THE RESEARCH INTO RELATIVE HEIGHT OF TOTAL BODY CENTER OF GRAVITY OF MALES AND FEMALES AGED 17 - 20 YEARS

Liying Jin [1], Xin Jin [2], Li Jin [3], Ailian Qu [1], Qing Han [1] and Aihua Liu [1]
[1]Shan Dong Institution of Physical Education, Jinan, China
[2]Shan Xi Technology College, Taiyuan, China
[3] Jin Xi Machinery Industries Group Limited Corporation NO. School, Taiyuan, China

By measuring the body center of gravity of 939 males and females aged 17–20 years in urban and rural areas when they stand at attention and hold up arms lathered, we found out the height and positions of the total center of gravity of them who were in different heights. It has great practical values to research the effect of body forms to the sports ability and also has great values to the selection of the sportsmen and technical analysis.

KEY WORDS: body center of gravity, males in cities and countries, females in cities and countries, the relative height of center of gravity of body height, the absolute heights of the center of gravity.

INTRODUCTION: At present, the research results of human body center of gravity are: Japan's method of compound, Soviet Union's scanning of radioactive apposition elements, America's datum got for the needs of space navigation technology and Germany's compound method of distance. China also did this kind of research, but there hasn't yet reports on the research of the relationship between the height of center of gravity of males and females in cities and countries when they stand at attention and hold up arms lathered and the index of legs length, the height of center of gravity of different body height. So this paper measured and analyzed the height of center of gravity of males and females aged 17–20 in cities and countries when stand at attention and hold up their arms lathered, their body heights, their heights when they sit and also their weights. It has great values to research the effect of figure to the sports ability and also has great values to the selection of the sportsmen and technical analysis.

METHODS: Testers are 939 students aged 17 - 20 among whom 465 are girls. We use the instrument "edge- groove one dimension measuring board of human body's gravity" invented by Beijing Normal University to measure two gestures of everybody – the gesture of standing at attention and the gesture of holding up arms lathered (lying on the back on the testing board). We use the device which is used to measure body height and sitting height invented by the State Sports Committee to measure the body height and sitting height. We carry out the testing according to the rules of national student' physic health. After dealing with all the datum, we get the results as follows: The absolute height and the relative height of the center of gravity of two gestures--standing at attention and holding up arms lathered.
The absolute height of human body center of gravity = $(M - M_0) \times AB / W$
The relative height of human body center of gravity = the absolute height of human body 's center of gravity / body height×100%
W: weight
M_0: weight of the board
M: the weight of people lying on the back on the board
AB: the distance between two fulcra
The index of leg's height: The index of leg's height = body height – sitting height/body height×100%
Relevant coefficient:
$y = L_x \sqrt{Lxx \times Lyy}$

RESULTS AND DISCUSSION: The index of leg's height is an important figure index of the length of human's leg's through the proportion in human's height. The bigger the index is, the

longer the legs are. Vice versa. The average index of males aged. 17–20 years is 45.9, which of female is 45.5. Compared between cities and countries, the index of boy students in cities are bigger than that in countries, the difference is 0.24 for males and 0.31 for females. Through the statistical examination, there is an obvious difference in the index of leg's height of males and females in cities and countries, and the index has the direct ratio with the involved index of relative height of the center of gravity when standing at attention and they go together with each other.

Table 1 The statistical table on the surveying figure of the center of gravity and the index of legs' length of males and females aged 17–20 years.

quota / Sex	the relative height of center of gravity when standing at attention(%)	t	the relative height of center of gravity when holding up arms lathered (%)	t	the index of legs length	t	N
Males in cities	$\bar{\chi}$ 36.32		59.39		46.02		250
	S 0.95		1.04		1.15		
Males in countries	$\bar{\chi}$ 56.09	2.63^{++}	58.72	7.00^{++}	45.78	2.24^{+}	224
	S 0.94		1.01		1.14		
Females in cities	$\bar{\chi}$ 55.28		54.48		45.68		248
	S 1.08		1.00		1.19		
Females in countries	$\bar{\chi}$ 54.96	2.47^{+}	57.89	4.80^{++}	45.37	2.17^{++}	217
	S 1.06		1.03		1.17		

++ $p < 0.05$, + $p < 0.05$.

The average of the relative height of the center of gravity when standing at attention and holding up arms lathered of people in cities are bigger than that of people in countries. The relative height of human's center of gravity is the percent of human's center of gravity to body height. The bigger it is, the higher the human's center of gravity is. Vice versa. The conclusion of the experiment proves that the relative height of center of gravity of males and females in cities are bigger than that of males and females in countries, the posture of standing at attention of females in cities are bigger than that of females in countries by 0.32%, holding up arms lathered by 0.59%. For males, those in cities are bigger than those in countries by 0.23%, 0.67%. Compared the datum above, the males and females in countries are shorter, the upper parts of body are relatively longer, the figure is thick and stalwart. Those in cities are higher, the upper parts of body are relatively shorter, and are longer and thinner than those in countries.

Females' average relative height when standing at attention and holding up arms lathered are smaller than that of males'. The females' average relative height when standing at attention is 55.12%, males' is 56.21% and the residual quantity is 1.09%. There is a difference of 0.87% in the average when holding up arms lathered. In cities, the differences of the average relative height when standing at attention and holding up arms are 1.04%, and 0.91% between males and females. In countries, the differences are 1.13% and 0.83%. It gives us a conclusion that whether people in cities or not the females' relative height of center of gravity is lower than males'. The cause is that the average index of males' aged 17–20 is 16.3, while the females' is 17.3. The fact reflects the figure characters that the females' pelvis are wider than males', in addition that the females' arms measure and legs measurement grow faster to make the relative weight of their lower limbs bigger. All these characters result in the figure with long and thin upper limbs and thick and short lower limbs. So in these ages the females' center of gravity is lower than males'.

Table 2 The relative height of general center of gravity of males and females aged 17–20 years.

Body height (cm)	Males Hb(%) $\bar{\chi}$	S	Number of people	Females Hb $\bar{\chi}$	S	Number of people	Remarkable examination	character
140-150				56.09	1.627	28		
150-155				56.960	1.648	95		
155-160	57.080	1.485	20	56.945	1.582	138	0.337	p<0.05
160-165	57.260	1.452	75	57.000	1.479	12	1.216	p<0.05
165-170	57.145	1.501	178	56.948	1.569	33	0.697	p<0.05
170-175	57.124	1.340	192	57.081	1.267	11	0.109	p<0.05
175-180	57.424	1.250	94					
180-190	57.428	1.049	63					

Hb: The relative height of body's general center of gravity, the percent in body height.

For the youngsters of the same height, the females' relative height of their center of gravity is lower than males. We can see from table 2 that the females' relative height of their center of gravity is lower than males' regardless of their body height and their Hb doesn't change with their body height. We can also see this from the datum given below: for males who are 155–190 cm high, their Hb changes among 0.342%; for females who are 140–175 cm high, their Hb changes among 0.173%. The height of human's center of gravity that depended on the distribution of body quality is one of the targets of sports and figure characters. So in order to choose athletes in a more exactly way, we should pay attention to the difference of the relative height of center of gravity between cities and countries to see if they conform to the demand of the sports project. On the other hand, we had better take account of the effect of divergence to it according to the height of body's center of gravity when we analyze the action skills.

CONCLUSION: Through the practical measurement of 736 males and females aged 17–20 years, we draw the following conclusion: Compared with the people in countries, the relative height of center of gravity when standing at attention and holding up arms lathered of those in cities is higher. Females' relative height of center of gravity when standing at attention and holding up arms lathered is lower than males'. The index of legs length is related to the height of center of gravity and they are in direct proportion. The average of Hb is: males 57.245%, females 56.838%. The average of Hb of people aged betwee17–20 doesn't change along with body height. They always keep in line with each other

Suggestion: Take the relative height of center of gravity when standing at attention, as one of the targets of body measurement. And make available a theoretical basis in athletes choosing.

REFERENCES:

Biomechanics in sports. The committee of national athletics college approved. People's athletics publishing house, Beijing, 1990, 222-227.