that did less running activity was 23.5 with age range

between 18.0-31.2.

The measurement of left foot posture obtained 47 normal postures (62.7%), 27 pronated postures (36%) and 1 hyperpronated posture (1.3%). In the squash group, there were 3 normal postures (37.5%) and 5 pronated postures (62.5%). 5 normal postures (55.6%) and 4

pronated postures (44.4%) were found in the martial arts group, while there were 12 normal postures (60%), 7 pronated postures (35%) and 1 hyperpronated posture (5.0%) in the sepaktakraw group. In the karate group, there were 3 normal postures (100%). Moreover, there were 7 normal postures (100%) in the athletic group, 8 normal (61.5%) and 5 pronated postures (38.5%) in the softball group, 4 normal (40%) and 6 pronated postures (60%) in the baseball group and 5 normal postures (100%) in the table tennis group (Table 5.4). There were differences between left and right foot postures in the group that did a lot of running activity, while there was no difference between left and right foot postures in the group that did less running activity. The differences were found in 8 subjects, consisting of 2 squash subjects, 1 martial arts subject, 3 sepaktakraw subjects and 2 karate subjects.

Moreover, the study found 1 normal posture (2.3%) and 1 pronated posture (3.2%) in the group with less BMI, 39 normal postures (88.6%) and 27 pronated postures (87.1%) in the group with normal BMI, as well as 7 normal postures (9.3%) and 3 pronated postures (9.7%) in the group with excess BMI.

Correlation between Running Activity and Pronated Foot Posture

The results of multivariate logistic regression analysis found that running activity, age, body mass index and exercise duration variables did not show significant results. Meanwhile, sex variable showed significant results with $p < 0.05$ (0.032) (Table 5.9 and 5.10).

The results of multivariate logistic regression analysis in the male sample group showed that age and exercise duration variables had significant results (*), while BMI and running variables did not show significant results (Table 5.11).

Moreover, the results of multivariate logistic regression analysis in the female sample group showed that BMI, running, age and exercise duration variables did not have significant results (Table 5.12).

Discussion

The research found no significant difference between sex and exercise duration in both sample groups. On the other hand, there was a significant difference between sex ($p = 0.001$) and body mass index ($p = 0.049$). The

number of subjects mainly affected these findings since there were 28 males and 4 females in the group that run less than 20 km per week, while there were 20 males and 23 females in the group that run more than 20 km per week. Moreover, there were 5 subjects with exceed BMI in the group that run less than 20 km week, while there were 2 subjects with exceed BMI in the group that run more than 20 km week.

Running Activity

Running provides external and internal forces in the run musculoskeletal system. External forces include resistance of air, gravitation and GFR, while internal forces are given by muscles and tendons in the joints⁵. Bone and ligament structures should hold the GFR three to four times the normal weight while running^{4,5}. The present study found two running distances performed by the athletes of different sports. The running distance data were classified into group with running distance more than 20 km per week and group with distance less than 20 km per week. The group with a lot of running activity consisted of squash, martial arts, sepaktakraw, karate and athletics with an average exercise duration of 9 years. Meanwhile, the group with less running activity consisted of softball, baseball and table tennis with an average exercise duration of 8.5 years. The body forces during running activity correlated with foot pronation's magnitude and speed. Foot pronation is a protective mechanism during running activity that could spread the force for a longer time compared to the condition without pronation⁵. The use of shoes and orthosis during exercise could maximize performance and minimize trauma risk. All subjects in the present study used running shoes during running exercise.

Foot Posture Measurement Results

Foot posture was measured using Foot Posture Index with 6 measurement criteria, including talar head palpation, supra and infra lateral malleolar curvature, calcaneal frontal plane position, prominence in the region of the talonavicular joint, congruence of the medial longitudinal arch and abduction/adduction of the forefoot and the rearfoot⁷.

Running activity

The pronated foot posture measurement results showed a higher percentage in the group with running activity more than 20 km per week. There were differences between right and left foot postures in the

group with a lot of running activity. These findings allegedly correlated with extremity dominance.

Age

Degenerative process, incomplete trauma healing and large mechanical loads allegedly become the cause of tendon rupture. The flat foot deformity is often associated with posterior tibial tendon dysfunction. Posterior tibial tendon dysfunction does not always occur due to trauma, but it commonly occurs due to degenerative process. The condition is more prevalent in females aged 50-60. The present study found no correlation between pronated foot posture and age. This finding was allegedly affected by the subject's age range (18-33.9 years old).

Sports

The study found that pronated foot posture was more prevalent in squash, karate and baseball. This might be due to a correlation between athlete's foot morphology and sports. Some data suggest that specific exercise and repetitive movements in certain sports can affect foot arch index ¹. Further studies are necessary in order to determine correlation between pronated foot posture and sports.

Sex

The study found that pronated foot posture was commonly found in the male subjects (23;74.2%) compared to females (8;25.8%). The statistical results showed no significant correlation between sex and foot posture in bivariate logistic regression test, with $p=0.126$. These findings were consistent with a study conducted by Rodriguez et al. (2013) that found no difference between male and female foot posture index. Multivariate logistic regression test found a significant correlation between sex and foot posture, with $p=0.032$. This finding indicated that age variable was a confounding factor.

Body Mass Index

Body weight is transmitted into foot through ankle. When standing and silent, about half the weight rests on the heel. In this condition, talar head will shift to medial as much as 2-6 mm, while lateral tubercle from calcaneus will shift to media as much as 2-4 mm. Rearfoot will be more adductive-pronation, while forefoot will be more flexyabductive-supination ⁹. Increased mass with an addition of 20% body mass will

result in static and dynamic plantar pressure, but it is not significantly change foot structure. Increased long-term body mass index associated with obesity can be seen in the horizontal medial longitudinal arch on the legs, confirmed by increased foot contact areas on the floor. This change is unclear whether permanent or reversible ¹⁰. The present study found no significant correlation between body mass index and foot posture, with $p=0.931$. This might be due to no subject classified as obesity.

Correlation between Running Activity and Foot Posture

In his study conducted in 1323 professional athletes, found an increased flat foot and splay foot risks in the endurance runner group ². After a 20-kilometer run, the force distributed on the legs increased on the forefoot, middle foot and medial heel, while decreased force occurs in the lateral toe. The foot posture study which was measured immediately after runners run at a speed of 3.3 m/s for 60 minutes showed foot posture change. 10 of 30 participants showed a more pronated posture after running, and there was an increased pressure in the plantar. This finding showed an excess force in the medial heel.

The present study found no significant correlation between running distance and pronated foot posture, with $p = 0.293$. The research hypothesis was not proven. This might be due to a distant foot posture measurement after the subjects performed running activity. This finding was consistent with a study conducted by Karagounis et al. that examined correlation between increased plantar pressures after running. They found that this increment would return again as before after 24 hours. Bisiaux and Moretto in their study found increased plantar pressures at 30 minutes after exercise did not return at 30 minutes after break. This plantar pressure change is allegedly correlated with muscle fatigue.

Conclusion

The research found no correlation between running activity more than 20 km per week and pronated foot posture. A higher percentage of pronated foot posture was found in the group that run more than 20 km per week, but it was not statistically significant.

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References

1. Aydoğ E, Aydoğ ST, Çakci A, Doral MN. Reliability of isokinetic ankle inversion-and eversion-strength measurement in neutral foot position, using the Biodex dynamometer. *Knee Surgery, Sport Traumatol Arthrosc.* 2004;12(5):478–81.
2. Klingele J, Hoppeler H, Biedert R. Statistical deviations in high-performance athletes. *Schweiz Z Sportmed.* 1993;41(2):55–62.
3. Baarveld F, Visser CAN, Kollen BJ, Backx FJG. Sports-related injuries in primary health care. *Fam Pract.* 2010;28(1):29–33.
4. Barr KP, Harrast MA. Evidence-based treatment of foot and ankle injuries in runners. *Phys Med Rehabil Clin.* 2005;16(3):779–99.
5. Hreljac A. Etiology, prevention, and early intervention of overuse injuries in runners: a biomechanical perspective. *Phys Med Rehabil Clin.* 2005;16(3):651–67.
6. Nigg BM. The role of impact forces and foot pronation: a new paradigm. *Clin J Sport Med.* 2001;11(1):2–9.
7. Redmond AC, Crane YZ, Menz HB. Normative values for the foot posture index. *J Foot Ankle Res.* 2008;1(1):6.
8. Cornwall MW, McPoil TG. Relationship between static foot posture and foot mobility. *J Foot Ankle Res.* 2011;4(1):4.
9. Kapandji IA. *The Physiology of the Joints: Vol. I-Upper Limb.* 1970.
10. Klenerman L, Wood B. *The human foot: a companion to clinical studies.* Springer Science & Business Media; 2006.