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Physical and Intellectual Development of Korean Children in Relation to Family Formation Patterns

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Ⅰ. Introduction

The literature relating to anthropometric measurements and IQ score in relation to the family formation pattern is voluminous. A critical appraisal of these literatures has been done extensively for the WHO collaborative studies by A.R. Omran in 1976[1] and was up-dated in 1981[2].

Many of these studies demonstrated that some of the family formation components such as family size and birth order were statistically associsted with the physical and intellectual development of the children although a part of the studies also showed no correlation, particularly when the sample sizes were not sufficiently large enough to demonstrate the correlation.

Immediate objective of this study is to evaluate the impacts of family formation pattern on physical and intellectual development of Korean children as measured respectively by specified anthropometric and IQ testing, which never been done before in large scale and well designed plan like this in Koreea.

The ultimate objective on the other hand is to provide health rationale for family

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planning; Korean parents are very much interested in physical and particularly intellectual development of their children owing to the highly competitive Korean society, and the health rationale accepted to parents will supplement the demographic rationale promoted by the government.

The overall hypothesis to be tested is that family size / birth order is negatively correlated with physical and intellectural development of children.

The operational or specific hypotheses are :

1) The mean height and weight of childern aged 12-14years will decrease with family size and birth order
2) The mean hematocrit level of children aged 12-14 years will decrease with family size and birth order.
3) The mean IQ scores of children aged 12-14 years will decrease with family size and birth order.
4) All the measurements of children aged 12-14 years are associated with birth interval between the children and their elder and younger siblings.
5) These relationships will be persistent for :
   (a) Rural and urban areas
   (b) Slum and well-to-do areas of urban
   (c) Social status of parents
   (d) Educational level of parents

Ⅱ. Methods and Materials

The study was carried out among middle school children aged 12-14 years in 1984. Middle schools were chosen for the study because they included the 12-14 years old children who are the most suitable for anthropometric and IQ measurements. Five middle schools each from well-to-do and slum areas of Seoul metropolitan city, and twelve schools from rural areas of Kangwon Province were randomly selected in such a way that each area has the similar number of children, about 15,000 children.

In order to make the socioeconomic classification distinctive, upper (well-to-do) and low (slum) socioeconomic classes were subjected for sampling in Seoul metropolitan city : Five schools out of 68 middle schools located formats were purchased.

Information on the family formation and other necessary variables were obtained from parents of the children with the teacher's assistance on semi-structured questionnaire. The questionnaire contained personal identification, list of family members with age and relationship to the child, educational levels of the parents, items to determine social class (WHO 1976), number of siblings before and after the index child, family size, birth order, and maternal age for the purpose of cross check.

The anthropometric and IQ measurements were carried out for all children but the hematocrit were examined only on half of the children in each stratum.

In addition to the weight, height and IQ measurements a few more measurements such as chest circumference, sitting height and hematocrit were inclued to the study. The sitting height and chest circumference have

been included to the anthropometric measurements in Korea for years routinely. Hematocrit was checked as a supplementary index of nutritional status because iron deficiency anemia had been so prevailing that the hematocrit value become indispensable for growth and development studies in Korea, particularly during this period of growth. All the measurements were carefully examined in terms of its validity and reliability in the phase of pilot study.

The pilot study was carried out prior to the major study on one examplary class in each area when also the research team members were trained by practicing their own part of activity : nurses for actual measurements and teachers for making the children prepared (to take off shoes and upper coat) and recording the measured values. Through this, measurements were standardized step by step in the well-to-do school districts and five schools from 41 schools in the low-income school districts were randomly sampled.

Since Korea has a school district system[3], the location of the school represents the community and the school board classifies 267 middle schools by the characteristics of its district or community. For a rural area Kangwon Province was selected because the provinc is not much different from other Korean rural areas and that the province used to provide the best cooperation owing to the official contract with Seoul National University. There were 127 middle schools located in counties or townships among which[4] is schools were randomly selected.

Almost all primary school graduates enroll to middle school; for example in 1984 about 96 % of the graduates entered middle school so that the middle school children represent the age group of the population.

According to the school board statistics the drop-out rate throughout three-year period is less than 2%. Also the class retention rate per class[3] is reported to be less than 0.5%.

The anthropometric measurements included standing and sitting heights, chest circumference, and weight. The nutritional status was assessed by hematocrit in addition to the physical developmental measurements.

Intellectual development was assessed by means of IQ test. The test used was developed for Korean children by two educational psychologists[5] of College of Education, Seoul National University. The test consists of 25 questions for word usage, 25 for verbal reasoning 20 for arithmatic reasoning, 20 for numerical reasoning, and 20 for figure reasoning.

The test was standardized on the basis of research on a large sample of middle school children and established standard scores by area, urban-rural, in accordance with the frequency distribution. The results of IQ testing were scored by trained regular personnel of the test center from where the testing by training research team including reachers and school nurses and by replacing less precise instruments with better ones. For example, the research members, teachers and school nurses of the schools under the study were trained to measure the anthropometry precisely by checking interpersonal and intrapersonal consistencies each another in a blinded fashion : the bathroom scales had been replaced by

beam scales later because the repeated measurements on the same individuals on bathroom scales in comparison with beam scale revealed not only inconsistency but also considerable difference in values measured; when the weight of a examplary class measured by bathroom scales were compared with that of measured by beam scale the mean difference between two scale was about 1.5Kg. The difference become larger when the bathroom scale used more iolently by male children.

IQ testing was carried out by teachers who were trained by the professional staff of the testing center, which is a routine job for them whenever the IQ testing formats are purchased as a part of service included in the price of the format.

The duration of centrifugation and r.p.m. for the capillary hematocrit had been selected after several trials and the hamatocrit was read by two fixed persons to minimize the possible interpersonal variation.

The anthropometric data were recorded by the teachers on the questionnaire sheet at the time of measurements and the IQ scores were recorded by the research assistants on the same sheet when the testing center had sent the results of IQ testing for all children tested a few months later. After the cleaning and editing the data they were coded and analyzed by computer.

Means and standard deviations of the physical and intellectual developmental measurements were computed by relevant variables with control of confounding variables. Multiple regression and partial regression analyses were also tried in order to cross check the data as many ways as possible.

Ⅲ. Study Results and Discussion

The study results may be presented in four parts namely characteristics of the children studied, frequency distribution of the data measured to understand their characteristics in terms of validity and reliability of the measurements and its nature itself, means of the measurements by variables, and correlation between the physical and intellectual developmental indices and family formation components.

1. The characteristics of the children studied

The summarized general characteristics of the children is in Table 1. The children studied were from three different strata classified by two criteria, urban-rural, and well-to-do-slum of a metropolitan city, Seoul. These children numbered 46,640 and belonged to 22 middle schools, five schools each from well-to-do and slum areas of Seoul and 12 schools from rural areas of Kangwon Province. The number of children for each stratum is about the same although there were more children in lower grade than in higher grade, which in fact is reflecting the base population of the middle school enrollment each year. For instance the ratio of enrollment to middle

school was 107 in 1983 (2nd grade in 1984) and 114 in 1984 (1st grade in 1984) when it was 100 in 1982 (3rd grade), exactly the same as the ratio among the group studied. Over 90% of the children were 12-14 years old and the sex ratio was 102.

Table 1. General characteristics of the children Studied

Area	No. of children	% total
Urban Well-to-do (5)	16,097	34.5
Slum (5)	15,427	33.1
Rural (12)	15,116	32.4
Sex		
Male	23,558	50.5
Female	23,082	49.5
Age (Year)		
11	3,229	6.9
12	15,522	33.3
13	15,740	33.7
14	10,993	23.6
15	1,156	2.5
Total	46,640	100.0

( ) : No. of school

The family formation characteristics of the children is shown in Table 2; father's current age was 40-49 years in 70% whereas the age of mothers was 35-44 years in 67%. The mean ages of parents were 46.0±5.5 years for fathers and 42.0±5.4years for mothers. In the distribution of the children by birth order showed that over 40% of the children were born as 3rd or later than that order. In the total number of siblings beside the index child two siblings were the most common compristing 35% of the children. The children with more than three siblings beside himself or herself were about 45%. The most frequent birth spaces between elder and younger siblings were 2-3 years and 1-2 years respectively.

2. Frequency distribution of the developmental measurements

The frequency distribution of some measurements renders us valuable information in understanding the data and in determining what kind of statistical in ference should be made for analysis; the shape of the distribution also provide information to certain extent on degree of consistency in measurements and on adequacy of classification (interval).

All the measurements in general reveal normal distribution, and the intervals seem to be quite adequate except hematocrit, for which the interval appears too crude. Figure 1 shows the frequency distribution of height, weight and IQ score; all of them reveal normal distribution with central tendency.

3. Means of the developmental indices by selected variables

The means are presented as a representative values for the groups classified. Since means by specific variables under the control of any other variables will be presented in the section of correlation the representative means are presented by area, age and sex. Fig. 2 shows the mean heights of the chirden by the variables mentioned above. For the same sex and

Table 2. Characteristics of family formation pattern

(A) Parent's Mean ages (yrs.) ±S. D.	Father	Mother
	46.0±5.5	42.0±5.4

(B)	Birth order	Number	% Total
	1st	13,835	29.7
	2nd	12,477	26.8
	3rd	10,068	21.6
	4th	6,110	13.1
	5th	2,654	5.7
	6th	950	2.0
	7th	448	0.9

(C) No. sibs.	Elder bro.		Younger bro.		Elder sis.		Younger sis.		Total	
	No.	%tot.	No.	%tot.	No.	%tot.	No.	%tot.	No.	%tot.
None	23,517	50.5	23,800	51.1	26,165	54.1	28,806	61.9	983	2.1
One	15,114	32.4	13,584	29.2	17,448	37.5	13,085	28.1	8,693	18.7
Two	5,738	12.3	6,234	13.4	3,603	7.8	3,630	7.9	16,150	34.7
Three	1,642	3.6	2,202	4.7	282	0.6	806	1.7	10,999	23.6
Four	442	1.0	600	1.3	32	0.0	177	0.4	5,729	12.3
Five	101	0.2	125	0.3	3	0.0	20	0.0	2,532	5.4
Six	24	0.0	30	0.0	4	0.0	2	0.0	1,067	2.3
Seven	9	0.0	12	0.0	6	0.0	7	0.0	420	0.9

(D) Birth Space (Yr.)	Elder sibs.		Younger sibs.	
	Number	%total	Number	%total
< 1	1,745	6.1	2,661	9.8
1 - 2*	8,284	28.7	9,578	34.9
2 - 3	8,812	30.6	8,304	30.4
3 - 4	4,490	15.6	3,649	13.3
4 - 5	2,237	7.8	1,542	5.7
5 - 6	1,224	4.2	726	2.6
6 - 8	1,193	4.1	540	2.0
8 - 10	506	1.8	246	0.9
> 10	324	1.1	123	0.4
Total		100.0		100.0

* 2 implies 1.99999....., and all numbers in this clumn have the same quality.

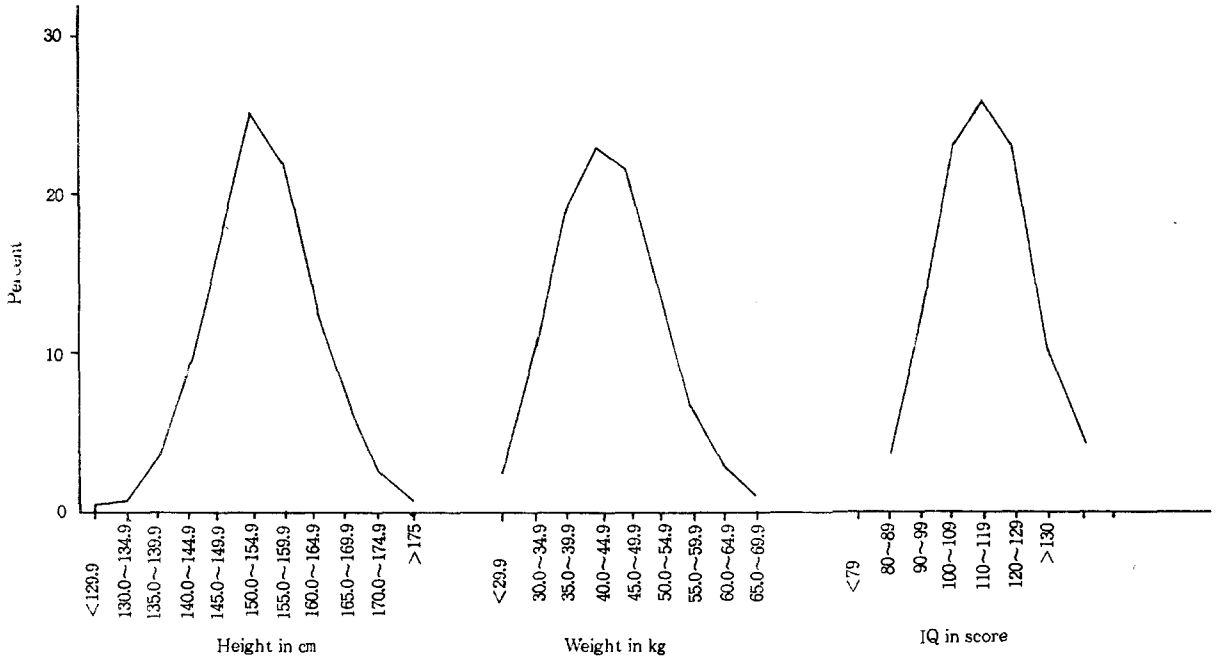


Fig.1 : Frequency Distribution of Height, Weight and IQ on 45,000 Korean Middle School Childern

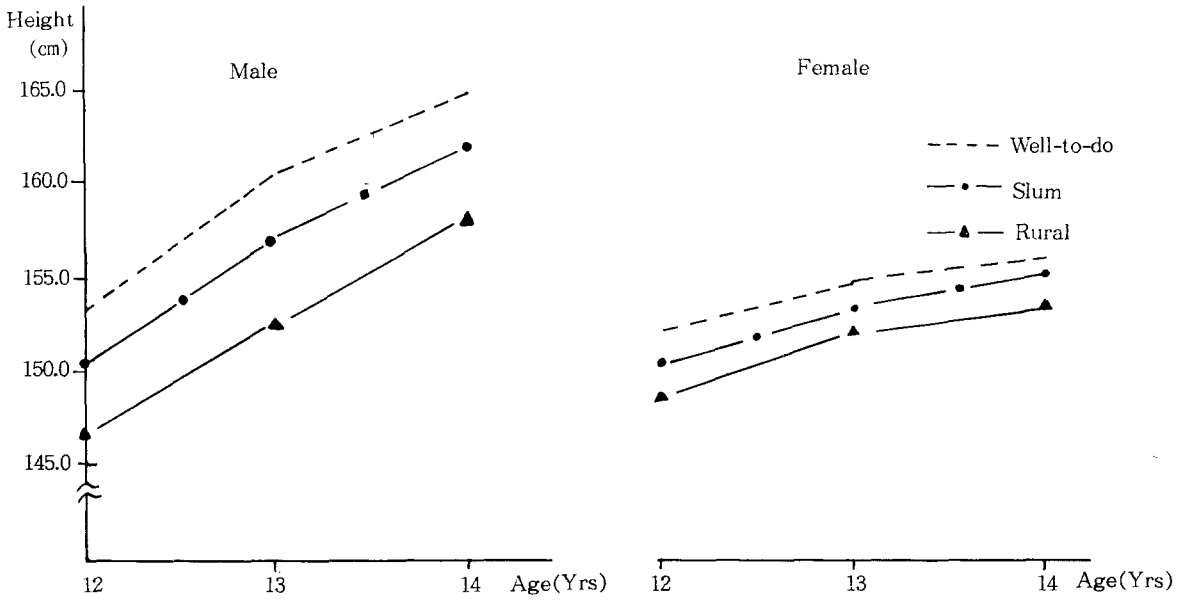


Figure 2 : Height by Area, Age and Sex

age the mean heights were higher in order of well-to-do, slum and rural area of which classification implies both urban-rural and socioeconomic status. It is interesting to see, however, that female children have higher height than male children at 12 years of age but the heights of male children are higher than females at the ages older than 12 years, which indictes the phase of growth is different by sex, the female growing more at younger ages than male; as is usually the case. The sitting height showed the similar pattern to the standing height in all aspects.

Fig. 3 presents the mean values of weight by area, age and sex. For the same sex and age the weight is heavier in order of well-to-do, slum and rural area like the case of height though with less variation than the height. Also when they get older the weight increases in all areas and sexes. The male-female comparison, however, reveals somewhat different pattern by area; for example females have heavier weight than males only at the age of 12 years in slum area whereas females at all ages (12, 13, 14) were heavier than males of the same ages in rural area, and females of all ages were lighter than males of the same ages in well-to-do area probably more conscious about weight among urban high class female children.

The mean IQ score is presented in Fig. 4. The mean IQ scores are higher among male children of the same ages in all areas than among females. The mean score generally decreases as age advances for which the psychologists in charge for the test in-

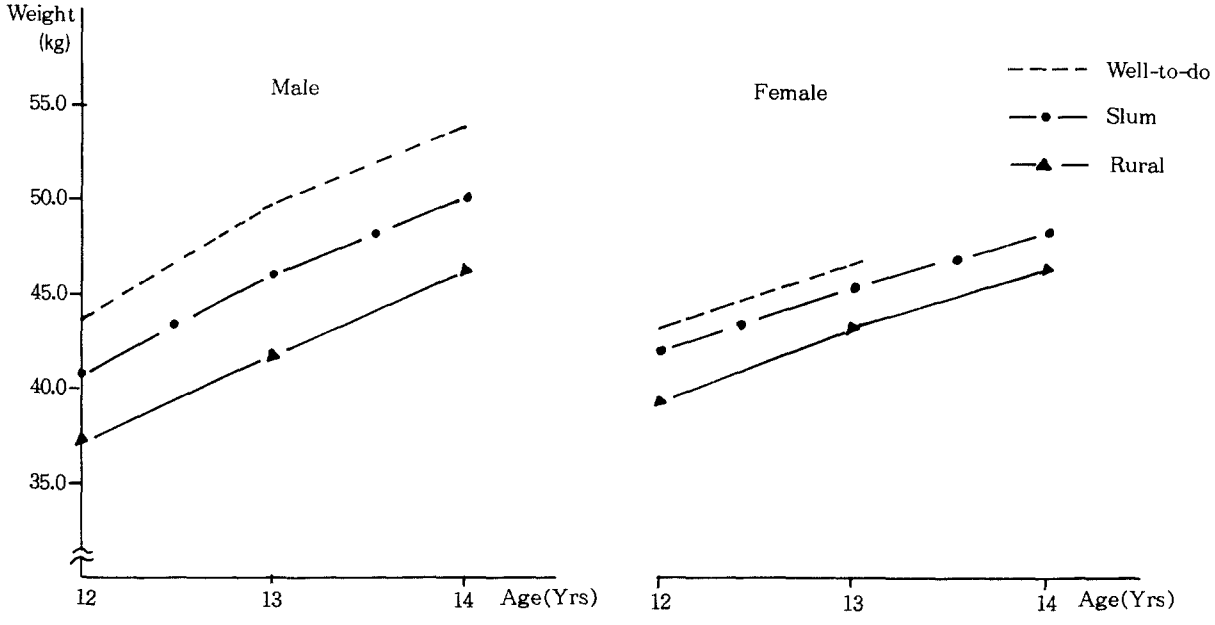


Figure 3 : Weight by Area, Age and Sex

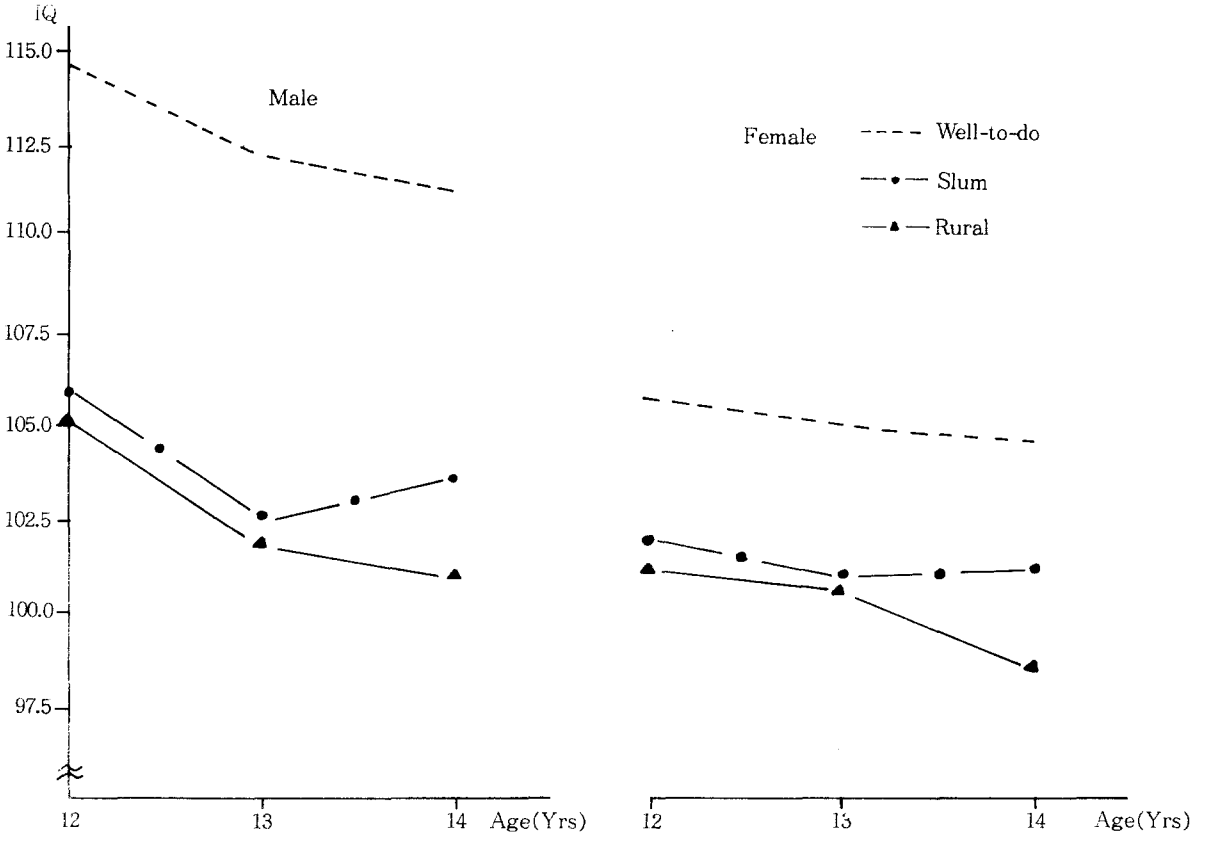


Figure 4 : I.Q. score by Area, Age and Sex

terpretation explained as folowings : in many tests for other groups of children the similar pattern was observed and it was considered to be due to two factors : first the standardized score of each individual is divided by age so that older the age (larger the denominator) smaller the score; the second factor may be due to the attitude of taking the test, for example the first grade children take the test more seriously than the 2nd and 3rd grade children because the test format is the same for the middle school. For the both sexes the mean scores are higher among children in well-to-do area and the lowest in rural area despite the separate standard by area.

The mean values of hematocrit shows less consistent pattern by the variables than the other developmental indices (Fig. 5). The hematocrit means are higher in order of well-to-do, rural and slum area with increasing tendency by age among male children but the pattern is quite different among female childern in that the mean values of hematocrit are higher among rural children than urban, and among younger children than older ones in urban area, probably owing to the differ-

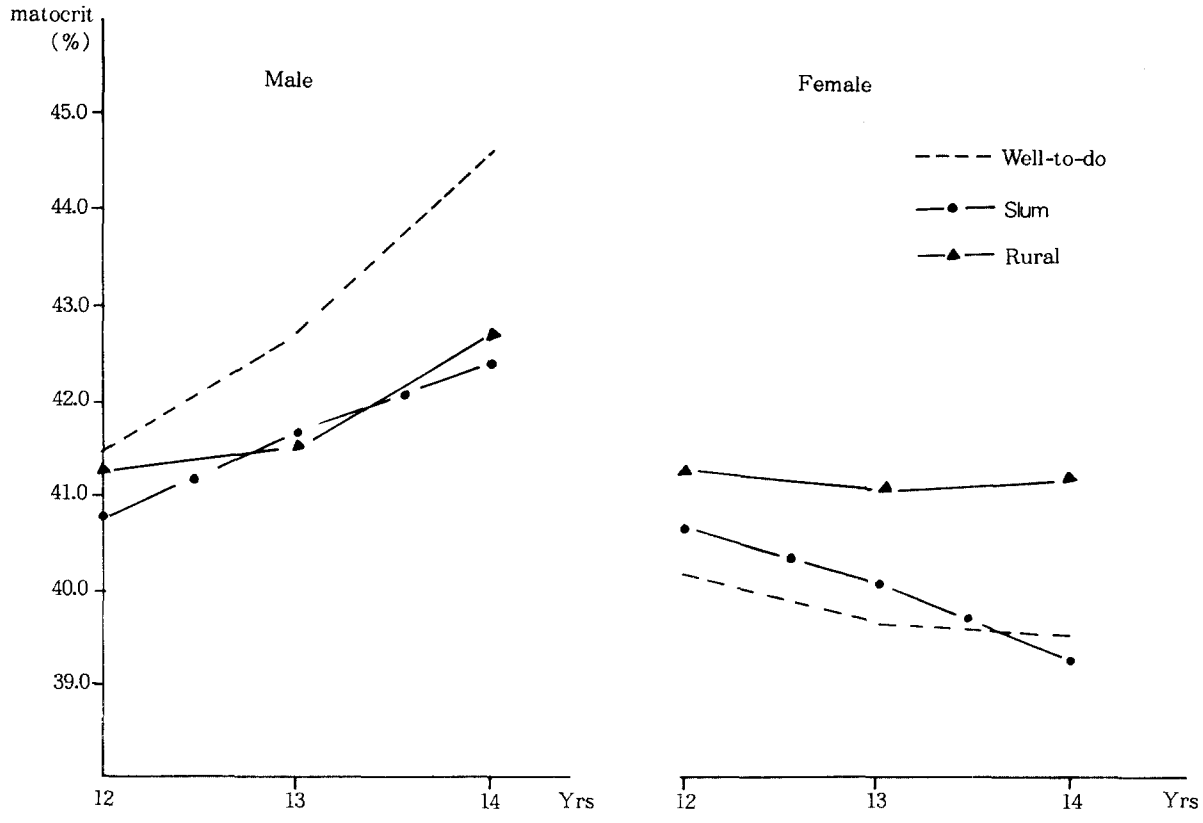


Figure 5 : Hematocrit by Area, Age and Sex

ence in age of menarche by area.

Mean values of the developmental indices by family formation pattern such as birth order, member of siblings, birth interval and maternal age are presented in form of graph. The mean height by area and family formation pattern is in the fig. 6; among the variables of family formation total number of siblings, birth order and maternal age appear to have strong impacts on the mean heights especially for the urban well-to-do area children. Fewer the siblings (except the only child of well-to-do area) and earlier the birth order higher the mean height. The mean height was the highest among the children born to the mother aged 25-29 years. The mean height in relation to birth interval is inconsistent.

The mean weight by the family formation variables has almost identical pattern to that of mean height as shown in Fig. 7. The most striking difference by the family formation variable is found in IQ score as shown in Fig. 8. A characteristics feature in mean IQ score pattern is that the difference between well-to-do and other areas is the biggest among other idices and urban

slum has quite similar pattern to that of rural area not like the other indices. The mean IQ score was the highest for the children having only one sibling, born first and to the mother aged 25-29 years. The birth interval does not show any consisent relationship with the mean IQ score.

Since it was infered that the IQ score might be strongly associated with level of maternal education, maternal age and birth order, the mean IQ scores are plotted against total number of siblings when the

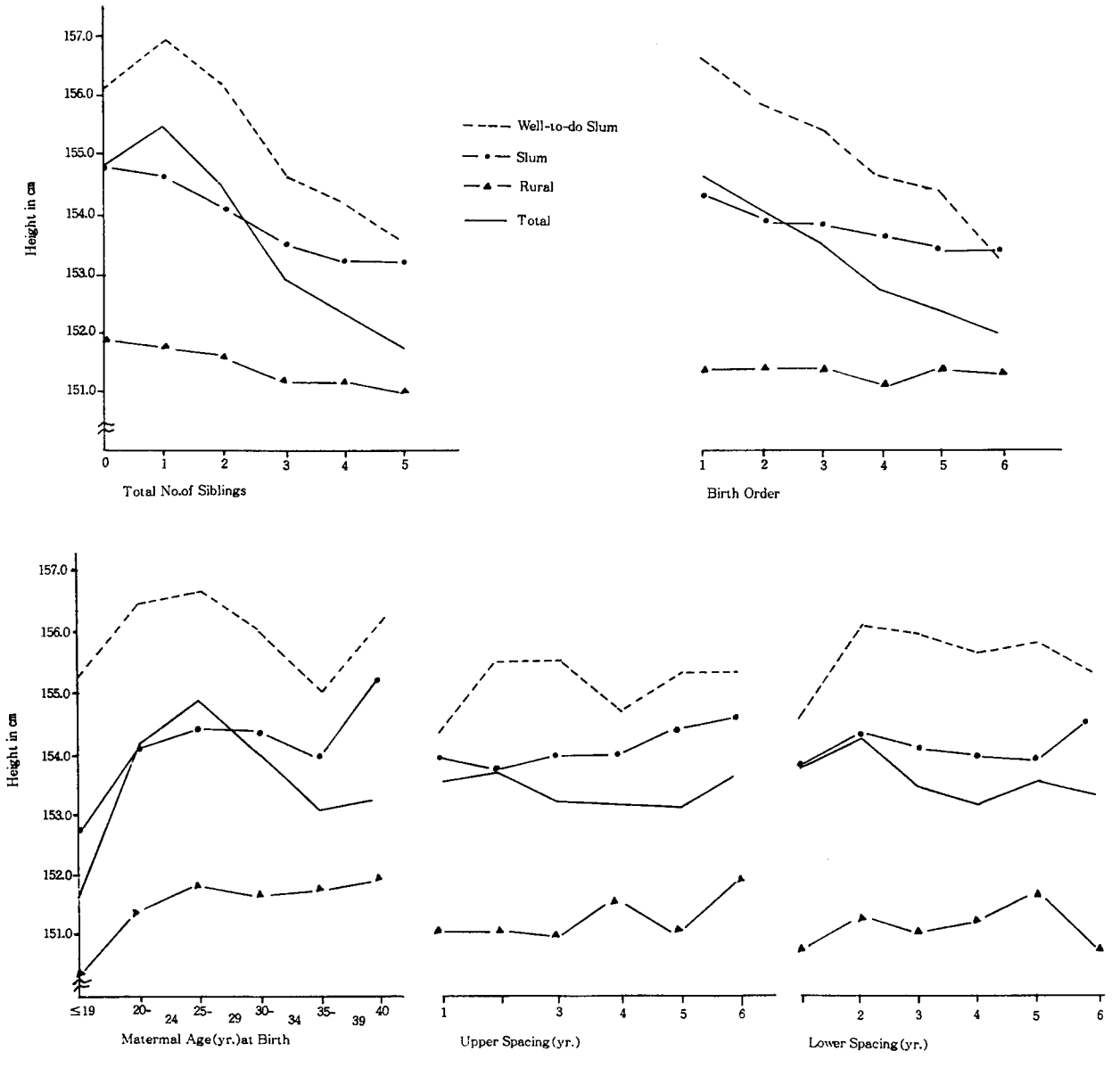


Fig. 6 : Height of the Children by Family Formation Pattern and Area

variables mentioned above are controlled. As shown in Fig. 9, 10, and 11 by area the mean IQ scores show impressive decrease as the number of total siblings increases almost in all areas and birth orders consistently by mother's educational level. Also in all areas the mean IQ scores are higher in accordance with the mother's educational level. There is more striking decrease of the mean IQ score by number of siblings for the first order children in well-to-do area.

Other developmental indices also reveal the similar pattern when confounding vari-

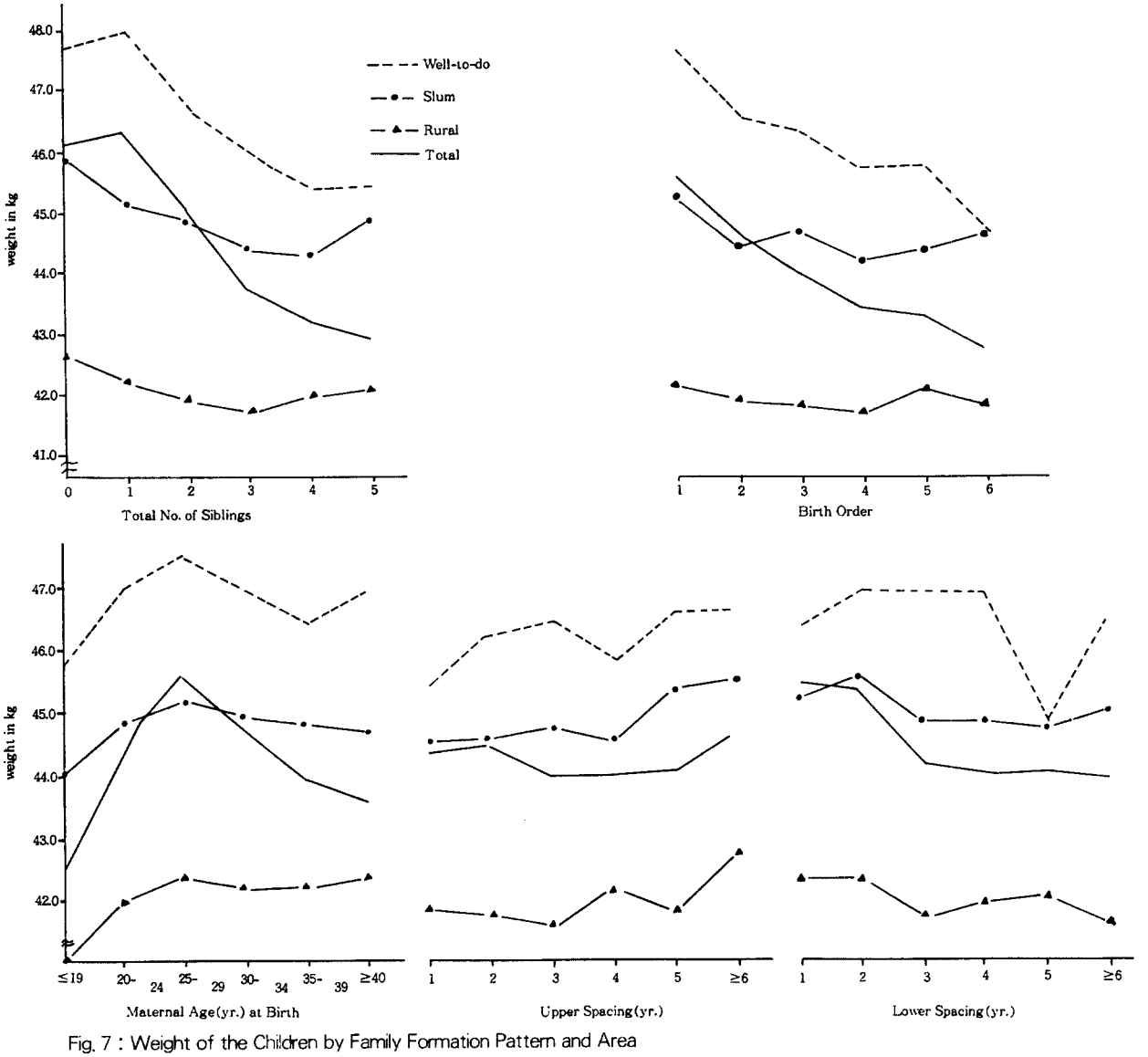


Fig. 7 : Weight of the Children by Family Formation Pattern and Area

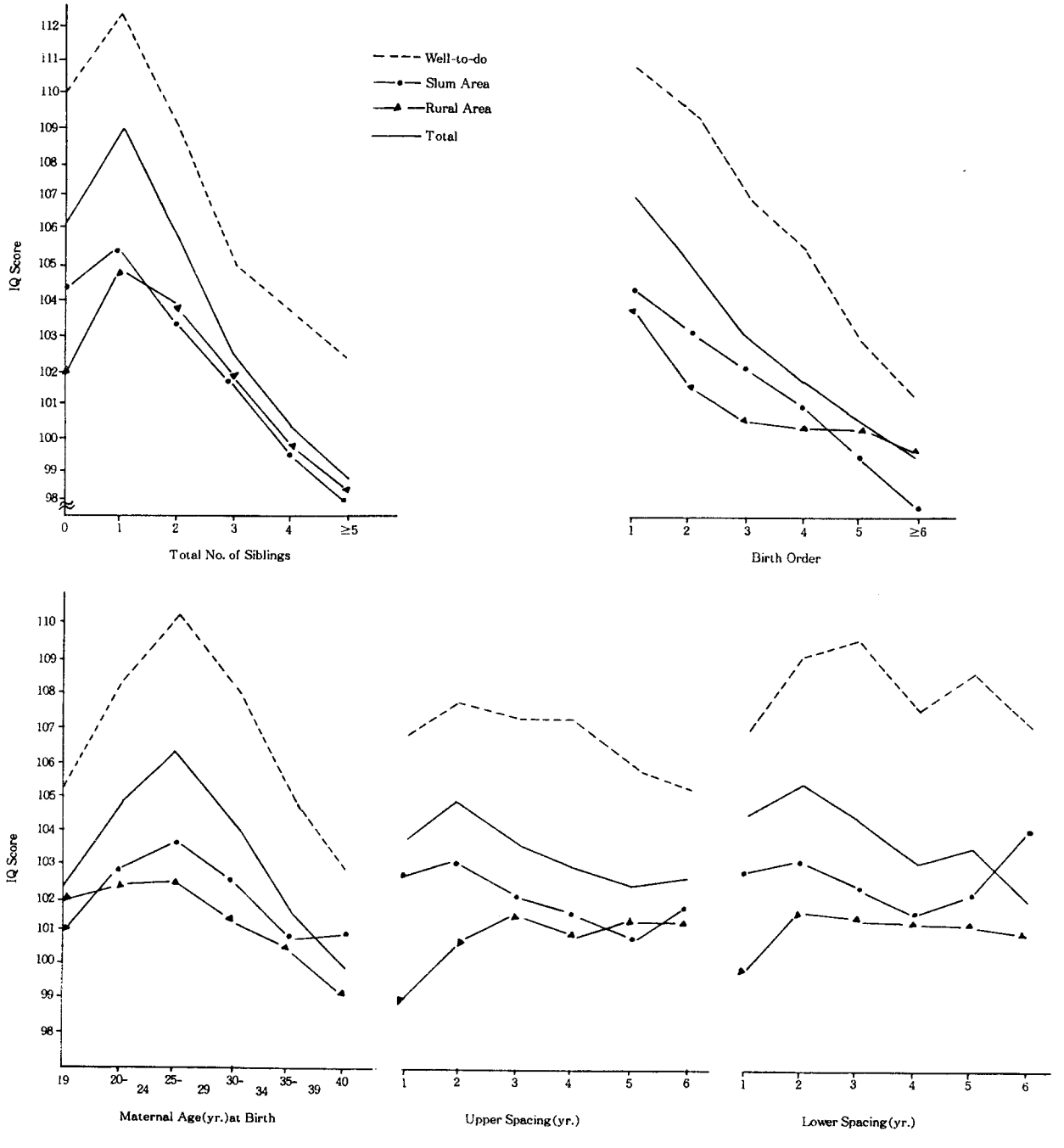


Fig. 8 : Mean IQ of the Children by Family Formation Pattern and Area.

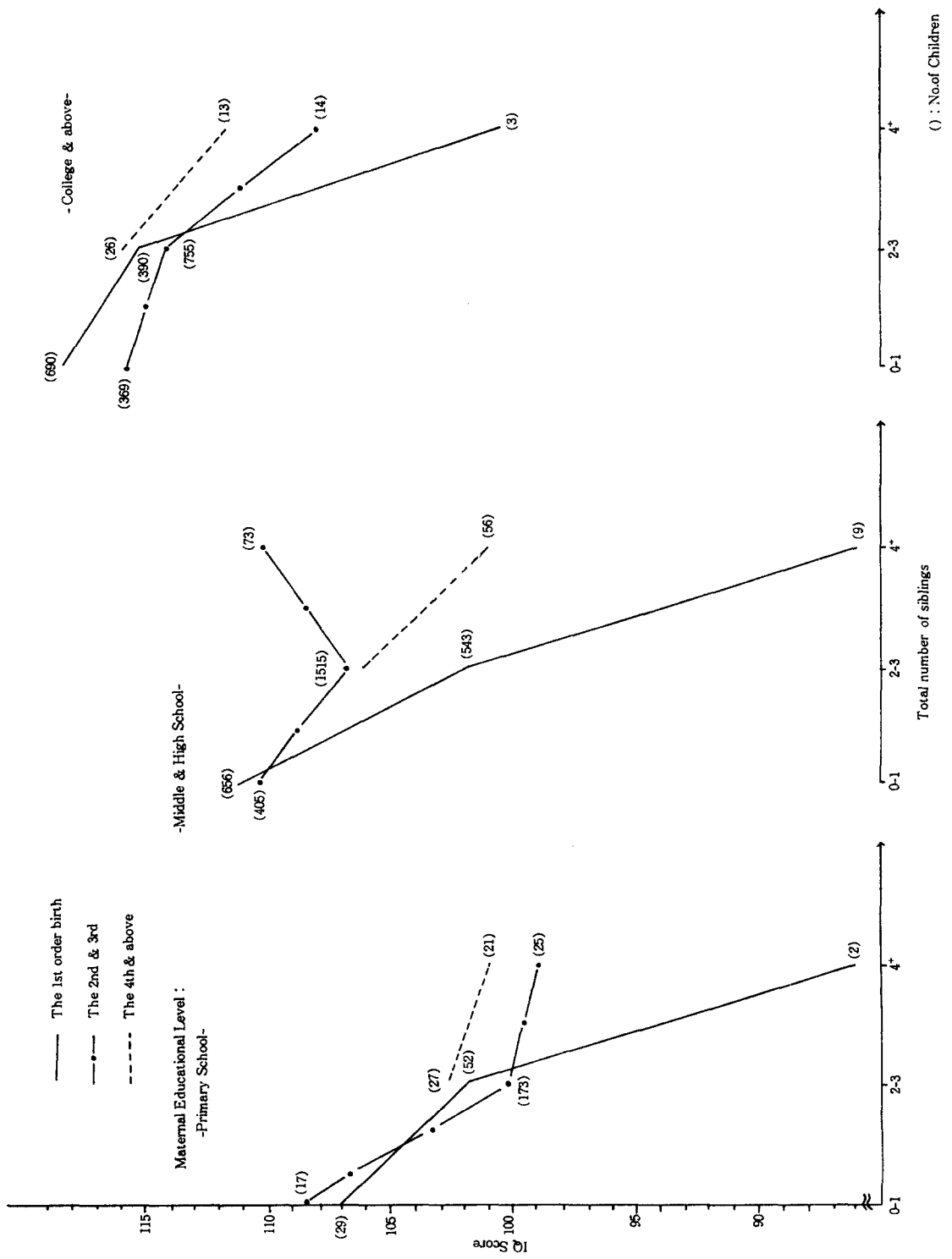
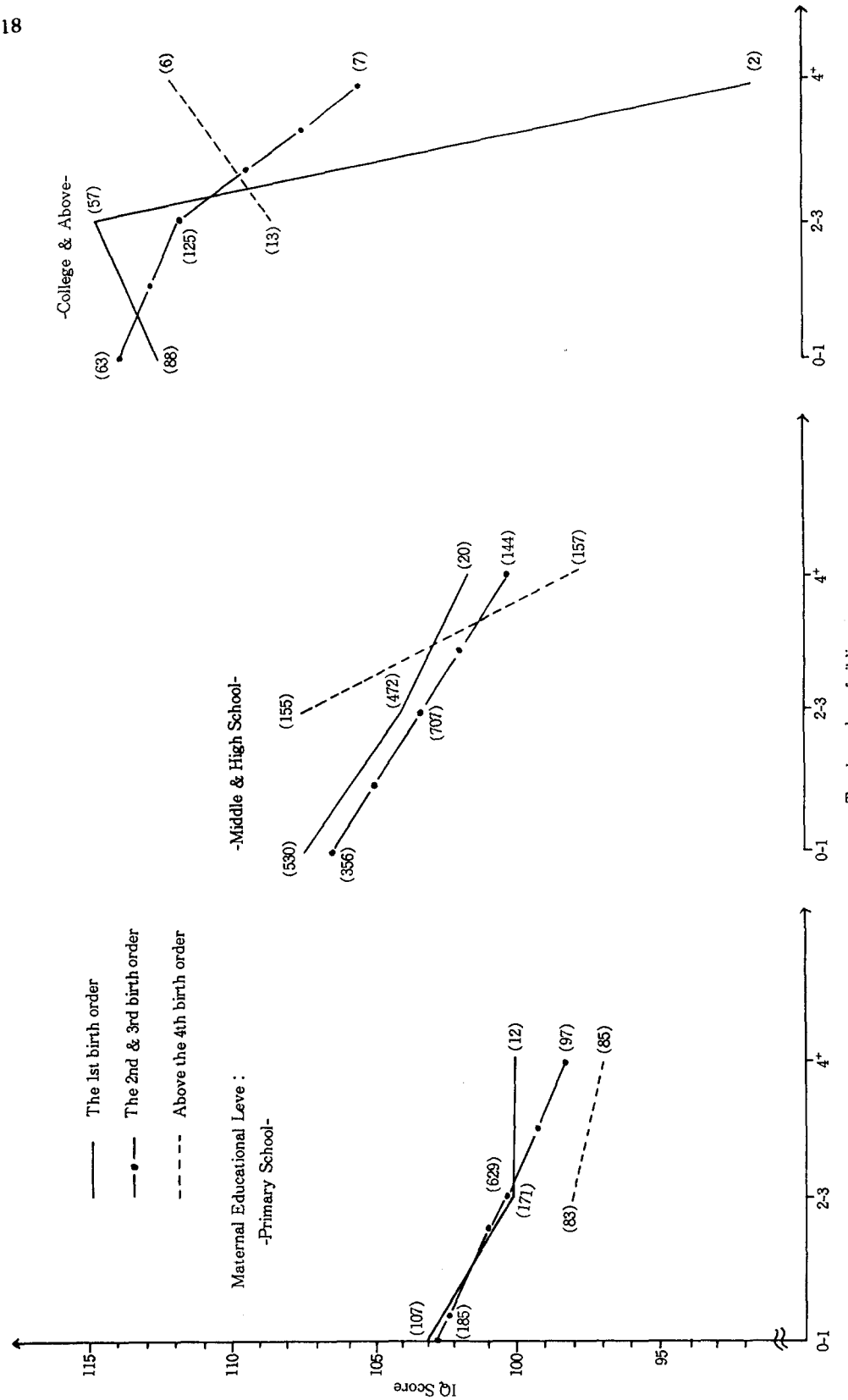


Fig. 9 : Mean IQ of the Urban Well-to-do Children Born to the Mother aged 25-29 years by Maternal Educational Level and Birth order.



( ) : Number of children in each respective group

Fig. 10 : Mean IQ Urban Slum Children Born to the Mother Aged 25-29 years by Maternal Educational Level, Birth Order and Total Number of Sidlings

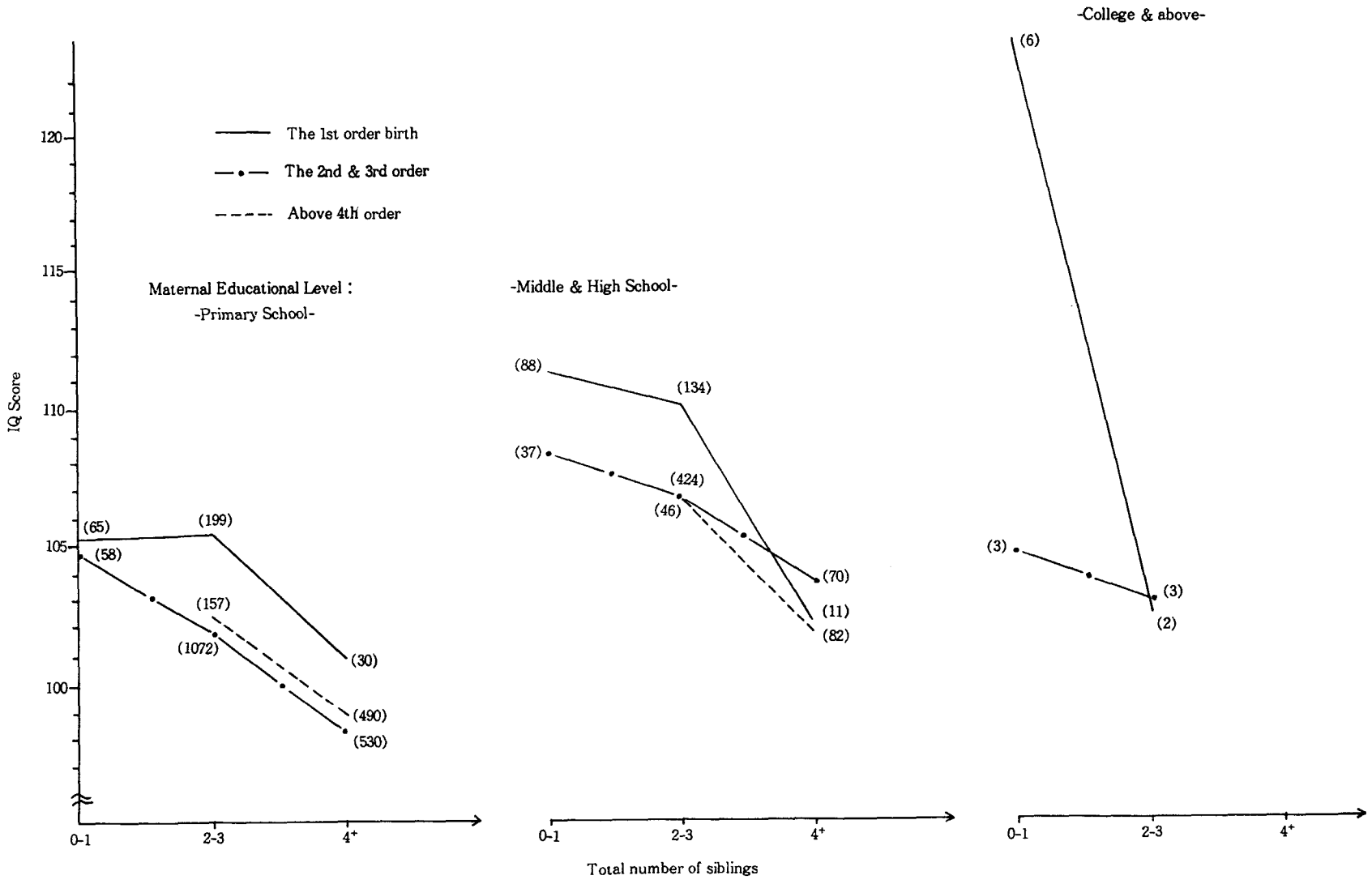


Fig. 11 : Mean IQ of Rural Children Born to the Mother aged 25-29 years by Maternal Educational Level, Birth order and Total Number of Siblings

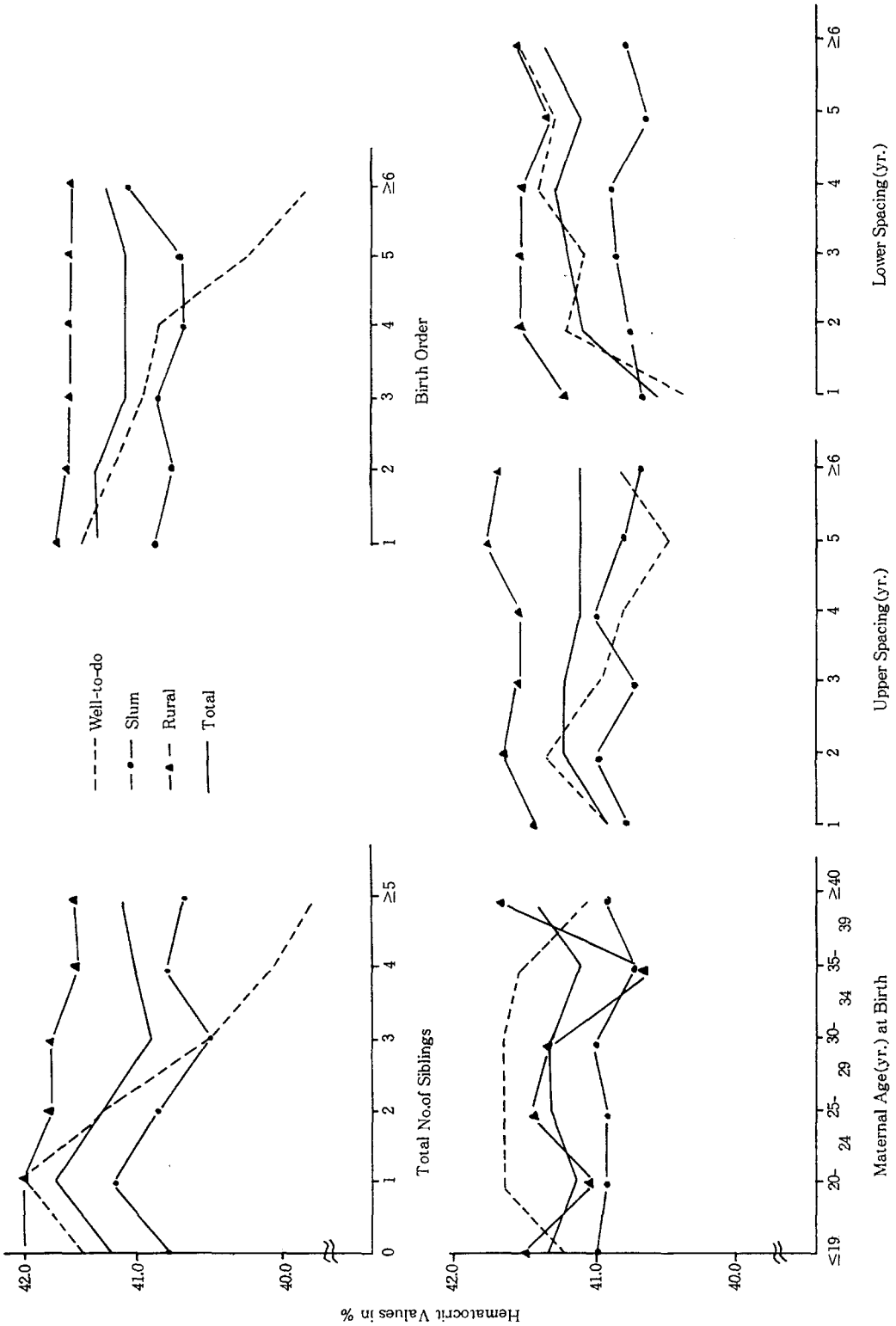


Fig 12 : Hematocrit by Family Formation Pattern and Area

ables are controlled as shown in appendix tables, even if only the IQ score is presented as an example.

The mean hematocrit, however, shown entirely different pattern from the height and weight; the rural children have the highest mean hematocrit values and no distinctive differences by classes of each variable (fig. 12) except the urban well-to-do children, whose low hematocrit values were associated with unbalanced diet according to the dietary survey done separately from this study.

4. Correlation between the developmental indices and the variables concerned

Multiple regression analysis has done on the developmental indices with variables as shown in Table 3 even though all the independent variables are not strictly independent each another. The family formation variables have influenced less on the power of explanation for the physical development than for the intellectual development in cultiple regression; a few family formation variables like number of siblings, lower spacing, paternal age at birth and upper spacing showed significant correlation with certain physical developmental indices whereas all the variables except birth order, lower spacing and maternal age at birth were correlated to IQ score at the level of $P < 0.05$ (Table 3).

Partial correlation analyses under the condition that allother variables but the one concerned are controlled, however, the total number of siblings and maternal age at birth show strong association with the physical developmental indices. The birth order reveals association only with chest circumference and weight at 0.05p-value level as shown in Table 4.

When the partial correlation analysis is done for IQ score with somewhat different variables controlled such as area, birth order, maternal age at birth, total number of siblings and maternal educational level, the IQ score shows association with maternal educational level, total number of siblings, maternal age and birth order (Table 5).

Ⅳ. Summary and Conclusion

The study of physical and intellectual development in relation to family formation pattern on about 46,000 Korean children in urban well-to-do and slum, and rural areas in order to test specific hypotheses has demonstrated that the physical and intellectual devlopments are influenced by family formation characteristics, some are strongly and the others are weakly.

Physical developmental indices among the same ages were the best for the children in urban well-to-do area, better for the children in urban slum area and the poorest for the rural children. Sex difference in the physical developmental indices was more striking for the older ages. Also the difference between ages and areas was more distinctive in male children. The pattern of IQ socre was somewhat different from the that of physical development in that the difference in mean IQ

Table 3. Multiple regression analysis on the indices

Ind. Variables	R square	Beta	Partial F sig*. test
Height			
Sitting height	0.41902	0.39647	Sig.
Weight	0.48739	0.39558	Sig.
Sex	0.50199	-0.11202	Sig.
Area	0.50481	-0.05289	Sig.
Chest circum.	0.50725	-0.08718	Sig.
Age	0.50960	0.05428	Sig.
No. of siblings	0.50979	-0.01382	n.s.
Mat. age at birth	0.50984	0.01706	n.s.
Pat. age at birth	0.50990	-0.00985	n.s.
Lower spacing	0.50991	0.00392	n.s.
Birth order	0.50992	-0.00538	n.s.
Upper spacing	0.50992	-0.00090	n.s.
Weight			
Chest circum.	0.62653	0.54917	Sig.
Height	0.71501	0.20352	Sig
Sitting height	0.74001	0.22525	Sig.
Area	0.74402	-0.05957	Sig
Lower spacing	0.74562	0.03970	Sig.
Sex	0.74655	-0.02639	Sig
Age	0.74728	0.03151	Sig.
No. of siblings	0.74780	-0.02397	Sig
Mat. age at birth	0.74783	0.01332	n.s.
Pat. age at birth	0.74785	-0.00574	n.s.
Birth order	0.74786	-0.00522	n.s.
Upper spacing	0.74786	-0.00215	n.s.
IQ			
Pat. educat. level	0.07058	0.12753	Sig.
Sex	0.08294	-0.08818	Sig.
Mat. educat. level	0.08903	0.12245	Sig.
Height	0.09417	0.11557	Sig.
Age	0.10187	-0.08485	Sig.
Birth order	0.10429	-0.02481	n.s.
Upper spacing	0.10508	0.03016	Sig.
No. of tuto. sibs	0.10569	0.03241	Sig.
sitting height	0.10620	-0.03719	Sig.
No. of siblings	0.10658	-0.02915	Sig.
Pat. age at birth	0.10681	0.02389	Sig.
Area	0.10702	0.02168	Sig.
Lower spacing	0.10719	-0.01466	n.s.
Weight	0.10731	0.04181	Sig.
Chest circum.	0.10768	-0.03202	Sig.
Mat. age at birth	0.10770	-0.00873	n.s.

* Level of Significance : $P < 0.05$

Table 4. Partial correlation coefficient (r) of the indices

Independent variable / Indices	No. exam.	Variables Controlled: (1), (2), (3), (4), (5) — Total no. of siblings	(1), (2), (3), (5), (6) — Birth order	(1), (2), (3), (4), (6) — Maternal age at birth
Height	40,206	-0.05**	-0.00	0.03**
Sitting ht.	40,167	-0.05**	0.01	0.01**
Chest circum.	40,191	-0.03**	-0.01*	0.03**
Weight	40,247	-0.06**	-0.01*	0.03**
Hematocrit	21,587	-0.02**	-0.00	0.02**

Table 5. Partial correlation coefficient (r) of I.Q.

Independent variables / Index	No. exam.	Variables Controlled: (1), (4), (5) and (7) — Tot. no. sibs	(1), (5), (6) and (7) — Birth order	(1), (4), (6) and (7) — Matern. age	(1), (4), (5) and (6) — Mat. ed. lev.
IQ	35,884	-0.05**	-0.01*	0.02**	0.18**

* $P < 0.05$, ** $P < 0.01$

(1) : Area, (2) : Age, (3) : Sex, (4) : Birth order, (5) : Maternal age at birth, (6) : Total number of siblings, (7) : Maternal educational level

between well-to-do children and children in other areas is the most striking, particularly in male children : 114.8 versus 106.1 and 105.3. Not like the other indices, the mean IQ scores of urban slum and rural area children are almost the same in both sexes except the 14 year-old children. IQ difference between male and female children has been reported by A.R. Omran on Taiwan study, females with lower IQ scores in all ages.

The family formation components such as maternal age at birth, birth order, upper and lower spacing, and total number of siblings influenced the physical and intellectual development independently even when all confounding variables are controlled.

Among the developmental indices the IQ score appears to be influenced by the family formation components more strongly than other indices, and among the family formation components the total number of siblings appears to have stronger impact than others on both physical and intellectual developments.

All these findings are corresponding to other many studies. The study result may be applied to the community health education for family planning program.

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《國文抄錄》

家族形成 樣相과 關聯된 韓國兒童의 身體 및 知能發達에 關한 硏究

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兄弟數, 出產順位, 出產터울, 母性의 出產時年齡等 家族形成 樣相은 兒童의 身體的發育 成長 및 知能發達과 強한 聯關性을 보여 왔음이 世界여러나라 兒童을 對象으로 遂行된 硏究에서 報告되엇다.

本 硏究는 兄弟數와 出產順位, 그리고 出產時 母性의 年齡은 兒童의 身體的 知能的 發達과는 逆相關關係를, 出產터울의 길이는 順相關關係를 나타낼 것이라는 假說을 證明하고자 1984年 韓國中學生 1, 2, 3學年 約 46,000名을 對象으로 遂行되었다. 地域別, 그리고 社會經濟的 狀態別 比較를 위하여 서울市 高所得層이 主로 居住하는 學區內의 中學校와 低所得層이 居住하는 學區內 中學校 各各 5個를 選定하고 江原道內 典型的 農村의 中學校 12個를 선정하여 身長, 體重, 坐高, 血球容積, 知能指數를 測定하였다. 이들 測定値들의 平均은 學父母와 담임선생님의 도움으로 作成된 家族形成 變數別로 比較되었으며 多重回歸分析과 部分相關分析으로 聯關性의 統計的 有意性을 檢定하였다.

同一年齡의 身體的 發育成長 指標들은 都市의 高所得地域 兒童들이 가장 優秀했으며 다음이 都市低所得 지역 아동이었고 農村兒童이 가장 貧弱하였다. 男女別 身體的 發育地標들의 差異는 年齡이 많을수록 더 顯著했으며 年齡別 地域別 差異는 男學生에게서 더 두드러졌다.

平均 知能指數는 都市高所得地域 男學生들이 越等히 높아 114.8인데 比해 都市低所得地域 男學生들은 106.1, 그리고 農村 男學生들은 105.3%이었다. 男學生보다는 女學生의 知能指數가 낮았는데 이것은 대만 兒童들도 女學生이 모든 年齡에서 男學生보다 낮았다는 報告와 一致하였다.

한편 都市低所得地域과 農村地域 學生들은 男女모두 平均知能指數가 비슷하였다. 家族形成變數들은 混亂變數들을 모든 制禦했을 경우에도 兒童들의 身體的 知能的 發達에 獨立的으로 영향을 미쳤다. 發育指標中에 知能指數와 형제수가 가장 가족형성 변수들과의 연관성이 強했다.

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