

*Information Processing of Sports Test Data  
on Freshmen in Osaka University  
of Economics and Law, 1991*

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ABSTRACTS

*The measured points of scores obtained from the computer processing data were as follows: for economics-major freshmen 394 points; for law-major freshmen 371 points. We took the 5-gradation evaluation, the mean values, the standard deviation, the regression coefficient, the multiple-correlation coefficient and the F-ratio of scattering analysis.*

*The data obtained were compared with the nationwide mean value of the university students. As a result, the comparison shows that the mean value of OUEL (Osaka University of Economics and Law) students for weight (63.44kg), girth of the chest (87.25cm) and trunk extension (57.79cm) to be recorded higher than the nationwide average. While as for height (171.05cm), side step (45.66 points), vertical jump (61.98 cm), back strength (134.49kg), grip strength (44.83kg), standing trunk flexion (11.95cm) and step test (60.65 points), OUEL students recorded lower than the nationwide mean value.*

*(The Review of the Osaka University of Economics and Law, 54 (1993) p. 1-33)*

## 1 PREFACE

The Japan Bureau of Physical Education in the Ministry of Education (JBPEME) has annually reported on the people's physique (height, weight and girth of the chest) and physical fitness since 1900 (the 33rd year of the Meiji Era)<sup>1)</sup>. In Osaka University of Economics and Law, we have also collected and reported OUEL student's data on the same matters in each year's Review and Annals of the General Sciences Institute of Osaka University of Economics and Law since 1980. Moreover, we put the data obtained from 1983 to 1990 in computer-transaction for information processing. Meanwhile, some other research and reports on physical fitness measurement have been published by S. AOYAMA in University of Tokyo<sup>2)</sup>.

In this paper, we will report the data collected in 1991 from 765 freshmen students in all: 394 economics-major and 371 law-major students. We gave them ten kinds of physical examinations and physical strength measurement, which we generally call a sports test. On the following stage, we put the data on these ten kinds in statistic processing such as the 5-gradation evaluation, the mean values, the standard deviation, the regression coefficient, the multiple-correlation coefficient and the F-ratio of scattering analysis. In the 5-gradation evaluation, the data resulted in the distribution as follows: step E (4.65%), step D (10.65%), step C (44.00%), step B (30.35%) and step A (10.05%).

Consequently, the mean values of all OUEL students turned out to be higher in some items than the nationwide ones: weight (63.44kg), girth of the chest (87.25cm) and trunk extension (57.79cm): while

opposite lower in height (171.05cm), side step (45.66 points), vertical jump (61.98cm), back strength (134.49kg), grip strength (44.83kg), standing trunk flexion (11.95cm) and step test (60.65 points). Furthermore, the mean values of law-major freshmen are higher than those of economics-major freshmen in weight, girth of the chest, trunk extension and step test, but they are lower in all the other items.

Accordingly, we find the difference between the two major students: economics-major freshmen are greater in degree than ones for physique test. In terms of standard deviation economics-major freshmen stand higher in height, girth of the chest and standing trunk flexion, but quite opposite in the other items. The multiple-correlation coefficient reads quite large in weight and girth of the chest: that is to say, 0.813 in economics-majors and 0.821 in law-majors, respectively. Therefore, the regression equation for these items is the most reliable of all in degree. At the same time, the reliability can be recognized in the multiple-correlation coefficient and the F-ratio of scattering analysis.

## 2 MEASURING METHOD

The measuring object and enumerators are department of economics freshmen (age: 18, males and 394 students) and department of law freshmen (age: 18, males and 371 students).

The measuring period was April 20 through May 15, 1991. In the measuring method and measurement members, we adopted the same measuring method as the one used for the physical fitness test used by the Ministry of Education. The measurement members are all instructors of physical education at Osaka University of Economics and Law.

In measurement items, we selected ten items referring to the above-mentioned test by the Ministry of Education. These are the items of physical examination; height, weight and girth of the chest; and also the items of physical strength test: side step, vertical jump, back strength, grip strength, trunk extension, standing trunk flexion and step test.

In information processing for sports test data, we entered all the information on OUEL's sports test in optical character reader sheets, and put them in a computer. We used Hitachi's HITAC-IID. The language we used for the information processing was FORTRAN, BASIC, STATISTICAL SYSTEM (BASIS), DRMLMN. N, or KH0003.

### **3 MEASUREMENT RESULTS**

#### **3.1 The 5-Gradation Evaluation for Physical Fitness Test**

##### **3.1.1 The 5-Gradation Evaluation of Side Step**

First of all, we made a classified JBPEME of the 5-gradation evaluation for side step: Grade 1 for 31 points and below, Grade 2 for 32-35 points, Grade 3 for 36-41 points, Grade 4 for 42-46 points, and Grade 5 for 47 points and higher<sup>1)</sup>.

According to **TABLE 1**, we then compared the data of economics-major (E) and law-major (L) freshmen. On Grade 1, (E) reads 1.7% and (L) reads 0.2% and the mean value reads 0.95%, which are both in smaller degrees. On Grade 2, (E) reads 1.5%, (L) reads 1.0%, and the mean value is 1.25%, which stand fairly low. On Grade 3, (E) reads 12.9%, (L) reads 15.0%, and the mean value is 13.95%. These are in the middle of this evaluation. On Grade 4, (E) reads

**TABLE 1** The Results of the 5 Gradation Evaluation on Events Judgement for OUEL Freshmen in 1991

Faculty	Grada- tion	Side Step (point)	Vertical Jump (cm)	Back Strength (kg)	Grip Strength (kg)	Trunk Extension (cm)	Standing Trunk Flexion (cm)	Step Test (point)	Total Evaluation
Economics	1	1.7	1.2	0.0	0.0	1.5	11.4	2.0	E 4.5
	2	1.5	0.7	14.7	5.5	8.6	33.7	32.4	D 9.8
	3	12.9	10.9	46.7	33.7	34.2	37.0	39.5	C 40.6
	4	34.7	40.6	31.7	50.0	40.6	15.2	19.2	B 32.2
	5	48.9	46.4	6.8	10.6	14.9	2.5	6.5	A 12.6
Law	1	0.2	0.0	0.0	0.0	0.2	14.8	1.8	E 4.8
	2	1.0	1.0	11.0	6.7	6.7	23.0	52.5	D 11.5
	3	15.0	11.8	56.8	37.7	29.3	37.4	32.6	C 47.4
	4	40.7	41.5	27.2	49.3	50.9	16.1	9.9	B 28.5
	5	42.8	45.5	4.8	6.1	12.6	3.5	2.9	A 7.5
Average	1	0.95	0.60	0.00	0.00	0.85	13.10	1.90	E 4.65
	2	1.25	0.85	12.85	6.10	7.65	30.85	42.45	D 10.65
	3	13.95	11.35	51.75	35.70	31.75	37.20	36.05	C 44.00
	4	37.70	41.05	29.45	49.65	45.75	15.65	14.55	B 30.35
	5	45.85	45.95	5.80	8.35	13.75	3.00	4.70	A 10.05

34.7%, (L) reads 40.7%, and the mean value reads 37.70%. On Grade 5, (E) reads 48.9 %, (L) reads 42.8%, and the mean value reads 45.85 %. These Grade 5 values indicate the highest degrees in the evaluation. We can see that as the grade goes up, the higher the percentage grows.

### **3.1.2 The 5-Gradation Evaluation of Vertical Jump**

First of all, we made a classified JBPEME of the 5-gradation evaluation for vertical Jump: Grade 1 for 32cm and below, Grade 2 for 33-42cm, Grade 3 for 43-53cm, Grade 4 for 54-63cm, and Grade 5 for 64cm and higher<sup>1)</sup>.

According to **TABLE 1**, we then compared the data of economics-major (E) and law-major (L) freshmen. On Grade 1, (E) reads 1.2% (L) reads 0.0%, and the mean value reads 0.6%, which are both in smaller degrees. On Grade 2, (E) reads 0.7%, (L) reads 1.0%, and the mean value reads 0.85%. On Grade 3, (E) reads 10.9%, (L) reads 11.8%, and the mean value reads 11.35%. These are in the middle of this evaluation. On Grade 4, (E) reads 40.6%, (L) reads 41.5%, and the mean value reads 41.05%. On Grads 5, (E) reads 46.4%, (L) reads 45.5%, and the mean value reads 45.95%. Almost half of the percentage of all the enumerators are on this grade. Needless to say, they stand highest in percentage. They stand higher in percentage than these on Grade 4. The difference between these two grades in percentage-distribution has a slightly different tendency with those of freshmen in (1983-1990).

### **3.1.3 The 5-Gradation Evaluation of Back Strength**

First of all, we made a classified JBPEME of the 5-gradation

**evaluation for back strength: Grade 1 for 71kg and below, Grade 2 for 72–107kg, Grade 3 for 108–143kg, Grade 4 for 144–177kg, and Grade 5 for 178kg and heavier<sup>1)</sup>.**

According to **TABLE 1**, we then compared the data between economics-major (E) and law-major (L) freshmen. On Grade 1, (E) and (L) reads 0.0%, which are both in very small degrees. On Grade 2, (E) reads 14.7%, (L) reads 11.0%, and the mean value reads 12.85%. On Grade 3, (E) reads 46.7%, (L) reads 56.8%, and the mean value reads 51.75%. Almost half of the percentage of all the enumerators are on this grade. In addition, they stand highest in percentage. On Grade 4, (E) reads 31.7%, (L) reads 27.2%, and the mean value reads 29.45%. Put another way, a fourth part of the enumerators are on this grade. Finally, on Grade 5, (E) reads 6.8%, (L) reads 4.8%, and the mean value reads 5.80%. They stand between on Grade 1 and 2 in percentage. The difference between these grades in percentage-distribution has a slightly similar tendency with those of OUEL students in (1983–1990).

#### **3.1.4 The 5-Gradation Evaluation of Grip Strength**

First of all, we made a classified JBPME of the 5-gradation evaluation for grip strength: Grade 1 for 23kg and below, Grade 2 for 24–34kg, Grade 3 for 35–43kg, Grade 4 for 44–54kg, and Grade 5 for 55kg and stronger<sup>1)</sup>.

According to **TABLE 1**, we then compared the data between economics-major (E) and law-major (L) freshmen. On Grade 1, (E) and (L) reads 0.0%, which are both in very small degrees. On Grade 2, (E) reads 5.5%, (L) reads 6.7%, and the mean value reads 6.10%,

which stand fairly low. On Grade 3, (E) reads 33.7%, (L) reads 37.7%, and the mean value reads 35.70%. On Grade 4, (E) reads 50.0%, (L) reads 49.3%, and the mean value reads 49.65%. Almost half of the percentage of all the enumerators are on this grade. On Grade 5, (E) reads 10.6%, (L) reads 6.1%, and the mean value reads 8.35%. About 8% of all the enumerators are on this grade. These are in the middle of the evaluation. The difference between these grades in percentage-distribution has a similar tendency with those of OUEL students in (1983-1990).

### **3.1.5 The 5-Gradation Evaluation of Trunk Extension**

First of all, we made a classified JBPEME of the 5-gradation evaluation for trunk extension: Grade 1 for 36cm and below, Grade 2 for 37-46cm, Grade 3 for 47-56cm, Grade 4 for 57-66cm, and Grade 5 for 67cm and heavier<sup>1)</sup>.

According to **TABLE 1**, we then compared the data between economics-major (E) and law-major (L) freshmen. On Grade 1, (E) reads 1.5%, (L) reads 0.2%, and the mean value reads 0.85%. On Grade 2, (E) reads 8.6%, (L) reads 6.7%, and the mean value reads 7.65%, about 8% of all the enumerators are on this grade. On Grade 3, (E) reads 34.2%, (L) reads 29.3%, and the mean value reads 31.75%. Put another way one-third of the enumerators are on this grade. On Grade 4, (E) reads 40.6%, (L) reads 50.9%, and the mean value reads 45.75%. In addition, they stand highest in percentage. On Grade 5, (E) reads 14.9%, (L) reads 12.6%, and the mean value reads 13.75%, they stand between on Grade 1 and 2 in percentage. About 10% of all the enumerators are on this grade. The difference between these grades in percentage-distribution has a similar tendency



with those of OUEL students in (1983-1987).

### **3.1.6 The 5-Gradation Evaluation of Standing Trunk Flexion**

First of all, we made a classified JBPEME of the 5-gradation evaluation for standing trunk flexion: Grade 1 for 4cm and below, Grade 2 for 5-11cm, Grade 3 for 12-18cm, Grade 4 for 19-24cm, and Grade 5 for 25cm and higher<sup>1)</sup>.

According to **TABLE 1**, we then compared the data between economics-major (E) and law-major (L) freshmen. On Grade 1, (E) reads 11.4%, (L) reads 14.8%, and the mean value reads 13.10%, which is only higher than 13%. On Grade 2, (E) reads 33.7%, (L) reads 23.0%, and the mean value reads 30.85%. On Grade 3, (E) reads 37.0%, (L) reads 37.4%, and the mean value reads 37.20%, these indicate the highest degrees in the evaluation. On Grade 4, (E) reads 15.2%, (L) reads 16.1%, and the mean value reads 15.65%, these are in the middle of this evaluation. On Grade 5, (E) reads 2.5%, (L) reads 3.5%, and the mean value reads 3.00%, they stand lower in percentage than those on Grade 1. The difference between these grades in percentage-distribution has a slightly different tendency with those of OUEL students in 1984, 1985, 1987 and 1990 years.

### **3.1.7 The 5-Gradation Evaluation of Step Test**

First of all, we made a classified JBPEME of the 5-gradation evaluation for step test: Grade 1 for 41.8 points and below, Grade 2 for 41.9-56.5 points, Grade 3 for 56.6-71.3 points and Grade 4 for 71.4-85.9 points, and Grade 5 for 86.0 points and over<sup>1)</sup>.

According to **TABLE 1**, we then compared the data between econo-

mics-major (E) and law-major (L) freshmen. On Grade 1, (E) reads 2.0%, (L) reads 1.8%, and the mean value reads 1.90%, which are both in small degrees. On Grade 2, (E) reads 32.4%, (L) reads 52.5%, and the mean value reads 42.45%, almost half of the percentage of all the enumerators are this grade. On Grade 3, (E) reads 39.5%, (L) reads 32.6%, and the mean value reads 36.05%. In addition, they stand highest in percentage. Put another way, one-third of the enumerators are on this grade. On Grade 4, (E) reads 19.2%, (L) reads 9.9%, and the mean value reads 14.55%, about 15% of all the enumerators are on this grade. On Grade 5, (E) reads 6.5%, (L) reads 2.9%, and the mean value reads 4.70%, they stand lower in 10% percentages than those on Grade 4.

### **3.2 Results of the Mean Value<sup>4-14)</sup>**

In order to calculate the mean value in statistical analysis value of physique and physical fitness on OUEL students, the experimental results are shown in **TABLE 2**.

#### **3.2.1 Comparing between the Average of the Economics-major Freshmen and the Nationwide Average**

The sports test data of economics-major freshmen in OUEL students was compared with the nationwide average. As a result, the economics-major freshmen were recorded heavier than the nationwide mean value of college students as a whole in height (171.25cm, gap: 0.02 cm), weight (63.29kg, gap: 1.14kg), girth of the chest (87.21cm, gap: 1.20cm), grip strength (45.44kg, gap: 0.99kg), trunk extension (57.31 cm, gap: 0.47cm) and step test (63.48 points, gap: 0.20 points). While as for side step (45.92 points, gap: -1.95 points), vertical jump (62.04 cm, gap: -0.21cm), back strength (135.39kg, gap: -1.93kg), and standing

**TABLE 2** The Statistical Analysis Values of Physique and Physical Fitness on OUEL Freshmen in 1991  
MEAN (Mean Values) and S.D. (Standard Deviation)

Name	MEAN	Height (cm)	Weight (kg)	Chest (cm)	Side Step (point)	Vertical Jump (cm)	Back Strength (kg)	Grip Strength (kg)	Trunk Exten- sion (cm)	Standing Trunk Flexion (cm)	Step Test (point)
Economics- major (E1)	MEAN	171.25	63.29	87.21	45.92	62.04	135.39	45.44	57.31	12.04	63.48
	S.D.	5.76	9.01	6.63	4.82	7.92	26.41	7.10	8.13	7.64	12.05
Law-major (L1)	MEAN	170.85	63.59	87.29	45.39	61.91	133.59	44.21	58.26	11.86	57.82
	S.D.	6.21	9.98	6.88	4.41	7.76	23.66	6.82	7.25	7.69	10.83
OUEL Mean (M.O)	MEAN	171.05	63.44	87.25	45.66	61.98	134.49	44.83	57.79	11.95	60.65
	S.D.	5.99	9.50	6.76	4.62	7.84	25.04	6.96	7.69	7.67	11.44
Nationwide (M.J)	MEAN	171.23	62.15	86.01	47.87	62.25	137.32	44.45	56.84	13.24	63.28
	S.D.	5.53	7.68	5.20	4.54	7.12	25.94	5.98	8.24	6.71	11.49
(E1) - (M.J)	MEAN	0.02	1.14	1.20	-1.95	-0.21	-1.93	0.99	0.47	-1.20	0.20
	S.D.	0.23	1.33	1.43	0.28	0.80	0.47	1.12	-0.11	0.93	0.56
(L1) - (M.J)	MEAN	-0.38	1.44	1.28	-2.48	-0.34	-3.73	-0.24	1.42	-1.38	-5.46
	S.D.	0.68	2.30	1.68	-0.13	0.64	-2.28	0.84	-0.99	0.98	-0.66
(M.O) - (M.J)	MEAN	-0.18	1.29	1.24	-2.21	-0.27	-2.83	0.38	0.95	-1.29	-2.63
	S.D.	0.46	1.82	1.56	0.08	0.72	-0.90	0.98	-0.55	0.96	-0.05
(E1) - (L1)	MEAN	0.40	-0.30	-0.08	0.53	0.13	1.80	1.23	-0.95	0.18	-5.66
	S.D.	-0.45	0.97	-0.25	0.41	0.16	2.75	0.28	0.88	-0.05	1.22

trunk flexion (12.04cm, gap: -1.20cm) were recorded lower than the nationwide average.





### **3.2.2 Comparing between the Average of the Law-major Freshmen and the Nationwide Average**

The sports test data of law-major freshmen was compared with the nationwide average. As a result, the students tested were recorded lower than the nationwide mean value of college students as a whole in height (170.85cm, gap: -0.38cm), side step (45.39 points, gap: -2.48 points), vertical jump (61.91cm, gap: -0.34cm), back strength (133.59 kg, gap: -3.73kg), grip strength (44.21kg, gap: -0.24kg), standing trunk flexion (11.86cm, gap: -1.38cm) and step test (57.82 points, gap: -5.46 points), while higher in weight (63.59kg, gap: 1.44kg) and girth of the chest (87.29cm, gap: 1.28cm) and trunk extension (58.26cm, gap: 1.42 cm).

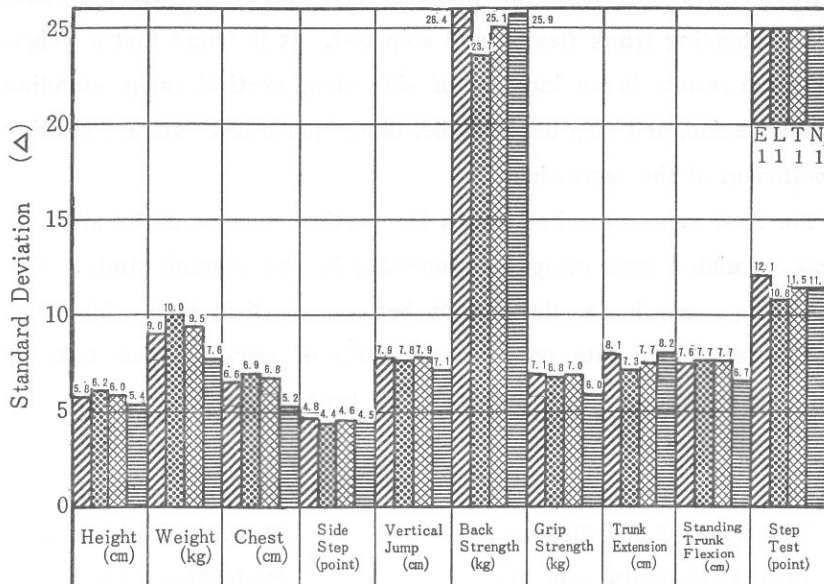
### **3.2.3 Comparing between the Average of the OUEL Students and the Nationwide Average**

The sports test data obtained compared the OUEL data with the nationwide mean value of the same college years. As a result, the comparison shows that the mean value of OUEL students, for height (171.05cm, gap: -0.18cm), side step (45.66 points, gap: -2.21 points), vertical jump (61.98cm, gap: -0.27cm), back strength (134.49kg, gap: -2.83kg), standing trunk flexion (11.95cm, gap: -1.29cm) and step test (60.65 points, gap: -2.63 points) to be recorded lower than the nationwide average. While higher in weight (63.44kg, gap: 1.29kg), girth of the chest (87.25cm, gap: 1.24cm), grip strength (44.83kg gap: 0.38kg), and trunk extension (57.79cm, gap: 0.95cm), respectively.

### 3.3 Results of the Standard Deviation<sup>4-14)</sup>

In order to calculate the standard deviation in statistical analysis value of sports test data on OUEL students, the experimental results are shown **FIG. 1** which shows the relation between the standard deviation and freshmen OUEL students in the examination of physique and physical fitness test. Economics-major and law-major OUEL freshmen students, OUEL students and the nationwide are shown in the histograms , ,  and , respectively.

As a result, the comparison shows that the standard deviation of OUEL students for height (gap: 0.46cm), weight (gap: 1.82kg), girth of the chest (gap: 1.56cm), side step (gap: 0.08 points), vertical jump (gap: 0.72cm), grip strength (gap: 0.98kg), and standing trunk flexion



**FIG. 1** The Histogram of Standard Deviation on Freshmen in 1991  
Where, EI: Economics-major, L1: Law-major,  
T1: OUEL Students and N1: Nationwide students

(gap: 0.96cm) was recorded lower than the nationwide average. While, as for back strength (gap: -0.90kg), trunk extension (gap: -0.55cm) and step test (gap: -0.05 points), were higher than the nationwide average.

### 3.4 Regression Analysis<sup>4-14)</sup>

It is assumed that one side sports test data (Y) is proportional to other sports test data (X). We used this equation

$$Y=a+b(X).....(1)$$

**TABLE 3** shows the upper coefficients (a) and the lower regression coefficient for freshmen economics-majors. In **TABLE 3**, the upper berth (a) and the lower berth (b) in the box are indicated as coefficients and regression, coefficients, respectively. The negative coefficient of the regression for weight are found in side step, vertical jump, standing trunk flexion and step test. It is found that a weight decrease results in an increase of side step, vertical jump, standing trunk flexion, and step test. While, other sports test data are positive coefficient of the regression.

For freshmen economics-majors, the vertical jump on OUEL students was calculated from computer processing in the present study. The following regression as the relation between vertical jump (Yv) and sports tests (the data from examinations of physique and tests of physical fitness on OUEL students) has been determined by the experimental data:

$$Yv=11.380+0.296 \text{ (height)} \quad (R=0.218).....(2)$$

$$Yv=63.211-0.019 \text{ (weight)} \quad (R=0.021).....(3)$$

$$Yv=60.268+0.020 \text{ (girth of the chest)} \quad (R=0.017).....(4)$$

$$Yv=32.971+0.633 \text{ (side step)} \quad (R=0.385).....(5)$$

**TABLE 3** The Coefficients in Equation of Regression ( $Y = a + bX$ ;  $a$ : Upper berth and  $b$ : Lower berth)  
for Economics-major Freshmen in 1991

	Height	Weight	Chest	Side Step	Vertical Jump	Back Strength	Grip Strength	Trunk Extension	Standing Trunk Flexion	Step Test
Height		-50.374 0.664	42.869 0.259	25.412 0.120	11.380 0.296	-88.282 1.306	-34.936 0.469	45.629 0.068	17.126 -0.030	39.011 0.143
Weight	154.060 0.272		49.414 0.597	48.200 -0.036	63.211 -0.019	64.101 1.113	25.183 0.320	53.791 0.056	16.494 -0.070	77.374 -0.220
Chest	154.160 0.196	-33.052 1.105		47.060 -0.013	60.268 0.020	-7.167 1.635	11.352 0.391	49.901 0.085		82.651 -0.220
Side Step	163.390 0.171	69.073 -0.126	88.339 -0.025		32.971 0.633	86.544 1.064	26.095 0.421	41.153 0.352	5.263 0.148	37.915 0.557
Vertical Jump	161.520 0.157	64.775 -0.024	86.321 0.014	31.361 0.235		67.245 1.098	23.534 0.353	49.019 0.134	2.129 0.160	55.572 0.128
Back Strength	162.830 0.062	45.531 0.131	73.274 0.103	41.124 0.035	48.682 0.099		25.736 0.146			57.179 0.047
Grip Strength	157.190 0.310	39.860 0.516	71.738 0.340	37.101 0.194	42.102 0.439	43.906 2.013		52.358 0.109	8.798 0.072	61.371 0.046
Trunk Extension	169.290 0.034	59.370 0.068	83.969 0.057	38.832 0.124	54.778 0.127	128.980 0.112	40.669 0.083		1.340 0.187	58.048 0.095
Standing Trunk Flexion	171.460 -0.017	64.482 -0.099		45.199 0.060	59.939 0.174		44.677 0.063	54.722 0.215		62.410 0.089
Step Test	169.180 0.033	71.092 -0.123	91.428 -0.067	40.262 0.089	58.548 0.055	121.190 0.224	44.413 0.016	54.573 0.043	9.831 0.035	

$Y_v = 48.682 + 0.099$ (back strength)	( $R = 0.329$ ).....( 6)
$Y_v = 42.102 + 0.439$ (grip strength)	( $R = 0.394$ ).....( 7)
$Y_v = 54.778 + 0.127$ (trunk extension)	( $R = 0.130$ ).....( 8)
$Y_v = 59.939 + 0.174$ (standing trunk flexion)	( $R = 0.167$ ).....( 9)
$Y_v = 58.548 + 0.055$ (step test)	( $R = 0.084$ ).....(10)

In this regression equation on vertical jump on freshmen of OUEL economics-major students, the multiple-correlation coefficient are noted in side step ( $R = 0.385$ ), back strength ( $R = 0.329$ ) and grip strength ( $R = 0.394$ ) at above  $R = 0.3$ . In the case of the multiple-correlation coefficient, height ( $R = 0.218$ ), trunk extension ( $R = 0.130$ ) and standing trunk flexion ( $R = 0.167$ ) are between  $R = 0.1$  and  $R = 0.3$ , respectively. In addition, the stand lower in reliability.

The coefficients of the regression equation for freshmen in law-majors are shown in **TABLE 4**. The back strength of OUEL students was calculated from computer processing in the present study. The following regression equation as the relation between back strength ( $Y_b$ ) and the sports tests is determined by a statistical analysis of sports test data:

$Y_b = -19.936 + 0.899$ (height)	( $R = 0.237$ ).....(11)
$Y_b = 87.658 + 0.722$ (weight)	( $R = 0.305$ ).....(12)
$Y_b = 21.261 + 1.287$ (girth of the chest)	( $R = 0.374$ ).....(13)
$Y_b = 74.526 + 1.301$ (side step)	( $R = 0.243$ ).....(14)
$Y_b = 83.242 + 0.813$ (vertical jump)	( $R = 0.267$ ).....(15)
$Y_b = 54.876 + 1.781$ (grip strength)	( $R = 0.513$ ).....(16)
$Y_b = 105.160 + 0.488$ (trunk extension)	( $R = 0.150$ ).....(17)
$Y_b = 126.670 + 0.584$ (standing trunk flexion)	( $R = 0.190$ ).....(18)



**TABLE 4** The Coefficients in Equation of Regression ( $Y=a+bX$ ;  $a$ : Upper berth and  $b$ : Lower berth)  
for Law-major Freshmen in 1991

	Height	Weight	Chest	Side Step	Vertical Jump	Back Strength	Grip Strength	Trunk Extension	Standing Trunk Flexion	Step Test
Height		-69.862	30.223	34.092	40.722	-19.936	-33.980	39.398	38.458	76.376
Weight	159.590		0.334	0.066	0.124	0.899	0.458	0.110	-0.156	-0.109
Chest	0.303			46.951	70.601	87.658	29.781	56.138	17.261	68.620
	147.070	-40.251	0.566	-0.025	-0.137	0.722	0.227	0.033	-0.085	-0.170
	0.272	1.190			-0.165	1.287	0.272		14.795	69.099
Side Step	164.900	69.284			35.555	74.526	28.165	48.299	-1.615	41.924
	0.131	-0.125			0.581	1.301	0.353	0.220	0.262	0.350
Vertical Jump	165.920	77.587	95.302	33.743		83.242	26.453	50.549	-4.201	49.021
	0.080	-0.226	-0.129	0.188		0.813	0.287	0.126	0.259	0.142
Back Strength	162.580	46.445	72.766	39.345	50.242		24.449		3.627	53.630
	0.062	0.128	0.109	0.045	0.087		0.148		0.062	0.031
Grip Strength	154.060	42.136	75.043	38.849	45.517	54.876		53.332	5.487	50.760
	0.380	0.485	0.277	0.148	0.371	1.781		0.112	0.145	0.160
Trunk Extension	166.120	59.906		40.648	55.501	105.160	38.453		-3.957	
	0.081	0.063		0.081	0.144	0.488	0.099		0.272	
Standing Trunk Flexion	172.050	65.288	87.611	44.369	58.782	126.670	42.862	55.402		55.825
	-0.102	-0.143	-0.027	0.086	0.264	0.584	0.113	0.241		0.168
Step Test	172.910	71.925	90.305	40.028	57.696	124.920	40.544		6.951	
	-0.036	-0.144	-0.052	0.058	0.073	0.150	0.063		0.085	

$$Y_b = 124.920 + 0.150 \text{ (step test)} \quad (R=0.069) \dots \dots (19)$$

In this regression equation of trunk extension in freshmen OUEL law-major students, the maximum class multiple-correlation coefficient are weight ( $R=0.305$ ), girth of the chest ( $R=0.374$ ) and grip strength ( $R=0.513$ ) at above  $R=0.3$ . While, in this the multiple-correlation coefficients, height ( $R=0.237$ ), side step ( $R=0.243$ ) and vertical jump ( $R=0.267$ ) are between  $R=0.2$  and  $R=0.3$ , respectively. In addition, the multiple-correlation coefficients between  $R=0.1$  and  $R=0.2$  stand lower reliability.

### 3.5 The Multiple-correlation Coefficient and F-ratio<sup>4-14)</sup>

This section presents the multiple-correlation coefficient and the F-ratio of scattering analysis relation based on the experimental data derived from the sports test data in freshmen economics-majors. One of the important characteristics is the multiple-correlation coefficient and the F-ratio of scattering analysis as it effects notably the coefficient of regression equation.

**TABLE 5** shows the experimental data of the multiple-correlation coefficient and the F-ratio of scattering analysis. In the case of **TABLE 5**, the upper berth and the lower berth are the multiple-correlation coefficient and the F-ratio of scattering analysis, respectively.

In the present experiments of the sports test data, it can be recognized that the effect of the multiple-correlation coefficients and the F-ratio of scattering analysis is evaluated by computer processing as follows: the multiple-correlation coefficient above  $R=0.8$  is the relation of the weight-girth of the chest ( $R=0.813$  and  $F=762$ ). On the other hand, the multiple-correlation coefficient between  $R=0.4$  and

**TABLE 5** The Multiple-Correlation Coefficient (Upper Berth) and the F-Ratio of Scattering Analysis  
(Lower Berth) for Economics-major Freshmen in 1991

	Height	Weight	Chest	Side Step	Vertical Jump	Back Strength	Grip Strength	Trunk Extension	Standing Trunk Flexion	Step Test
Height		0.4268 87.3230	0.2278 21.4510	0.1466 8.6145	0.2176 19.4870	0.2861 34.9590	0.3835 67.5900	0.0503 0.9958	0.0232 0.2120	0.0699 1.9271
Weight	0.4293 88.5610		0.8126 761.9700	0.0680 1.8203	0.0211 0.1742	0.3845 68.0200	0.4083 77.5250	0.0620 1.5116	0.0834 2.7427	0.1642 10.8590
Chest	0.2329 22.4870	0.8126 761.9100		0.0200 0.1563	0.0173 0.1179	0.4102 79.3240	0.3649 60.1950	0.0695 1.9021		0.1209 5.8171
Side Step	0.1545 9.5891	0.0669 1.7624	0.0182 0.1302		0.3854 68.3980	0.1942 15.3650	0.2860 34.9120	0.2087 17.8420	0.0942 3.5121	0.2228 20.4780
Vertical Jump	0.2230 20.5190	0.0193 0.1462	0.0174 0.1192	0.3855 68.4320		0.3293 47.6690	0.3937 71.8830	0.1303 6.7661	0.1672 11.2680	0.0839 2.7813
Back Strength	0.2901 36.0180	0.3844 67.9770	0.4102 79.3160	0.1943 15.3850	0.3292 47.6580		0.5413 162.4700			0.1022 4.1339
Grip Strength	0.3862 68.7300	0.4062 77.4770	0.3648 60.1820	0.2860 34.9300	0.3936 71.8680	0.5413 162.4700		0.0953 3.5938	0.0675 1.7935	0.0278 0.3033
Trunk Extension	0.0709 1.9776	0.0614 1.4815	0.0695 1.9007	0.2088 17.8700	0.1302 6.7633	0.0349 0.4788	0.0955 3.6039		0.2006 16.4340	0.0642 1.6198
Standing Trunk Flexion	0.0549 1.1880	0.0828 2.7069		0.0945 3.5323	0.1671 11.2600		0.0675 1.7963	0.2006 16.4260		0.0560 1.2349
Step Test	0.0858 2.9085	0.1639 10.8250	0.1209 5.8120	0.2229 20.5030	0.0839 2.7758	0.1022 4.1369	0.0281 0.3092	0.0641 1.6168	0.0561 1.2376	

$R=0.7$  were the height-weight ( $R=0.429$  and  $F=89$ ), the weight-grip strength ( $R=0.406$  and  $F=78$ ), the girth of the chest-back strength ( $R=0.410$  and  $F=79$ ) and the back strength-grip strength ( $R=0.541$  and  $F=162$ ), respectively.

The back strength reveals a large confident coefficient for the sports test item data. Although the trunk extension, the standing trunk flexion and the step test are a small confidence coefficient. In this paper, it is shown that the multiple-correction coefficient and the  $F$ -ratio of scattering analysis will remain consistent with the experimental data (1983-1990 years) with freshmen OUEL economics-majors.

The multiple-correlation coefficient and the  $F$ -ratio of scattering analysis in law-majors freshmen based on the experimental date in **TABLE 6** which shows the experimental data of the multiple-correlation coefficient and the  $F$ -ratio of scattering analysis for the relation between the sports test data items. In the case of **TABLE 6**, the upper berth and the lower berth are the multiple-correlation coefficient and the  $F$ -ratio of scattering analysis, respectively.

In the sports test data, we obtained the multiple-correlation coefficient ( $R$ ) and the  $F$ -ratio of scattering analysis ( $F$ ) which was calculated using experimental data. The multiple-correlation coefficient above  $R=0.8$  is the relation of weight-girth of the chest ( $R=0.821$  and  $F=761$ ). On the other hand, the multiple-correlation coefficient between  $R=0.3$  and  $R=0.7$  were the height-weight ( $R=0.488$  and  $F=116$ ), the height-girth of the chest ( $R=0.305$  and  $F=38$ ), the height-grip strength ( $R=0.420$  and  $F=79$ ), the weight-back strength ( $R=0.305$  and  $F=38$ ), the weight-grip strength ( $R=0.332$  and  $F=46$ ), the girth of the chest-back strength ( $R=0.374$  and  $F=60$ ), the side

**TABLE 6** The Multiple-Correlation Coefficient (Upper Berth) and the F-Ratio of Scattering Analysis  
(Lower Berth) for Law-major Freshmen in 1991

	Height	Weight	Chest	Side Step	Vertical Jump	Back Strength	Grip Strength	Trunk Extension	Standing Trunk Flexion	Step Test
Height		0.4981 115.3700	0.3043 37.6570	0.0969 3.4952	0.1015 3.8409	0.2368 21.9190	0.4192 78.6480	0.0967 3.4814	0.1259 5.9418	0.0610 1.3777
Weight	0.4884 115.5900		0.8206 760.6400	0.0562 1.1687	0.1757 11.7510	0.3047 37.7560	0.3318 45.6630	0.0450 0.7494	0.1103 4.5438	0.1563 9.2447
Chest	0.3049 37.8180	0.8206 760.5900			0.1458 8.0101	0.3743 60.1110	0.2749 30.1680		0.0305 0.3440	0.0821 2.5015
Side Step	0.0982 3.5928	0.0546 1.1035			0.3307 45.3140	0.2428 23.1170	0.2288 20.3780	0.1332 6.6674	0.1503 8.5243	0.1428 7.6845
Vertical Jump	0.1029 3.9467	0.1753 11.6940	0.1454 7.9697	0.3307 45.3230		0.2666 28.2420	0.3262 43.9310	0.1345 6.8023	0.2617 27.1340	0.1020 3.8752
Back Strength	0.2374 22.0910	0.3045 37.6980	0.3742 60.0670	0.2429 23.1270	0.2666 28.2430		0.5132 131.9600		0.1897 13.7800	0.0688 1.7558
Grip Strength	0.4195 78.7810	0.3317 45.6070	0.2748 30.1310	0.2288 20.3920	0.3262 43.9370	0.5132 131.9600		0.1044 4.0637	0.1280 6.1441	0.1008 3.7838
Trunk Extension	0.0989 3.6464	0.0452 0.7539		0.1339 6.7377	0.1351 6.8624	0.1496 8.4498	0.1051 4.1216		0.2559 25.8560	
Standing Trunk Flexion	0.1271 6.0578	0.1097 4.4978	0.0291 0.3133	0.1504 8.5431	0.2618 27.1440	0.1898 13.7880	0.1280 6.1487	0.2557 25.8030		0.1197 5.3644
Step Test	0.0635 1.4917	0.1560 9.1976	0.0816 2.4708	0.1430 7.7023	0.1021 3.8834	0.0689 1.7625	0.1008 3.7869		0.1197 5.3626	

step-vertical jump ( $R=0.331$  and  $F=45$ ), the vertical jump-grip strength ( $R=0.326$  and  $F=44$ ) and the back strength-grip strength ( $R=0.513$  and  $F=132$ ), respectively.

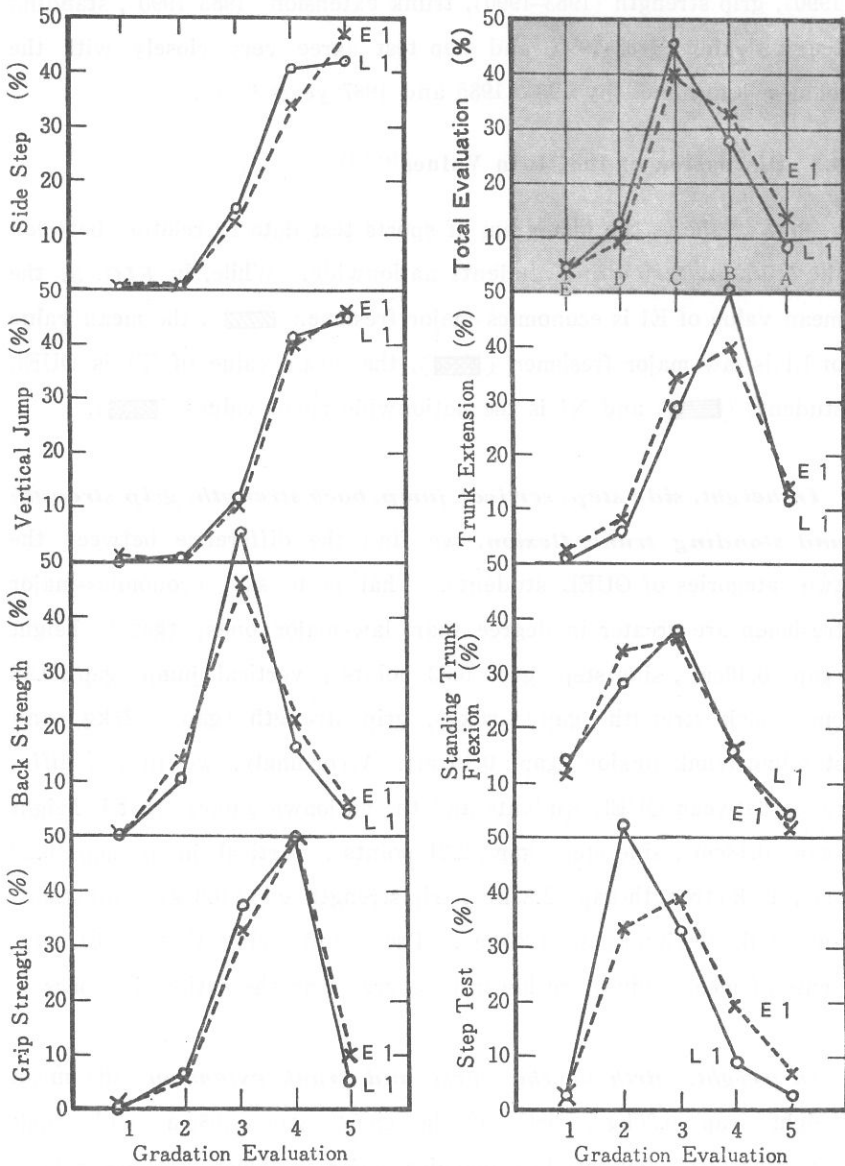
Therefore, the sports test items for back strength and grip strength with the multiple-correlation coefficient were a very large value. Although, in trunk extension, standing trunk flexion and step test, the multiple-correlation coefficient and the F-ratio of scattering analysis have a very small value. The multiple-correlation coefficient and the F-ratio of scattering analysis can be recognized as experimental data (1983-1990 years) freshmen OUEL law-majors.

## 4 DISCUSSION

### 4.1 Discussion of the 5-Gradation Evaluation<sup>(4)-(14)</sup>

**FIG. 2** shows the experimental data derived from relation appraisal of the 5-gradation evaluation and the physical fitness on the students tested. In **FIG. 2**, the dotted line ( $\times---\times$ ) and the solid line ( $\bigcirc---\bigcirc$ ) are plotted economics-major and law-major freshmen, respectively.





We can see that as the grade goes up the higher the percentage grows for the side step and vertical jump in economics-majors (E) and law major freshmen. While, the physical fitness percentages decrease with an increase of from 1 to 3 grade and 4 gradation, respectively, as follows: side step (L), vertical jump (E and L), grip strength (E and L) and trunk extension (E and L) agree very closely with the percentage values determined by economics- and law-major freshmen, respectively. The side step (1983E2, 1987L2, 1988E2, 1988L2 and 1989E1), vertical jump (1989E1 and 1990E1), back strength (1983-



**FIG. 2** Relation between Appraisal of the 5 Gradation Evaluation and Sport Test for OUEL Freshmen in 1991

1990), grip strength (1983-1990), trunk extension (1983-1990), standing trunk flexion (1988-1990) and step test agree very closely with the values determined by 1984, 1985 and 1987 years<sup>(4)-(10)</sup>.

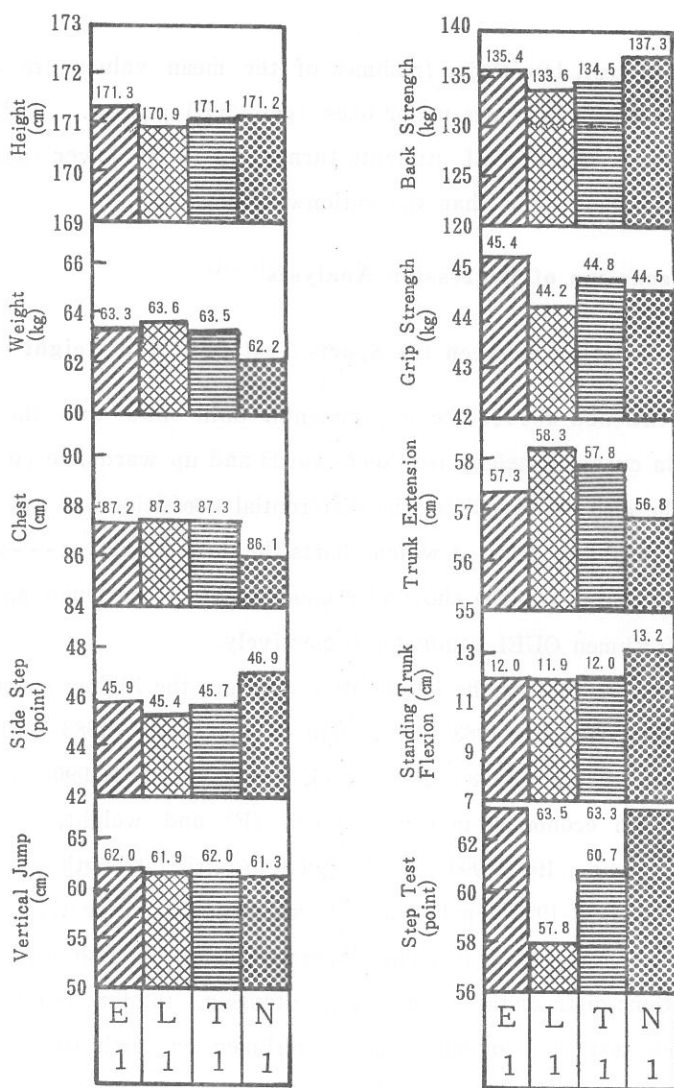
#### 4.2 Discussion of the Mean Values<sup>(4)-(14)</sup>

**FIG. 3** shows the histogram of sports test data in relation between the students tested and students nationwide. While, in **FIG. 3**, the mean value of E1 is economics-major freshmen () , the mean value of L1 is law-major freshmen () , the mean value of T1 is OUEL students () and N1 is the nationwide mean values () .

*In height, side step, vertical jump, back strength, grip strength and standing trunk flexion*, we find the difference between the two categories of OUEL students. That is to say, economics-major freshmen are greater in degree than law-major ones; that is height (gap : 0.40cm), side step (gap : 0.53 points), vertical jump (gap : 0.13 cm), back strength (gap : 1.80kg), grip strength (gap : 1.23kg) and standing trunk flexion (gap : 0.18cm). Accordingly, we find a difference between OUEL students and the nationwide ones; that is height (gap : 0.18cm), side step (gap : 2.21 points), vertical jump (gap : 0.27 cm), back strength(gap : 2.83kg), grip strength(gap : 0.38kg) and standing trunk flexion (gap : 1.29cm). The result being that OUEL students of mean values are lower in degree than the nationwide ones.

*In weight, girth of the chest and trunk extension*, the mean weight (gap : 0.30kg), girth of the chest (gap : 0.08cm) and trunk extension (gap : 0.95cm) in economics-major freshmen are lower than those of law-major freshmen. At the same time, OUEL students in the weight (gap : 1.29kg), girth of the chest (gap : 1.24cm) and trunk





**FIG. 3** *The Histogram of Sport Test Data in Relation between Economics-major Freshmen (E1), Law-major Freshmen (L1), OUEL Freshmen (T1) and Nationwide Freshmen (N1) in 1991*

extension (gap : 0.95cm) are higher in degree than the nationwide ones.

**In step test**, law-major freshmen of the mean values are greater in degree than economics-major ones (gap : 5.66 points). While, the mean values of all OUEL students turned out to be lower (gap : 2.63 points) in some items than the nationwide ones.

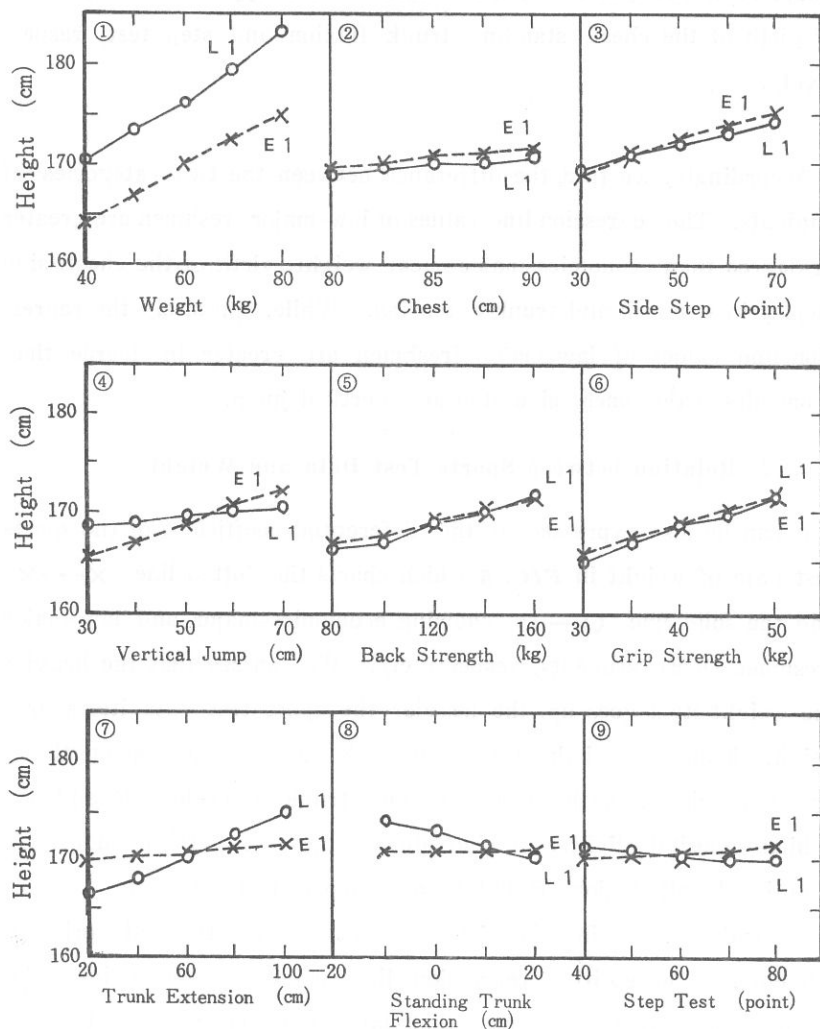
#### **4.3 Discussion of Regression Analysis<sup>(4)-(14)</sup>**

##### **4.3.1 Relation between the Sports Test Data and Height**

As mentioned above, the experimental data show that the sports test data curve of height are down-wards and up-wards, respectively. It can be also expressed by the differential coefficient of the sports data of height in **FIG. 4** which charts the dotted line (X---X) and the solid line (O—O) showing economics-major freshmen and law-major freshmen OUEL students, respectively.

We can see that as the height item goes up, the higher sports data items grow; weight (1983-1990), girth of the chest (1983-1990), side step, vertical jump (1983-1990), back strength (1983-1990) and grip strength on economics-major freshmen (E) and weight, side step, vertical jump (1983-1990), back strength, grip strength and trunk extension (1983-1990) on law-major freshmen (L), respectively. It is noted that as the sport test data increases, height data shows a smaller fluctuation; girth of the chest, trunk extension, standing trunk flexion and step test on economics-major freshmen or girth of the chest, vertical jump and step test on law-major freshmen, respectively.

Therefore, a relation can be recognized in the sports test data and height data. That is, height depends on weight, side step, vertical



**FIG. 4** The Regression Line of Height for Sport Test Data in Freshmen in 1991

Where, (×---×): E1 (Economics-major Freshmen) and  
(○—○): L1 (Law-major Freshmen)

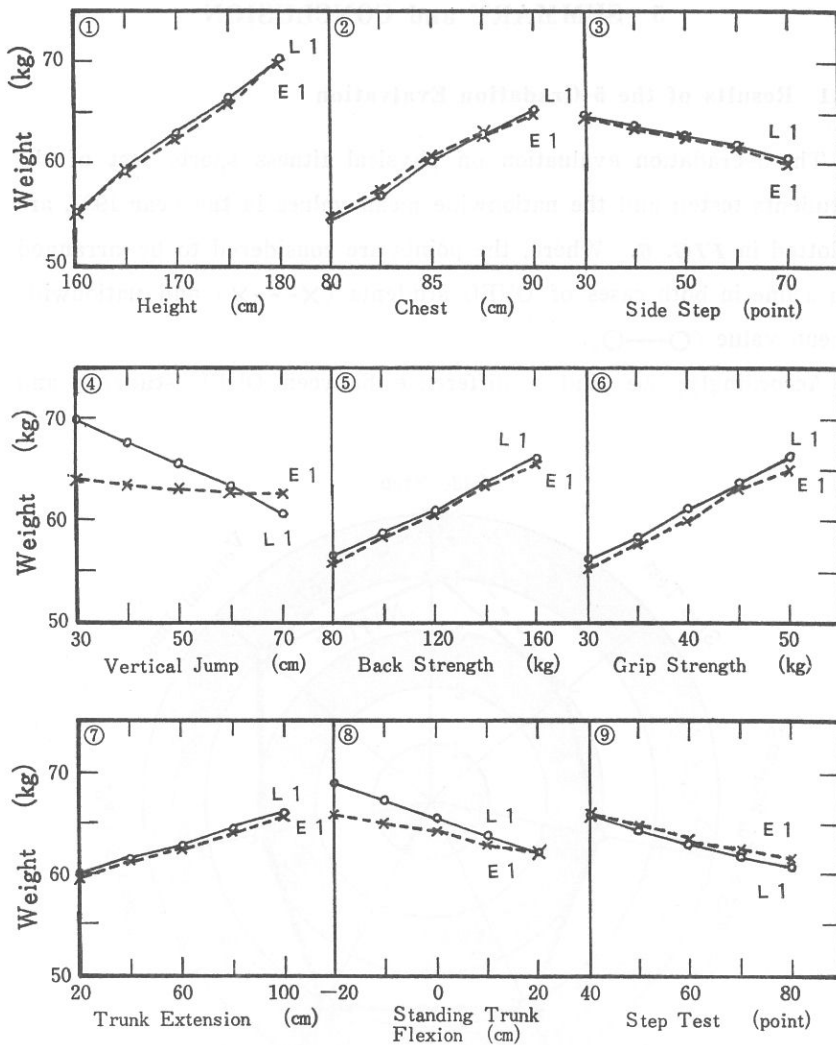
jump, back strength and grip strength. While oppositely independent of girth of the chest, standing trunk flexion and step test, respectively.

Accordingly, we find the difference between the two categories of students. The regression line values of law-major freshmen are greater in degree than economics-major ones; weight, girth of the chest, side step, grip strength and trunk extension. While, oppositely the regression line values of law-major freshmen are greater in degree than economics-major ones; side step and vertical jump.

#### **4.3.2 Relation between Sports Test Data and Weight**

It can be also expressed by the differential coefficient of the sports test data of weight in **FIG. 5** which charts the dotted line (X---X) and the solid line (O—O) showing economics-major and law-major freshmen OUEL students, respectively. We can see that the heavier the weight item goes up, the heavier the sport test data items are: height (E and L), girth of the chest (E and L), back strength (E and L), grip strength (E and L) and trunk extension (E and L). While, oppositely lighter in side step (E and L), vertical jump (L), standing trunk flexion (E and L) and step test (E and L).

Accordingly, we find the difference between the two categories of students. The positive regression line values of economics-major freshmen are greater in degree than law-major ones: back strength, grip strength and trunk extension, but they are lower in height and girth of the chest.



**FIG. 5** The Regression Line of Weight for Sport Test Data in Freshmen in 1991

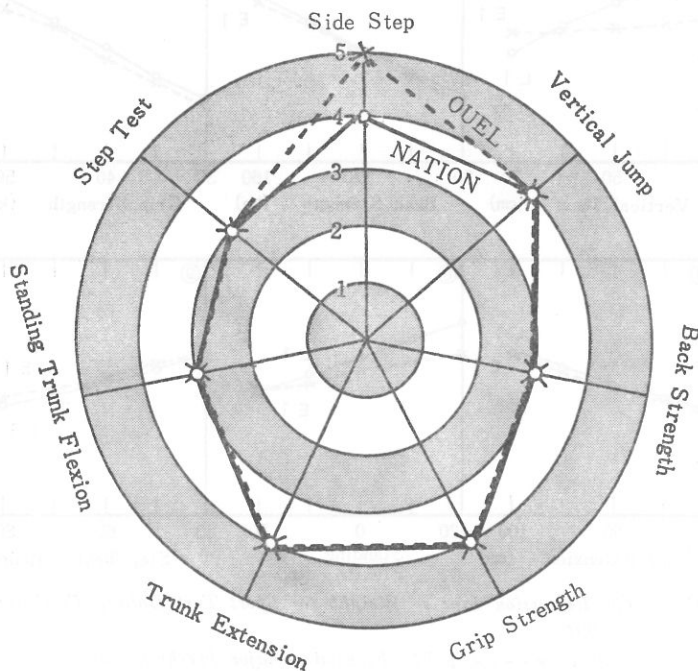
Where, (x---x): EI (Economics-major Freshmen) and  
(o—o): LI (Law-major Freshmen)

## 5 SUMMARY and CONCLUSION

### 5.1 Results of the 5-Gradation Evaluation

The 5-gradation evaluation on physical fitness sports test of the students tested and the nationwide mean values in the year 1991, are plotted in **FIG. 6**. Where, the points are considered to be arranged in a line in both cases of OUEL students ( $\times$ --- $\times$ ) and nationwide mean value ( $\bigcirc$ — $\bigcirc$ ).

Accordingly, we find a difference between OUEL students and



**FIG. 6** The 5 Gradation Evaluation of Physical Fitness Test for OUEL Freshmen ( $\times$ --- $\times$ ) and Nationwide Mean Values ( $\bigcirc$ — $\bigcirc$ ) in 1991

nationwide mean value. The nationwide mean values are the greater grade with side step in degree for OUEL students, but other grades are at same level.

## **5.2 Results of the Mean Values**

The mean values of economics-major freshmen are higher than those of law-major freshmen in height (171.25cm and gap : 0.40cm), side step (45.92 points and gap : 0.53 points), vertical jump (62.04cm and gap : 0.13cm), back strength (135.39kg and gap : 1.80kg), grip strength (45.44kg and gap : 1.23kg) and standing trunk flexion (12.04cm and gap : 0.18cm), but they are lower in all the other items (weight and girth of the chest, trunk extension and step test).

Consequently, the mean values of all OUEL students turned out to be higher in some items than the nationwide ones; weight (63.44kg and gap : 1.29kg), girth of the chest (87.25cm and gap : 1.24cm) and trunk extension (57.79cm and gap : 0.95cm), but they are lower in all the other items (height, side step, vertical jump, back strength, grip strength, standing trunk flexion and step test).

## **5.3 Regression Coefficient**

In economics-major freshmen, regression coefficient on OUEL students calculated using computer processing in the present study are positive and negative regression coefficients (**TABLE 3**). The positive regression coefficients for it items are back strength, grip strength and trunk extension. It was found that a mixed positive and negative regression coefficients for its items are height, weight, girth of the chest, side step, vertical jump, standing trunk flexion and step test.

Next, in law-major freshmen regression coefficient on OUEL students calculated from information processing in the present study are po-

sitive and negative coefficients (**TABLE 4**). The positive regression coefficient for its items are back strength, grip strength and trunk extension. While it was found that mixed positive and negative regression coefficient are height, weight, girth of the chest, side step, vertical jump, trunk extension, standing trunk flexion and step test.

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