Effect of flat foot on the running ability of an athlete

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Introduction

Anatomy: Human foot has become greatly specialized for the performance of two divergent functions- static balance & propulsion. These objectives are fulfilled by series of bones forming various arches. Arches serves for a dispersal of forces applied to plantar aspect of foot. Variation in the height of arch is achieved by contraction or relaxation of tibial muscles. Arches are- Longitudinal arch, transverse arch: become apparent when foot is placed together. Anterior metatarsal arch disappears with weight bearing.

Hicks (1955) regarded the foot as being a balance between an arch, a truss mechanism, and a beam mechanism. A beam is a mechanical situation in which ends are prevented from being thrust apart.

Flat Feet & Atheletic Performance: Flat foot occurs from a partial or complete collapse of the arch. Flexible flat feet is the most common type in which the foot is flat on standing and return to normal arch in weight bearing positions. Flat feet are associated with pronation. A certain amount of pronation is required for normal running activity, but too much pronation may hamper the running performance. Flat feet can be evaluated clinically by using either of the following methods: Arch index, % of area of arch of footprint, Arch angle, Navicular drop test.

Kinematic analysis of running indicates excessive increase in range of pronation, leading to stress on soft tissues surrounding foot complex. Kinetic analysis shows moderately high load imposed on toes & imposition of load on medial rather than the lateral side of foot.

Pronation & Supination are normal foot movements that occur during walking & running. When pronation & Supination exceeds norms of degree or duration, stability of the entire musculoskeletal complex is at risk. Excessive pronation hampers the body's ability to stand, walk & run. Also, foot dysfunction lead stress on lower leg & spine. These areas bear stress of compensating for weakness in the pedal foundation.

Purpose of the Study: Thus, purpose of our study was to determine the effects of flat foot on running ability (short distance, middle distance, long distance) of an athlete.

Review of Literature

(I) Clarke conducted a study to find an objective method for measuring the height of the longitudinal arch in foot examination and developed the arch angle as an objective method. His findings concluded as flatfeet are strengthened arch angle increases steadily and vice versa.
Clarke H. Harrison, "*An Objective method of measuring the height of the longitudinal arch in foot examination"* **Research Quarterly4:3***(oct.1941)*

(II) Thompson studied the relationship between deviation in the human feet and their strength and flexibility and concluded that: The Strength of the muscles activating ankle movements was weaker for men with navicular drop. Also; the feet of those with navicular drop are more flexible than of those with control.
Cameron Thompson," *Relationship between deviation in normal human feet and their strength and flexibility*" (Doctoral dissertation, University of oregon1969) cited in Clarke and Clarke 1987.

(III)Ajay Kumar concluded a study to develop a new graphic method for measuring flatfooted ness in foot examination. The present study showed a significant high positive relation ship between percentage of area of arch of footprint, arch angle of footprint and subjective rating of experts.
Ajay Kumar," *Development and Standardization of an objective graphic method for measuring flat foot.* (Gwalior, june 1990).

Research Design and Methodology

- **Nature of The Study:** Experimental study design
- **Research Setting:** This study was organized with support of School of Physical education, Devi ahilya vishwavidhyalay Indore (MP)

- **Consent And Ethical Approval:** From the institute - From the subjects, (prior to the study)
- **Population:** Selection was made out of 200 students of Physical Education
- **Sample:** A Total of 99 players were selected as a sample size

Selection Criteria

Inclusion Criteria

- Normal (mentally and physically fit) physical education students (both male & female).
- Age of the players 18-25 years.
- Subjects involved in daily running activities.
- Should satisfy minimum fitness level in form of strength (Grade5) and flexibility (Sit and Reach Test at least 5cm).
- Normal range of motion for all the joints.

Exclusion Criteria

- Subjects with any history of injury in the past 6 months, which is interfering in the running performance.
- Any abnormal biomechanical fault in any of the lower limbs.
- Any visual, auditory, or systemic deficit.
- Subjects not willing to participate

Variables of the Study

Independent Variable

- 100 mtr sprint
- 600 mtr run
- 12 min run/walk

Dependent variables

- 100 mtr performance(time)
- 600 mtr performance(Time)
- 12 min. run/walk(max. distance covered)

Material Used

- Stop watch
- Inch tape
- clapper

Procedure

Experimental Groups

- The foot condition of 99 subjects were measured by the graphic method and they were classified into two groups-- normal foot and flat feet group.

Foot print of right and left foot is taken on the graph paper. A line is drawn to represent the medial border of foot. Than, the total area of foot print was calculated by counting the total squares of the graph foot print in cm2.Then, the area of arch of foot print was calculated by counting the total squares of the unprinted area of foot print in cm2.

Percentage of area of arch of foot is calculated by:

Area of arch of foot/total area of foot printx100

Arch Index: AI was calculated by dividing the narrowest part of sole by the widest part of the heel and then multiplying the ratio by 100.

Arch Angle: It is calculated as described by Clarke. Subject stand in neutral position. Draw one line parallel to shaft of first metatarsal from medial malleolus to ball of great toe. Another line is from medial malleolus to perpendicular to the ground. Angle between these two lines is arch angle.

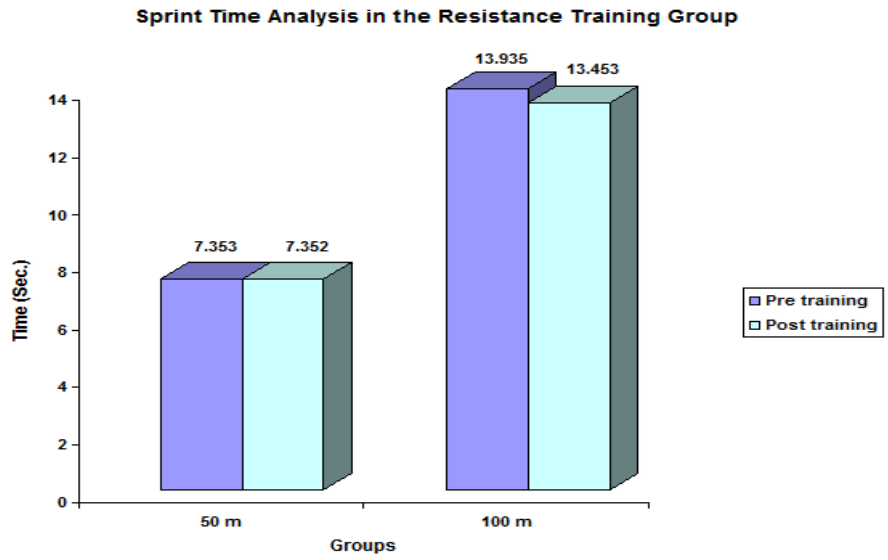
Table: Norms for each angle and percentage of area of arch of foot print

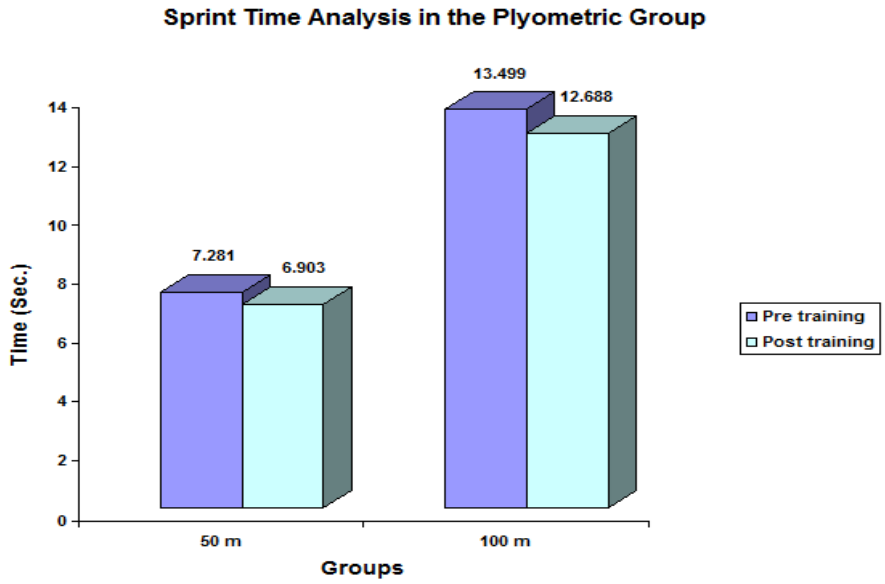
Scale	Flat foot	Low arch	Normal	High arch	pes cavus
Arch angle	below230	230-380	380-530	530-680	above 680
% of Area of Arch of footprint	below 6.5%	6.5%-13.5%	13.5%-21%	21%-28%	above 28.5%
Arch index	Above 1		1		less than 1

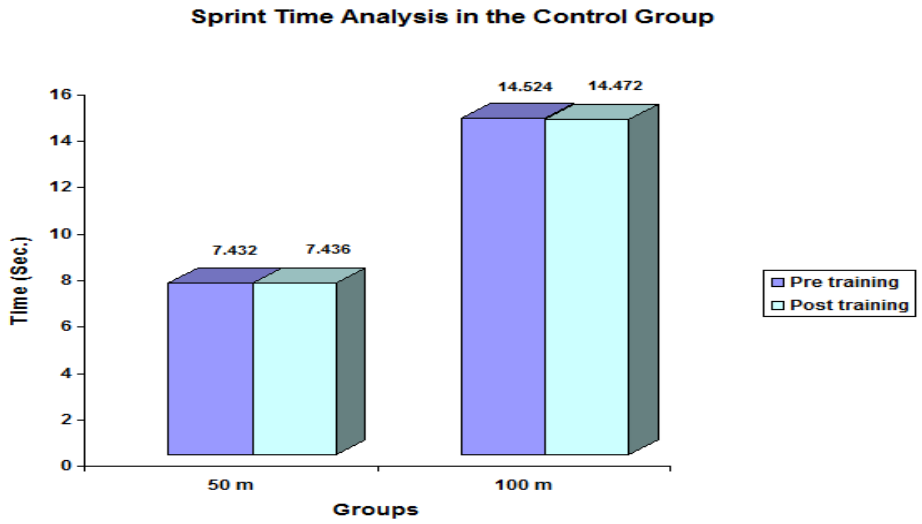
Testing Protocol

Testing protocol began with warm up (jogging) for five minutes and self- stretching protocols. 100 mtr and 600 mtr run test were conducted on 4 subjects at a time. The subjects ran individually, starting from a crouched position (medium type). No starting blocks were used. Starting commands were similar to those used in competition. All technical errors related to the arm, legs and trunk movements, starting and finishing technique, were eliminated prior to testing. All players performed in similar conditions, at the same time of the day to avoid any diurnal variations in performance. Four time keepers were assigned to measure the time of each subject. The time was calculated upto 1/100th a second which was rounded upto 1/10 of a second in a higher side.

For 12 min walk/run test, number of laps completed is counted and multiplied by course distance. Each runner is assigned to a spotter who will count each lap.


Sprint Time Analysis in the Resistance Training Group
13.935
13.453
7.353
7.352
Time (Sec.)
0
2
4
6
8
10
12
14
50 m
100 m
Groups
Pre training
Post training


Sprint Time Analysis in the Plyometric Group
13.499
12.688
7.281
6.903
Time (Sec.)
0
2
4
6
8
10
12
14
50 m
100 m
Groups
Pre training
Post training


Sprint Time Analysis in the Control Group
14.524
14.472
7.432
7.436
Time (Sec.)
0
2
4
6
8
10
12
14
16
50 m
100 m
Groups
Pre training
Post training

Data Analysis & Results

- Un-Paired t test was used to test the difference between flat foot & normal foot scores Mean and S.D. was calculated for all variables. Significance was set at $p< 0.05$.

Testers Reliability: The Author was learnt the method of measuring the foot print by the pedograph and had practiced these test a number of times before the collection of data.

Findings

Table (100 mtr)

Flat foot	Normal foot	M.D.	SE.D	t-value
14.776	13.606	1.170	0.322	3.634

"t" needed for significant at 0.05 level with df(97) =1.98
t value=3.634 is higher than required t value at 0.05 significant level .Thus normal foot group performed better than flat foot group.

Table (600 mtr)

Flat foot	Normal foot	M.D.	SE.D	t-value
2.069	2.011	.058	.084	.690

"t" needed for significant at 0.05 level with df(97)=1.98
t value=.690 is lower than required t value at 0.05 significant level .This shows no significant difference between means of normal foot and flat foot group, so both group perform equally on the 600 mtr run test.

Table (12 min walk/run)

Flat foot	Normal foot	M.D.	SE.D	t-value
2503.921	2858.590	354.669	96.874	3.661

"t" needed for significant at 0.05 level with df(97) =1.98
t value=3.661 is higher than required t value at 0.05 significant level .Thus normal foot group performed better than flat foot group in the 12 min walk/run test.

Discussion

The analysis of data for 100 mtr sprint, 600 mtr run and 12 mi walk /run test revealed. That the normal foot performs better in 100 mtr sprint and 12 min run test but no difference was found for 600 mtr run test.

100 mtr sprints is an explosive activity which requires more forceful reaction from the ground and normal arched foot must be given help than a flat foot due to its springing action and strong muscles for the performance of 100 mtr sprint. Again 12 min run is a long distance run and weak foot might get fatigued in this run. Our findings correlate withy the authors (Cameron Thompson) who showed decrease in ankle muscle strength in flat foot. This might be the reason for hampered performance. Again 600 mtr run is neither explosive activity nor an endurance event, so the flat foot might had not fatigued and performed equally as normal foot.

Limitations of the study

- Subjects were not matched for anthropometric similarities.
- Quality of shoes of the different subjects may have some effects on the data.
- There is a probability of personal physical error since measurement were not computerized.

Implications of the study

The study may provide a base for proper selection of a sports person. The findings of the study may give the basis for the selection of running events for flat foot persons.

Conclusion

Performance of person with flat foot may hamper in short explosive events like sprint and long distance endurance running. Flat foot persons may perform equally with par of normal subjects in events which does not place much stress on foot musculature.

Conflict of Interest: None
Source of Support: Nil

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