Twin Database of the Secondary School Attached to the Faculty of Education of the University of Tokyo

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This article profiles the historical twin databases of the secondary education school attached to the Faculty of Education at the University of Tokyo. The school was established in 1948. Every year, about 50 pairs of twins of all sex and zygosity combinations and aged 11 to 12 years take an examination, and about 10 to 20 pairs are admitted based on the results. Three independent datasets exist: one for applicants (11–12 years), one for students (12–18 years), and one for graduates (18–72 years). These three historical databases and research perspectives are introduced herein.

The secondary education school of the University of Tokyo is famous in Japan as many twins study at the school. When the school was established, twin studies were burgeoning in Japan. Since its establishment, the school has adopted a unique entrance system. An outline of the process is shown in Figure 1. The school gathers applications from twins in addition to applications from the general student population. About 50 pairs of twins aged 11 to 12 years, of all sex and zygosity combinations, and living in the Tokyo metropolitan area, take an entrance examination. From the results, about 10 to 20 twin pairs are admitted each year (Ooki et al., 2004). The school provides ongoing education for the 6 years of junior high and high school. Of the 120 students in each grade, there are about 20 to 40 twins (10–20 pairs). As there are three classes in each grade, there are around 7 to 14 twins in each of the three classes of 40 students. During their 6 years of enrolment, the twins participate in observational studies for educational and related projects.

As shown in Figure 2, three independent datasets exist: one for school applicants (age 11–12 years), one for enrolled students (12–18 years), and one for graduates (18–72 years). As this school is nearly 60 years old, an extraordinarily large amount of data on twin pairs exists in these databases. Not all of the data have been exhaustively and effectively combined as yet, however parts of them have been put into data files for analysis. All data from the retrospective perinatal and neonatal periods through childhood, school age, and adulthood are theoretically linkable using individual specific identification numbers, though in practice the linkage has only been partially completed thus far.

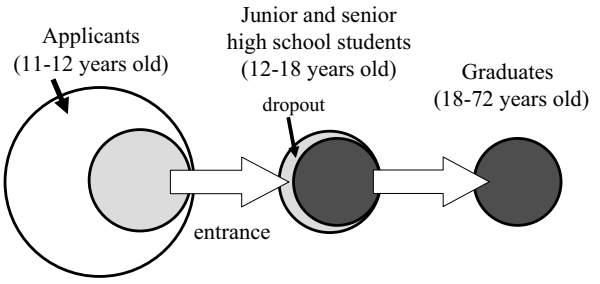

Figure 1
The relationship of the three databases.

Database of the Junior High School Applicants (All Twin Applicants After 1981)

Applicants and their parents are the subjects of this database. Mothers of all of the twin applicants complete and return a Twins Protocol Questionnaire, the format of which has remained fairly constant since 1981. The questionnaire gathers information on family structure, obstetrical findings, the twins' physical growth, zygosity and placentation, and motor and mental development from birth through 11 to 12 years of age. Information on socioeconomic status has recently been excluded because of privacy concerns. One parent of each applicant, usually the mother, participates in a medical interview conducted by two or three interviewers, in which responses to the questionnaire are checked carefully. A total of 1140 parents of applicants have returned questionnaires to

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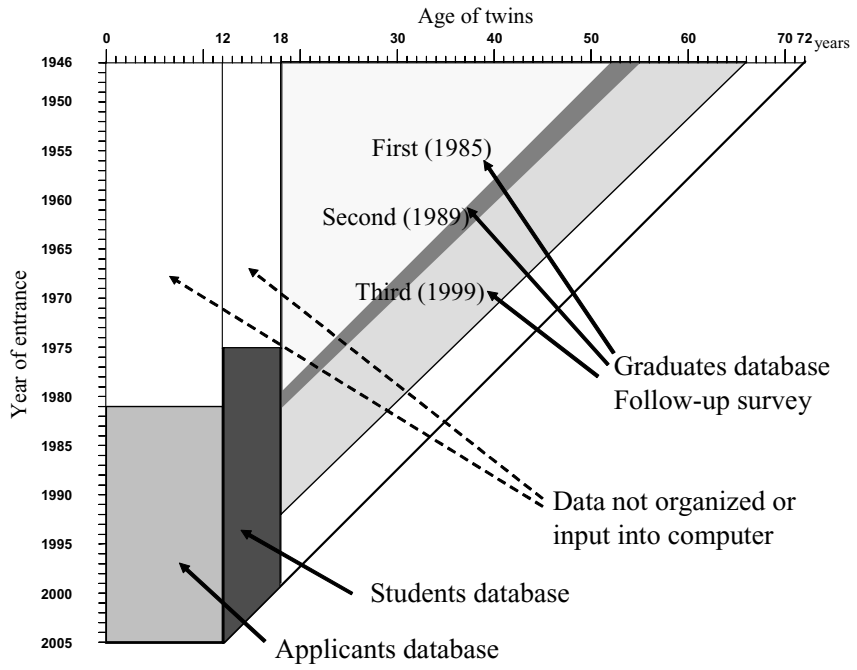

Figure 2

Outline of the three databases with relation to the entrance year and age of twins.

date. Moreover, data from the *Maternal and Child Health Handbook* have been obtained since 1992. This handbook is presented by the Ministry of Health and Welfare to all pregnant women, and includes detailed obstetric records written by obstetricians and a detailed record of the child's general growth until 6 years, written by the parents at home or by medical staff at regular mass health examinations. We can use this data as a standard for questions regarding the growth and development of Japanese children. Zygosity has been determined by means of questionnaire (Ooki & Asaka, 2004). All same-sex twins and their mothers completed the zygosity questionnaire, on the basis of which twins' zygosity was determined with greater than 95% accuracy. Zygosity diagnosis using genetic markers or DNA polymorphisms was performed for those twin pairs admitted into the school.

No subjects showed apparent growth retardation at 11 to 12 years of age. This dataset undoubtedly represents one of the largest and most thorough sets of accurate growth data on twins in Japan (Ooki & Asaka, 2005), especially since zygosity testing is very rare in Japan. The basic characteristics of the subjects in the applicants' database are presented in Table 1. Growth and development features of twins in childhood were extensively analyzed for maternal and child health (Ooki & Yokoyama, 2003, 2004; Ooki, 2005a, 2006) and were found to not be markedly different from that of the general Japanese twin population (Kato, 2004), at least regarding physical growth within the normal range. Several genetic studies have also been performed (Ooki, 2005b, 2005c, 2005d).

Database of the Junior and Senior High School Students (All Students After 1975)

Once twins are admitted to the school, twins and their parents take a medical examination which gathers detailed anthropometric and physical measurements, information on dentition, and fingerprints. The blood pressure of twins and their parents is also measured. Blood specimens are taken, but these are permitted to be used only for the purposes of zygosity diagnosis and medical checks at present. Biochemical data are measured and blood types are determined. These examinations, including zygosity diagnosis based on DNA/genetic markers, are performed by the twins' medical examination committee.

The authors gather predominantly longitudinal data on physical growth and development and medical conditions, for example eyesight and allergic disease, through the results of the health examination performed each year at the Japanese School of Health Law. These results as a whole are presented as school health statistics by the Ministry of Education, Culture, Sports, Science and Technology. Information on singleton students is gathered as control data. The number of subjects is shown in Table 2. This is basically longitudinal data; students of the first grade are followed for 6 years.

Adult Twin Database of High-School Graduates

The information on all graduates of the school is updated. Zygosity is diagnosed strictly by the best method available, given the year of entrance. For example, many anthropometric characteristics and blood

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Table 1

Basic Characteristics of the Applicants Database

N			1140 pairs
Method of data collection			Handed questionnaire and interview
Year of data collection			1981–2005
District			Tokyo metropolitan area
Birth year of twin pairs		Mean ± *SD* (range)	1979 ± 7 (1968–1993)
Sex of twin individuals		M/F	1065 / 1215
Zygosity	Monozygotic	MM/FF	329 / 405
	Dizygotic	MM/FF/MF/FM	91 / 83 / 72 / 57
	Suspended	MM/FF	29/39
	Insufficient information	MM/FF	19 / 16
Age of twin pairs at data collection (years)		Mean ± *SD* (range)	11.9 ± 0.4 (11–12)
Maternal age at twins birth (year)[a]		Mean ± *SD* (range)	29.1 ± 3.9 (19–43)
Paternal age at twins birth (year)[b]		Mean ± *SD* (range)	31.9 ± 4.7 (19–53)
Gestational age (weeks)[c]		Mean ± *SD*	37.5 ± 2.2
Parity		1	598 (52.5%)
		2	426 (37.4%)
		3–5	115 (10.1%)
		Unknown	1 (0.1%)
Neonatal condition (twin individuals)		Healthy	1793 (78.6%)
		Hyposthenia (not so healthy)	304 (13.3%)
		Neonatal asphyxia	128 (5.6%)
		Unknown	55 (2.4%)

Note: [a]4 missing values.
[b]14 missing values.
[c]15 missing values.
SD = standard deviation; M = male, F = female.

groups were used in the early years. More recently, genetic markers and DNA polymorphisms are used (Ooki et al., 2004).

A total of 792 pairs of twins, consisting of 638 monozygotic (MZ; 309 male–male and 329 female–female) and 154 dizygotic (DZ; 50 male–male, 48 female–female, and 56 opposite-sex), have graduated from this school through 2006. Cumulative frequencies according to the combination of sex and zygosity are increasing almost proportionally year by year. The distribution of birth year and sex-zygosity combinations of this cohort is shown in Table 3.

Twins are followed longitudinally (Ooki et al., 2004). The three follow-up studies that have been performed are outlined in Table 4. All three surveys included questions about occupation, marital status, number of children, body weight and height, drinking habits, smoking habits, food preferences, medical history, and so forth. The third follow-up study was performed in 1999. Considering the 10-year gap between the second and third surveys, the database was substantially reconstructed for future studies. Family data have also been collected. In the third survey, at least 81% (352/435) of the twins expressed their intention to

Table 2

Numbers of Subjects According to Sex Combination and School Grade of Students

Grade	Age	Twin pairs						Singletons		
		MZM	MZF	DZM	DZF	DZOS	Total	Males	Females	Total
First	12–13	119	140	18	24	28	329	1132	1079	2211
Second	13–14	116	136	20	21	27	320	1069	1023	2092
Third	14–15	114	128	17	19	25	303	953	907	1860
Fourth	15–16	112	128	17	21	26	304	919	880	1799
Fifth	16–17	106	122	13	18	25	284	857	817	1674
Sixth	17–18	100	121	15	18	25	279	813	754	1567

Note: Birth year of twin pairs ranges from 1962 to 1987; First grade students are followed longitudinally. MZM = monozygotic males, MZF = monozygotic females, DZM = dizygotic males, DZF = dizygotic females, DZOS = dizygotic opposite-sex.

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Table 3

Numbers of Subjects in the Graduates Database According to Birth Year and Sex-Zygosity Combination

Birth year of twins	Age	MZM	MZF	DZM	DZF	DZOS	Total
1986–1976	18–29	38	48	8	10	7	111
1975–1966	30–39	57	68	8	9	15	157
1965–1956	40–49	70	75	15	7	13	180
1955–1946	50–59	87	84	9	9	10	199
1945–1933	60–72	57	54	10	13	11	145
Total		309	329	50	48	56	792
							(pairs)

Note: MZM = monozygotic males, MZF = monozygotic females, DZM = dizygotic males, DZF = dizygotic females, DZOS = dizygotic opposite-sex.

co-operate to some extent in the future. The 'future' co-operation rate among MZ twins (81.9%) was slightly higher than among DZ twins (76.0%). There was no sex difference (80.8% for males and 81.0% for females). The fourth follow-up survey is planned for 2006 or 2007. The authors plan to study the functional molecular genetics of twin pairs who are discordant in relation to certain diseases; to date such twin studies are rare in Japan.

Ethical Issues

Written informed consent concerning the statistical analysis of the data was obtained from each twin applicant and his or her parents as part of the application process. An ethical committee for twin studies at the school is currently being formed.

Limitations

The greatest limitation of this cohort is its selection bias based on the sampling process itself. The subjects lived in the Tokyo metropolitan area when they were enrolled at the school, and all passed the entrance examination. Thus, they are not representative of Japanese children in general with regards to socioeconomic status and abilities. This selection bias would be fatal to some study designs. It has been found, however, that the birthweight according to gestational weeks was not different from that of the general twin population in Japan (Kato, 2004; Ooki & Asaka, 2005).

Moreover, the zygosity imbalance in favor of MZ twins, in contrast to the small sample size of DZ pairs, especially in the students and graduates group, clearly differs from the MZ/DZ ratio of the twin population in Japan (Imaizumi & Nonaka, 1997). This difference may be as a result of the entrance process. If only DZ twins who were similar in their abilities or school achievements were admitted together, this could be a potential source of bias. It is however difficult to estimate the long-term effects of this selection bias.

Perspective

This school is no doubt one of the most important sources in the history of Japanese twin studies. Numerous data is in existence as a result of the school's 60-year-old history, not all of which are organized or established as databases as yet for systematic analysis from the same platform, unfortunately. Therefore, it is essential to make this database more complete. In addition, many study results are written in Japanese; many important research findings have not, therefore, necessarily been introduced to the global research community. The first priority is to list and organize all available data and historical research results; this will require much time and financial support, however.

The main focus of each database is shown in Table 5. It is very difficult to perform lifetime follow-up studies, especially for twins; the existing datasets exceptionally permit this type of pioneering twin research in Japan,

Table 4

Follow-up Surveys on the Graduates Database

	Year of survey	Number of all graduates	Age of graduates	Response rate (individuals)	Response rate (pairs)	Medical examination	Medical topics
First	1985	541 pairs	18–52	Unknown	28.6% (120/420)	44 pairs	Diabetes, personality, drinking
Second	1989	573 pairs	19–55	45.5% (435/957)	37.5% (167/445)	27 pairs	Bone mineral density, osteoporoses, personality
Third	1999	722 pairs	19–66	36.0% (435/1207)	31.0% (174/562)	Not performed	Metabolic syndrome, lifestyle-related disease

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Table 5

Summary of the Database

	Applicants	Students	Graduates
N (pairs)	1140	329	792
Age (years)	11–12	12–18	18–72
Participants	Twins and their parents	Twins and singletons control	Twins and their family members
Zygosity assessment	Questionnaire	DNA/genetic markers	The best possible method (mainly DNA/genetic markers)
Method of data collection	Handed questionnaire and interview	Medical examinations	Mailed questionnaires and medical examinations
Blood sample	No	Twins and their parents at entrance (only once)	Participants of secondary medical examination
Follow-up	Impossible	Possible	Possible
Main focus	Effects of obstetrical conditions and family environment on later development, physical growth and motor and language development of early twin children, diseases often occurring in the early children, problem behavior	Physical growth and development, diseases often occurring in school children, allergic disease, myopia, attention-deficit/ hyperactivity disorder and related diseases	Genetic study of lifestyle (eating, smoking, drinking, and sleep habits, stress reaction, physical exercise etc) and lifestyle-related disease, metabolic syndrome, cognitive ability, and longevity. Fetal origin hypothesis. Psychology as to twinship

Note: Subjects are overlapping in part, as shown in Figures 1 and 2.

although the sample size and data quality are insufficient. Considering these characteristics and limitations, we need to maintain and make the most use of this historically important cohort in Japan.

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References

Imaizumi, Y., & Nonaka, K. (1997). The twinning rates by zygosity in Japan, 1975–1994. *Acta Geneticae Medica et Gemellologiae, 46*, 9–22.

Kato, N. (2004). Reference birthweight range for multiple birth neonates in Japan. *BMC Pregnancy and Childbirth*, *4*, 2.

Ooki, S. (2005a). Language development of Japanese twins in childhood based on maternal reports. *Japanese Journal of Health and Human Ecology, 71,* 12–24.

Ooki, S. (2005b). Genetic and environmental influences on stuttering and tics in Japanese twin children. *Twin Research and Human Genetics, 8,* 69–75.

Ooki, S. (2005c). Genetic and environmental influences on finger-sucking and nail-biting in Japanese twin children. *Twin Research and Human Genetics, 8,* 320–327.

Ooki, S. (2005d). Genetic and environmental influences on the handedness and footedness in Japanese twin children. *Twin Research and Human Genetics, 8,* 649–656.

Ooki, S. (2006). Motor development of Japanese twins in childhood as reported by mothers. *Environmental Health and Preventive Medicine, 11,* 55–64.

Ooki, S., & Asaka, A. (2004). Zygosity diagnosis in young twins by questionnaire for twins' mothers and twins' self-reports. *Twin Research, 7,* 5–12.

Ooki, S., & Asaka, A. (2005). Comparison of obstetric and birthweight characteristics between the two largest databases of Japanese twins measured in childhood. *Twin Research and Human Genetics, 8,* 63–68.

Ooki, S., Okazaki, Y., & Asaka, A. (2004). Characteristics of a Japanese adult twin database of high school graduates. *Twin Research*, 7, 430–434.

Ooki, S., & Yokoyama, Y. (2003). Reference birth weight, length, chest circumference, and head circumference by gestational age in Japanese twins. *Journal of Epidemiology, 13*, 333–341.

Ooki, S., & Yokoyama, Y. (2004). Physical growth charts from birth to six years of age in Japanese twins. *Journal of Epidemiology, 14*, 151–160.

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