

## The Size of the Chinese Terra-Cotta Warriors - 3<sup>rd</sup> Century B.C.

John Komlos  
Department of Economics  
University of Munich  
Ludwigstraße 33/IV  
D-80539 Munich, Germany  
Telephone: +49-89-2180-5824  
+ 49-89-8983-9700  
Voice Mail: +49-89-2180-3169  
Fax: +49-89-33-92-33  
email: [jk@econhist.de](mailto:jk@econhist.de)

**Abstract:** The size of the terra-cotta underground army made to “protect” the tomb of the first Chinese Emperor Qin more than 2,200 years ago bears considerable resemblance to modern infantry units in armies which enforced a minimum height requirement. The height requirement meant that the distribution of size deviated from a normal distribution, and this is precisely what one finds for the terra-cotta figures. Assuming that the underlying population from which the Chinese warriors were recruited was normally distributed, and that its standard deviation was about the same as modern values, the estimate of the physical stature of the Chinese population two thousand years ago can be estimated as between 162-171cm. The other body dimensions are quite similar to those of US soldiers who fought in the Civil War.

The extraordinary life-size terracotta warriors discovered in 1974 near the present day town of Xi'an in China's Shaanxi Province have been excavated and measured.<sup>1</sup> The famous statues were made in the 3<sup>rd</sup> century before our time – that is to say, they are more than two thousand years old. Numbering more than 7,000 - buried in three pits,- this amazing terra-cotta underground army, was created in order to symbolically “guard” the mausoleum of the first Chinese Emperor Qin Shi Huangdi. The soldiers are true-to-life, and are buried in battle formation fully armed.<sup>2</sup> We analyse the size of these figures on the basis of a sample of 734 measurements (out of 1087 figures excavated so far), in order to consider the extent to which this imaginary army reflects the actual physical size of the Chinese population of the time.<sup>3</sup> The mean size of the figures is 177.7 cm (range: 166.0 - 187.5 cm). There was very little difference between the size of the armoured and plain infantry (Table 1).

In considering the distribution of the size of the figures one should consider that a) the size of human populations is normally distributed; b) the standard deviation ( $\sigma$ ) of the height distribution of human populations is very close to 6.85 cm even in populations whose mean

height is substantially different; and c) most military prior to the universal conscription laws of the 19<sup>th</sup> century enforced a minimum height requirement (*mhr*). An examination of the size distribution can give one a good sense of the *mhr*. The measurement of the figures by the archaeologists were made in metric units, which are converted to chi, the linear measure used at the time of the Qin Dynasty (1 chi = 23.0 cm). The distributions should be examined in the original measurement units because that is the appropriate method for identify the *mhr* for entering the military.<sup>4</sup> The size ought to be considered as an approximation of reality because the figures were assembled from individual components, and therefore, the craftsmen could not possibly reproduce the true height of the soldiers exactly. In addition, the clay shrank as much as 10 percent in the kiln so that the final outcome could not be determined exactly.<sup>5</sup> Hence, it should suffice to consider the size distribution of soldiers in increments (bins) of 0.1 chi (Figure 1). The values indicated are at the centre of the intervals. The size distribution resembles almost precisely the distributions obtained in most military institutions of the 18<sup>th</sup> century.<sup>6</sup> It indicates that the *mhr* was probably at 7.65 chi (175.95 cm), because this is the point at which the sample distribution obviously begins to deviate markedly from a normal distribution. The *mhr* was not enforced stringently, inasmuch as 17.9 percent of the observations are below the *mhr*.

In order to estimate the height of the Chinese population from which the soldiers were drawn, one should calculate the mean of the truncated sample (after the data below the *mhr* have been discarded), and subsequently, convert these values into population mean estimates by using the above mentioned two attributes of human height distributions, namely that they are normal with a  $\sigma = 6.858$  cm.<sup>7</sup> Hence, we discard data less than 175.95 cm, because these are not representative of the height of the population from which the soldiers were drawn. The mean size of the figures above the *mhr* is the truncated mean of 178.5 cm (Table 1). This truncated mean translates into a population mean height of 162.3 cm (Table 2). In other words, if one draws a sample from a population with mean of 162.3 cm and  $\sigma = 6.858$  cm, but limits the sample to those who are taller than 175.95 cm, then the sample obtained will have a mean of 178.5 cm.

Admittedly, this estimate is quite sensitive to the assumed values of the  $mhr$  and  $\sigma$ . With different plausible values, the estimated height of the Chinese population can range all the way up to 171.2 cm (Table 2). Thus, the exact population mean height cannot be ascertained with certainty, but we can, nonetheless, infer that the size of the terra-cotta figures could well represent the true physical stature of the Chinese infantry, and these, in turn, could well have been drawn from the population at large. The physical stature of the Chinese population implied by the terra-cotta figures is certainly within the plausible range, even if one were to subtract 1-2 cm as an allowance for the head-dress and cap of the terra-cotta figures.<sup>8</sup> The other available body dimensions of the terra cotta figures can be compared to those of American soldiers of the Union Army in the 1860s (Table 3).<sup>9</sup> Foot length, shoulder width, arm length, as well as the height/arm-length ratio are all remarkably similar, while waistline differs somewhat on account of the different mode of measurement. The head length does differ considerably, but that is caused by the different ethnicity of the Chinese army. All in all, the resemblance of the body dimension to modern populations is quite remarkable.

Figure 1. The Size Distribution of the Terra-Cotta Figures

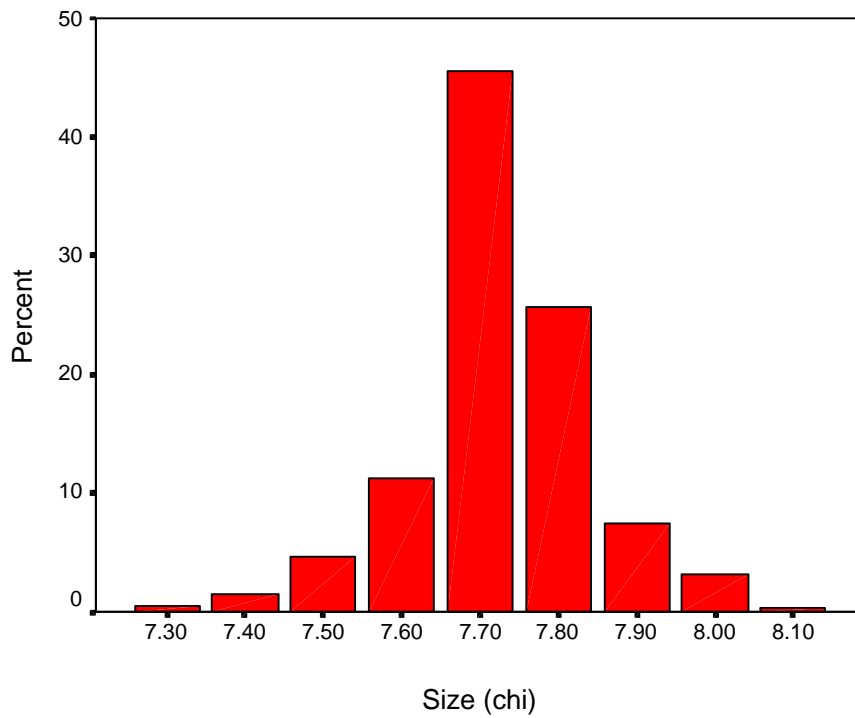


Table 1. Descriptive Statistics (cm) of the Size of the Terra Cotta Figures

Type of Figure	N	Size of Figures	Standard Deviation	Minimum	Maximum	N after Truncation	Truncated Mean
Plain infantry	305	177.6	2.8	168.5	187.5	236	178.7
Armored infantry	427	177.7	2.6	166.0	186.0	365	178.4
All	733	177.7	2.7	166.0	187.5	601	178.5

Table 2. Estimated Mean Height (cm) of the Chinese Population of the Qin Empire

	standard deviation	
mhr	<b>6.858</b>	<b>6.8</b>
<b>175.95</b>	162.3	171.1
<b>175.00</b>	166.3	171.2

Table 3. Body Dimensions of Terra Cotta Figures compared to US Soldiers, 1860

		Head Length		Source	Comments
Terra-Cotta	733	24.5	2.7		
US 1860s	10,876	34.3	n.a.	Gould p. 370.	
		Waistline			
Terra-Cotta	733	94.6	7.8		with clothing
US 1860s	10,876	80.0	n.a.	Gould. p. 267	without clothing
		Arm Length			
Terra-Cotta	733	74.5	13.8		arm + hand length
US 1860s	7,889	74.2	n.a.	Gould. p. 267	
		Shoulder Width			
Terra-Cotta	733	43.5	3.1		with clothing
US 1860s	4,085	41.6	n.a.	Gould. p. 285.	without clothing
		Height/Arm Length Ratio			
Terra-Cotta	733	2.5	0.4		
US 1860s	4,855	2.3	n.a.	Gould. p. 271	
		Foot Length			
Terra-Cotta	733	27.7	1.6		with shoes
US 1860s	6,400	25.6	n.a.	Gould. p. 273	without shoes

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## Endnotes

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<sup>1</sup> Zhang Wenli, The Qin Terracotta Army. Treasures of Lintong, London: Scala Books, 1996.

<sup>2</sup> Even if the statues are probably not actual portraits. Ladislav Kesner, “Likeness of No One: (Re)presenting the First Emperor’s Army,” Art Bulletin, 77, 1 (1995): 115-32.

<sup>3</sup> Shaanxi sheng kaogu yanjiusuo and shihuangling Qinyongkengkaogu fajuedui, (eds.), Qin Shihuangling bingmayong keng: Yi hao keng fajue baogao, 1974-1984, Beijing: Wenwu Press, 1988, Vol. 1, pp. 349-75.

<sup>4</sup> John Komlos, “How To (and How Not to) Analyze Deficient Height Samples,” Unpublished Manuscript, University of Munich, 2002; available at: [http://www.vwl.uni-muenchen.de/ls\\_komlos/howto.pdf](http://www.vwl.uni-muenchen.de/ls_komlos/howto.pdf)

<sup>5</sup> Lothar Ledderose, Ten Thousand Things, Module and Mass Production in Chinese Art, (Princeton: Princeton University Press, 2000), pp. 51-74.

<sup>6</sup> John Komlos, Nutrition and Economic Development in the Eighteenth-Century Habsburg Monarchy: An Anthropometric History (Princeton: Princeton University Press: 1989).

<sup>7</sup> We do not use maximum likelihood (ML) method, because the *mhr* was probably well above the mean, and in such cases ML procedure does not provide the most reliable results. Komlos, “How To (and How Not to).”

<sup>8</sup> The height of 19<sup>th</sup> century Chinese men ranged between 162 and 167 cm. John Murray, “Stature and Body-Mass Index among Mid-Nineteenth Century South Chinese Immigrants,” Annals of Human Biology, 1994, 21, 6, 617-620.

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<sup>9</sup> Gould, Benjamin, Investigations in the Military and Anthropological Statistics of American Soldiers (Cambridge: Riverside, Press. 1869, reprinted Arno Press, NY 1979).