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Height, nutrition and the side production of sericulture and carp feeding in modern rural Japan(1) aggregate data analysis:the case of Zakouji-village, Shimo-Ina gun, Nagano, 1880s-1930s

Kenichi Tomobe, Takako Kimura and Keisuke Moriya

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Graduate School of Economics
Osaka University, Toyonaka, Osaka 560-0043, JAPAN

Height, nutrition and the side production of sericulture and carp feeding in modern rural Japan (1) aggregate data analysis*
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Kenichi Tomobe[+], Takako Kimura[++] & Keisuke Moriya[+++]

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Abstract

Our fact findings of the paper on height growth of primary students are as following;1: The average heights of all grades of the Zakouji students borne at 1912-1914 and 1918-1920 clearly declined due to the economic damage of lower local cocoon prices ;2: The Peak Height Velocity analysis shows the level of 1912-14 birth cohort declined from 5.64 to 4.72 comparing with the previous cohort, but at the next cohort the level soon returned to the almost same one; 3: Comparing height growth speed between eldest sons and other brothers, there was not clear difference of height growth speed between them. Rather in many cases the height growth speed of the eldest son looks lower than the average especially after nine years-old after when children started to become productive labor.

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+: Corresponding author, Graduate School of Economics, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo, 186-8601, Japan. Email address: kenichi.tomobe@r.hit-u.ac.jp

++: Graduate School of Economics, Osaka University, 1-7 Machikaneyama, Toyonaka, Osaka, Japan

+++: Graduate School of Economics, Hitotsubashi University

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Introduction

Anthropometry for understanding human physical variation has a very long history by itself, but anthropometric history is relatively young research field in economic history where physical stature can be used as an indicator of how a well human organism prospers in its socio-economic environment[1]. Economic historians have strong interest in height as indicator of standard of living resulting from how human stature reacts to changing socio-economic environments. Moreover, as the Human Development Index shows, if infant mortality and primary education are important factors to decide growth of human capital, historians and social scientists should pay attention to the physical growth such as height and weight of school boys and girls. In this context anthropometric history has been become a main research field of socio-economic history in the world since the 1990s. Until recently anthropometric history of Europe and US tended to show macro-scopic and long-term trends of average height and weight using the large scale records of the army and prisons[2]

Most impressive studies of anthropometric history so far show the effect of urbanization and some infectious diseases on human height mainly observed in US and European countries commonly experienced industrialization and massive urbanization. The former is well-known as urban penalty which means in the environment of emerging air and water pollution, both work stress and body energy deficiency resulted in decreasing the average height of the population at risk while the latter indicates specific disease such as small pox, measles and tuberculosis (TB) stunted growth during childhood[3]. These studies contributed much to the development of economic history by widening our observation eye, but since these are commonly based on aggregated data, we cannot know the process and mechanism in detail shown by using individual and micro data. Most recently new gender-oriented historical studies using anthropometric data as indexes of gender gap or sexual discrimination has emerged with feminist perspective in European history while others show more complicated processes of bargaining between male heads and female families in households[4]. Paying more attention to anthropometric indexes would only enhance historical studies, making them more productive and attractive.

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[1] Komlos (1994) and (1995) are standard studies of the first generation of anthropometric history in the world.

[2] These records were basically stocked every year at the entrance by which we cannot follow later heights of soldiers and prisoners. Nicholas & Oxley(1996), Floud et al(1990) and (1993)

[3] See Cuff (2005), Oxley (2006), and Sharp(2012) clearly summarize these debates.

[4] Horrell & Oxley (1999) and Horrell & Oxley (2017) are in relatively feminist perspective while Saaritsa(2017) in Finland shows more complicated process.

This research project collects individual data of anthropometry such as height, and weight, health such as TB and tooth decay, attendance status and cognitive or academic performance booked for six years normally from 6 to 12 years old in the school registers, in Japanese *Gakusekibo*, 学籍簿[5]. The individual data saved for 6 or 8 years are becoming short-term panel data by which we can know exactly how students grew during the period. This is different from other studies of anthropometric history done so far by historians. These individual data require careful handling because of privacy, and as a result the process of machine-readable data making and sorting can appear complicated. Especially, the data sorting looks delicate and can be done partly by PC but needs human eye at the last stage of data review.

Important fact findings on students' height will enable historians to reconsider traditional and controversial topics of Japan's modern socioeconomic history in relation to stereotypes of how children were feed in a peasant household under the Japanese stem family system, especially during the period of strong militarization, ca. early 20th century. Secondly, due to the availability of individual height data, we can look at short-term fluctuations of average height of the same entrance/ birth cohort. This will enable fellow anthropometric historians with the same interest to deepen their own analysis. What was the cause of short-term fluctuation of average height? Showing new hypotheses on these topics is the main purpose of this paper.

Historical background of research area since the Edo period
: Zakouji-village and Shimo-Ina gun

Zakouji village, currently Zakouji-cho in Iida-city, was located in the Shimo-Ina region of southern Nagano prefecture and the Zakouji primary School also locates there to this day provided the needed school register data. The Ina region covers an area in the south of Suwa Lake of Nagano prefecture and Iida-city has been a principal city of the region since the Edo period, ca. early 17th century. The Ina region consists of a small scale of flat land spread along the Tenryu River while most of other part belong to the mountain area.

The Ina region of Nagano was not only a relatively older place where many defeated warriors from Nagoya and Kyoto entered since the medieval period to stay and develop but also a very special place for Japanese economic history where some institutions and organizations such as *Chuma*, 中馬, privately organized transportation system, were devised to innovate older systems and to efficiently utilize market economy despite the area was too narrow canyon with the rapid Tenryu river in the

[5] If the student went to the higher primary school, 尋常高等小学校, the duration of stock got longer 8 years from 6 to 14 years old.

middle to stay and cultivate easily as desired[6]. Such geographical difficulty probably brought the seeds of innovation to this area. At the same time, very traditional systems of household relationship such as *Nago-Hikan* system, 名子被官制 still stayed until modern time to disturb the sound development of the marriage market in the region[7].

At least since the Edo period many peasants in the Ina region were actively engaged in not only agricultural production but the side production to pay monetary tax to local domain lords and the Bakufu. Paying tax by money or wooden products, *Kureki*, 楮木, in place of rice had been usual in the region during the Edo period. Until the late Edo period they preferred the individual horse shipping named as *Chuma* to earn money, which was permitted by exception by the Tokugawa government, Bakufu, during the Edo period. This was in place of usual public transportation system named as *Sukegou* , 助郷, and *Tenma*, 伝馬, which could not function because of the road narrowness and difficult geography there. Traditionally, the Ina peasants had a market-oriented mentality to enlarge their economic possibility.

In the late Edo period the sericulture reached there to become prosperous and one of centers of silk-reeling industry in modern Japan as well as Gunma prefecture by the middle Meiji period, ca.the late 19th century. Zakouji village played a role as a driving force of the silk development in the region where the Kitahara family, a later founder of local reeling union named as Kumiai Seishi, stayed and ran the *Terakoya* school, 寺子屋, for local children before the Meiji restoration. In such a socioeconomic environment the Zakouji primary school was opened during the early Meiji period and formally started at 1886 by the Shougakko Rei as Zakouji primary school, Jinjo-Shougakko, 尋常小学校, and other schools in Japan[8]. Many local people with an educational passion devise a method to share the necessary minimum expense by asking for reduce land tax or interest rates. What was the most important for school boys and girls was the adjustment of seasonal distribution of annual holidays to seasonal labor intensity. According to the common schedule of other schools in Japan, most students in the school could not attend at classes during the busy season of sericulture. To resolve this problem the school firstly introduced the special schedule in Japan to take three weeks holidays for the sericulture work from early June by shortening normal longer holidays of summer and winter.

Sericulture and primary education in this village depended on each other very much. The sericulture

6 Toshio Furushima was a champion economic historian of the region.
7 The *Nago-hikan* system clearly reflects power structure between households in the village inherited from the beginning of worrier age, c. early 16th century. This was just a rule of worrier people as ancestor of the villager. The power structure people image until recently became a disturbance of marriage as matching households in the region.
8 See Zakouji Gakko Enkakushi (1965).

in Tokugawa Japan became a champion side production of peasants who lived in the eastern part of Japan, especially at Nagano, Gunma and Fukushima since the age of proto-industrialization. The sericulture constituted many stages of work from taking mulberry leaves to feed silkworm to reeling silk off cocoons which was carried out by family labor in the peasant household.

[Table 1]

For example, looking at the result of regression analysis of the effect of family labor on the volume of silkworm paper in the case of the sericulture peasants of Fukushima around the Meiji restoration (Table1), the total number of female family laborers who contributed to it is statistical significance[9]. Generally, not only the working age population but elderly population over aged 60 was indispensable to sericulture production. Traditionally economic historians usually called the sericulture labor pattern as a family-labor completely consumed side production.

Even if the adjustment was successful, whether many children frequently attending classes or not, was another problem because of how children are treated depended on the households. Some historians think if there was gender bias about dealing with children in the peasant household, for example, due to the traditional stem-family formation system of Japan, female children would be likely to be neglected in their education while others think female children might be well treated there because they clearly made a positive contribution to their budget current income, inherited assets such as land holding, type of side production, ecology of residence area and household head's thinking. If the better treatment of female children spread throughout the region, expected gender gaps of sex ratio at birth, infant mortality, growth of height and marriage rate under the stem family formation system could not be so socially significant even if still present.

Lastly, from 1875 to 1935 the total number of village population almost linearly increased from about 1500 to more than 3100 with very slightly decline both at 1905-07 and after 1930 of the Showa Crisis[10]. The mean size of households fluctuated around 5.5 to 6.5 person, but interestingly this change correlated with negative changes to student's average height. It probably means height looked sensitive to the nutritional redistribution in a household.

Data Source: *Gakusekibo*, School register

The school register in modern Japan, Gakusekibo, was the public book for enrollment and general status of students in the school and has been legislated since 1900 by the Japanese Ministry of Education. It changed the name to Shido-Youroku, 指導要録, instruction guide, at 1949 to continue

[9] See Tomobe (2007), Table4-3, p.138.
[10] See *The History of Zakouji Villeage,Zakouji Sonshi,*(1993).

until today. The Zakouji primary school had already made the register by itself at 1890 before the formal legislation. The school register compiles individual records of student from entrance until graduation from the school. It means the data in the register are available as short-term panel data of individual student with the correct treatment of private information.

So far very few Japanese historians and social scientists have been interested in using the register for study mainly because many schools and public archives were unwilling to open these documents to researchers. However, the exceptional study using the school register left in the northern Nagano by Professor Sonoko Hijikata showed us very impressive results on the actual condition of attendance at class by peasant students[11]. Usually many historians of Japanese modern education showed us relatively higher rates of enrollment and the increasing tendency from the beginning year by year due to using another records left in the school. But by using the school register Hijikata shed light on the actual rate of attending at class of students which revealed that most of them were more frequently absent from class than our expectation. The difference between enrollment rate and attending rate proven by using the school register provided a new dimension and perspective to studies of primary school history in modern Japan.

[Photo 1, 2]

These are slides of school register sample of the Zakouji primary school. Basically, the register was made separately by sex until the end of Taisho period, ca.1925, and since then they were recorded together in one register. There is a space at center for student's information of name, permanent or de jure address, date of birth, entrance, leaving, and graduation of school and additionally student's household information of parent, current residence address, name of occupation such as agriculture, commerce, craftsman and household position such as eldest son and second daughter. On the left side of the page both the academic performance of 10 stages evaluation and the behaviors such as personality, cognition, manner, physicality evaluated by word expression were recorded. On the other side, the right page was occupied by both physicality such as height, weight, chest measurement, backbone curve, and eye, ear and dental disease as well as the situation of attendance. Physicality data of height, weight and chest were expressed numerically and others were written by word, such as, correct or not and exist or not. Attendance data were recorded by month every grade from 1st to 6th of primary course and more two years of higher course if existed. The standards of evaluation were days of attendance, sick or accident absence, and late or early leave expressed by month. It has not been determined if a blank space means zero or no record.

Additionally, writing on the document, taking photos of them are not acceptable at all because they

[11] See Hijikata (1994). Many students tended to be absent during the agricultural season of planting and harvesting.

contain highly private information of the individual student and their family member[12]. As a result the field work for this research required that the authors carry out hand-writing of some necessary information, but also excluding any information relating to the full name of student by which we can specify the individual and the family. As for highly private information such as academic record, whether we can use or not varies and is actually depends on the policy of the archives and public administration in the region concerned.

Results: Height analyses based on *Gakusekibo*

Table2 shows the transition of average height of total students born from 1894 to 1920 by birth-cohort. Interestingly, the sex ratio of students enrolled in the register had been almost 100 because the previous study by Sonoko Hijikara showed female students registered at school much less than male ones. The sample size of student also increased about one and half times from 1890s to 1920, but the outbreak of dysentery in 1894 made the sample size of this cohort smaller than others. Because of the absence of any other ready-made cohort data of average height like ours from previous studies, no comparable data of average height exists. Here as a reference compared with age- specific target heights indicated by the ministry of education of Japan in 1919, the Zakouji students' data were relatively taller than them[13].

[Table 2, Table3]

Table 3 shows changes in average height compared with the previous cohort of the same years age group. Negative difference from the previous cohort means that the average height at age concerned became smaller than the previous year. As reviewing historical studies of Japan using macro data of average height such as conscription, linear growth curves of average height were usual there. The Zakouji micro data shows the years of height decreased four times during the observation period, with the first and second effect happened from 1900 to 1905 appearing to be much smaller than other two later periods. Moreover, here the sample size of 14 years old students is too small to be considered. Actually and surely short-term fluctuations of average height of students in the primary school happened every three years.

These analysis are based on the total students of male and female in the Zakouji primary school because of the smallness of sample size. To know gender gap of height growth in detail from the small

[12] As for using historical records registered by family or household unit, researchers are easier accessible to those of the Edo period than modern one with some exceptions. The availability of using PC depends on archives too.

[13] These heights were target parents and students aimed at the age concerned, so probably the level looked like higher than the real average height.

sample size, we introduce as a new index[14], the peak height velocity, PHV, which means the peak age of the adolescent growth spurt and simply calculated as gap of height between next two ages. The PHV of adolescence usually visit a few years earlier girls than boys around 12 or 13 years old which is almost the same age of menarche. In human physiology, the PHV also reflects the current situation of the intake of nutrition. Especially, chronic malnutrition diminishes the level of PHV and makes menarche delayed.

[Table 4]

Table 4 clearly shows girls experienced their PHV at aged 12 or 13 during the whole period. The level of PHV increased from 1897 until 1908 and then declined until 1914. But the value of PHV decline was less than one cm, and then very soon returned to the same level or more at the next period. If the transition of PHV reflects the current living standard of girls in households, it surely declined slightly from 1912 to 14 when the village experienced a crisis in the form of a significant downturn in the price of cocoon. The degree of decline would be close to minimum under the expected condition of Japanese stem family system where female member were likely to be neglected.

[Figure 2]

Related to the difference of treatment between the eldest son and others in the stem family system, Figure1 interestingly shows at least there was no clear difference of height growth speed between them. Rather in many cases the height growth speed of the eldest son looks lower than the average especially after nine years-old. Many senior students older than nine years-old were expected to be productive family labor indispensable to their household income. From the viewpoint of Japanese economic history, these findings shed light on the battle between the adaptations to economic opportunity coming from market expansion and traditional family values occurred throughout Japan at the turn of the century. They strongly show since the Edo period at latest peasant households as unit of production and consumption repeatedly encountered the difficulty of adjusting the old and traditional value spread into the household and the village to emerging market economies.

Speculation: side production linked between nutrition and height in peasant households

Since the beginning of Edo period, at the latest, many Japanese peasants were vigorously engaged in both rice cultivation and side production under the household division of labor. Their production function of labor intensive livelihood depends on the total amount of family labor and the efficiency of the household division of labor. The eastern Japanese peasants of the later Edo period welcomed sericulture as a great side production of labor intensive earnings to improve their monetary income and standards of living. As above indicated, sericulture needs more family labor to complete various stages of work, and moreover not only male productive labor but female labor and aged labor

[14] Lars G. Sandberg & Richard H. Steckel (1980)

contributed equally to the household economic performance. In that sense, sericulture was a blessing to labor intensive peasant household economies of the Edo Japan. At the latest by the 19th century the eastward movement of sericulture reached north- eastern part of Japan such as Gunma, Fukushima, and Nagano. Lastly, after the age of Ansei open port, c. 1858, silk and silk fabric became the most excellent products exported to foreign countries until the Second World War in Japan. Since the late Edo period the Ina region became one of the advanced areas of sericulture and silk making.

Based on the development of sericulture and silk making as side production, another important industry in the region peasants actively engaged and originally imported from the northern part of Nagano since the 19th century was carp-breeding[15]. From the view point of Japanese peasants' livelihood, the carp-breeding was very efficient and important device to utilize the wet rice field usually from June to September where young fish were bred for three month and then captured for commercial sale or self-consumption[16]. Among them, some peasants became carp merchants who had another carp-breeding ponds beside the rice field for longer breeding young fishes and learned how to hatch carp eggs and breed them until they were young fish[17]. The synergies of carp-breeding and sericulture as side-production included peasants being able to use dried silkworm pupa, 蚕 蛹 , as food for young carp since the end of Edo period. Before then they utilized leftover vegetables and small bran of rice, wheat and soybeans after using watermill. After the introduction of small scale factory of hand reeling to the region, large scale silkworm pupa became easily available for all carp breeders there.

Zakouji Village possessed 15 reservoirs from the Edo period. In addition, during the summer season, water was precious enough not to turn the water wheels from spring equinoctial week to autumn equinoctial week. Also, there is a possibility of creating a pond at the dry riverbed of the Tenryu River, although there was always a concern that the river will constantly suffer from flooding. However, in the Meiji era, prefectural projects were undertaken to build embankments in Zakouji Village and neighboring areas. After the embankment on the Tenryu River coast was completed in 1904, the flood plain became an adequate zone. Since then, the peasants living in the mountainside began to settle in lowlands. However, due to poor drainage and the need to remove moisture from under the housing floor embankment was conducting in residential lots. And using the

15 See Shinano Kyoikukai Shimoina-bukai. ed.(1934), Ch.12 and Naganoken Gyogyo Kyoudo Kumiai Rengoukai (1969).Ch.4-Ch.6. As for the joint production between rice and carp breeding in the contemporary Japan, see Yasumuro (2005, 1998).

16 Originally not irrigated wet rice fields were fitted to carp breeding. After the introduction of irrigation after 20th century, peasants made artificial ponds beside rice field to breed carps. Then, they welcomed advanced and new technology of hatching eggs.

17 Even after the Meiji period every peasants could not necessarily know and get this consistent technology from hatching carp eg9gs to breeding young fishes.

holes made by digging the embankment as a pond, the peasants began to keep carps at their home location[18]. The above-mentioned carp farming in the Saku district was limited mainly to the period during which the water was spread over the rice field. On the other hand, in Zakouji village, the peasants repeated a very characteristic breeding method which is releasing the fry carps in the paddy field after the rice planting and wintering the captured carps before the rice reclamation at the aquaculture pond for 2 years, and in the third year, they bred the carps until the fall utilizing only a pond. Adopting this breeding method of separately choosing a pond and paddy fields for season makes it possible to prolong the total amount of carp fishing in the village dramatically and to trade adult fish with high price and also to sell them as a carp for mating to other areas.

In Zakouji village of the early 20th century, many of peasants were doing carp-breeding as side-production using their own rice fields mainly for self-consumption, but at the good time of rising carp prices they actively sold carp to increase their monetary income. The Kitahara family who was resident and a great carp merchant in Zakouji village functioned as a center for distributing the latest knowledge and technology related to carp breeding to small scale carp breeders and neighboring peasants. Peasants in this region as well as other regions of silk industry had experienced big damage of Cocoon disease and silk price fluctuations many times since the end of Edo period. At times of severe cocoon and silk production, carp production probably compensated for deficit income of peasant budget.

The compensation was useful not only for economic damage but for nutritional deficiency of growing children[19]. As very few but important previous studies show, it is believed smaller physicality of Japanese boys investigated at the conscription test at the turn of the twentieth century came from the deficiency of taking animal protein and calcium such as milk and meat[20]. It must be important factor of lower physicality because height of the 20 aged Japanese young boys became taller and taller after the spreading of local refrigerating systems. However, height was not always rising linearly, such as the national average height of 20 aged Japanese male. As this research shows, local average height surely experienced growth and decline every few years. These fluctuations of average height were the outcome of gathering individual height change.

It means in a sense the intra-household allocation of nutrition, especially fish protein and calcium, was sensitive to the growth of height of primary students in the region and it is also physiologically

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18 See *Zakouji Sonshi*(1993)

19 In "Zakoji Village History", "In the 1877, Shutaro Kushoihara who lived in Nakahaba (Kami-Ina) started to keep carps for private." In addition, "Since he discovered that the carp that was given the pupa of silkworms as a diet grows sooner and faster than usual, so everyone has been kept in Zakoji temple." This shows that not only the income from aquaculture of carp but also the animal protein ingested steadily as self-consumption.

20 See Ch.2 in Mosk(1996) and Shay(1994).

reasonable. If so, from above analyses, the case of Zakouji village didn't surely show the discriminatory aspect of female neglect in the intra- household allocation of nutrition. Rather, all children, from the eldest sons to other children, were almost equally in households of the village from the view point of height growth. This result probably, and partly, came from the unique form of side-production in the region where the mixture of labor intensive sericulture and land intensive carp breeding needed many young laborers of both male and female physically productive and healthy.

Concluding remarks

Firstly, main fact findings of the paper on height growth of primary students are as following;
1: The average heights of all grades of the Zakouji students borne at 1912-1914 and 1918-1920 clearly declined due to the economic damage of lower local cocoon prices (see Table 3);
2: The Peak Height Velocity analysis shows the level of 1912-14 birth cohort declined from 5.64 to 4.72 comparing with the previous cohort, but at the next cohort the level soon returned to the almost same one (see Table 4);
3: Comparing height growth speed between eldest sons and other brothers, there was not clear difference of height growth speed between them. Rather in many cases the height growth speed of the eldest son looks lower than the average especially after nine years-old after when children started to become productive labor (see Figure 2).

Since this research is just one local study of height growth and its distribution based on using the school register, any major conclusion should be withheld until further study and analysis have been conducted. However, the research of students' height growth surely makes historical studies of the intra-household allocation of nutrition with gender neglect more productive and exciting. The bargaining power between male household head and female children related to the intra-household allocation generally depended on the triangle interaction of technology, environment and value-system in the age and the place concerned. In Zakouji village before the second world war, the environment meant the unique development pattern of side-production, the technology meant the introduction of latest technology of carp breeding, and the value-system meant an open, liberal and market oriented mentality emerged. The flexibility of the triangle interaction looked unique to the region, but it was indispensable to the regions where proto-industrialization took place in the late Edo period, and after then partly transferred to full-scale industrialization.

Additionally, the regional or local teachers association such as Shimo-Ina Kyoikukai 下伊那教育会, contributed much to the development of the regional education system[21]. Not only students' and

[21] See Shimo-Ina Kyoikukai(1987)

their family's passion for education but teachers' belief and industriousness brought higher educational performance to the region. The good ties between students and teachers produced a virtuous cycle of achievement, and then Nagano prefecture became famous as a champion prefecture of good education in modern Japan.

Lastly, very few Japanese historians have interests in height studies as a proximate index of living standard and this probably came about from simple from results of height studies in modern Japan showing the linear grown-up curves of 20 aged male in time series using conscription data[22]. However, the recent development of intra- household allocation studies using wages, heights and age at menarche has been extending perspectives of anthropometric history and historical studies of living standards[23]. To know exactly the mechanism of intra-household allocation, many micro studies based on household data will be needed. In Japan as well as other countries modern individual data of household member are likely to be less available because of the protection of privacy. As a result, the school register used in this study are promising for further development of anthropometric history and intra-household allocation study.

[22] Shay (1994) is a good example, in his analysis at best the comparison of gaps of growth speed between regions and prefectures was possible.
[23] Tomobe (2019, 2007) show the change of mean age of menarche in modern Japan.

Photo1: Gakusekibo,学籍簿, Front page

Photo2: Gakusekibo, 学籍簿, Contents

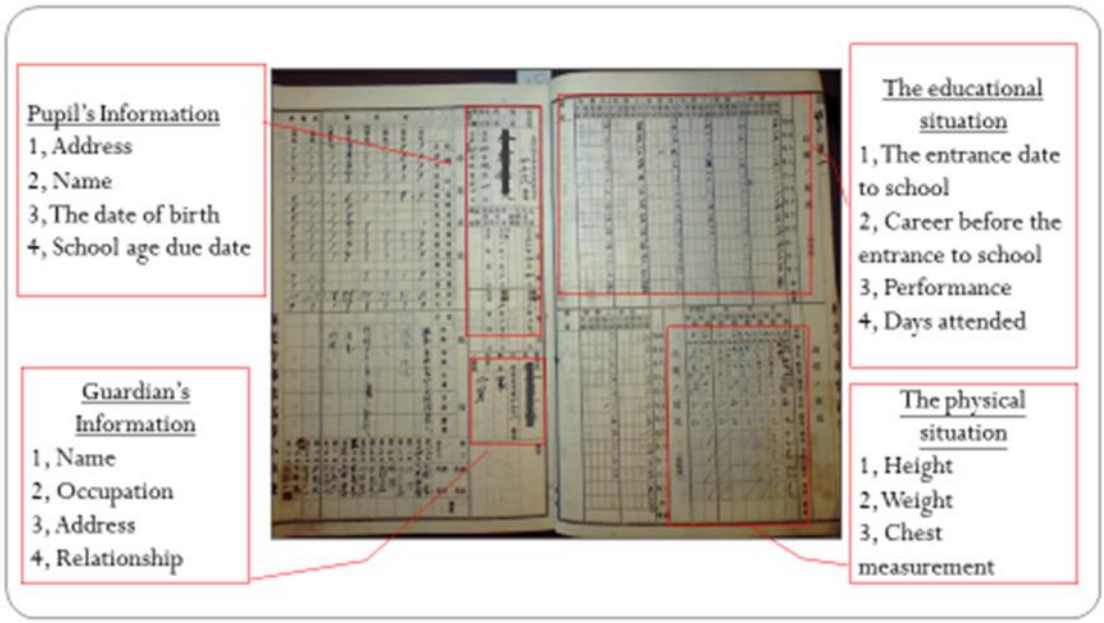


Table 1. Regression analysis of the effect of family labor on the volume of silkworm paper production: Moniwa-village, Shinobu-gun, Iwaki(Fukushima), 1867-70.

	N. of silkworm Paper (piece,枚)	X1 Land	X2 TPF	X3 TAF	X4 TFPF	R2
(1)	n = 104	0.092	0.077			0.306
		(5.602)	(3.111)			
(2)	n = 104	0.095	0.078	0.097		0.328
		(5.848)	(3.193)	(1.824)		
(3)	n = 104	0.090			0.134	0.321
		(5.552)			(3.495)	

Note 1) X1: Mochidaka;

X2: Total Number of Productive Family aged 16-59;

X3: Total Number of Aged Family over 60;

X4: Total Number of Female Productive Family aged 16-59

Source: Tomobe (2007), Table4-3, p.138.

Table2. Changes of Average Height of total students by birth-cohort

age	6		7		8		9		10		11		12		13		14	
Birth-Year	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm	N	cm
1894-96	79	104.87	91	108.65	89	113.21	86	117.82	62	122.47	60	127.82	60	132.87	71	134.85	32	136.71
1897-99	131	105.21	146	110.14	146	115.15	148	120.01	147	124.43	138	128.78	95	133.83	66	138.62	6	142.04
1900-02	112	105.83	143	110.89	143	115.36	142	119.94	139	124.31	142	129.12	88	133.20	56	138.08	9	137.01
1903-05	134	106.39	158	110.70	154	115.29	151	120.06	152	124.21	150	129.25	114	133.54	74	139.30	15	141.55
1906-08	171	106.33	186	111.34	187	116.29	180	120.35	177	124.47	167	129.59	108	133.95	84	140.12	5	145.44
1909-11	192	107.52	177	113.27	192	117.74	201	122.11	208	126.48	206	131.12	139	135.99	113	141.15	10	141.17
1912-14	189	107.45	223	111.75	221	116.67	224	121.41	227	126.16	225	130.41	161	135.17	128	139.11	21	140.01
1915-17	193	108.10	205	112.66	203	117.88	201	123.41	199	127.56	195	131.45	141	135.11	111	140.89	10	143.27
1918-20	192	107.29	206	112.58	204	117.01	210	121.73	208	126.36	205	130.80	136	134.62	108	141.88	8	149.41

*Age-specific target height (cm) announced by the Ministry of Education in 1919

7 age: 106.7; 8 age: 111.3; 9 age: 116.2; 10 age: 120.4; 11 age: 126.5; 12 age: 128.9

Table3. Difference of average height by previous cohort

age / Birth-Year	6	7	8	9	10	11	12	13	14
	cm	cm	cm	cm	cm	cm	cm	cm	cm
1894-96	104.87	108.65	113.21	117.82	122.47	127.82	132.87	134.85	136.71
1897-99	0.34	1.48	1.94	2.19	1.96	0.96	0.96	3.77	5.33
1900-02	0.63	0.75	0.21	-0.07	-0.12	0.34	-0.63	-0.54	-5.04
1903-05	0.56	-0.19	-0.07	0.12	-0.10	0.14	0.34	1.22	4.55
1906-08	-0.06	0.64	1.00	0.30	0.26	0.34	0.41	0.82	3.89
1909-11	1.19	1.92	1.46	1.75	2.01	1.53	2.04	1.04	-4.27
1912-14	-0.07	-1.52	-1.07	-0.70	-0.33	-0.72	-0.82	-2.04	-1.15
1915-17	0.65	0.91	1.20	2.00	1.40	1.04	-0.06	1.77	3.26
1918-20	-0.81	-0.08	-0.86	-1.67	-1.19	-0.65	-0.48	0.99	6.14

Note: the yellow years shows the period of cocoon price decline in Nagano prefecture.

Table4. Changes of the Difference of height velocity from Previous Age: female

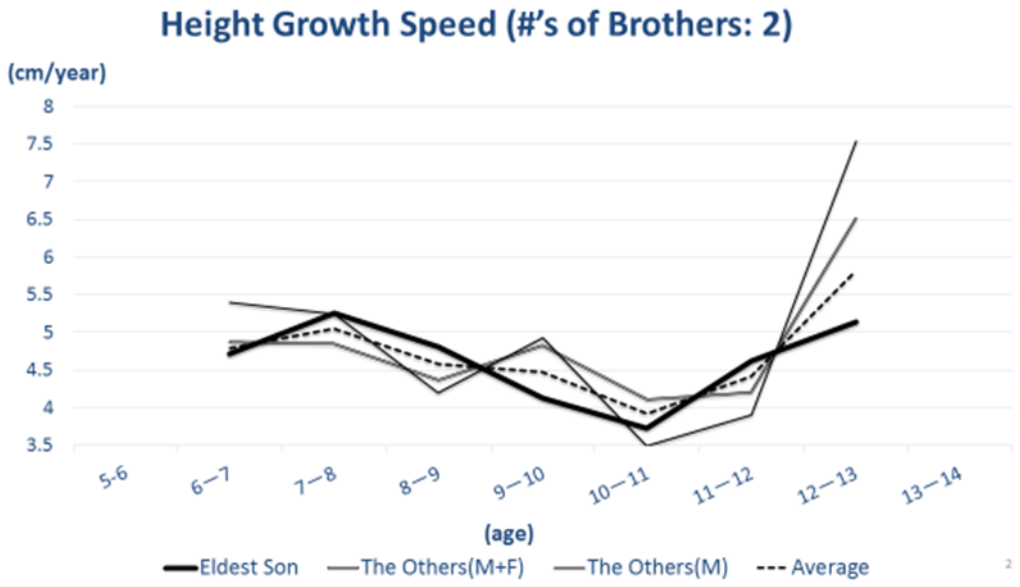
Birth-year	6	7	8	9	10	11	12	13	14
1894-96	0	4.40	4.80	4.83	4.22	5.51	6.42	1.43	-0.21
1897-99	0	4.65	5.02	4.74	4.53	4.83	5.21	4.80	0.99
1900-02	0	4.81	4.32	4.38	4.80	4.26	4.85	5.58	-1.43
1903-05	0	3.92	4.44	5.07	4.18	5.20	3.95	6.77	-0.08
1906-08	0	5.18	4.78	3.71	4.06	5.63	4.11	7.10	
1909-11	0	5.98	4.26	4.67	4.43	5.16	4.96	5.64	
1912-14	0	4.83	4.98	4.57	4.85	4.52	4.72	3.88	1.91
1915-17	0	4.67	5.31	5.65	3.99	4.68	3.28	5.52	
1918-20	0	5.70	4.38	4.83	4.65	5.19	3.02	7.23	

Figure 2. Height growth speed by status in the household

Height Growth Speed (#'s of Brothers: 2)

age	Eldest Son			The Others(M+F)			The Others(M)		
	N	SD	V	N	SD	V	N	SD	V
6—7	30	1.423	1.958	61	1.860	3.403	14	0.529	0.260
7—8	36	2.680	6.985	61	1.649	2.675	15	2.282	4.859
8—9	35	2.057	4.112	63	1.451	2.072	16	0.962	0.868
9—10	36	1.879	3.432	59	2.149	4.540	15	1.188	1.317
10—11	34	1.967	3.755	59	2.115	4.396	15	1.309	1.600
11—12	29	2.538	6.219	43	3.038	9.013	12	2.776	7.064
12—13	25	4.120	16.295	34	2.660	6.867	11	1.933	3.396

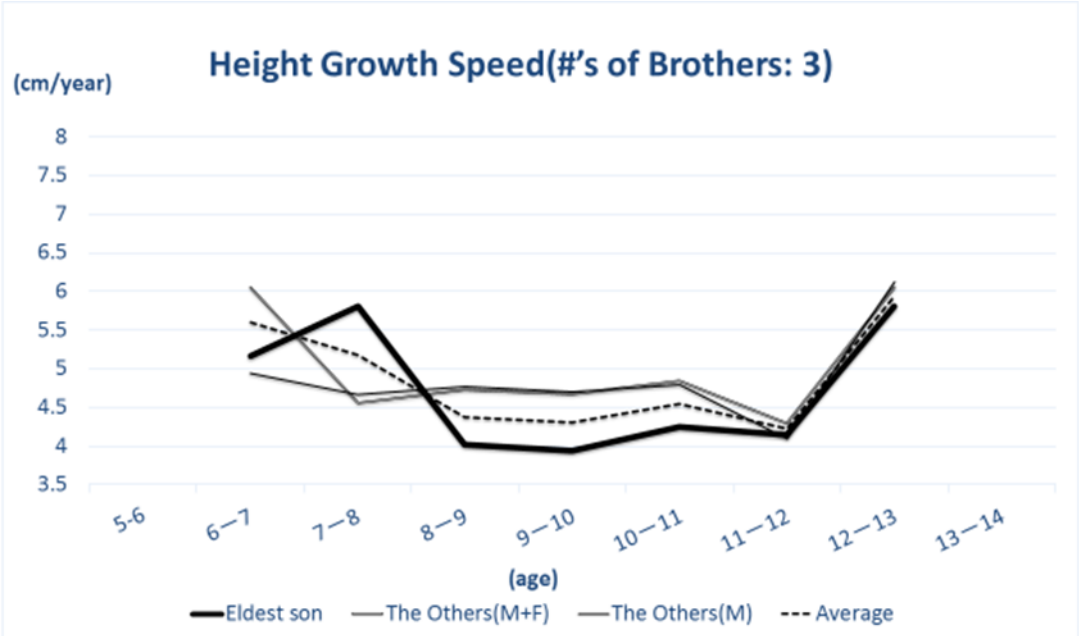
1



2

Height Growth Speed(#'s of Brothers: 3)

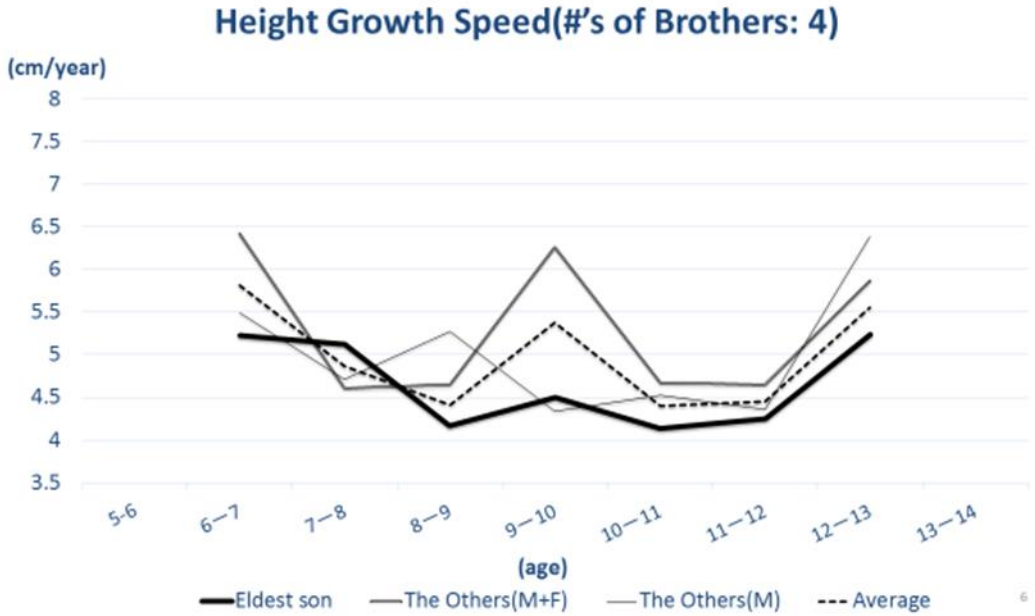
age	Eldest Son			The Others(M+F)			The Others(M)		
	N	SD	V	N	SD	V	N	SD	V
6—7	28	1.514	2.211	106	10.128	101.605	25	1.252	1.505
7—8	30	2.812	7.645	107	2.375	5.588	28	1.853	3.312
8—9	30	2.722	7.162	108	1.880	3.503	26	2.221	4.744
9—10	31	2.176	4.583	110	1.640	2.664	26	1.246	1.493
10—11	32	2.075	4.170	110	2.459	5.994	26	2.021	3.928
11—12	28	2.433	5.707	64	2.182	4.686	19	2.058	4.014
12—13	19	2.246	4.779	47	2.601	6.620	16	3.186	9.516



Height Growth Speed(#'s of Brothers: 4)

age	Eldest Son			The Others(M+F)			The Others(M)		
	N	SD	V	N	SD	V	N	SD	V
6—7	21	0.873	0.726	79	11.734	135.951	24	1.971	3.722
7—8	23	1.564	2.339	80	1.588	2.490	26	1.876	3.382
8—9	24	1.692	2.743	79	1.860	3.417	25	1.504	2.173
9—10	26	1.068	1.098	82	14.772	215.554	24	1.203	1.386
10—11	28	0.951	0.873	85	1.533	2.322	24	2.016	3.893
11—12	22	1.664	2.641	53	2.458	5.930	19	2.790	7.375
12—13	21	2.175	4.505	43	2.357	5.427	15	2.928	8.001

5

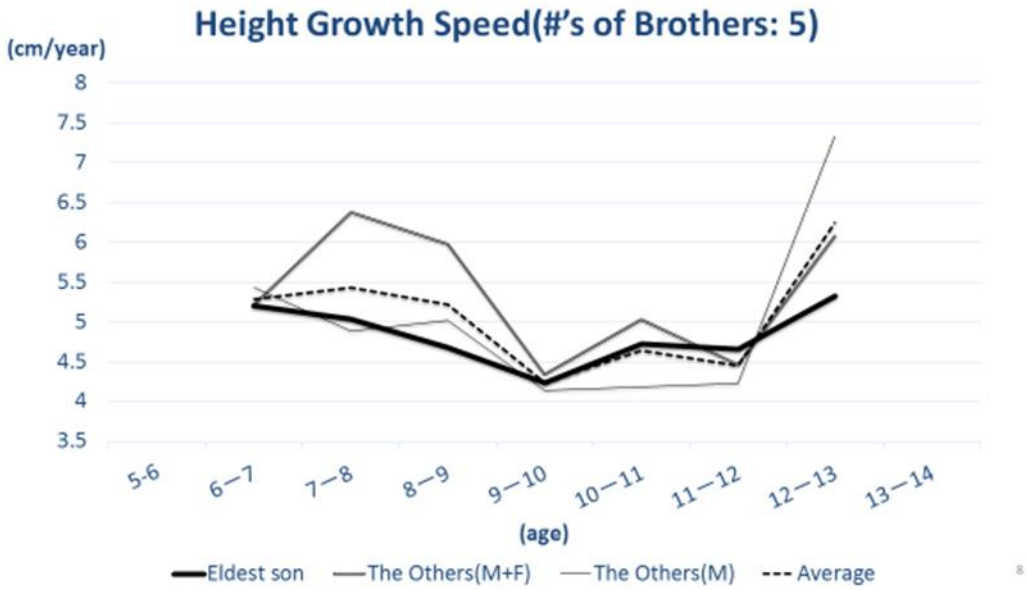


6

Height Growth Speed(#'s of Brothers: 5)

age	Eldest Son			The Others(M+F)			The Others(M)		
	N	SD	V	N	SD	V	N	SD	V
6—7	22	1.074	1.102	70	1.577	2.450	23	1.186	1.347
7—8	23	1.147	1.258	82	2.005	135.678	29	1.534	2.273
8—9	23	1.703	2.774	86	1.975	174.286	29	2.078	4.167
9—10	24	1.413	1.913	86	2.081	4.281	29	1.631	2.570
10—11	24	1.503	2.165	84	2.120	4.440	28	1.155	1.287
11—12	19	1.419	1.908	55	2.138	4.490	22	2.106	4.234
12—13	14	2.197	4.483	49	2.974	8.664	20	3.394	10.943

7

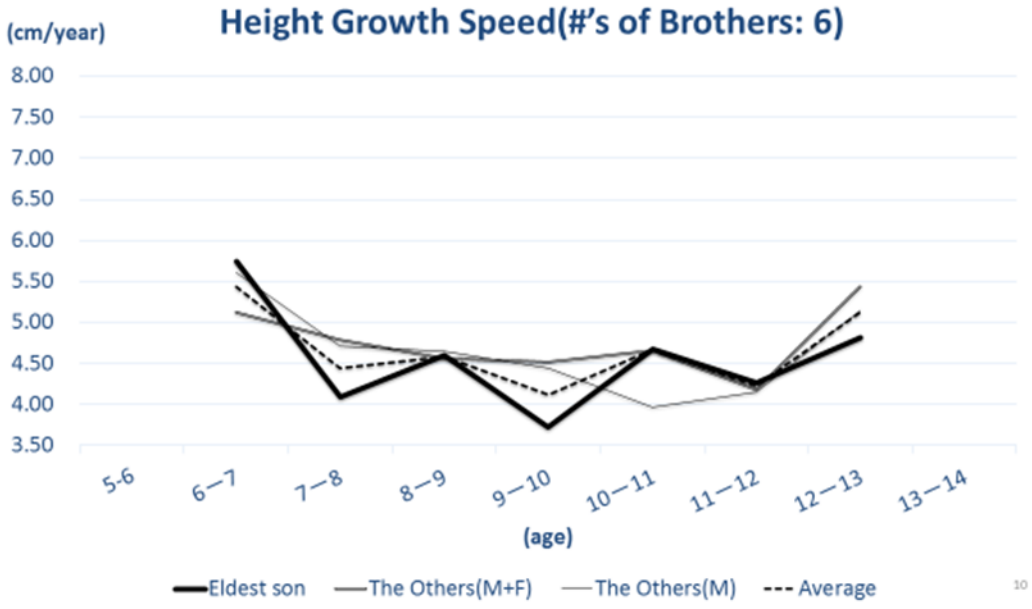


8

Height Growth Speed(#'s of Brothers: 6)

age	Eldest Son			The Others(M+F)			The Others(M)		
	N	SD	V	N	SD	V	N	SD	V
6—7	11	1.696	2.614	50	1.797	3.166	18	2.304	5.013
7—8	12	1.531	2.147	53	1.586	2.467	20	1.855	3.269
8—9	12	0.745	0.508	53	1.756	3.024	20	1.446	1.986
9—10	11	1.280	1.490	56	1.406	1.942	22	0.895	0.765
10—11	11	2.415	5.304	57	1.670	2.739	21	1.361	1.765
11—12	10	0.802	0.578	36	2.033	4.019	17	1.687	2.680
12—13	10	2.402	5.191	23	2.241	4.804	11	2.839	7.329

9

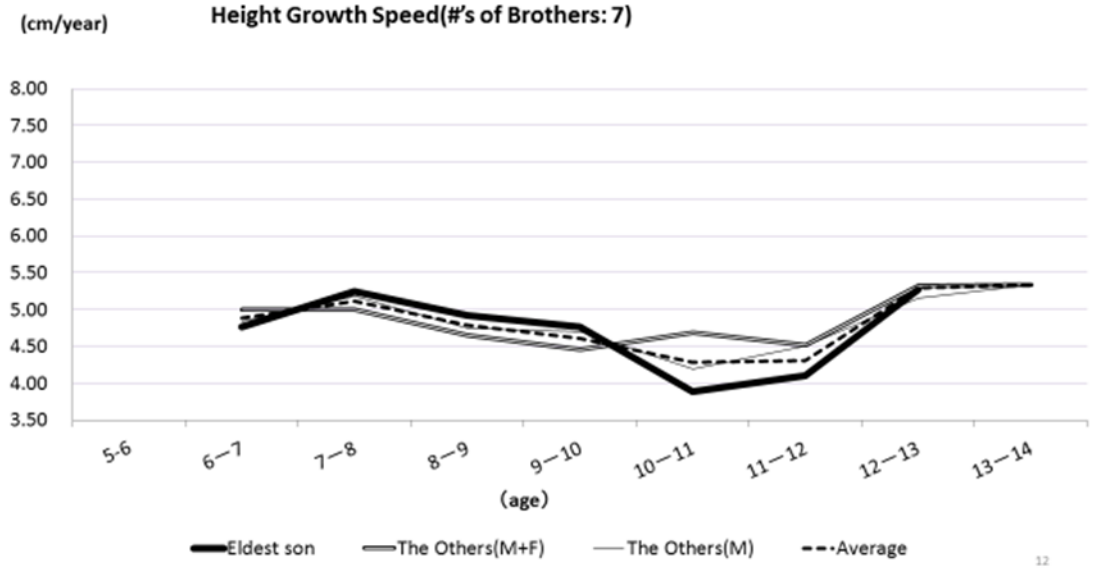


10

Height Growth Speed(#'s of Brothers: 7)

age	Eldest Son			The Others(M+F)			The Others(M)		
	N	SD	V	N	SD	V	N	SD	V
6—7	11	1.000	0.908	84	1.481	2.168	40	1.176	1.349
7—8	13	1.188	1.303	88	1.698	2.850	45	1.650	2.661
8—9	13	1.119	1.155	84	1.539	2.339	42	1.708	2.847
9—10	13	1.301	1.563	83	2.013	4.005	41	2.023	3.991
10—11	12	1.079	1.067	82	1.521	2.286	42	1.332	1.733
11—12	11	1.373	1.715	49	1.914	3.590	28	2.062	4.101
12—13	9	1.778	2.810	36	2.627	6.707	20	3.280	10.223

11



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< Appendixes >

A: Original data of average height: All children

age			Birth-Year 1894-96	1897-99	1900-02	1903-05	1906-08	1909-11	1912-14	1915-17	1918-20
6	Zakouji	average	104.87	105.21	105.84	106.4	106.34	107.53	107.46	108.11	107.3
		N	79	131	112	134	171	192	189	193	192
		SD	3.77	3.96	3.81	4.30	4.48	4.82	4.18	4.31	4.59
		difference	–	(0.34)	(0.63)	(0.56)	(−0.06)	(1.19)	(−0.07)	(0.65)	(−0.81)
	National	average	106.15	106.3	105.85	106.2	106.1	106.15	106.35	106.475	106.75
7	Zakouji	average	108.65	110.13	110.88	110.69	111.33	113.25	111.73	112.64	112.56
		N	91	146	143	158	186	177	223	205	206
		SD	4.30	4.18	4.14	4.93	5.07	5.84	4.72	4.98	4.59
		difference	–	(1.48)	(0.75)	(−0.19)	(0.64)	(1.92)	(−1.52)	(0.91)	(−0.08)
	National	average	110.65	110.45	110.25	110.7	110.65	110.95	110.95	111.35	111.5667
8	Zakouji	average	113.21	115.15	115.36	115.29	116.29	117.75	116.68	117.88	117.02
		N	89	146	143	154	187	192	221	203	204
		SD	4.26	4.49	4.66	5.12	4.51	6.61	4.83	5.66	5.07
		difference	–	(1.94)	(0.21)	(−0.07)	(1.00)	(1.46)	(−1.07)	(1.20)	(−0.86)
	National	average	115.15	114.6833	114.95	115.4	115.25	115.55	115.7	116.25	116.75
9	Zakouji	average	117.82	120.01	119.94	120.06	120.36	122.11	121.41	123.41	121.74
		N	86	148	142	151	180	201	224	201	210
		SD	4.55	4.83	4.73	5.10	4.60	5.50	4.71	6.68	5.35
		difference	–	(2.19)	(−0.07)	(0.12)	(0.30)	(1.75)	(−0.70)	(2.00)	(−1.67)
	National	average	119.5	119.3	119.5	119.85	119.95	120.35	120.525	121.05	121.5833
10	Zakouji	average	122.47	124.43	124.31	124.21	124.47	126.48	126.15	127.55	126.36
		N	62	147	139	152	177	208	227	199	208
		SD	5.82	5.47	5.06	5.30	5.48	5.85	5.67	5.78	5.51
		difference	–	(1.96)	(−0.12)	(−0.10)	(0.26)	(2.01)	(−0.33)	(1.40)	(−1.19)
	National	average	124.1667	123.9	124.05	124.45	124.3333	124.8	125.4	125.7	126.3
11	Zakouji	average	127.82	128.78	129.12	129.26	129.6	131.13	130.41	131.45	130.8
		N	60	138	142	150	167	206	225	195	205
		SD	6.14	5.73	5.40	5.90	5.31	5.35	5.43	5.71	5.78
		difference	–	(0.96)	(0.34)	(0.14)	(0.34)	(1.53)	(−0.72)	(1.04)	(−0.65)
	National	average	128.35	128.35	128.75	128.95	129.4	129.475	130.15	130.7333	131.2167
12	Zakouji	average	132.87	133.83	133.2	133.54	133.95	135.99	135.17	135.11	134.63
		N	60	95	88	114	108	139	161	141	136
		SD	5.22	6.44	6.11	7.01	6.23	5.85	5.63	6.16	7.07
		difference	–	(0.96)	(−0.63)	(0.34)	(0.41)	(2.04)	(−0.82)	(−0.06)	(−0.48)
	National	average	133.7	133.7	134.5167	134.6833	135.05	135.55	136.5	137.2833	137.7667
13	Zakouji	average	134.85	138.62	138.08	139.3	140.12	141.16	139.12	140.89	141.88
		N	71	66	56	74	84	113	128	111	108
		SD	5.62	7.52	6.98	7.51	6.08	5.97	5.98	6.66	6.69
		difference	–	(3.77)	(−0.54)	(1.22)	(0.82)	(1.04)	(−2.04)	(1.77)	(0.99)
	National	average	139.35	139.35	140	140.4	141.1	141.2	142.6167	143.35	143.6333
14	Zakouji	average	136.71	142.04	137	141.55	145.44	141.17	140.02	143.28	149.42
		N	32	6	9	15	5	10	21	10	8
		SD	5.73	3.18	12.33	7.03	7.28	8.33	7.14	5.13	8.58
		difference	–	(5.33)	(−5.04)	(4.55)	(3.89)	(−4.27)	(−1.15)	(3.26)	(6.14)
	National	average	145.05	145.4	145.9667	146.4833	146.825	147.6	148.4833	149	149.7167

B: Original data of average height: Girls

age			Birth-Year 1894-96	1897-99	1900-02	1903-05	1906-08	1909-11	1912-14	1915-17	1918-20
6	Zakouji	average	103.40	104.92	105.09	105.10	105.88	106.81	106.75	107.26	105.54
		N	15	52	62	51	98	111	115	101	88
		SD	3.75	4.18	3.64	3.89	4.12	4.64	4.45	4.31	4.59
		difference	(0)	(−1.52)	(0.16)	(0.01)	(0.78)	(0.93)	(−0.06)	(0.51)	(−1.72)
	National	average	105.30	105.70	105.30	105.60	105.40	105.40	105.70	105.80	106.10
7	Zakouji	average	107.80	109.58	109.90	109.02	111.06	112.79	111.58	111.93	111.24
		N	16	58	82	60	99	82	120	98	92
		SD	3.43	4.15	4.09	4.53	4.45	4.90	4.44	4.64	4.40
		difference	(0)	(1.77)	(0.32)	(−0.88)	(2.04)	(1.73)	(−1.21)	(0.35)	(−0.69)
	National	average	110.10	109.90	109.70	110.10	110.10	110.30	110.20	110.60	110.97
8	Zakouji	average	112.60	114.60	114.22	113.46	115.85	117.05	116.55	117.25	115.62
		N	15	56	82	54	99	99	122	98	91
		SD	4.24	4.61	4.39	4.58	4.51	4.98	4.50	5.19	5.09
		difference	(0)	(2.00)	(−0.37)	(−0.76)	(2.39)	(1.20)	(−0.49)	(0.69)	(−1.62)
	National	average	114.40	114.10	114.20	114.70	114.50	114.80	115.00	115.60	116.03
9	Zakouji	average	117.43	119.34	118.60	118.52	119.56	121.72	121.12	122.90	120.44
		N	15	57	81	54	97	108	126	100	94
		SD	4.67	4.54	4.42	4.83	4.50	4.76	4.52	7.09	5.39
		difference	(0)	(1.90)	(−0.73)	(−0.07)	(1.03)	(2.16)	(−0.60)	(1.77)	(−2.45)
	National	average	118.80	118.60	118.80	119.20	119.30	119.70	119.85	120.40	120.83
10	Zakouji	average	121.65	123.87	123.40	122.70	123.62	126.15	125.97	126.89	125.09
		N	23	56	79	56	96	112	128	101	96
		SD	5.72	5.20	4.65	5.30	5.69	5.32	5.16	6.18	5.42
		difference	(0)	(2.21)	(−0.46)	(−0.70)	(0.91)	(2.53)	(−0.17)	(0.91)	(−1.79)
	National	average	123.60	123.30	123.50	123.70	123.60	124.20	124.85	125.20	125.73
11	Zakouji	average	127.17	128.70	127.66	127.90	129.25	131.31	130.49	131.57	130.28
		N	24	48	85	56	89	111	129	98	93
		SD	5.76	6.04	5.35	5.40	5.08	5.52	5.44	5.95	5.94
		difference	(0)	(1.53)	(−1.04)	(0.23)	(1.34)	(2.06)	(−0.82)	(1.08)	(−1.28)
	National	average	128.30	128.20	128.60	128.80	129.20	129.40	130.10	130.77	131.20
12	Zakouji	average	133.59	133.91	132.51	131.85	133.35	136.27	135.21	134.85	133.30
		N	23	25	43	34	44	60	73	62	52
		SD	5.11	6.65	6.61	8.33	5.16	6.32	5.40	7.00	5.90
		difference	(0)	(0.32)	(−1.40)	(−0.65)	(1.50)	(2.91)	(−1.06)	(−0.35)	(−1.55)
	National	average	133.80	133.80	134.93	135.07	135.40	136.10	137.20	137.93	138.43
13	Zakouji	average	135.01	138.71	138.08	138.62	140.46	141.91	139.09	140.37	140.53
		N	27	20	25	20	36	47	50	45	37
		SD	6.41	6.38	6.97	6.69	4.86	4.91	4.81	5.73	5.26
		difference	(0)	(3.69)	(−0.62)	(0.53)	(1.83)	(1.44)	(−2.81)	(1.28)	(0.16)
	National	average	139.00	139.40	140.10	140.70	141.40	141.05	142.73	143.40	143.70
14	Zakouji	average	134.80	139.71	136.65	138.55			141		
		N	10	2	6	4	0	0	1	0	0
		SD	4.95	2.71	7.94	4.61	−	−	0	−	−
		difference	(0)	(4.90)	(−3.05)	(1.89)	−	−	−	−	−
	National	average	143.60	144.00	144.93	145.27	145.60	146.20	147.10	147.50	148.03

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