

Measurement and Research on Foot Size of Juveniles in Shanghai

Zhou Xiang and Hu Shouzhong

*Fashion College
Shanghai University of Engineering Science
No.333 Longteng Road, Shanghai, China*

ABSTRACT

China has been lack of accurate human body size datas of juveniles in a long term, which foot size is one of them. This article discusses the application of three-dimensional anthropometry technology. By measuring the foot length and sole circumference of 4000 juveniles between 4 to 17 years old in Shanghai, foot shape of Juveniles can be defined and classified, which can provide effective scientific basis for Juveniles' shoes design, plate-making, edition and publishing, while Juveniles' shoes, leather shoes, sports shoes, cloth shoes, etc., can only achieve the best suitable, comfortable, warm, beautiful effect with perfect matching with human foot shape. The classification, shape definition and ergonomics research of juveniles in Shanghai has a profound economic and practical significance to the footwear manufacturing enterprise and the society.

Keywords: Juvenile, Foot length, Sole circumference, Foot shape

INTRODUCTION

Anthropometry is very important groundwork for garment production and design. The traditional manual measurement method has a dominant position in the garment industry. With the development of technology, advanced three-dimensional anthropometry technology has been gradually used in apparel design and production. Therefore, analyzing the advantages and disadvantages of three-dimensional anthropometry technology and traditional manual measurement technology, researching and applying three-dimensional anthropometry technology for the development of the apparel industry has a very important practical significance.

Using non-contact three-dimensional anthropometry technology, precisely measured 3500 data of juveniles in Shanghai. Then, using pretreatment methods of statistical analysis software, studied the physical characteristics of the Shanghai juveniles' value changing with age relationship. After the measurement, obtained juveniles' foot shapes data. Research juveniles' foot shapes can be applied to related areas, such as children's shoes, to be more perfect in size, can be adapted to different types of juveniles' foot, and can provide more choices.

FOOT MEASUREMENT

Foot measurement can be divided into manual measurement and three-dimensional anthropometry technology which is based on laser scanning. In the three-dimensional coordinate system, the movable laser device emitted a laser line,

the laser beam was sent at a certain frequency from one or more laser sources. Meanwhile, multi-frame images of foot from different angles can be taken by using a plurality of cameras. And the three-dimensional coordinates of leg points can be extracted for measuring the size of the foot. Compared with manual measurement, three-dimensional anthropometry technology has many features, such as fast, efficient, accurate, reproducible and comprehensive scientific data collection and so on.

Currently, most scan the foot by using the German TecMath three-dimensional non-contact laser scanning system, and capture the data which is from foot-dimensional image key parts in AutoCAD. This approach improves the efficiency and accuracy, and make up for deficiencies of contact. The result is a system of three-dimensional image scanning, and a variety of output formats to facilitate data processing. The result of system scanning is a three-dimensional image, and a variety of output formats to facilitate data processing. Foot base data, foot-shaped cross section and foot projection, can improve the three-dimensional database construction and data sharing, providing data base for footwear research and theoretical support for enterprise production.

Measurement methods

Juveniles' (4 years old to 17 years old) foot type classification reference the standard of Chinese adults' foot size. Foot measurement method is a three-dimensional anthropometry technology. The human foot is scanned by the German TecMath dimensional non-contact laser scanning system.

First, juveniles are divided into men and women, then statistics the number of each foot length and sole circumference. Among them, the 5mm foot length and 4mm sole circumference can be as the interval, and draw several shapes.

Secondly, according to the statistical data of people belonging to a certain number of all types, this type of the coverage rate in the number of all those can be acquired. Then, compared with the setting of the number of adult foot type shapes, the number of juvenile's foot type can be set on the basis of the coverage rate greater than or equal to 5% (contrary not set the number type).

Thirdly, the average value of foot type shapes of each age can be calculated, then the growth trends and characteristics of boys and girls can be analyzed.

Finally, the average value of foot length and sole circumference of boys and girls can be calculated. Thus, as a design basis for children's shoes push version, the foot gear difference of juveniles can be achieved according to the average value of adult foot shapes and the variation. Then, the appropriate number can be selected as a reference code according to the different styles of types. The process of playing board and pushing version can be accomplished with the assistant of using Lectra CAD system. In the end, the typesetting can be achieved.

Foot shapes defined



Figure 1 foot model of juveniles

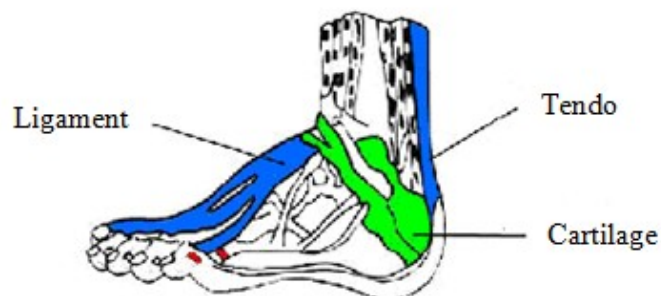


Figure 2 Foot Structure of juveniles

Figure 1 is foot model of juveniles and Figure 2 is foot structure of juveniles. The people with barefoot who is measured stand on stage when measuring. The corresponding three-dimensional body scanner images can be obtained, then import it into computers to gain foot floor plan. Select the widest point (from left to right as shown in Figure distance between two points CD) as the foot width; surrounded by a circle of CD is the sole circumference. The distance of AB is long enough in Figure1.

Table 1 The distribution of boys (1807 people) foot length and sole circumference

foot length	sole circumference (mm)																
	178	182	186	190	194	198	202	206	210	214	218	222	226	230	234	238	242
155	1																
160	5																
165	6	8	2														
170		9	5														
175		12	20	15													
180			13	18	21												
185				10	25	26	8										
190					28	34	25	22									
195					12	22	61	25	14								
200						8	44	109	11								
205							7	12	73	25	6						
210								14	50	74	10	3					
215								6	13	62	81	38	8				
220									19	30	68	50	21				
225										7	22	75	35	12			
230											8	38	63	17	8		
235												10	36	48	50	11	
240													13	51	5	6	
245																2	1

Table 2 The distribution of girls (1807 people) foot length and sole circumference

foot length	sole circumference (mm)															
	170	174	178	182	186	190	194	198	202	206	210	214	218	222	226	230
150	2															
155	2	3														
160		4	10	1												
165			12	33	8	1										
170				5	20	50	25									
175					13	28	41	8	2							

180	25	63	75	10	8														
185	2	14	45	73	19	12													
190			9	41	60	27	22												
195			5	20	42	78	23	17											
200					14	38	50	22											
205						5	18	72	68	21									
210							2	24	85	62									
215								4	38	48	23								
220								1	5	38	19								
225									4	19	28	3							
230										18	5	1							
235											4	2							
240																			1

Table 3 Boys foot coverage (%)

foot length	sole circumference (mm)																		
	178	182	186	190	194	198	202	206	210	214	218	222	226	230	234	238	242		
155	0.5																		
	5																		
160	2.7																		
	6																		
165	3.3																		
	2	4.26	1.83																
170		4.90	2.21																
175		6.64	11.0	8.30															
180			7.19	9.96	11.6														
185				5.53	13.8	14.3	4.4												
							2												
190					15.4	18.8	13.8												
							8	12.1											
195					6.64	12.1	33.7	13.8	7.74										
							7												
200						4.42	24.3	60.3	6.00										
							3												
205							3.8	6.64	40.3	13.8	3.32								

230	18.0	2.94	0.58
235		2.35	1.17
240			0.58

Table 5 Boys set foot shapes

number	type														
175	182	186	190												
180		186	190	194											
185			190	194	198										
190				194	198	202	206								
195				194	198	202	206	210							
200						202	206	210							
205							206	210	214						
210							206	210	214	218					
215								210	214	218	222				
220									214	218	222	226	230		
225										222	226	230	234		
230											226	230	234		
235											226	230	234	238	242
240												230	234	238	

PS: If the coverage is not less than 5 %, this position is set type.

If the coverage is less than 5 %, this position is not set type.

Table 6 Girls set foot shapes

number	type				
160	178				
165	178	182			
170			186	190	194
175			186	190	194

180	190	194	198	202						
185	190	194	198	202	206	210				
190			198	202	206	210	214			
195				202	206	210	214	218		
200					206	210	214	218		
205						210	214	218	222	
210							214	218	222	
215								218	222	226
220									222	226
225									222	226
230									222	

PS: If the coverage is not less than 5 ‰, this position is set type.

If the coverage is less than 5 ‰, this position is not set type.

According to foot length and sole circumference of juveniles, draw the shape definition of juveniles' foot. Number refers to the length of the foot, namely foot length. Type refers to the foot too fat, namely sole circumference. Both units are mm (hereinafter the same), which means that the size of the foot.

The foot shape and the Settings

We know that adult feet long and feet width are classified by 5mm after checking data and researching; Man has 10 shape, women's seven shape. Juveniles who are in the vigorous growth stage, have more foot shape. If feet long is classified by 3mm and foot width is classified 2mm, and take the foot 150mm long, the 170mm width as the first shape classification, the foot long in 150 ~ 153mm, the soles of your feet around 170 ~ 172 mm boys or girls as 150/170 shape, found that coverage is less than 5 ‰ due to the limited number of measurement. So, foot long and width classified by 4 mm feet and 5 mm step. Foot shape is set on the basis of the actual distribution parameters of a juvenile foot length, foot width.

The classification of foot shape. Take the boy and the girl's feet long, the sole of the foot number in order, and find and record the conform shape. Boys and girls feet long and feet width in paragraphs number distribution are shown in table 1 and table 2.

Boys and girls are obtained by table 1 and table 2 foot coverage, are shown in table 3 and table 4.

Coverage reflects the proportion of the various foot type in the measured population (boy, 1807; girl 1700). By boy foot coverage, for example, table shows: boys foot long match with the soles of your feet around 202mm accounts for the proportion to be measured is 33.7 ‰, show that sufficient length from 195mm to 200mm (not including 200mm) interval, and the soles of your feet around 202mm to 206mm (not including 206mm) of boy, in the measurement of the 1807 people accounted for 33.7 ‰.

According to the table, boys and girls of foot shape coverage, we know that the coverage rate is greater than or equal to 5 ‰ (on the contrary not set in shape) and set up the principle of shape, to develop a boy and a girl's foot shape, as shown in table 5 and table 6.

Obtained from table 5 and table 6, underage girls foot shape are more concentrated; And underage boys foot shape are relatively scattered, also more than girls.

CONCLUSIONS

Trend of foot growth

Excluding special data such as the over length and over width of foot, we get the foot data of 3612 juveniles. Calculate the averages of length and width of foot on every age, and make them as foot length growing charts for boys and girls (see figure 2, figure 3); sole width growing charts for boys and girls (see figure 4, figure 5)

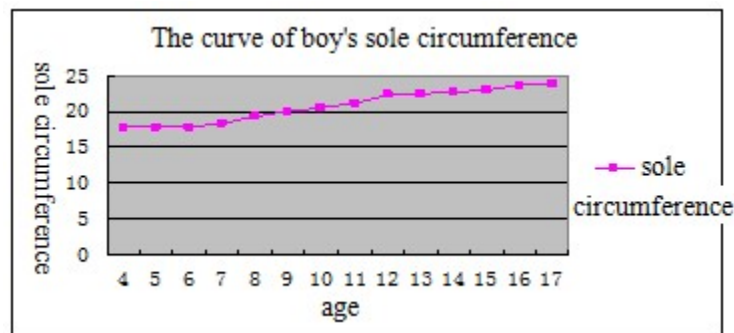


Figure 2 Boy's sole circumference growth trend diagram

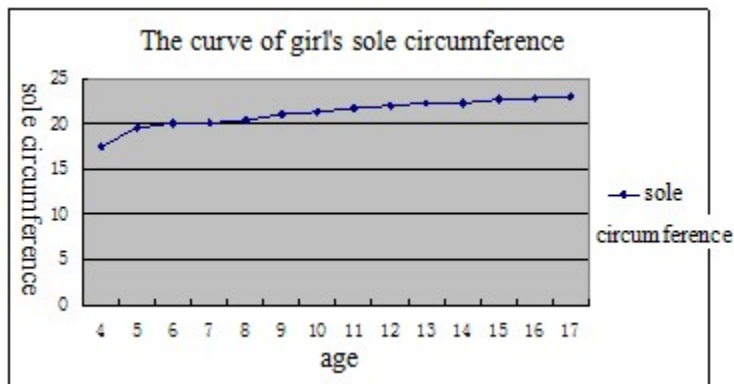


Figure 3 Girl's sole circumference growth trend diagram

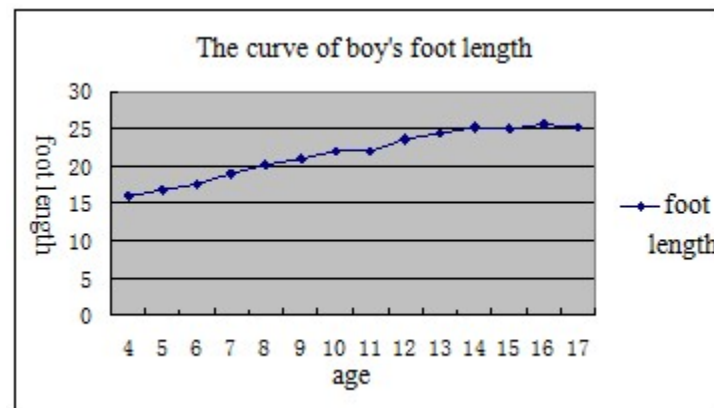


Figure 4 Boys' foot length growth trend diagram

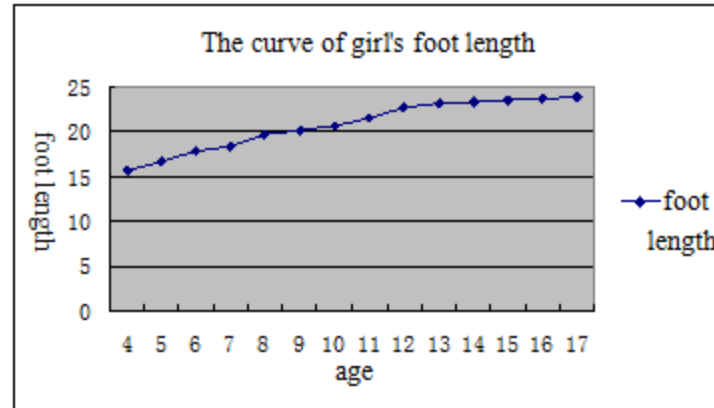


Figure 5 Girls' foot length growth trend diagram

From figure 2 and figure 3, the sole width of juveniles grows in proportion to age with a small increasing range. From figure 4 and figure 5, foot length is also proportional to age, but with a larger growing extent.

From figures, besides, it's suggested that foot of boy grows in steady state from 15 to 17, increasing range decreasing gradually even tending to remain unchanged, which indicates foot of boy grows continually to 15 years old with small increasing extent afterward. The growing curve of girl's foot remains unchanged after 13 years old, which shows foot of girl grows to about 13, with small increasing tendency.

The size of foot of juveniles.

Due to the different foot shapes among the same age, the sizes are different from one another. It is calculated that the averages of foot length and sole width of teenage boy are 217.1mm and 210.2mm, the corresponding size are 215/214 M; the averages of foot length and sole width of teenage girl are 207.6mm and 211.8mm, the corresponding size are 205/210W. The comprehensive conclusion is that foot sizes are classified at 215/214 M for teenage boys and 205/210W for teenage girls; the latter sizes approach to adult foot sizes.

REFERENCES

- Fang Fang, Zhang Weiyuan, Zhang Wenbin, Lang Jun (2005), "Study on Standards of the Human Body Measurement", Journal of Donghua University.
- Xian Liwen (1994), "Size of Chinese Adult Body' Standard and Application", China Standards Review.
- Zhou Xiang, Xie Hong, Chen Jing (2007), "Measurement and Analysis of the Juvenile's Bodily Form Based on Fussy Recognition", Electrical Automation.