ANTROPOMETRIC FOOT MEASUREMENTS OF CHINESE ADULTS WITH DIFFERENT BMI

Youlian Hong, Lin Wang

**Department of Sports Science and Physical Education,
The Chinese University of Hong Kong, Hong Kong, China**

The purpose of this study was to examine whether foot shape was affected by different body weight levels in the same foot length. Foot shape data were collected from 476 male and 499 female subjects. Each gender was divided into two normal and overweight or obesity groups. The results showed that there are some differences in foot length, breadth, girth and height between different BMI groups in same foot size. Overweight or obese group have shorted fore foot length, longer girth length, larger foot breadth and larger size in some foot height. The results will help make shoe last and choose fitting shoe for overweight and obese group.

KEY WORDS: foot shape, BMI, Chinese adults.

INTRODUCTION:

Reliable and definitive data of foot shape is essential in the creation of proper shoes. It is commonly recognized that correct shoe fit is attained by matching shoe shape to the shape of the foot. Some studies have indicated that the obese group of people often suffers foot discomfort from wearing poorly fitting shoes. Therefore, the foot measurements were did to determine whether BMI influenced foot shape.

Body Mass Index (BMI) is defined as body mass divided by height squared (kg/m^2). It is an indicator in assessing whole body obesity and correlates with health conditions. The World Health Organization (WHO) suggested that a BMI of over $25kg/m^2$ is defined as overweight and a BMI of over 30 kg/m^2 represents "obesity" (WHO, 2003). It has been suggested that for Asian people, the BMI cutoff point for obesity should be lower (Deurenberg P., Yap M., 1998). Therefore, the International Obesity Task Force (IOTF) collaborated with the Regional Office for Western Pacific of the WHO to propose another classification of BMI categories for Asian people. The cutoff point for Asians for being at-risk of obesity is set at 23 kg/m^2. For obesity it is set at 25 kg/m^2 (Seidell JC.,1999). In the study, we divide different BMI levels according to the definitions.

Reliable and definitive data of foot shape is essential in the creation of proper shoes. It is commonly recognized that correct shoe fit is attained by matching shoe shape to the shape of the foot (Wunderlich R.E., 1999). Some studies have indicated that the obese group of people often suffers foot discomfort form wearing poorly fitting shoes; particularly true for obese young males (Dowling AM., 2001). Obesity may have specific characteristics in foot shape. It is therefore unknown whether different body weights would affect the parameters in characterizing foot shape in the Chinese adult, particularly factors that relate to shoe fit. Therefore, the purpose of this study was to examine whether foot shape was affected by different body weight levels in the same foot length.

METHODS:

A total of 476 adult males and 499 females (aged from 18 to 25 years old, foot length for males was from 24.7cm to 25.2cm; for females it was 23.3cm to 24.3 cm) participated in this study (Table 1.). The foot lengths were selected from what is considered normal in China. Each gender was divided into two groups (normal, NG; overweight or obesity, OG). The 3D foot shape data were collected through video filming according to procedures which have been developed in our earlier study (Li JX., et al.,2005). Four length variables (foot length FL; first and fifth metatarsal head length M1L, M5L; and forefoot length ForeL), two breadth variables (foot breadth FB; heel breadth HB) and 12 height variables (height of the first and fifth phalangeal head P1H, P5H; height of the first and fifth metatarsal head M1H, M5H;

height of inner arch ArH; height of the cuneiform bones CBH; height of the point where leg meets the foot DH; height of medial and lateral malleolus MMH, LMH; height of sphyrion and sphyrion fibulare SphH, SphfH; height of the calcaneus CH) were calculated. Together with the five girth variables (metatarsal-phalangeal joint girth MPJH; midfoot girth MFG; heel-Midfoot girth HMFG; heel-instep girth HIG; malleoli girth MG) measured manually, a total of 23 foot shape variables were obtained.
For each variable, mean and standard deviation were calculated. The variables were analyzed using independent T-test design to determine whether there were any significant differences in the different BMI levels in each sex.

RESULTS AND DISCUSSION:

There were no significant differences between two groups in age and height. However, in weight and BMI, significant differences were found between the normal and overweight or obese groups.

Table 1. Subject Characteristics (mean±SD).

	Male (n=476)		Female (n=489)	
	NG (n=381)	OG (n=95)	NG (n=410)	OG (n=89)
Age(years)	20.02±1.33	20.51±1.58	19.93+1.41	19.86±1.45
Height(cm)	173.49±4.44	172.47±4.10	164.93±4.33	164.71±4.32
Weight(Kg)	62.82±4.76	75.17±8.11	55.35±4.31	67.82±6.70
BMI(Kg/ m^2)	20.86±1.34	25.29±2.92	20.34±1.37	24.97±1.99

Length variables

There was no significant difference between groups in FL, M1L, and M5L in both sexes. However, for ForeL, the normal group showed a longer length than the overweight and obese group (Male normal group: 14.60 ±0.39cm; overweight and obese group: 14.41±0.41cm, Normal group Vs. Overweight and obese group $P < 0.001$.; Female normal group: 13.61 ±0.49cm; overweight and obese group: 13.39±0.44cm, Normal group Vs. Overweight and obese group $P < 0.001$).

Girth variables

In all girth variables, the overweight and obese group showed longer length than the normal group in all sexes (Fig 1.).

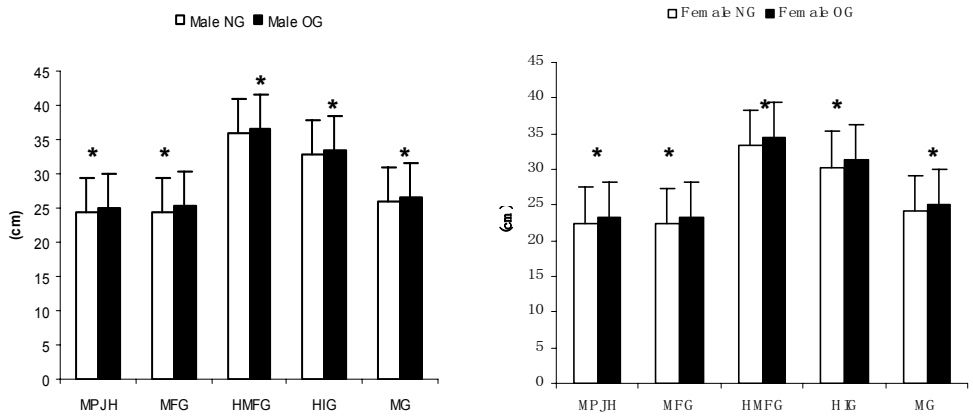

Figure 1. Girth variables in NG and OG in different sex. *P < 0.05

Breadth variables

FB and HB in OG were larger than NG in all sexes (Table 2.).

Table 2. Breadth variables (mean±SD).

	Male		Female	
	NG	OG	NG	OG
FB (cm)	9.90±0.42	10.18±0.42 *	9.16±0.50	9.40±0.37 *
HB (cm)	6.24±0.40	6.41±0.41 *	5.75±0.47	5.86±0.38 *

Notes: *P < 0.05, NG Vs. OG

Height variables

There were no significant differences between groups in ArH, CBH, SphH, SphfH, MMH, LMH, DH, and CH in both sexes. In females, there were no differences between two groups in P5H and M5H. OG showed larger size in P1H and M1H in both sexes. In males, OG had bigger size in P5H and M5H.There are some obvious differences between OG and NG in foot girth, foot breadth, and height. Some studies have found that obese people have a lower foot arch and a larger foot breadth (Hills AP., et al. 2001). In our study, we found that OG have bigger breadth, but we did not find similar results for foot arch. Some researchers suggest that stress may cause the flattening of the longitudinal arch (Riddiford-Harland DL., 2000; Wearing SC., 2004). Our subjects in OG have less BMI and weight; this may explain the problem we had with our findings.

CONCLUSION:

The overweight and obese populations showed some specific characteristics in the study. It is recommended that these different characteristics of foot girth, breadth, and height be considered when making shoes that are built to last. These different characteristics should be considered when choosing fitting shoes for the overweight and obese populations so as to reduce foot discomfort from wearing poorly fitting shoes.

REFERENCES:

Deurenberg P., Yap M. (1998). Body mass index and percent body fat: a meta analysis among different ethic groups. International Journal of Obesity, 22; 1164-71.

Dowling AM., et al. (2001). What are the effects of gender and obesity on foot structure in children? 5th Symposium on Footwear Biomechanics, 30-1.

Hills AP, Hennig EM, McDonald M. (2001). Plantar pressures under the feet of obese adults: a biomechanical study. International Journal of Obesity, 25: 1674–1679

Li JX., Xu DQ., et al. (2005). Analysis Of Foot Shape Measured From Chinese Male And Female Adults, 7th Symposium on Footwear Biomechanics, 84-5.

Riddiford-Harland DL., Steele JR., Storlien LH. (2000). Does obesity influence foot structure in prepubescent children? International Journal of Obesity, 24: 541–544

Wearing SC., Hill AP., Byrne NM., Hennig EM., McDonald M. (2004). The arch index: a measure of flat or fat feet? Foot & Ankle, 25(8):575-81

World Health Organization (2003).Global strategy on diet, physical activity and health.

Seidell JC. (1999). The world epidemic of pbesity. Progress in obesity research, 8; 661-8.

Wunderlich R.E., et al. (1999). Sexual dimorphism in foot shape, 4th Symposium on Footwear Biomechanics,92-3.