[Environmental Health and Preventive Medicine 10, 190–200, July 2005]

Original Article

Associations of Physique with the Socioeconomic Factors of Family and Regional Origin in Chinese University Students

Xiao Jian YIN[1], Chao Qun HUANG[2], Hong Miao CHEN[1] and Toyoho TANAKA[1]

[1]*School of Health and Sports Sciences, Chukyo University, Aichi, Japan*
[2]*School of Health and Sports Sciences, East China Normal University, Shanghai, China*

Abstract

Objectives: The purpose of this study is to define and clarify the causes of differences in physique between urban students and rural students in China.

Methods: Subjects are 2,524 students (male, 838; female, 1686) who entered K University in Shanghai in September, 2001. The data used in this study is based upon K university's Yearly Health Check Record and Students' Family Condition Record. Correlation analysis, analysis of variance (ANOVA) and analysis of covariance (ANCOVA) were applied to analyze the relationships between physique and gross family income, family income per capita, latitude, air temperature, precipitation or altitude.

Results: Urban students' height and weight are significantly greater than rural students' in both males and females. Both male students and female students are significantly taller and heavier in accordance with per capita increases in students' family income. The height and weight of male and female students whose parents are peasant farmers are least. With regard to the relationship between physique and urban-rural factors, the F value decreases clearly when family income per capita is taken as a covariate, while the F values slightly decrease also when factors of latitude etc. are taken as covariates. The main cause of differing family income is occupational difference between urban areas and rural ones.

Conclusion: Students born in urban areas are taller and heavier than those born in rural areas. The main cause of these differences is family income per capita. The main cause of variations in family income is the income difference in occupations.

Key words: physique of university students, family income per capita, parents'occupation, natural environment, regional origin

1. Introduction

Since the execution of the reform and open policy in 1979, China's economy has developed quickly. However, the development is not at all balanced. There is a significant difference between urban areas and rural areas in particular. For example, the ratio of annual family income between the city and the country was 2.65:1 in 1999. This kind of difference is larger in China's western regions. The Tibet Autonomous Region has the greatest difference (5.38:1) followed by Yunnan Province (4.30:1) (1). Because of the imbalance of economic development at different areas and the difference in natural conditions, the lifestyles of different areas in China naturally vary. All these socioeconomic and natural environment factors must influence Chinese university students' physique.

Formerly, the research into physique in China was mainly concerned with variations between different provinces, urban and rural areas, different occupations and such different natural conditions as latitude separately (2–17). The survey of adults (18–60 yrs, male and female 101, 250) in 19 of China's provinces and cities by Jiang C. et al. shows that the people of Liaoning, Tianjing, Shandong, Beijing and Jilin were taller than those of Chongqing, Yunnan and Guangdong. Moreover, the civil servants and company workers' stature was larger and the peasant farmers' were the shortest (2). The survey of 42,101 people (male, 21,051; female, 21,050) aged 3–69 yrs in Jiangsu province by Jiang W. et al. showed that urban citizens' physique

Received Feb. 14, 2005/Accepted May 16, 2005
Reprint requests to: Xiao Jian YIN
School of Health and Sports Sciences, Chukyo University, 101 Tokodachi, Kaizu-cho, Toyota, Aichi 470-0393, Japan
TEL: +81(565)46-1211, FAX: +81(565)46-1297
E-mail: xyinch@cnc.chukyo-u.ac.jp

was greater than rural citizens' physique across different genders and ages (3). Ohsawa S. et al. reported that there was a positive correlation between physique and latitude and a negative correlation between physique and temperature, precipitation or altitude (13). Schmitt L. H. et al. expounded the negative correlation between physique and altitude (18).

With regard to researches on the relationship between physique and socioeconomic factors, Schmitt L. H. et al. discussed the difference between the well-off in Europe, North America and the poorly off in the Third World. Although they indicated that rich people's physique was larger than poor people's, differences in the racial and economic indices were not mentioned in their report (18). Takahashi E. discussed the difference between physique and socioeconomic levels of families in the central district of Sendai, Japan, in 1960, which were divided into 3 class upper (A), middle (B) and lower class (C). The results were that the physique of group A was the greatest of the three groups. The indicators of socioeconomic class were judged by their teachers (19). Ashizawa K. et al. reported that children of well-off families were taller and heavier than those of poorly-off families in both rural and urban regions, and growth of the rural well-off group coincided with that of the urban poorly-off group in the Philippines, but this study did not inform specific socioeconomic data on the children family (20). A study by Bogin B. A. et al. showed that low socioeconomic class children were always significantly shorter and lighter than high socioeconomic class children in Guatemala. The principle indicators of socioeconomic class were parental education, parental occupation and zone of residence within the city (21). The research by Zhang L. indicated that in the 20 years after implementation of the open and reform policies, Chinese university students' physique is gradually increasing, as the annual income per capita increases. Since this research is on the level of ecological study, the relationship between university students' personal socioeconomic factors and physique was not mentioned (14).

To sum up, analyzing the cause of difference in physique between urban people and rural people on the basis of personal socioeconomic factors has not yet reported, at least in Chinese publications. This research defines and clarifies the cause of difference in physique between urban students and rural ones in China by analyzing students' physique at the beginning of university enrollment and its relation to their regional origin and respective family socioeconomic factors. The hypothesis of this study is that the difference in physique between urban students and rural students in China associates with the differences of their families' socioeconomic conditions such as income.

2. Methods

2.1 Subjects and their characters

The total number of students entering K university in Shanghai, China in September, 2001 was 2990. Eliminating students under the age of 17, those majoring in physical education and those from ethnic minority groups, the remaining 2,524 (male, 838; female, 1686) were selected as subjects for this study.

K university is one of the key state universities in China. Only hard-working students can enter this university, thus they may be supported by families in, to some degree, better financial circumstances. The annual tuition is about 5,000 RMB (Ren Min Bi) for these students. The annual income per capita of subjects in this study is 7,217 RMB for urban students and 2,752 RMB for rural students. In the year 2001, however, the average income per capita over the whole of China was 6,860 RMB in urban areas and 2,366 RMB in rural areas. So it is inferred that most of the subjects in this study belonged to a family enjoying a better than average level of income.

2.2 Data

The data used in this study come from K university's Yearly Health Check Record and Students' Family Condition Record. The data on stature and weight (measured in September, 2001) in the Yearly Health Check Records were used and the data on students' regional origin (province, city, county, road, room No. or Village, squad No.), birth date (date, month and year), family income (numeral, in RMB), family members (counted by the structures of family) and parents' occupation (the occupation such as peasant farmer, teacher and so on were registered) in Students' Family Condition Records which were registered by university students themselves in November, 2001 were used. The family income is the average monthly income reported by each subject. Permission to make use of these data was granted by the Health Care and Development Section and the Student Administration Section in accordance with the document signed by the Dean of the School of Sports and Health Care at K university, which required them to show the data to the authors. Before using these data, the heads of the sections of university explained to all the subjects that in order to improve the students' health administration further, their data would be used for statistical purposes only. When the authors entered those data into the computer for this study, the students' names were coded to make the data anonymous; the original data is managed by K university. The data on latitude (Note 1), annual average temperatures (about two-third of them were the 50 years' average from 1951 to 2001 according to the data from 180 national meteorological observational locations, the others reference the books listed in Note 2 in which there were no information on the calculation of annual average temperatures), annual average precipitation (Note 2) and altitude (Note 3) are based on statistics held at the seats of local or prefectural government of those places where students lived before entering university.

2.3 Methods of measurement

All the testers were serving professionals (doctors, nurses) working at K university. The test equipment was a ZT-120 Weight-Height Meter (digital meter which can record to 0.1 kg) produced by Wuxi Weighing Apparatus Company. Calibration was performed before the health examination. Male students were measured wearing underpants only, female students wore a t-shirt and a pair of light trousers, and no person wore shoes. Weighing was done on platform scales, and the results were recorded to the nearest 0.1 kg. Heights were measured against metal column bars, and recorded to nearest 0.1 cm. Measurements were performed without any distinction between urban

students and rural ones.

2.4 Analysis

The relationship between students' physique and their regional origins, gross family income, family income per capita, parents' occupation and family members was analyzed. The index of physique include stature, weight and the Body Mass Index (BMI=weight (kg)/height $(m)^2$) on entry to university. Students were identified by factors of urban-rural, coastal, latitude, temperature, precipitation and altitude. The subjects usually lived with their parents before entering university. Even though some students who lived in rural areas lodged at their high school, they were usually in the same locality where their parents lived.

The urban-rural factors were divided by address (e.g: Room XX, XX Road, Fuzhou City, Fujian Province is considered an urban address; XX squad, XX village, Yuancheng County, Shanxi Province is considered a rural address). There are marked differences between urban and rural areas in such matters as obtaining employment, economics and local culture, so it was taken as a general factor to analyze.

In the matter of the coastal factor, students were divided into 3 groups: the first group as coastlands (adjacent to the sea); the second group as the middle areas (provinces adjacent to a province with a seacoast) and the third group as inland areas (provinces with at least two provinces between them and sea). This coastal factor was included mainly for the following two reasons: firstly, there are diseases such as endemic goiter due to iodine deficit inland (22). Intake of iodine is closely related to the intake of seafood. However, it is difficult to obtain such information, so the coastal factor was introduced rather than that index. Secondly, there are economic differences between coastlands and inlands (23). This distinction is better to explain issues when the urban-rural factor cannot be expressed.

The coding of parents' occupation is worker in office or factory (WOF), civil servant, teacher, peasant farmer and others (because some kinds of occupation had very small sample size, they were pooled together as one group). The averages of gross family income per month with occupations are: WOF (n=1234, 1911 RMB), civil servant (n=339, 2213 RMB), teacher (n=141, 2198 RMB), peasant farmer (n=6, 1217 RMB), others (n=347, 1214 RMB) in urban areas; WOF (n=93, 1216 RMB), civil servant (n=8, 1238 RMB), teacher (n=15, 842 RMB), peasant farmer (n=282, 631 RMB), others (n=59, 1019 RMB) in rural areas.

2.5 Statistical methods

Statistical analysis was executed by converting gross family income and family income per capita into the value of root, converting latitude into the value of logarithm and converting temperature into the value of square considering the data's normal distribution.

1) Comparison of means for single factors

The comparison of means is applied to the comparison of physique between categories within such factors as urban-rural, coastal, family members, gross family income, family income per capita or parents' occupation. T-test was used to draw comparison between two groups, while F-test was used to compare among three groups.

2) Analysis by correlation coefficient

Correlation analysis was applied to analyze the relationships between physique and gross family income, family income per capita, latitude, air temperature, precipitation or altitude.

3) Analysis of variance

Because there is a high correlation between height and weight, firstly, multivariate analysis of variance (MANOVA) was carried out by taking height and weight as dependent variables. Then, analysis of variance (ANOVA) was done by taking height, weight or BMI as dependent variables, and analysis of covariance (ANCOVA) was also carried out by taking latitude, temperature, precipitation, altitude and family income per capita as covariates.

Eleven analysis models are listed as follow:

Model 1: factors=urban-rural, coastal
Model 2: factors=urban-rural, coastal; covariate=family income per capita
Model 3: factors=urban-rural, coastal; covariate=latitude
Model 4: factors=urban-rural, coastal; covariate=temperature
Model 5: factors=urban-rural, coastal; covariate=precipitation
Model 6: factors=urban-rural, coastal; covariate=altitude
Model 7: factors=urban-rural, coastal; covariates=family income per capita, latitude, temperature, precipitation, altitude
Model 8: group including urban students only
Model 9: group including rural students only
Model 10: group excepting peasant farmers
Model 11: group including peasant farmers only

Model 1 is used to observe the effect of urban-rural factors adjusted by the coastal factors, and Models 2–6 are used to test how the covariates such as family income per capita, latitude, etc. process the effects of urban-rural, separately, while Model 7 is used to analyze how all of the covariates process the effects of urban-rural. Because peasant farmers mostly lived in rural areas, the factors of occupation were not added in Models 1–7. Alternatively, Models 8–11 are used to analyze how the factors of occupation influence the physique.

The value of gross family income divided by total family members is that of family income per capita; thus, the total number of family members was not analyzed as a separate factor.

In all analyses, the level of statistical significance was set at 0.05. The statistical analyses were carried out by using the SPSSv11.0.

3. Results

3.1 Results of single factor analyses

3.1.1 Relationship between Physique and Socioeconomic Factors

Table 1 shows a significant difference between urban and rural students' height and weight in that both height and weight are markedly greater in students from an urban background. There was also a significant difference in the matter of BMI

Table 1 Number of subjects, family condition, natural environment and physique

Sex	Area		N	Family members	Gross income (RMB)/month	Income Per Capita (RMB)/month	Latitude (°)	Temperature /year (°C)	Precipitation /year (mm)	Altitude (m)	Height (cm)	Weight (kg)	BMI Kg/m^2
M		Coastal	472	3.1±0.5	2067±1093	674±362	31.2±2.3	15.7±1.7	1125±163	21±103	173.7±5.9	68.2±11.3	22.6±3.6
	Urban	Middle	95	3.2±0.5	1212±582	385±180	33.8±6.2	12.5±5.3	1009±414	283±453	172.3±5.9	66.7±13.9	22.5±4.4
		Inland	87	3.1±0.3	1221±595	396±201	32.8±4.7	14.2±4.4	891±389	512±439	171.2±5.3	62.9±11.3	21.4±3.3
		Coastal	90	3.5±0.7	1001±849	295±235	30.2±4.7	16.4±3.0	1174±340	47±70	169.9±6.6	60.3±11.4	20.8±3.0
	Rural	Middle	54	4.0±0.9	521±363	129±77	30.5±4.9	15.1±4.0	1300±411	192±324	166.6±5.8	56.4±7.7	20.3±2.1
		Inland	40	3.7±0.7	428±309	119±88	31.9±4.2	15.4±3.5	956±318	396±427	168.1±5.6	56.6±6.5	20.0±2.0
	Urban-Rural	Urban	654	3.1±0.4	1830±1051	595±347	31.8±3.6	15.0±3.1	1077±266	124±306	173.2±5.9	67.3±11.9	22.4±3.7
		Rural	184	3.7±0.8	736±691	208±194	30.7±4.7	15.8±3.5	1163±376	166±301	168.5±6.3	58.4±9.6	20.5±2.6
				***	***	***	**	**	**		***	***	***
		Coastal	562	3.2±0.5	1897±1127	371±16	31.0±2.8	15.8±2.0	1133±202	25±98	173.1±6.2	66.9±11.7	22.3±3.5
	Coastal	Middle	149	3.5±0.8	962±612	195±16	32.6±6.0	13.5±5.0	1114±435	250±412	170.2±6.5	63.0±13.0	21.7±3.9
		Inland	127	3.3±0.6	971±639	309±216	32.5±4.6	14.6±4.2	911±368	476±437	170.3±5.6	60.9±10.4	21.0±3.0
				***	***	***	***	***	***	***	***	***	***
F		Coastal	1098	3.1±0.5	1997±1151	647±370	31.2±2.6	15.7±1.8	1135±184	16±42	161.3±5.3	53.1±8.0	20.4±2.8
	Urban	Middle	180	3.3±0.7	1511±882	470±273	32.0±5.7	14.2±4.0	1074±382	342±570	160.3±4.9	51.7±7.3	20.1±2.7
		Inland	135	3.2±0.5	1368±771	435±239	35.1±6.1	12.5±5.2	752±404	507±376	160.4±4.7	52.4±6.9	20.4±2.7
		Shore	183	3.7±0.8	1018±621	288±191	31.1±4.2	15.7±2.7	1127±312	28±49	159.1±5.5	50.8±6.9	20.1±2.3
	Rural	Middle	49	4.2±1.0	633±535	166±175	30.8±5.3	14.9±3.9	1160±436	282±478	157.7±4.6	51.5±7.2	20.7±2.7
		Inland	41	4.1±1.2	516±313	137±102	33.3±5.9	14.0±4.8	960±391	345±351	157.0±5.7	50.9±5.4	20.6±1.8
	Urban-Rural	Urban	1413	3.1±0.5	1875±1112	604±357	31.6±3.8	15.2±2.8	1090±270	105±291	161.0±5.2	52.9±7.8	20.4±2.8
		Rural	273	3.9±0.9	873±605	244±188	31.4±4.7	15.3±3.4	1108±354	121±280	158.6±5.4	51.0±6.7	20.3±2.3
				***	***	***					***	***	
		Coastal	1281	3.2±0.6	1597±1141	596±372	31.2±2.9	15.7±2.0	1133±207	18±43	161.0±5.4	52.8±7.9	20.4±2.7
	Coastal	Middle	229	3.5±0.8	1323±895	405±284	31.7±5.6	14.3±4.0	1092±395	329±551	159.7±4.9	51.7±7.3	20.3±2.7
		Inland	176	3.4±0.8	1169±780	365±249	34.7±6.1	12.9±5.1	800±410	469±376	159.0±5.2	52.1±6.6	20.5±2.5
				***	***	***	***	***	***	***	***		

Note: 1) 1 RMB exchanges about for 14 JPY.
2) * p<0.05, ** p<0.01, *** p<0.001

Table 2 Correlation coefficients of physique with family income per capita, gross family income latitude, temperature, precipitation or altitude

	Height	Weight	BMI
Male			
Family Income Per Capita	0.357***	0.329***	0.220***
Gross Family Income	0.338***	0.304***	0.199***
Latitude	0.212***	0.234***	0.172***
Temperature	–0.188***	–0.213***	–0.159***
Precipitation	–0.197***	–0.205***	–0.145***
Altitude	–0.039	–0.083*	–0.081*
Female			
Family Income Per Capita	0.195***	0.079***	–0.013
Gross Family Income	0.183***	0.068**	–0.019
Latitude	0.188***	0.152***	0.077***
Temperature	–0.189***	–0.144***	–0.068**
Precipitation	–0.162***	–0.169***	–0.109***
Altitude	–0.032	–0.014	0.004

Note: * p<0.05, ** p<0.01, *** p<0.001

between urban and rural male students; however, there was no significant difference between their female counterparts. In addition, the difference between male students is more obvious than between female ones. There was a significant difference between family members, gross income or income per capita in urban areas and that in rural areas for both male students and female students, and there was also a significant difference between latitude, temperature or precipitation in urban areas and that in rural areas for male students, while there was no significant difference in female students.

Table 1 shows that both male and female students living in coastal areas are taller and heavier, but there is no significant difference in females' weight. The BMI of male students living in coastal areas is a little more than that of those living inland; however, there was no significant difference between female students. It also shows that there is a significant difference among the areas of coastal, middle and inland in the matter of the family members, the gross income, income per capita, latitude, temperature, precipitation and altitude for both male students and female students.

Table 2 indicates that there are significantly weak positive correlations between height, weight or BMI and family income per capita or gross family income for male students, while there are significantly weak positive correlations between height or weight and family income per capita or gross family income for female students.

Fig. 1 shows that both male and female students whose fathers are WOF are tallest while those whose fathers are peasant farmers are shortest. Both male and female students whose parents are peasant farmers are lightest. The BMI of male students whose fathers are peasant farmers is smallest, but there is no significant difference between female students. With regard to mothers' occupations, the results yield almost the same ones as fathers'.

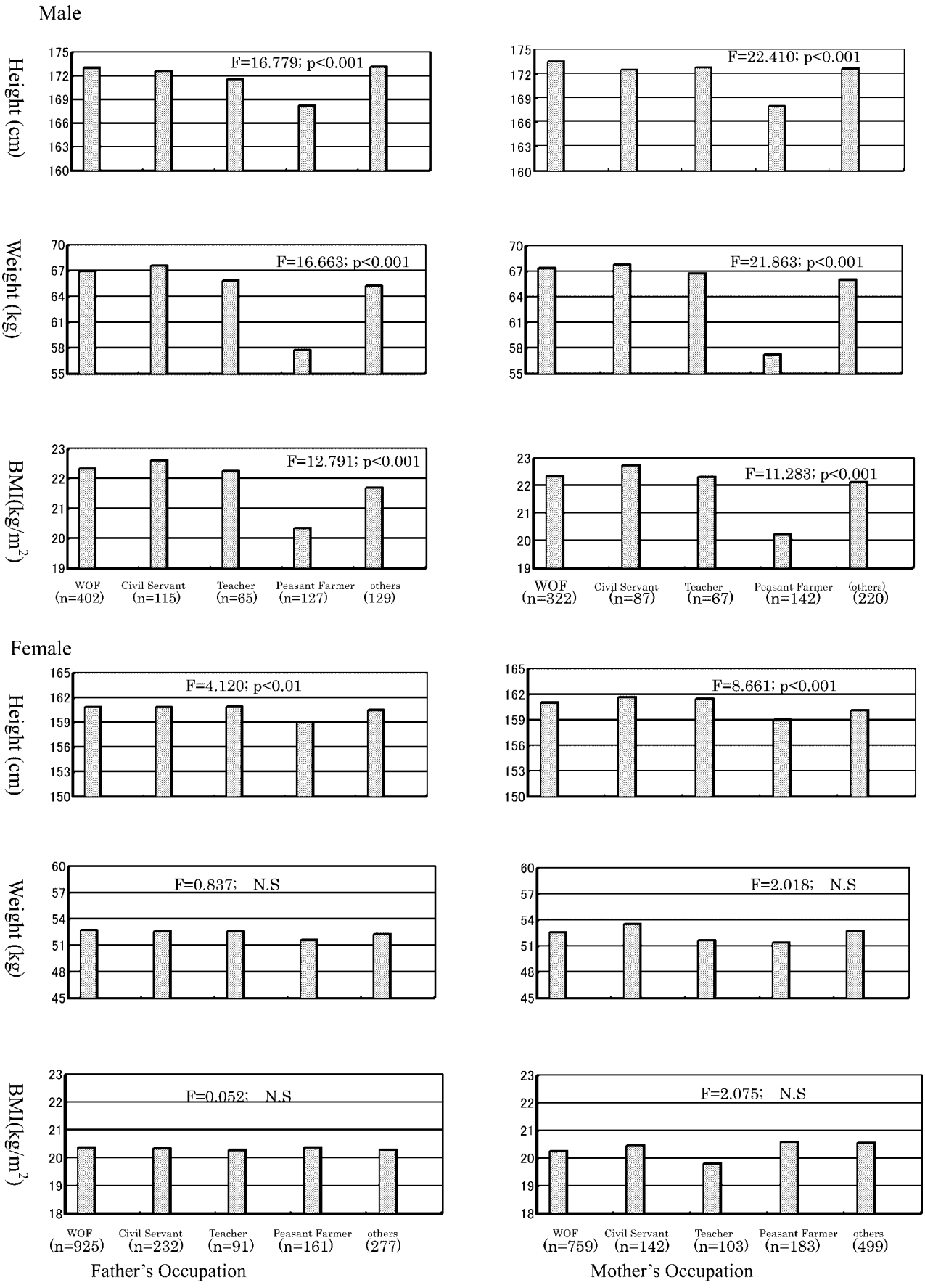

Fig. 1 Physique specified by parents' occupation. Note: WOF=worker in office or factory

3.1.2 Relationship between physique and the factor of natural environment

Table 2 shows that there is a significantly weak positive correlation between height, weight or BMI and latitude for both male and female students. The correlation for male students is stronger than for female ones.

There is a significantly weak negative correlation between height, weight or BMI and temperature or precipitation for both male and female students. The correlation for male students is also stronger than for female.

There is a significantly weak negative correlation between weight or BMI and altitude for male students, while there is no significant correlation for female students.

3.2 Results of multiple factor analyses by ANOVA and ANCOVA

3.2.1 Results of MANOVA—whole group—

Table 3 shows that there is a significant relationship between physique and the urban-rural factor for both men and women in all analysis models. Furthermore, the significance of these relationships becomes weaker as covariates such as family income per capita, latitude, temperature and precipitation are considered. As to the relationship between physique and the coastal factor, there is no significant relationship when the covariate of family income per capita is considered. Model 7 reveals a significant association for males between physique and the factors of urban-rural, coastal, family income per capita and latitude, and a significant association for females between physique and the factors of urban-rural, coastal, family income per capita and precipitation.

3.2.2 Results of ANOVA and ANCOVA—whole group—

Models 1–6 of Table 4 show that there is a significant relationship between the urban-rural factor and male students' height, weight or BMI. With regard to the relationship between physique and the urban-rural factor, the F value decreases clearly when family income per capita is taken as covariate, and although the F values decrease also when factors of latitude, etc. are taken as covariates, reductions of the F values are much smaller than that of when family income per capita is taken as the covariate. As for the coastal factor, there is no significant association when family income per capita is taken as the covariate. Models 1–6 of Table 5 show that the situation regarding female students' height is the same as with male students; however there is almost no significant association between weight or BMI and other variables except that there is a significant association between weight or BMI and latitude, temperature or precipitation. Model 7 of Table 4 and Table 5 indicate that, for male students, there are significant associations between height and the factors of urban-rural, coastal, family income per capita, latitude and altitude; between weight and the factors of urban-rural, the coastal, family income per capita and precipitation; between BMI and the urban-rural factor and family income per capita. In the case of female students, there are significant associations between height and the urban-rural factor, the coastal factor and family income per capita; and between weight or BMI and precipitation.

Analyses taking age as a covariate were also performed, but the results were almost the same as the above results. At the same time, analyses taking gross family income and mother's occupation as substitutive variable of family income per capita and father's occupation respectively were also performed, but the results were almost the same as the above.

Table 3 Association of physique with the attributes of regional origin and income by MANOVA—whole group—

Dependent Variables/Independent Variables	Model 1 F-value	Model 2 F-value	Model 3 F-value	Model 4 F-value	Model 5 F-value	Model 6 F-value	Model 7 F-value
Male							
Height*Weight							
/Urban-rural	41.661***	13.698***	31.530***	30.814***	31.448***	40.221***	8.400***
Coastal	6.616***	2.064	10.254***	10.777***	10.866***	7.249***	4.784***
Income Per Capita	—	19.432***	—	—	—	—	19.372***
Latitude	—	—	31.661***	—	—	—	3.221*
Temperature	—	—	—	27.249***	—	—	0.879
Precipitation	—	—	—	—	30.417***	—	2.830
Altitude	—	—	—	—	—	2.455	2.459
Female							
Height*Weight							
/Urban-rural	18.153***	7.440***	15.041***	14.729***	14.085***	17.565***	5.452**
Coastal	3.365**	1.608	5.861*	6.633***	7.038***	3.350**	3.625**
Income Per Capita	—	10.976***	—	—	—	—	9.866***
Latitude	—	—	43.832***	—	—	—	0.020
Temperature	—	—	—	45.596***	—	—	1.273
Precipitation	—	—	—	—	47.399***	—	8.160***
Altitude	—	—	—	—	—	0.454	0.056

Note: 1) —; indicates the factor is not included in the Model
2) Test by Lambda of Willks
3) * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 4 Association of physique with the attributes of regional origin and income by ANOVA and ANCOVA—whole group— (Male)

Dependent Variables/Independent Variables	Model 1 F-value	Model 2 F-value	Model 3 F-value	Model 4 F-value	Model 5 F-value	Model 6 F-value	Model 7 F-value
Height							
/Urban-rural	58.340***	17.261***	43.571***	42.686***	43.430***	55.318***	13.365***
Coastal	10.436***	2.682	15.549***	16.847***	15.417***	12.804***	8.380***
Income Per Capita	—	31.000***	—	—	—	—	26.153***
Latitude	—	—	39.785***	—	—	—	5.911**
Temperature	—	—	—	34.828***	—	—	1.772
Precipitation	—	—	—	—	38.845***	—	2.840
Altitude	—	—	—	—	—	4.648*	4.445*
Weight							
/Urban-rural	59.481***	20.858***	43.663***	42.825***	43.648***	58.412***	17.100***
Coastal	7.132***	2.078	11.994***	12.342***	13.764***	6.255*	5.269**
Income Per Capita	—	22.826***	—	—	—	—	17.180***
Latitude	—	—	47.598***	—	—	—	2.753
Temperature	—	—	—	40.648***	—	—	0.305
Precipitation	—	—	—	—	45.228***	—	4.692*
Altitude	—	—	—	—	—	0.175	0.009
BMI							
/Urban-rural	30.573***	12.695***	21.963***	21.683***	22.037***	30.796***	10.749***
Coastal	3.184*	1.519	5.162**	5.026**	6.512**	2.025	2.111
Income Per Capita	—	7.453**	—	—	—	—	4.711*
Latitude	—	—	22.870***	—	—	—	0.577
Temperature	—	—	—	19.319***	—	—	0.001
Precipitation	—	—	—	—	21.406***	—	2.617
Altitude	—	—	—	—	—	0.251	0.655

Note: 1) —; indicates the factor is not included in the Model.
2) * p<0.05, ** p<0.01, *** p<0.001

Table 5 Association of physique with the attributes of regional origin and income by ANOVA and ANCOVA—whole group— (Female)

Dependent Variables/Independent Variables	Model 1 F-value	Model 2 F-value	Model 3 F-value	Model 4 F-value	Model 5 F-value	Model 6 F-value	Model 7 F-value
Height							
/Urban-rural	36.164***	14.864***	29.767***	29.275***	27.548***	34.972***	12.761***
Coastal	6.283**	2.895	11.609***	13.281***	13.810***	6.430**	17.184***
Income Per Capita	—	21.606***	—	—	—	—	19.222***
Latitude	—	—	74.394***	—	—	—	0.003
Temperature	—	—	—	78.989***	—	—	2.501
Precipitation	—	—	—	—	67.262***	—	2.754
Altitude	—	—	—	—	—	0.851	0.004
Weight							
/Urban-rural	4.203*	1.970	2.411	2.377	2.864	3.970*	0.771
Coastal	0.156	0.031	1.281	1.451	1.565	0.289	1.554
Income Per Capita	—	1.737	—	—	—	—	1.001
Latitude	—	—	44.505***	—	—	—	0.025
Temperature	—	—	—	42.514***	—	—	0.084
Precipitation	—	—	—	—	63.531***	—	16.188***
Altitude	—	—	—	—	—	0.348	0.074
BMI							
/Urban-rural	0.450	0.079	0.844	0.818	1.370	0.474	0.522
Coastal	0.796	0.524	0.394	0.265	0.307	0.522	0.397
Income Per Capita	—	0.816	—	—	—	—	1.212
Latitude	—	—	10.262***	—	—	—	0.042
Temperature	—	—	—	8.432**	—	—	0.187
Precipitation	—	—	—	—	23.217***	—	13.295***
Altitude	—	—	—	—	—	0.059	0.094

Note 1) —; indicates the factor is not included in the Model.
2) * p<0.05, ** p<0.01, *** p<0.001

Table 6 Association of physique with the attributes of regional origin and income by ANOVA and ANCOVA—Subgroup— (Male)

Dependent Variables/Independent Variables	Urban Group	Rural Group	Group excepting Peasant Farmers	Peasant Farmer Group
	Model 8	Model 9	Model 10	Model 11
	F-value	F-value	F-value	F-value
Height				
/Urban-rural	—	—	2.704	—
Coastal	5.638**	0.277	1.501	1.914
Father's Occupation	1.294	1.193	1.487	—
Income Per Capita	31.285***	7.670**	32.071***	8.210**
Latitude	8.629**	0.831	8.422*	0.993
Temperature	5.025*	2.667	3.857*	2.047
Precipitation	1.614	1.533	1.655	1.849
Altitude	4.669*	0.713	4.221*	1.134
Weight				
/Urban-rural	—	—	1.734	—
Coastal	3.977*	0.883	1.217	0.583
Father's Occupation	0.098	0.354	0.317	—
Income Per Capita	16.942***	1.794	14.227***	11.491***
Latitude	3.408	0.015	3.278	0.145
Temperature	0.707	0.905	0.410	0.687
Precipitation	2.414	1.506	1.943	4.549*
Altitude	0.008	0.148	0.045	0.451
BMI				
/Urban-rural	—	—	0.782	—
Coastal	1.528	0.511	0.407	1.110
Father's Occupation	0.280	0.696	0.481	—
Income Per Capita	4.098*	0.029	2.761	4.781*
Latitude	0.637	0.101	0.562	0.030
Temperature	0.001	0.088	0.170	0.008
Precipitation	1.254	0.651	0.847	2.879
Altitude	0.989	0.004	1.249	0.049

Note 1) —; indicates the factor is not included in the Model.
2) * p<0.05, ** p<0.01, *** p<0.001

Table 7 Association of physique with the attributes of regional origin and income by ANOVA and ANCOVA—Subgroup— (Female)

Dependent Variables/Independent Variables	Urban Group	Rural Group	Group excepting Peasant Farmers	Peasant Farmer Group
	Model 8	Model 9	Model 10	Model 11
	F-value	F-value	F-value	F-value
Height				
/Urban-rural	—	—	2.655	—
Coastal	6.950***	0.120	0.975	2.517
Father's Occupation	0.473	1.286	0.983	—
Income Per Capita	17.552***	6.271*	8.897**	8.616**
Latitude	0.008	0.095	0.231	1.152
Temperature	2.843	0.003	4.490*	0.487
Precipitation	1.255	1.208	1.159	0.522
Altitude	0.022	0.108	0.200	0.222
Weight				
/Urban-rural	—	—	0.024	—
Coastal	4.950**	0.544	0.996	1.193
Father's Occupation	0.543	1.114	0.451	—
Income Per Capita	2.236	0.482	1.638	2.243
Latitude	0.020	0.292	0.156	0.996
Temperature	0.062	0.117	0.228	0.323
Precipitation	9.535**	2.838	8.671**	0.462
Altitude	0.008	0.070	0.148	0.064
BMI				
/Urban-rural	—	—	0.827	—
Coastal	1.510	0.410	0.453	0.540
Father's Occupation	0.307	0.888	0.411	—
Income Per Capita	0.162	5.074*	0.003	12.892***
Latitude	0.013	0.161	0.038	0.258
Temperature	0.234	0.177	0.211	0.064
Precipitation	7.929*	1.678	7.152**	0.137
Altitude	0.026	0.007	0.035	0.003

Note 1) —; indicates the factor is not included in the Model.
2) * p<0.05, ** p<0.01, *** p<0.001

3.2.3 Subgroup analyses by ANOVA and ANCOVA

1) Urban group (Model 8)

Tables 6 and 7 show that male students display significant associations between height and the coastal factor, family income per capita, latitude, temperature and altitude; between weight and family income per capita and the coastal factor; and between BMI and family income per capita. Female students display significant associations between height and the coastal factor and family income per capita; between weight and the coastal factor and precipitation; and between BMI and precipitation.

2) Rural group (Model 9)

Tables 6 and 7 show significant associations between height and family income per capita for male students. For female students, there are significant associations between height and family income per capita; and between BMI and precipitation.

3) Group excepting peasant farmers (Model 10)

Tables 6 and 7 show that in the case of male students there are significant associations between height and family income per capita, latitude, temperature and altitude; and between weight and family income per capita. The tables also show that for female students there are significant associations between height and family income per capita and temperature; between weight and precipitation; and between BMI and precipitation.

4) Peasant farmer group (Model 11)

Tables 6 and 7 show that in the case of male students there are significant associations between height and family income per capita; between weight and family income per capita and precipitation. For female students there are significant associations between height and family income per capita; and between BMI and family income per capita.

4. Discussion

The results show that urban students are both taller and heavier than rural students. This is consistent with the results reported by Shen T. et al. after investigating China's 7 provinces in 1990 which indicated that rural children's average height was 92.5 cm and urban children's was 96.9 cm (3.5 yrs) (7) and is also consistent with the study executed by Qian J. et al. which indicated that in Jiangsu province both male and female urban students' height and weight are greater than those of rural students (19–22 yrs) (17). Although there were no data about the differences of students' physique between urban and rural before the execution of the reform and open policy in 1979, in China, it seemed that those differences after the execution of the reform and open policy became bigger from 1979 to 2000. Chen Z. reported that at Guangzhou, in Guangdong province, in 1979, 1985, 1991, 1995 and 2000, the students' height in urban areas was 4.39 cm, 5 cm, 4.37 cm, 5.40 cm, 4.17 cm higher than that in rural areas for male (17 yrs), and 2.66 cm, 3.51 cm, 3.88 cm, 4.18 cm, 3.42 cm higher for female (17 yrs), and the students' weight in urban areas was 2.70 kg, 3.02 kg, 3.88 kg, 5.26 kg, 5.97 kg heavier than that in rural areas for male, and 0.11 kg, 0.26 kg, 0.47 kg, 1.55 kg, 3.15 kg heavier for female, respectively (24).

This study indicates that the difference in physique between rural students and urban students is largely due to the factor of family income per capita. There is a large difference in income between town and country in China. Since 1979, the policy of reforming and opening has been carried out with the result that the urban economy has developed quickly as well as the littoral rural economy. However, the standard of living inland rural areas is still lower. It is reported that, in 2001, the income per capita in urban areas was 6,860 RMB per year (about 96,040 JPY; during this study it was 7,217 RMB, about 101,031 JPY). In 2001 it was 2,366 RMB per year in rural areas (about 33,124 JPY; during this study it was 2,752 RMB, about 38,527 JPY). Urban income per capita is 2.9 times rural income. Rural income per capita reached a peak in 1985, then the difference between urban and rural income per capita gradually grew and the share in the GDP correspondingly shrank. The income differences between the eastern area (mostly littoral), central area and western area (mostly inland) have become larger leading to a polarization of the developed area and the developing areas. From 1991 to 1999, the western area's share in GDP dropped from 16.3% to 13.8%, the central area's share dropped from 28.6% to 27.3%, while however, the eastern area's share grew from 55.1% to 58.8%. Shanghai's GDP per capita is highest, 7.5 times that of Guizhou, the lowest in China in 1991. However, it was 12.5 times greater in 1999 (23). As mentioned above, the present Chinese economic situation results in an income difference between urban citizens and rural citizens, and that income difference has caused the difference in physique between urban and rural students.

This study shows that the income difference between urban and rural is mainly due to the difference in the occupations. The Shanghai Statistical Bureau reported that in Shanghai an employee's annual income in 2001 was 20,760 RMB in industry, 35,051 RMB in finance and insurance, 21,852 RMB for teachers, 25,247 RMB for civil servants, 14,204 RMB in agriculture and others (25). Li W. reported that since 1985, employees' income in agriculture, commerce and manufacturing has become the lowest, while it is the highest in finance, real estate and electric power (26). Moreover, Cui J. reported that employees' income in agriculture, industry and geological investigation is lower than that of traffic, communication, finance and insurance and real estate (27). As mentioned above, the income difference is due to the occupational differences in China. This study indicates that there is no significant income difference among WOF, civil servants, teachers, while peasant farmers' income is the lowest. In China, the main rural occupation is agriculture, which is almost completely absent in urban areas. Thus, it is inferred that rural income is much lower than urban income.

Ohsawa S. et al. reported that there was a positive correlation between physique and latitude and a negative correlation between physique and temperature, precipitation or altitude (13). Schmitt L. H. et al. also indicated there is a negative correlation between physique and altitude (18). This study has also reflected those results. Which influence do these natural factors produce on differing urban and rural physiques? This study shows that for both male and female the latitude of urban groups is a little higher than that of rural groups and the temperature is a little lower (Table 1). Besides, multivariable

analysis shows that, considering these natural factors, although the F value for the urban-rural factor decreased, the change was much smaller than family income per capita. These results indicate that natural factors are not the main factors influencing physical differences between people from urban and rural areas.

There is a significantly different trend between male students and female students regarding the relationship between physique and the factors of regional origin. This kind of trend finds such natural factors as latitude, etc. weaker than such socioeconomic factors as urban and rural differences, family income per capita, etc. This result is clearly testified by male and female students' weight (Tables 4, 5). Yu D. et al. reported that the difference in male physique between urban and rural areas was greater than the female physique (2, 6). Table 1 in this study shows that family income per capita for female students' families is higher than that for male students' families. It may be that the socioeconomic difference results in this difference between male and female. Besides, the difference in physical development between male and female students at the age of entering university should be considered. Other factors such as biological mechanisms of socioeconomic circumstances and the natural environment should also be considered. The differences of mechanism in which socioeconomic factors and natural environment work might be the cause of the difference between male students and their female counterparts.

Because K university, the subject of this study, is located in the vast city of Shanghai, students from in and around Shanghai account for about one-fifth of the student body at this university; the rest come from all over China. It has been suggested that the results of this study indicate some traits reflecting conditions in Shanghai and its peripheral areas. This is an Educational University, or Teachers' Training College, therefore the number of female students is many more than that of male students. Data of latitude, annual average value of air temperature, annual average value of precipitation and altitude are based on the seat of local or prefectural government in the places where students lived before entering university. Taking these data as subjects' attributes is not really accurate, because of the difference within the area. Moreover, it is thought that an urban student's family income is relatively more accurate, while a rural student's family income is not completely accurate, so the difference of family income between urban and rural might be smaller than indicated in this study, because some parts of the rural families' income may not be included.

5. Conclusion

The purpose of this study was to explore the cause of difference in physique between urban and rural students. Students from K University in China were selected as subjects in this study. The relationship of Chinese students' physique with the attributes of regional origin and family conditions was analyzed.

Students born in urban areas are taller and heavier than those born in rural areas. The main cause of these differences is family income per capita. The main cause of differing family income is occupational difference. The influence of regional-origin's latitude, temperature, precipitation and altitude on physique is less marked than that of family income per capita. The relationship between physique and regional origin and family clearly shows a different trend between male and female, a trend evidently arising more from urban and rural factors than from factors of latitude, air temperature and precipitation.

Note

1. Data concerning latitude are from the following:
   Yu Chang, Jin Ying-Chun. State Atlas of P. R. C. Beijing: China Cartographic Publishing House, 1995.
   Murakoshi E, Yano K. Provincial Atlas of Continental China. Tokyo: Revue Diplomatic Press, 1971.
   World Atlas. Microsoft ENCARTA. 2001.
2. The data of annual average values of air temperature and precipitation are from the following:
   Zhu Da-ren. Provincial Atlas of China. Beijing: China Cartographic Publishing House, 2000.
   Han Jian-zhong. Atlas of Zhongguo Shenghui Chengshi. Changsha: Hunan Cartographic Publishing House, 2002.
   Gao Xiu-Jin. Atlas of Anhui Sheng. Beijing: China Cartographic Publishing House, 2000.
   Zhang Hong. Atlas of Hunan Sheng. Beijing: China Cartographic Publishing House, 2000.
   China Meteorological Administration. The Data from 180 National Meteorological Observational locations. Nanjing: Department of Meteorology of Nanjing Institute, 2001.
   Mao Zhong-Ming. Tongyong Atlas of Henansheng. Chendu: Chendu Cartographic Publishing House, 2001.
   Gao Xiu-Jin. Atlas of Fujian Sheng. Beijing: China Cartographic Publishing House, 2000.
3. Data concerning altitude are from the following:
   Xiu Bing-Nan. Meteorological Annals of Guizhou Province, China. Beijing: Fangzhi Publishing House, 1998.
   Shao Wen-Jie. Meteorological Annals of Henan Province, China. Zhenzhou: Henan Renming Publishing House, 1993.
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