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Original Article:

Effect of Obesity on Arch Index in Young Adults

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Abstract: Background: Excessive increases in weight bearing forces caused by obesity may negatively affect the lower limbs and feet but minimal research has examined the long-term loading effects of obesity on the musculoskeletal system, particularly in reference to the feet. Objectives: The purpose of the study was to investigate the effect of obesity on medial longitudinal arch of foot in young adults. **Method:** 60 subjects, 30 obese & 30 non obese were assessed for height & weight using standard technique. Radiographic images under static condition were used for calculating the arch index. **Result:** The arch index of obese subjects was significantly lower than the non obese subjects & there is a negative correlation between the BMI & the arch index. **Conclusion:** These results suggest that obesity lowers the medial longitudinal arch of foot.
Key Words: Obesity; Medial longitudinal arch; Arch index

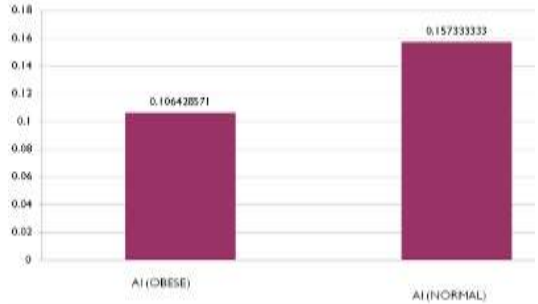
Introduction:
Feet, as the body's base of support, continually endure often high ground reaction forces generated during activities of daily living. The component primarily responsible for absorbing and dissipating these forces in the feet is the longitudinal arch. Although this arch comprises bony articulations, ligaments and muscles, it is primarily the ligaments that support and stabilize the longitudinal arch, as well as acting as powerful energy-storing mechanisms.[1,2]Muscles provide secondary support by maintaining the arch during dynamic tasks. Ligaments rarely incur physiological fatigue and therefore offer a greater resistance to stress compared to muscles.[3] However, repeated excessive loading may stretch ligaments beyond their elastic limit, damaging soft tissues and increasing the risk of foot discomfort and subsequent development of foot pathologies. Various authors have suggested that excessive increases in weight bearing forces caused by obesity may negatively affect the lower limbs and feet. Although studies pertaining to temporary and short-term loading effects on lower limb and foot mechanics are available,[4,5] minimal research has examined the long-term loading effects of obesity on the musculoskeletal system, particularly in reference to the feet. Therefore the purpose of the study was to investigate the effect of obesity on medial longitudinal arch of foot in young adults.

Methodology:
Thirty subjects (mean age: 22years, Mean BMI 30,) without other health problems were selected as experimental subjects & 30 non obese subjects matched to the obese subjects for gender, age & height (mean age: 22 years, mean BMI 22) were selected as controls. Height and weight were measured on subject in light clothes and without shoes using standard apparatus. The weighting scale used could be read to the nearest 0.1 kg. It was calibrated at the beginning of each working day and at frequent intervals throughout the day. Height was measured to the nearest 0.5 cm, using a measuring tape. To measure height, the measuring tape was fixed to the wall. Height was measured while the subject stood with heels, buttocks, shoulders and occiput touching the vertical tape. The head was held erect with the external auditory meatus and the lower border of the orbit in one horizontal plane. Each subject's body mass index (BMI) was then calculated using the standard Quetelet Index protocol: body mass divided by height squared (kg/m2).All measurements were taken by the author.
Lateral x-rays were taken by a standard technique. Patients stood on a wooden platform with their knees extended and their heels and toes at same level. The x-ray film pack was placed vertically between the feet. Patients were instructed to place equal weight on both feet. The x-ray tube was oriented parallel to floor with the central beam targeted immediately above base of fifth metatarsal. Arch Index was calculated using the formula: Navicular height/ Truncated foot length.[6] Following image describes the method used for calculating the Arch Index. For calculating the truncated foot length a perpendicular was drawn from posterior surface of calcaneum and another from the head of first metatarsal and a

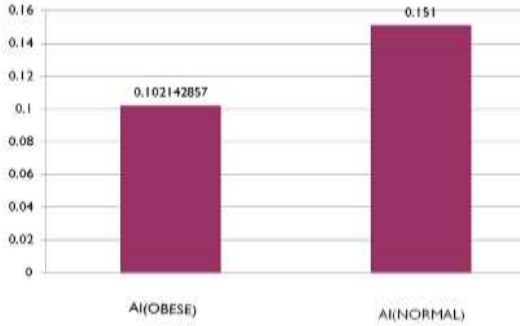
line passing through the base of calcaneum was intersected to the two perpendicular line. For measuring the Navicular height a perpendicular was intersected from the navicular tuberosity to the truncated foot length, both the measurements were taken in cm.

Figure 1: Arch index calculation on radiographic image in static condition:

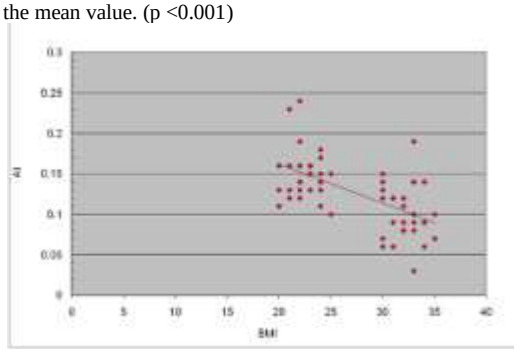
Results:



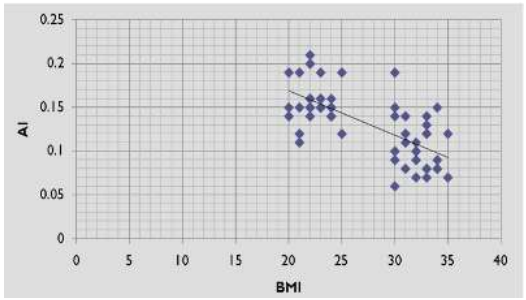
Graph 1 shows the comparison of mean AI of Rt foot in obese and non-obese. The graph shows a significant difference in the mean value ($p < 0.001$)



Graph 2 shows the comparison of mean AI of Lt foot in obese and non- obese and shows a significant difference in the mean value. ($p < 0.001$)



Graph 3 shows correlation between BMI and AI (Right foot), showing a negative correlation between BMI and AI (r= -0.6)



Graph 4 shows correlation between BMI and AI (Left Foot) and shows a negative correlation between BMI and AI (r= -0.6)

Discussion

The study shows that the arch index in obese is lower as compared to the control group. There is a negative correlation between the body weight & arch index. Increased loading of the feet may be classified according to time-frame and described as temporary, short-term or long-term. A temporary loading effect occurs, for example, when carrying a backpack or wearing a weighted belt that temporarily increases body mass. In contrast, a long-term loading effect occurs over an extended period, such as in obesity, where the increase in mass is continuous.[7]The significantly lower plantar arch height found in the overweight/obese suggests that their flatter feet may be caused by a lowering of the longitudinal arch, most probably caused by their feet continually bearing excess mass. It is postulated that these structural changes, which may adversely affect the functional capacity of the medial longitudinal arch, might be exacerbated if excess weight bearing continues throughout adulthood. A recent review of the impact of childhood obesity on musculoskeletal form revealed that obese children exhibit a variety of biomechanical changes in the lower extremities. The authors noted that these changes have the potential to produce obesity-associated musculoskeletal pain in children and adolescents; however, data are limited.[8] As feet are our base of support during most weight bearing activities, it is postulated that foot dysfunction associated with obesity may act as a deterrent on obese individuals to participate in physical activity & in turn perpetuate the cycle of obesity.

Conclusion:

These results suggest that obesity lowers the medial longitudinal arch of foot.

Conflict of Interest: None

Source of Support: None

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Ethical Approval: Granted by M.G.M. Medical College Research & Ethical Committee.

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