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Onset of the Release of Spermatozoa (Spermarche) in Chinese Male Youth

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ABSTRACT Data on the prevalence of the first ejaculating emission for 83,902 Chinese boys 9 through 18 years were collected using interviews. Median spermarcheal ages (MSAs) were calculated by using the status quo data and probit analysis. Subjects consisted of 61,812 Han boys from urban and rural areas in 29 provinces, and 22,090 minority boys from 17 minority ethnic groups. Median spermarcheal ages were 14.24 years for urban Han boys and 14.85 years for rural Han boys, and ranged from 13.46 to 16.32 years for the 17 minority ethnic groups. The differences in MSAs between urban and rural Han boys in each province were significant and the correlation between MSA of urban and rural boys in each province was high ($r = 0.83$, $P < 0.001$). For both urban and rural Han boys, there were significant geographic variations. MSAs of boys living in north China were generally higher than those living in the south, while those living in the west were higher than those living in the east. Variation in MSA may be related to ecological conditions in the Chinese Han populations. The different estimates of spermarcheal ages with two approaches, periodical urine sample analysis vs. interview, and their effect on estimating male puberty are discussed. Am. J. Hum. Biol. 12:577–587, 2000.

Spermarche refers to the onset of the release of spermatozoa. Because the establishment of spermatogenesis only occurs if a boy's reproductive system has gained sufficient maturation, spermarche is regarded as a milestone in male puberty (Müller et al., 1989). On the population level, the median spermarcheal age (MSA), the age when 50% or more of boys have experienced their first ejaculation of semen, has been used to define a stage of puberty that is equivalent to menarche in girls (Hirsch et al., 1985).

However, gonadal maturation in boys is not characterized by a critical visible event, as menarche is in girls. Achieving a reliable and sensitive estimate of the onset of sperm production is difficult. Two approaches were used in early studies. It has been known for a long time that a postpubertal boys excrete spermatozoa in the urine; thus, the first approach is to analyze the urine samples periodically for the presence of spermatozoa and estimate spermarche on the basis of the age at first observed spermaturia (Baldwin, 1928; Richardson and Short, 1978; Hirsch et al., 1979; Nielsen et al., 1986a). The second approach is to investigate puberty in boys by questionnaires, and to estimate spermarche on the basis of the age when first ejaculation of sperm occurs, either by masturbation or spontaneously (Laron et al., 1980). According to many authors, only the use of urine sample analysis may serve as an ethical approach to determine spermarche. Studies based on questionnaires were considered inappropriate because they cannot generally be employed with normal boys for ethical reasons. Furthermore, such studies often yield erroneous information (Nielsen et al., 1986b).

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The estimation of spermarche has been performed successfully in China for many years. The method used is similar to questionnaires, but relies on personal interviews during school health education. Based on the status quo technique, Ye et al. (1965) reported that the MSA of Beijing boys was 16.6 years. Since the beginning of the 1980s, a series of studies on spermarcheal age and its relationship to other pubertal events in boys has been reported in several large cities in China, such as in Beijing (Huang, 1987; Huang et al., 1990; Ji, 1991), Shanghai (Zhang, 1982), Wuhan (Jin, 1980), and Nanjing (Dai, 1981). Spermarcheal ages of several Chinese ethnic minority groups, such as the Dong, Bai, Miao, Zhuang, and Tibetan, were reported by Tan (1982), Wei et al. (1985), and Wu (1984). Although a large amount of data on spermarcheal age has been accumulated, there is a lack of recent data reflecting the overall status of spermarche in Chinese boys. In addition, the statistical techniques for estimating spermarcheal age were different in the previous studies. To remedy this situation, a nationwide survey on spermarcheal age in Chinese boys was included as an item in the 1991 Chinese National Surveillance on Students Constitution and Health (Chinese National SSCH Association, 1993).

Using the data of 1991 Chinese National Surveillance, the present study focused on describing differences in MSA of Chinese Han boys living in diverse areas and of Chinese minority boys in 17 ethnic groups. In order to achieve a more reliable and comparable estimation of MSA in the population, a standard procedure of inquiry was used.

MATERIALS AND METHODS

Subjects

Male subjects of Han ancestry and 17 minority ethnic groups 9 through 18 years were recruited in the study. They were participants in the 1991 Chinese National Surveillance. This surveillance is an ongoing national comprehensive survey conducted every 3 years since 1985 by the Chinese National SSCH (Survey on Students' Constitution and Health) Association. The survey includes a physical examination, screening for common diseases, physique, physiology, and motor ability, as well as inquiry as to menarcheal age in girls and spermarcheal age in boys (Chinese National SSCH Association, 1993). All measures and inquiry were conducted between April and June, 1991. This study only describes geographic and ethnic variation in spermarcheal ages of Chinese boys.

Han nationality

Han is the major Chinese nationality, which accounts for 94.2% of the total population. The Han are distributed nationwide among 31 administrative districts/provinces. In the present study, all Han schoolboys 9 through 18 years were randomly sampled from the 29 provinces (Fig. 1). The subjects were classified into two subgroups, urban and rural. In each of these cities, there were 97–122 boys for each age group, and urban and rural division. Urban boys were resident in the provincial capitals; rural boys were resident in the country side around the capitals. The rural boys are from peasant families. The only exception was Wulumuqi city in Xinjiang, which only had 64–74 boys for each of the age subgroups.

Minority ethnic groups

In addition to the Han, there are 55 officially recognized minority ethnic groups in China. Among them, 17 were surveyed: Mongolian, Hui, Uygur, Zhuang, Korean, Tibetan, Miao, Buyi, Dong, Bai, Hani, Dai, Li, Shui, Naxi, Tu, and Salar. Their geographic distribution is shown in Figure 2. These ethnic groups constitute 88.5% of all the ethnic minority populations in China. In five of the groups (Mongolian, Hui, Uygur, Zhuang, and Korean), subjects were divided into urban and rural subgroups. Because of the living conditions, subjects from another 12 minority ethnic groups were only selected from rural areas.

The same age definition (age at last birthday) was used in all samples, and the precise age of each boy was used in questioning. Sample size was 93–144 in each of the age groups. The exceptions were those of Salar and Tu, which had only 62–76 subjects for each age. Thus, this study is composed of 83,902 subjects in total, 30,675 urban Han, 31,137 rural Han, and 22,090 minority boys.

Selection method

Personal interviews, not the periodic collection of urine samples, were used to estimate the onset of sperm production. A preliminary comparison of results of interviews and periodic urine samples is summarized

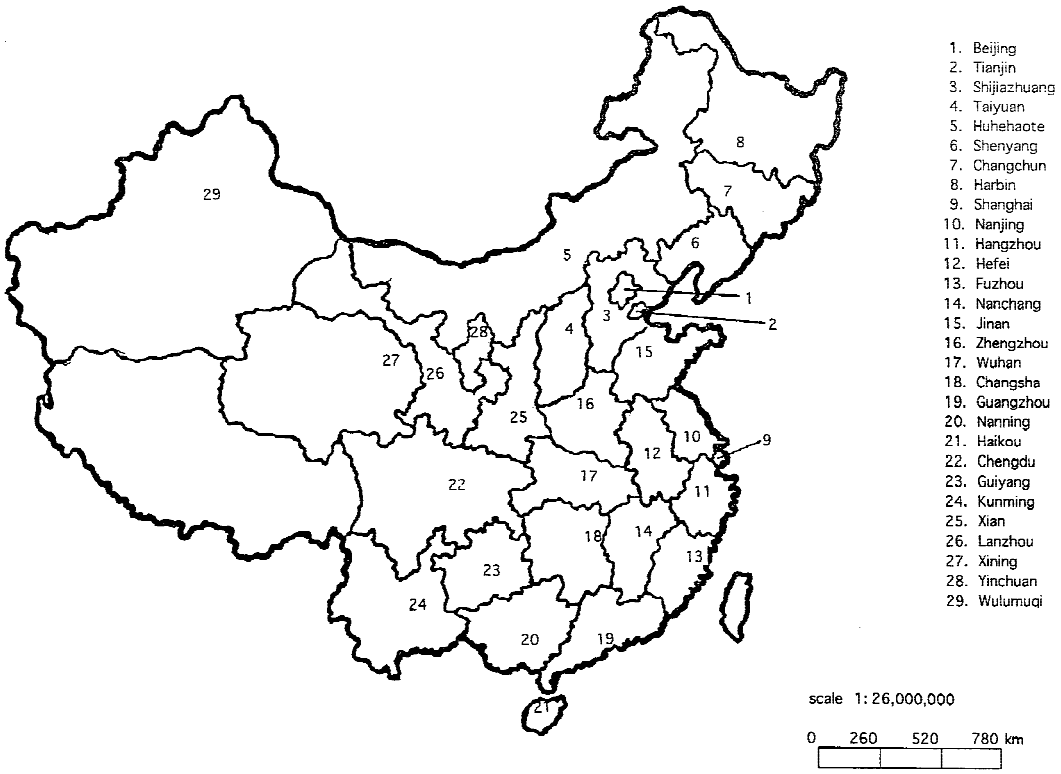

Fig. 1. The geographic distribution of 29 provinces in China (except for Tibet and Taiwan).

in Tables 1 and 2. First urine samples were collected in the morning, according to the method of Hirsch et al. (1985). The results showed that the positive rate was as high as 79.9% when five samples of urine were tested (a positive case means that semen was found in the urine at least once) in youth who gave a positive answer of ejaculation at interview (Table 1). On the other hand, only 2–10% of the youth who gave the negative answer of ejaculation at interview were found to have semen in the urine (Table 2). These results are similar to those reported by Hirsch et al. (1985), and provide evidence of the accuracy of the personal interview method.

Procedures of inquiry

A thorough medical examination was initially performed to ensure that subjects were in good health and free from overt diseases and physical deformities, such as cryptorchildism and infections of ejaculatory ducts.

The subjects entered the interview room individually. Male investigators interviewed each boy face-to-face, and asked whether or not he had experienced the first ejaculation of semen. Dichotomous responses (yes/no) of spermarche were collected. Because almost all schoolboys age 13 and over have some knowledge on male pubertal events from school health education, it was not difficult to obtain responses. For boys 12 and younger, a special course was conducted at the school sites prior to the formal inquiry. The course usually took 2–3 hours and were conducted by trained physicians. It covered knowledge about sexual maturation, including pubertal events, the development of male primary and secondary sex characteristics, maturation of the testis, and the ejaculation of sperm (Ji, 1991).

Technicians in charge of the personal interviews had to pass a standard training program. In addition to implementing the techniques, they were instructed to provide sufficient explanation of sperm emission, if

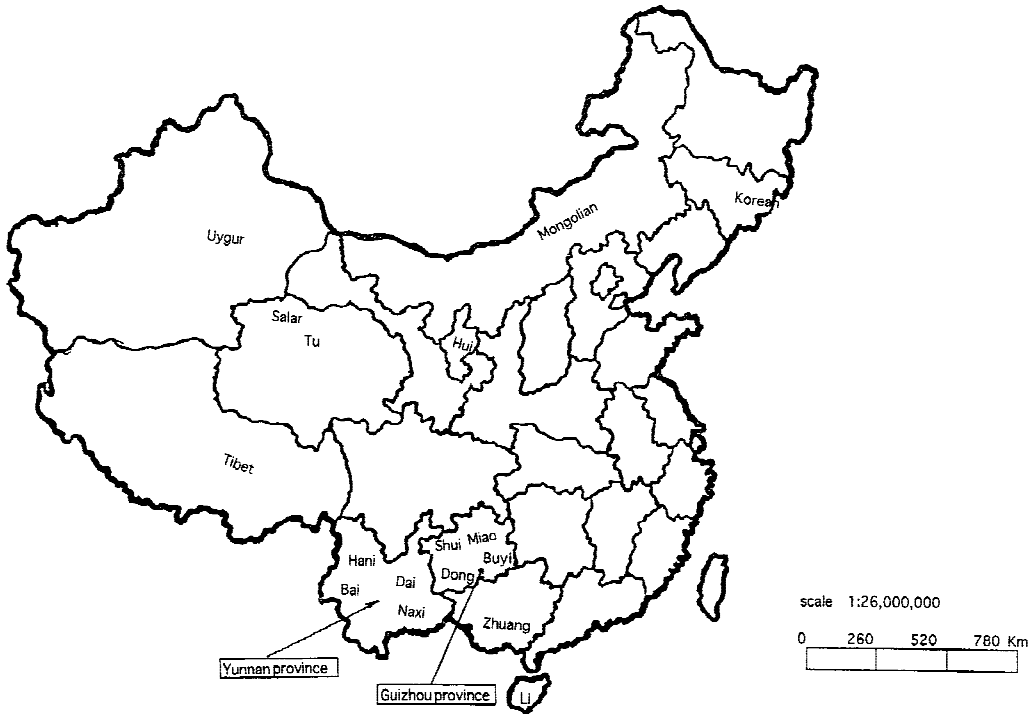

Fig. 2. The geographic distribution of 17 minority ethnic groups in China.

TABLE 1. Positive rate of finding semen in five urine samples for youth who gave a positive answer on ejaculation

Age (years)	N	Positive rates (%)				
		1st exam %	2nd exam %	3rd exam %	4th exam %	5th exam %
11+	6	33.3	33.3	50.0	66.7	66.7
12+	23	56.5	65.2	69.6	69.6	73.9
13+	55	52.7	61.8	69.1	74.5	74.5
14+	89	61.8	67.4	70.8	71.9	76.4
15+	126	69.0	78.6	82.5	85.7	87.3
16+	84	69.0	73.8	77.4	81.0	82.1
17+	83	78.3	80.7	84.3	84.3	88.0
18+	92	76.1	84.8	87.0	89.1	90.2

necessary, to the youth during the interview. Some of the explanations were as follows: 1) semen is a white, waxy or milky fluid, and differs from other fluids, such as in bed-wetting; 2) semen has a special irritant smell; 3) semen is usually ejaculated as nocturnal emissions during dreams or wakefulness, whether by masturbation or spontaneously; 4) there are usually some starchy stains, spots, or speckles remaining on the underwear after nocturnal emissions. Youth whose parents refused to sign the notification forms did not participate in the interviews. The interview attempted to provide a relaxed atmosphere, and the interviewers were instructed not to permit the subjects to give their answers under stress. During the interviews, the boys were encouraged to ask questions freely.

After all of the above education and explanation, boys who still did not understand sperm emission, could not remember their ejaculation history, or refused to answer questions were excluded from the study as invalid cases. The incidence of invalid cases decreased with increasing age. For those 9–12 years, invalid rates were 9.8%, 11.8%, and 15.1% for the urban Han, rural Han,

TABLE 2. Positive rate of finding semen in five urine samples for youth who gave a negative answer on ejaculation

Age (years)	N	Positive rates (%)				
		1st exam %	2nd exam %	3rd exam %	4th exam %	5th exam %
9+	35	0	0	0	0	0
10+	37	0	0	0	0	0
11+	41	0.0	0.0	4.9	4.9	4.9
12+	40	0.0	0.0	7.5	10.0	15.0
13+	39	2.6	2.6	2.6	5.1	5.1
14+	44	2.3	4.5	4.5	6.8	6.8
15+	22	4.5	4.5	4.5	4.5	13.3
16+	10	10.0	10.0	10.0	20.0	20.0

and minority ethnic boys, respectively. The rates decreased to 2.3%, 7.7%, and 2.2% for those 16–18 years for the urban Han, rural Han, and minority ethnic boys, respectively. Data of 29,241 urban Han, 28,845 rural Han, and 20,231 minority ethnic boys were analyzed in the present study.

Analyses

Spermarcheal data were collected by the status quo method (Marshall and Tanner, 1986). Median spermarcheal ages (MSAs) for Han boys in each of the capitals of the provinces and for each of the minority ethnic groups were calculated using probit analysis (Finney, 1971).

The Han data were accumulated for calculating the MSAs of urban and rural boys separately, and then for the combined sample. Because minority ethnic boys may vary genetically, their data were not combined. In both urban and rural subgroups, there were only a few boys who did not have a first experience of ejaculation at age 18. The upper limit of the samples was thus 18 years, whereas probit analysis should include age categories from the last fully prespermarcheal boys to the first fully postspermarcheal boys. Thus, in calculating the MSAs, the percentages of postspermarcheal boys were assumed to be 100% at age 18 years.

RESULTS

Percentages of ejaculating emission for Han boys

Table 3 lists the percentages of ejaculating emission for each age of Han boys. Both the urban and rural boys, as well as the combined total, show curves of percentages of ejaculating emission as similar long 'S' shapes (Fig. 3). The earliest age when ejaculation occurred is 10 years. Ejaculating rates of urban boys are significantly higher than those of rural boys in all age groups. For example, the ejaculating rate in urban boys age 11 was 4.18% compared to only 2.36% for rural boys at this age. In those age 14, more than 50% of urban boys (51.8%) had experienced ejaculating emission, compared to only 41.08% for rural boys at the same age.

Median spermarcheal age (MSA) for Han boys

Table 4 summarizes MSAs, 95% intervals of the reference, and 95% confidence intervals for Han boys in each of the provincial capitals. The 95% intervals of the reference are calculated from means and standard deviations, which show the normal distribution of MSA for each of the urban and rural samples in the study; the 95% confidence intervals are calculated with means and standard errors for estimating the age range of MSA for the total sample in each city. For urban boys, mean MSA for the total sample is 14.24 years (95% confidence interval 13.95–14.53 years; 95% reference interval 11.50–17.44 years, n = 29,241). For rural boys, mean MSA is 14.85 years (14.53–15.16 years in 95% confidence intervals, 11.78–18.58 years in 95% reference intervals, n = 28.845). In most of the cities, MSAs in urban areas are earlier than in rural areas by 0.04 to 1.55 years, and the differences are significant ($t = 2.88$, $P < 0.05$). In four of the cities, the MSAs of rural boys were lower than in urban boys. However, the differences are small and no significance was found ($t = 0.61$, $P > 0.05$). The correlation of MSAs between urban and rural boys in the 29 areas is moderately high ($r = 0.83$, $P < 0.01$), suggesting that if urban boys in one area have early spermarcheal ages, MSA of rural boys in this area is also likely to be lower, and vice versa. Table 4 also shows that in urban boys, the MSA of Chengdu boys was the low-

TABLE 3. Prevalence of spermarche (onset of the release of spermatozoa) in Chinese Han boys 9 through 18 years

Age (yrs)	Urban			Rural			Combined		
		Post-spermarche			Post-spermarche			Post-spermarche	
	N*	N	%	N*	N	%	N*	N	%
9+	2,845	0	0.00	2,642	0	0.00	5,487	0	0.00
10+	2,832	4	0.14	2,694	0	0.00	5,526	4	0.07
11+	2,965	124	4.18	2,919	69	2.36	5,884	193	3.28
12+	2,956	265	8.96	2,916	179	6.14	5,872	444	7.56
13+	2,906	742	25.53	2,911	672	23.08	5,817	1,414	24.31
14+	2,948	1,527	51.80	2,919	1,199	41.08	5,867	2,726	46.46
15+	2,950	2,266	76.81	2,960	1,941	65.57	5,910	4,207	71.18
16+	2,936	2,702	92.03	2,958	2,491	84.21	5,894	5,193	88.11
17+	2,936	2,841	96.76	2,962	2,780	93.86	5,898	5,621	95.30
18+	2,967	2,912	98.15	2,964	2,891	97.54	5,931	5,803	97.84
Total	29,241			28,845			58,086		

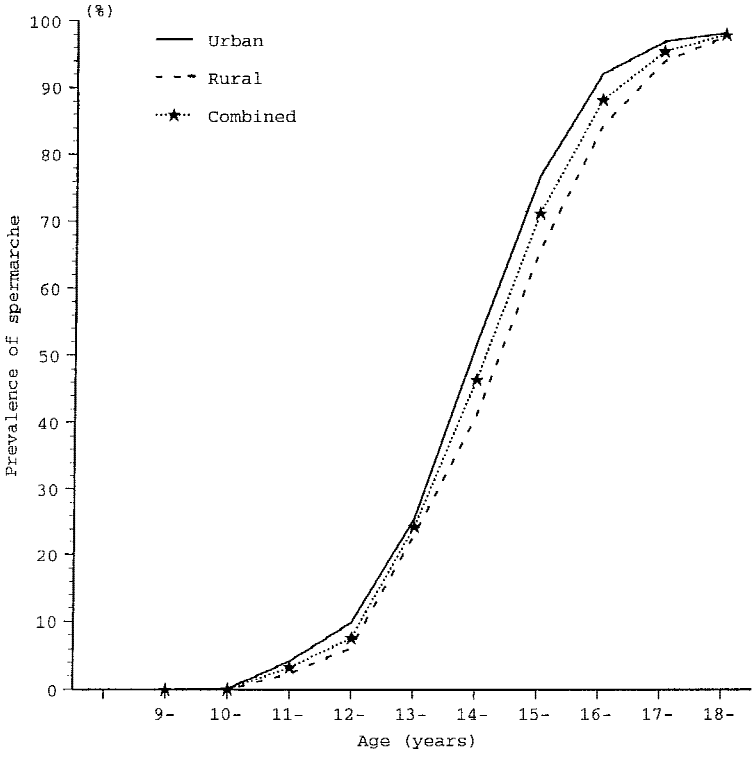

Fig. 3. Prevalence of post-spermarcheal boys with ages in Chinese urban, rural, and their combined total group.

est, 12.32 years, and that of Jinan boys was the highest, 15.69 years. For rural boys, the MSA of Haikou boys was the lowest, 13.08 years, and that of Jinan boys was the highest, 16.49 years.

To further analyze geographic variation of MSA, the 29 provinces are administratively divided into six regions: northeast, northwest, eastern, southeast, southwest, and municipalities. Three major cities, Beijing, Shanghai, and Tianjin, are municipalities directly under the central government. Comparisons of MSA in the six regions are listed in Table 5. MSAs of boys in southwest and southeast regions were the lowest, whereas those of boys in the northwest and northeast regions were the highest. Most significant geographic variation of MSA is apparent between urban boys in southwest and rural boys in northeast China, with the former being 2.15 years earlier than the latter.

TABLE 4. Median spermarcheal ages (MSAs) in Han boys from 29 Chinese areas (provincial capitals)

Provincial capitals	Urban				Rural				Urban-rural differences[c]
	n[a]	MSA	95% Ref int[b]	95% Conf int[b]	n[a]	MSA	95% Ref int[b]	95% Conf int[b]	
Beijing	993	13.84	11.31–16.94	13.54–14.15	975	14.18	11.32–17.77	13.82–14.55	0.34
Tianjin	1,099	14.67	12.10–17.78	14.36–14.99	1,096	15.39	12.59–19.32	15.01–15.79	0.72
Shijiazhuang	1,020	14.46	11.68–17.90	14.23–14.69	1,040	15.47	12.60–19.00	15.05–15.90	1.01
Taiyuan	1,089	13.17	11.66–14.87	13.00–13.33	1,095	14.10	11.85–15.35	13.75–14.47	0.93
Huhehaote	1,130	14.49	11.73–17.89	14.20–14.78	1,051	14.96	12.50–17.88	14.69–15.22	0.47
Shenyang	1,097	14.64	11.56–18.54	14.33–14.95	1,011	16.03	13.18–19.50	15.51–16.56	1.39
Changchun	1,112	14.91	12.40–17.93	14.66–15.18	1,098	16.28	13.71–20.88	15.88–16.68	1.37
Harbin	1,103	14.99	12.20–18.20	14.61–15.37	1,022	16.15	13.28–19.25	15.80–16.51	1.16
Shanghai	1,077	14.36	12.78–16.14	14.14–14.59	1,007	15.42	13.09–18.03	15.03–15.82	1.06
Nanjing	1,026	14.41	11.81–17.58	14.02–14.82	1,071	15.15	12.87–17.83	14.81–15.49	0.74
Hangzhou	1,003	14.26	12.15–16.74	13.91–14.63	1,096	15.67	12.72–20.97	15.35–16.01	1.41
Hefei	1,017	14.20	12.69–15.90	14.01–14.40	1,109	14.99	13.10–17.14	14.76–15.22	0.79
Fuzhou	1,100	13.72	11.92–15.80	13.48–13.96	1,031	14.26	11.56–17.57	13.92–14.59	0.54
Nanchang	1,091	14.65	12.38–18.58	14.35–14.97	995	14.92	12.26–18.16	14.58–15.27	0.27
Jinan	1,099	15.69	13.05–20.20	15.38–16.01	1,098	16.49	13.72–19.16	15.84–17.15	0.8
Zhengzhou	993	14.71	12.24–16.34	14.54–14.88	1,094	14.64	12.33–17.58	14.44–14.84	–0.07
Wuhan	999	13.30	11.36–16.77	13.01–13.60	908	14.40	13.14–17.82	14.09–14.73	1.1
Changsha	915	14.30	11.60–17.88	13.95–14.66	830	14.34	12.76–16.12	14.13–14.56	0.04
Guangzhou	901	13.26	10.29–17.09	12.96–13.57	945	13.75	11.43–16.54	13.46–14.05	0.49
Nanning	949	13.33	10.57–16.82	13.09–13.58	896	13.10	10.44–16.36	12.82–13.40	–0.23
Haikou	961	13.32	10.75–18.03	13.02–13.64	910	13.08	11.43–15.98	12.90–13.27	–0.24
Chengdu	1,114	12.32	9.92–17.01	12.01–12.65	1,023	13.42	11.71–15.37	13.24–13.61	1.1
Guiyang	892	13.45	10.59–17.07	13.16–13.75	955	13.52	10.92–16.75	13.30–13.75	0.07
Kunming	856	13.92	11.16–17.36	13.69–14.16	906	14.28	11.71–17.41	14.03–14.54	0.36
Xian	1,140	14.44	11.84–17.61	14.08–14.81	1,108	14.60	11.85–17.98	14.31–14.90	0.16
Lanzhou	1,086	15.59	13.56–17.93	15.36–15.82	1,104	15.43	13.03–18.28	15.14–15.74	–0.16
Xining	900	14.21	12.53–16.11	13.90–14.46	896	15.76	13.76–18.04	15.46–16.06	1.55
Yinchuan	898	15.35	13.24–17.80	15.06–15.65	891	15.60	13.61–17.88	15.32–15.88	0.25
Wulumuqi	581	14.92	12.17–17.92	14.58–15.26	584	15.29	11.88–18.00	14.99–15.61	0.37
Total	29,241	14.24	11.50–17.44	13.95–14.53	28,845	14.85	11.78–18.58	14.53–15.18	0.61

[a]Valid numbers.
[b]95% Ref int = 95% reference intervals, 95% Conf int = 95% confidence intervals.
[c]MSA of rural (yrs); "–", MSA of urban (yrs).

*TABLE 5. Comparison of median spermarcheal ages (MSAs) of Han boys in six geographic regions of China**

Geographic regions	MSA (yrs)	
	Urban boys	Rural boys
Cities in northwest China (n = 5)	14.90	15.34
Cities in northeast China (n = 7)	14.48	15.38
Three metropolises (n = 3)	14.29	15.00
Cities in eastern China (n = 6)	14.49	15.25
Cities in southeast China (n = 5)	13.50	13.74
Cities in southwest China (n = 3)	13.23	13.73

*Cities in northwest China include Xian, Lanzhou, Xining, Yinchuan, and Wulumuqi; cities in the northeast include Shijiazhuang, Taiyuan, Huhehaote, Shenyang, Changchun, Harbin, and Zhengzhou; cities of metropolises include Beijing, Tianjin and Shanghai; cities in the east include Nanjing, Hangzhou, Hefei, Fuzhou, Nanchang, and Jinan; cities in the southeast include Wuhan, Changsha, Guangzhou, Nanning, and Haikou; cities in the southwest China include Chengdu, Guiyang, and Kunming.

Median spermarcheal ages for minority ethnic boys

MSAs of minority ethnic groups are listed in Table 6. The MSA of Shui boys is the lowest, 13.46 years, and that of Salar boys was the highest, 16.32 years. The difference between the lowest and the highest means was 2.86 years. Urban-rural differences for the five minority ethnic groups appear to be lower than those in Han boys. In the Hui, Zhuang, and Korean ethnic groups, MSAs of urban boys were even slightly higher than those of the rural boys.

The 17 minority groups (22 subgroups) were classified into six regions according to geographic location: northeast, southeast, Yunnen province, Guizhou province, and Tibet (see Fig. 2). Average MSA of the four groups living in Guizhou (Miao, Dong, Buyi, and Shui) was the lowest, 13.74 years, whereas that of the six subgroups (in four ethnic groups) living in northwest China (Uygur, Hui, Tu, and Salar) was the highest, 15.51 years (Table 7). MSAs of minority ethnic boys in northwest, northeast, and southeast China were generally higher than those of Han boys living in the same regions. There are no significant differences in MSA between Han and most of the minority boys living in Yunnan or Guizhou provinces, except for the Bai (15.13 years), which was much later than that of Han boys (13.92 years) living in Kunming City situated in the same province.

DISCUSSION

Results of this study can be summarized as follows. Spermarcheal age can be estimated successfully in a population of normal boys, based on personal interview about the experience of ejaculating emission to establish current status and probit analysis. There were significant differences in MSAs for urban and rural Han boys, and the correlation of MSAs between the urban and rural samples is moderately high. Both in urban and rural Han, there were significant geographic variations among groups living in diverse areas, which generally indicate that the MSAs of boys living in the north were higher than those living in the south, and those living in the west were higher than those living in the east. For most of the Chinese ethnic minority groups considered in this study, MSAs were later than those of Han boys living in the same regions, whereas the urban-rural difference in MSA for the minority boys was not as large as that for the Han.

Growth is a product of a continuous and complex interaction of heredity and environment. Environmental factors can be generally divided into two dimensions: socioeconomic (nutrition, disease, income, occupation, family size, social mobility, urbanization, etc.) and ecological (altitude, season, climate, etc.) (Malina and Bouchard, 1991). Difference in MSAs of minority boys in this study can be attributed to the effects of both hereditary and environmental factors. In contrast, differences in MSA of Han boys living in diverse regions, especially the urban-rural contrasts, are most likely due to the effect of two dimensions of environmental factors. A close relationship between the median menarcheal age (MMA) of Chinese girls and socioeconomic status has already been shown both in 1985 (Lin et al., 1992) and 1991 data (Ji et al., 1994). For example, MMAs of girls living in Beijing, Shanghai, and Tianjin (the most advanced socioeconomic areas in China) were significantly lower than those in other provinces, and the MMA of girls in Guizhou province (one of the border areas with lowest economic conditions) was rather high. On the other hand, the MSAs of Han boys in the present study show an evident trend of lower MSAs for boys in southwest and southeast China than those living in the municipalities and other relatively developed regions located in northeast China. The role of ecological factors on the sexual maturation of boys cannot be overlooked. Southwest and southeast China are charac-

*TABLE 6. Median spermarche ages (MSAs) of boys in 17 minority ethnic groups (22 subgroups) of China**

Ethnic groups	n	MSA	95% Ref int	95% Conf int
Urban Mongoli	1,157	15.17	12.06–19.08	14.84–15.52
Rural Mongoli	1017	15.73	12.23–20.23	15.37–16.11
Urban Hui	896	15.69	13.53–18.21	15.34–16.06
Rural Hui	831	15.65	13.60–18.00	15.33–15.99
Urban Uygur	1,359	14.50	12.44–16.90	14.21–14.80
Rural Uygur	1,360	15.06	13.11–17.30	14.75–15.38
Urban Zhuang	844	14.29	11.74–17.40	13.99–14.60
Rural Zhuang	851	14.05	11.47–17.23	13.76–14.35
Urban Korean	984	15.10	12.82–17.78	14.79–15.42
Rural Korean	909	14.98	12.64–17.76	14.65–15.34
Tibetan	891	14.68	12.27–17.56	14.35–15.03
Miao	896	13.50	11.33–16.09	13.21–13.80
Buyi	914	13.83	11.07–17.29	13.47–14.19
Dong	899	14.17	12.03–16.67	13.82–14.53
Bai	916	15.13	12.72–17.99	14.81–15.47
Hani	898	13.86	11.80–16.27	13.53–14.20
Dai	875	13.92	12.63–15.35	13.57–14.28
Li	903	14.14	11.62–17.20	13.85–14.44
Shui	879	13.46	10.07–18.00	13.17–13.76
Naxi	916	14.10	11.49–17.30	13.78–14.44
Tu	566	15.85	13.44–18.58	15.51–16.21
Salar	560	16.32	13.22–20.16	15.95–16.71

*See Table 4 for abbreviations.

*TABLE 7. Comparison of median spermarcheal ages (MSAs) of ethnic minority boys (22 subgroups) in six geographic regions of China**

	MSA (years)	
Geographic regions	Average age	Age range
Groups in northwest China (n = 6)	15.51	14.50–16.32
Groups in northeast China (n = 4)	15.25	14.98–15.73
Group in Tibet (n = 1)	14.68	—
Group in southeast China (n = 3)	14.16	14.05–14.29
Groups in Yunnen province (n = 4)	14.25	13.86–15.13
Groups in Guizhou province (n = 4)	13.74	13.46–14.17

*Groups in northwest China include urban Uygur, rural Uygur, urban Hui, rural Hui, Tu and Salar; groups in northeast China include urban Mongolian, rural Mongolian, urban Korean and rural Korean, groups in southeast China include urban Zhuang, rural Zhuang and Li; groups in Yunnan province include Bai, Hani, Dai and Naxi; groups in Guizhou province include Miao, Buyi, Dong and Shui.

terized by a hot and humid environment, with a much lower temperature range than that in the cold and wet environment in northeast and northwest China. This tendency is consistent with Jiang's (1985) report, which showed that in 470 postspermarcheal Chinese boys, 41.0% had the onset of ejaculating emission in the hot and humid summer, 23.4% in the spring, 19.2% in the autumn, and only 16.4% in the cold and wet winter. However, because no further information is presently available, additional study is necessary before concluding that this trend suggests a seasonal influence on male reproductive maturation.

The MSAs estimated in this study were 14.24 and 14.85 years for the urban and rural Han boys, respectively. These not only approximate earlier studies in China, which also used personal interviews (Jin, 1980; Dai, 1981; Zhang, 1982; Huang, 1987), but are also quite similar to that reported by Laron et al. (1980). Using a questionnaire with Israeli boys, Laron et al. (1980) reported an average spermarcheal age of 14.7 years, with a range of 12.5–16.5 years. On the other hand, compared to the earlier reports using periodic urine samples, the MSAs estimated in the present study are much later. Neilsen et al. (1986b), tracking 40 Scottish boys with 24-hour urine samples every 3 months for 6 years, reported an MSA of 13.4 years. With the same method, Hirsch et al. (1985) suggested that the MSA of Israeli boys was around their 13th birthday. Clearly, the different estimates for MSA with the two approaches may be attributed to different definitions of the term spermarche. Spermarche should be defined as either the first ejaculation of semen or the appearance of sperm in the urine. In urine sample analysis, the second definition is used. Thus, the age at first observed spermaturia is used for calculating MSA. The levels of testosterone, the main hormone in promoting male sexual develop-

ment, at that time are actually low. Thus, spermarche is observed as an early event of male puberty. In the present study, the first definition is used, and the estimation of spermarche should be taken only after the formation and ejaculation of sperm. The maturation of the male reproductive system and testosterone excretion at this time has almost reached that found in adult men (Müller et al., 1989). That is why MSAs estimated by personal interview are about 1–2 years later than those estimated by the onset of spermaturia.

Exact information on the achievement of reproductive capacity in boys can be provided by the urine sample analysis. For example, when a group of boys is studied longitudinally, relationships between spermarche and the development of pubic hair, growth of testes, peak height velocity, sitting height, and testosterone excretion in the urine can also be precisely examined. This method is time-consuming and is only suitable for small samples. Furthermore, urine examinations may carry a considerable rate of false negatives due to a number of factors, even in boys who provide five or more urine samples. For example, if nocturnal emission urine is voided prior to the first morning void, or if the subject brought a later void in breach of the protocol, no sperm will be found because it will be rinsed out in the first void after emission (Hirsch et al., 1985). In the study of Hirsch et al. (1985), over 40% of the boys who were positive at age 12 were negative at age 13. This technical negativity will no doubt underestimate the true rate of spermatogenesis. In contrast, the false negative rate of spermatogenesis by inquiring as to the occurrence of sperm emission is low. Thus, the approach of personal interviews is thought to be more suitable for the population based surveys. Two strategies were used for obtaining objective and exact responses. The first is school health education prior to the inquiry. As a result, many postspermarcheal boys are not ashamed to provide exact responses because they know that nocturnal sperm emission is an event of normal puberty rather than a pathological or a shameful phenomenon. The results of the comparison of urine analysis and interviews (Tables 1 and 2) provide evidence of the accuracy of the interview method. The second strategy is to provide some explanation of sperm emission to the subjects who have not yet experienced it. This resulted in less than 30% invalid cases than in a survey, which only required boys to select one of the responses in the questionnaire (Ji, 1991).

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