International Journal of Health Sciences and Research
DOI: https://doi.org/10.52403/ijhsr.20211005
Vol.11; Issue: 10; October 2021
Website: www.ijhsr.org
ISSN: 2249-9571
Original Research Article

A Comparative Study of Footprints of Security Guards with Age and Gender Matched Individuals

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ABSTRACT

Aim: To compare footprints of security personnel with age and gender matched individuals.
Background: The human foot and ankle are the last segments, the last within the complex kinetic chain of the lower limb as a whole. The foot is one of the most important interaction parts of the body with the ground, especially in the upright posture. During growth, the foot changes not only its dimensions but also its shape. The lower back, leg, ankle and foot are the most commonly affected region causing pain in security personnel during prolonged standing and sitting. This may also lead to change in the arch of the foot and predispose it to the injury. In this study, we aim to analyze footprints with reference to Staheli Index and Chippaux-Smirak Index of security guards and age and gender matched individuals.
Methodology: 25 security personnel and 25 age and gender matched individuals were selected as per inclusion criteria. Demographic data like age, gender, height, weight, BMI and any injury in last 6 months were recorded for all study participants. For obtaining foot prints, ink was applied to the feet of the subjects. The subjects were tasked to step on graph paper in standing position, leaving a clear impression of foot's plantar surface on the paper. The various distances in centimeters were taken using a transparent ruler. The Staheli Index and Chippaux-Smirak Index were also calculated.
Result: Statistical analysis showed significant difference in Staheli Index, Chippaux-Smirak Index, Distance E and G between security personnel and age and gender matched individuals. The other values (A, B, C, D, F) were not found to be statistically different.
Conclusion: The distance E and distance G is more in age and gender matched individuals as compared to security personnel. Also the Staheli Index and Chippaux-Smirak Index is less in security guards which indicates higher arch as compared to age and gender matched individuals.

Keywords: footprint, arch of foot, security personnel, Staheli Index, Chippaux-Smirak Index

INTRODUCTION

The modifications and development in the human foot starts from the postnatal developmental stage. Human feet comprises of fifty two bones with 25% of the bones are present within the ankle. The foot is bifurcated into 3 predominant parts: the tarsal, metatarsal and phalanges. [1] The development of lower limb and foot structural modification makes a firm and stable posture that distinguishes humans from other mammalian species [2]. The human foot has been structurally and functionally advanced to be one of the most striking modifications in human evolution [3]. It is a complex structure tailored to permit orthograde bipedal stance and locomotion. It is the only part of the body which is in regular contact with the ground [4]. This advanced modification of foot is attained by its anatomy which comprises of bones, strengthened by ligaments and tendons permitting the feet to support the weight of the body in erect balanced posture with least weight. These composite anatomical components form a rigid structure called the arches of the foot. Three important arches are identified in the foot. They are the medial longitudinal arch, the lateral longitudinal arch, and the transverse arch [5]. The presence of arched foot is one of the exceptional functions of human evolution. In a few cases, this arched foot becomes impaired and loses its contour resulting into a deformity referred to as “Pes planus.” It is a situation where in the longitudinal arch of the foot is impaired and consequently the whole sole touches the floor making the foot to flatten [5]. Thus, there's a functional relationship between the anatomy of the arches of the foot and the bio mechanism of the lower limb [6]. The most commonly occurring problem of the medial longitudinal arch are both due to the excessively excessive arch, a condition regarded as “Pes cavus” or cavus foot or because of extremely low arch regarded as “Pes planus” or flat foot [7-9]. This has a significant impact on the foot function of the individuals and the development of the musculoskeletal pathologies [10-11]. They are believed to have a poor impact on the quality of life [12]. Flat foot refers to the tenuous mixture of anatomical variations and pathological modifications [13]. When the arches of the foot collapse, the entire sole of the foot comes in direct or partial contact with the ground resulting in postural deformities. The arch gives an elastic and springy impact between the forefoot and hind foot. During weight bearing the foot can be dissipated before the majority of forces reach the long bones of the leg and thigh [14]. In flat foot, the head of the talus bone is displaced medially and distally from the navicular. As a result, the spring ligament and the tendons are stretched so much that the individual with flat foot loses the function of the medial longitudinal arch. This latter situation can be corrected with well-supporting arch supports [15]. The appearance of flat foot in elderly is regular which masks the arch of the foot of the people. During the human evolution, the foot and hands experienced extraordinary changes. [16, 17]. The assessment of the plantar arch development, by the relationship between the arch region and heel region, proposed by Engel and Staheli. The foot is a complex structure enabling three essential functions such as supporting, shock absorbing, and weight bearing. Many factors influence the structure and functioning of the foot, one of them is aging. During walking, a neutral foot should have a mechanical benefit to adapt from ground while facilitating shock absorption and weight bearing and to function as a rigid fulcrum to push the body in space [18]. However, both supinated and pronated foot feet have a severe impact in the mechanics of gait. The pronated foot is more loosely packed, causing the mid-tarsal joint to unlock during ambulation which permits the foot to act as a shock absorber [19-21]. However this may reduce the ability to act as a rigid lever. In contrast, the supinated foot is more firm, which permits the foot to acts as a more efficient fulcrum for anterior motion but not as an efficient shock absorber [22]. Security guards spend nearly their entire working hours in standing position. This places them at higher risk of hazards than any other occupation. Back pain in standing can be because of increased perceived exertion and discomfort in low back and increased muscle fatigue from efforts required to maintain an upright posture [23]. Working in standing gives big degree of freedom and permits the worker to carry out task in an easy and efficient manner improving the productiveness. But while workers spend more than 50% of working hour in standing it exposes them to various occupational injuries [24] Literature quotes that standing for more than 4 hours a day exposes the worker to low back ache, while 50% of healthy people complain of pain in back and leg even after 2 hours of prolonged standing [25]. Security guards spend nearly their entire working hours in standing position. Since there are numerous studies done on prevalence of occupational hazards, low back pain and varicose veins in security personnel and there were no researches done on footprints of security personnel, our aim was to the compare footprints of security personnel with aged and gender matched individuals which will help to enhance their physical well-being as well as their productivity and performance at work.

MATERIALS AND METHODS

Materials: Ink, tray, weighing scale, Stadiometer, graph paper

Sample Design

Sample Size: 50

Group A - 25 Security Personnel

Group B - 25 Age and Gender matched Individuals

Sampling: Convenient Sampling

Type of study – Cross-sectional Observational Study

Duration of study – 1 year

Place of study – Metropolitan City

Selection Criteria

INCLUSION CRITERIA:

- Security personnel willing to participate in the study.
- Only male security personnel.
- Security personnel in the age group 20-40 years.
- Security personnel having experience for more than 5 years.
- Security personnel working for 8 hours a day.

EXCLUSION CRITERIA:

- Security personnel with Acute Musculoskeletal Injury.
- Security Personnel with any Recent Surgery or Fracture.
- Security personnel with Cardio Respiratory Insufficiency.
- Security personnel with Neurological Impairment.

Procedure:

The subjects will be selected according to the inclusion and exclusion criteria who are willing to participate. A written consent form will be taken in the language best understood by the subject. Demographic data will be recorded. 25 security guards and 25 normal individuals were selected who matched our inclusion criteria. Demographic data regarding age, gender, height, weight, BMI and any past injury in last 6 months were recorded for all study participants.

For obtaining foot prints using simple ink print method, a thin (1–2 cm width), large piece of sponge about 30 cm (larger than the foot size) is placed on a tray, and diluted ink is poured and wetted. The sponge absorbs all the ink and when the foot is placed, the ink sticks on the surface of the foot. The subjects were then asked to step on graph paper in standing position, leaving a clear impression of foot's plantar surface on the paper. Post the creation of impression, the subjects were asked to lift the foot from paper. The various distances in centimeters were taken using a transparent ruler as shown in the below figure.

Figure 1: Foot Measurements

In taking foot length measurements, the points of reference at the different parts of the foot print were assigned including the point number 1 to 11. The definition of the length and distance was determined as follows:

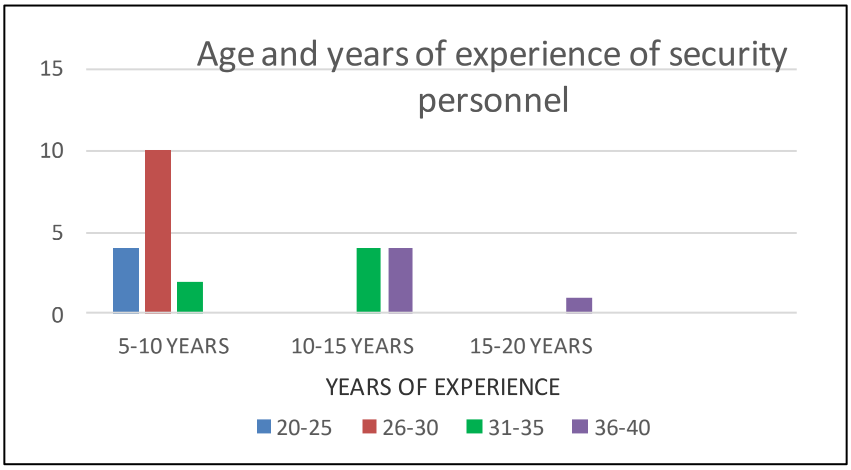
Distance between points no. 1 and 2 was the length measured from point first toe to heel (A). Distance between points no. 2 and 3 was the length measured from point second toe to heel (B). Distance between points no. 4 and 5 was the metatarsal distance (D). Distance between point no 4 and 6 was the length of the base of the longitudinal arch contour (C).Distance between point no 6 and 7 was the widest part of the heel (F). Distance between point No.8 and No.9 was the width of the footprint that did not touch the ground or longitudinal arch contour (E). Distance between No.10 and No.11 was the narrowest part of the footprint (G). Staheli index: This is the ratio of the minimum width of the midfoot arch region to the maximum width of the rear foot region Distance (G)/ Distance (F). Chippaux-Smirak Index: This is the ratio of the minimum width of the midfoot arch region to the maximum width of the forefoot region was calculated by dividing Distance G by Distance D. above measurements were considered in assessment of the footprints.

RESULT

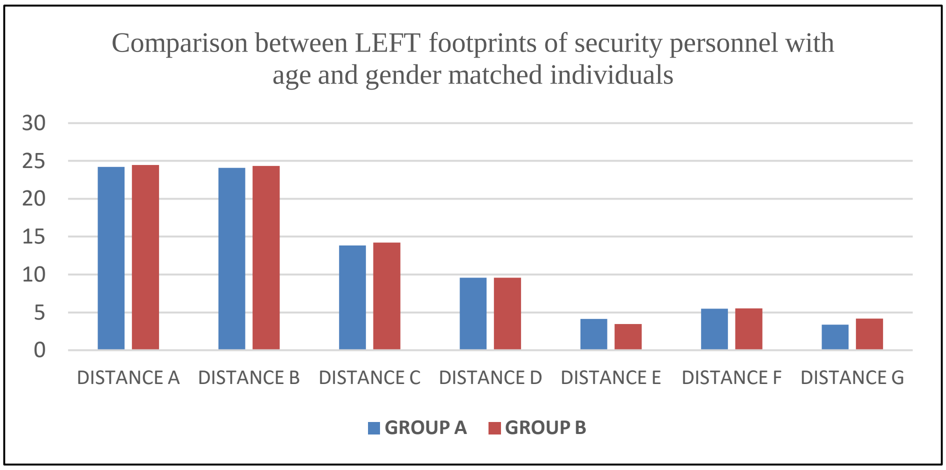
50 subjects meet the inclusion criteria. There were no drop outs in the study.

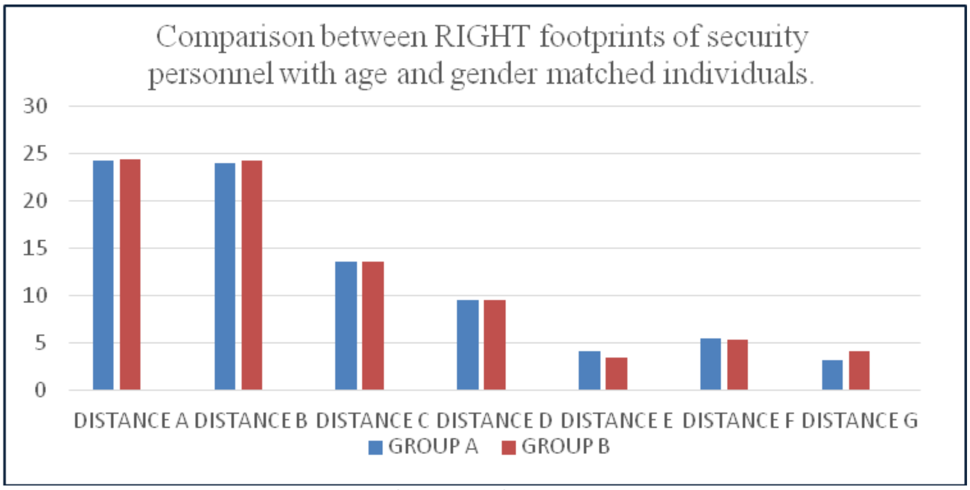
Data was collected on a data sheet and encoded for computerized analysis using Graph Pad Prism 9.2 version for Windows.

Footprint variables of security personnel with age and gender matched individuals were compared. Normality was checked using Shapiro-Wilk test. Tables and graphs were made using Microsoft Word.



GRAPH 1: Age and years of experience of security personnel





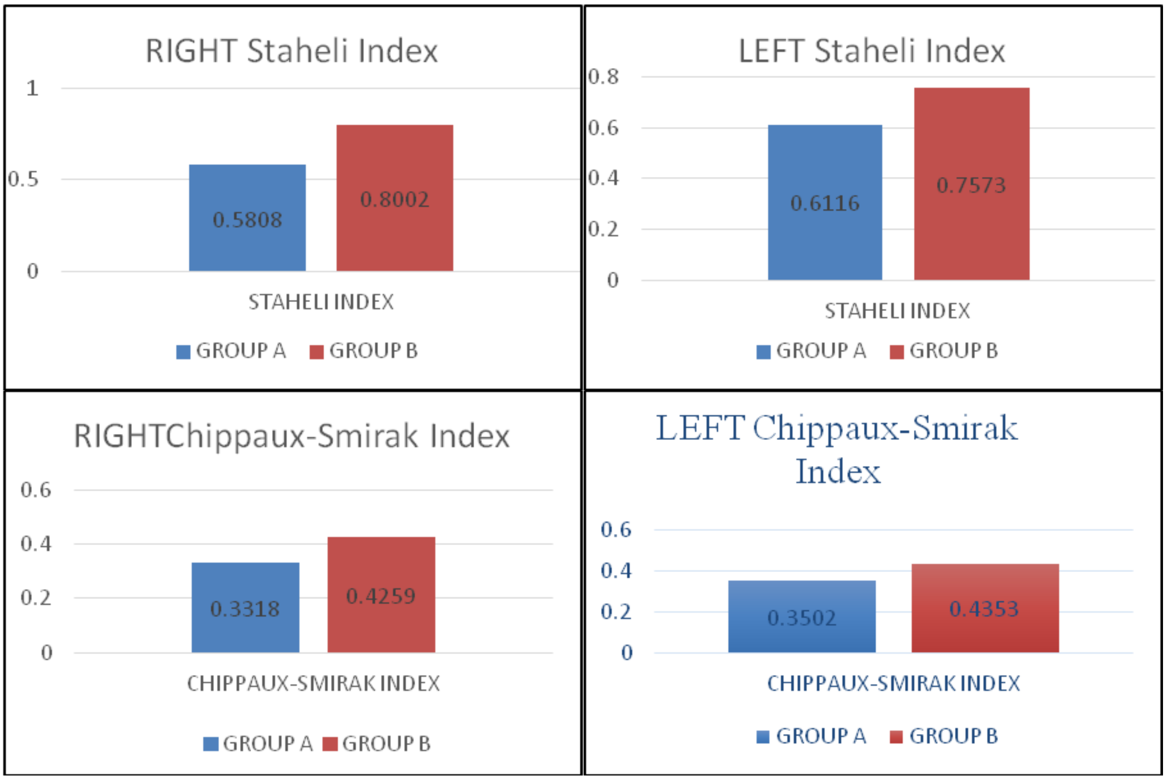
GRAPH 2: Comparison between LEFT and RIGHT footprints of security personnel with age and gender matched individuals

TABLE 1: COMPARISON BETWEEN RIGHT VARIABLES OF GROUP A AND GROUP B

GROUP A (RIGHT)	MEAN	SD	GROUP B (RIGHT)	MEAN	SD	P VALUE
A	24.25	1.097	A	24.40	1.77	0.4891
B	24.07	1.263	B	24.25	1.244	0.5862
C	13.59	1.171	C	13.57	2.727	0.2643
D	9.60	0.469	D	9.60	0.413	0.8269
E	4.18	0.538	E	3.48	0.604	<0.0001
F	5.51	0.396	F	5.35	0.800	0.4895
G	3.19	0.682	G	4.10	0.844	<0.0002

TABLE 2: COMPARISON BETWEEN LEFT VARIABLES OF GROUP A AND GROUP B

GROUP A (LEFT)	MEAN	SD	GROUP B (LEFT)	MEAN	SD	P VALUE
A	24.22	1.172	A	24.46	1.00	0.4606
B	24.09	1.078	B	24.36	1.143	0.3879
C	13.82	1.071	C	14.22	1.152	0.1960
D	9.59	0.490	D	9.59	0.480	0.9040
E	4.14	0.532	E	3.45	0.794	<0.0004
F	5.49	0.353	F	5.53	0.422	0.4948
G	3.36	0.628	G	4.17	0.992	<0.0011



GRAPH 3: Staheli and Chippaux-Smirak Index

TABLE 3: STAHELI INDEX AND CHIPPAUX-SMIRAK INDEX OF GROUP A AND B

	GROUP A (RIGHT)		**GROUP B (RIGHT)**		
	MEAN	SD	MEAN	SD	P VALUE
STAHELI INDEX	0.5808	0.126	0.8002	0.302	0.0001
CHIPPAUX-SMIRAK INDEX	0.3318	0.065	0.4259	0.080	<0.0001
	GROUP A (LEFT)		**GROUP B (LEFT)**		
	MEAN	SD	MEAN	SD	P VALUE
STAHELI INDEX	0.8002	0.104	0.7573	0.1864	0.0024
CHIPPAUX-SMIRAK INDEX	0.4259	0.063	0.4353	0.1026	<0.0008

DISCUSSION

This study was initiated to acquire in depth information about the impact of long working hours on the footprints of security personnel. Foot posture has long been considered to influence the mechanical alignment and dynamic function of the lower limb and may therefore be related to the development of lower limb musculoskeletal conditions. The procedure used was by comparing the footprints with respect to various parameters like distance between 1st and 2nd toe to heel, metatarsal distance, Staheli Index and Chippaux-Smirak Index. It was observed that Distance E, Distance G, Staheli Index and Chippaux-Smirak Index of security personnel when compared with age and gender matched individuals were statistically significant. Security guards are exposed to numerous hours of active work that includes various working postures. Due to such prolonged working conditions in such postures, they were at the highest risk of developing many medical conditions in the future. Due to prolonged standing, the common health problems were lower back pain, physical fatigue, muscle pain, leg swelling, tiredness, and body part discomfort. So security guards are at a very high risk of developing these conditions in the future. This can be prevented by making proper policies that address these problems. [27] The results of this study conclude that there was a significant difference in some variables of the footprints of security personnel compared with age and gender matched individuals. Distance A, Distance B, Distance C, Distance D, Distance F were not statistically significant whereas Distance E, Distance G, Staheli Index, Chippaux-Smirak Index were found out to be statistically significant. Staheli Index and Chippaux-Smirak Index of security guards was found out to be lower than the compared groups. According to our study, 72% of security personnel had an experience of 5-10 years, 24% had an experience of 11-15 years and only 4% had an experience of 15-20 years. 68% of security personnel had 12 hour shift while 32% had 8 hour shift. 52% of security guard maintained sitting posture during their shift and 48% maintained standing posture during their shift. 40% of security personnel belonged from the age group 26-30 years, 24% belonged from the age group 31-35 years, 20% belonged from the age group 36-40 years and 16% from the age group of 20-25 years. The BMI of security personnel showed that 60% had a normal BMI whereas 40% were overweight (25-29.9kg/m2)

CONCLUSION

There was a significant difference seen in the footprints of security personnel when compared with age and gender matched individuals. Understanding foot prints helps to detect any persistence of deviations beyond a certain stage of development, and also to provide scope for timely intervention to prevent any possible deformities and dysfunctions

CLINICAL IMPLICATIONS

The result and the process of study can be used in structural assessment of ankle and foot complex of security personnel, especially those who have prolong standing hours. Understanding foot posture helps to detect any persistence of deviations beyond a certain stage of development, and also to provide scope for timely intervention to prevent any possible deformities and dysfunctions. This study can be useful in assessment and shoe modification for security personnel. The security guards are definitely at risk of multiple health problems in the present as well as in the future. This becomes even more important to address because this profession demands active physical work, however, less importance is being given to control health hazards in the security guards.

LIMITATIONS AND SUGGESTIONS

Larger studies are required for conclusive evidence.

Only male participants were included.

Acknowledgement: None

Conflict of Interest: None

Source of Funding: None

Ethical Approval: Approved

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How to cite this article: Shetty S, Gokhale P. A comparative study of footprints of security guards with age and gender matched individuals. *Int J Health Sci Res.* 2021; 11(10): 26-33. DOI: *https://doi.org/10.52403/ijhsr.20211005*

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