Recent Change in the Fertility Pattern in Korea

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1. Introduction

Increasing use is being made of model-building in demography. In many cases demographic models are used as tools of estimation—a role which is particularly important when the available data are limited and defective. On the other hand, a judicious use of models is indispensable in checking and adjusting data, in filling gaps in the available records [5]. With the advent of the computer, the tabulation of whole systems of model life tables and model stable population distributions became readily feasible [1].

Recently, Ansley J. Coale and T. James Trussell tabulated an extensive set of model age-specific fertility schedules by assigning various numerical values to parameters regarding nuptiality and fertility control [3]. The model tables have the advantage of describing in detail age patterns of fertility that are widely experienced but seldom recorded.

This paper is to give an outline of the age-specific fertility model constructed by them and, by means of its practical application, to estimate single-year fertility rates and a measure of fertility control in Korea, based on age-specific fertility rates by five-year age group, calculated from the Korean census data for 1960 and 1975.

2. The Model of Age-Specific Fertility

If the proportion ever married at age a in the given female population is

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$G(a)$, and the marital fertility defined as the proportion of married women at age a experiencing a live birth is $r(a)$, then age-specific fertility is

$$f(a)=G(a)\cdot r(a) \tag{1}$$

The basic assumption upon which the model rests is as follows:

A) There is no fertility outside marriage, and no dissolution of marriage before the end of childbearing span of ages.

B) Schedules $G(a)$ and $r(a)$ have remained constant in the recent past, and also can be closely approximated by a model nuptiality schedule and a model marital fertility, respectively.

(1) Model Nuptiality Schedule

Let $g(a)$ represent the frequency of first marriages by age, defined as the number of first marriages in a short age interval divided by the number of females in that interval.

Then the proportion ever married at age a, $G(a)$, can be expressed as

$$G(a)=\int_{a_0}^{a} g(x)dx \tag{2}$$

where a is the age at which first marriages begin in the female population. Specifically the ultimate proportion of women who ever marry in the cohort is

$$G(w)=\int_{a_0}^{w} g(x)dx \tag{2}$$

where w stands for the highest age attainable in human life.

If $g(a)$ is normalized by dividing by $E=G(w)$, then $g^*(a)=g(a)/E$ becomes a probability density function. Namely, $g^*(a)$ is the distribution of first marriages of those who ever marry.

An analytical expression of $g^*(a)$, which is very useful for computation, has been developed by Donald McNeil [2]. This expression is;

$$g^*(a)=(0.19465/k)\exp\{-0.174/k)(a-a_0-6.06k)$$
$$-\exp[(-0.2881/k)(a-a_0-6.06k)]\} \tag{3}$$

where k is a scale factor of the nuptiality schedule, which shows that half of the population who ever marry is to experience first marriage $10k$ years after a_0.

Then $G(a)$ can be calculated by numerical integration of $g^*(a)$ and if multiplied by a factor E, the proportion ultimately experiencing marriage. Namely

$$G(a)=E\int_{a_0}^{a} g^*(x)dx \tag{4}$$

However, since we are concerned only with the age pattern of nuptiality and not the level, the poportion of females who will ultimately marry, E, can be omitted hereafter. Then a family of nuptiality schedules is obtained by assigning various values to a_0, the age of initiaiton, and k, the pace of first marriages.

(2) Model Marital Fertility Schedule

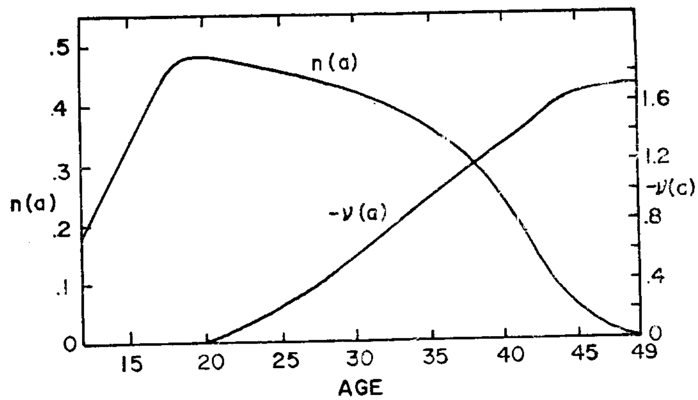
Louis Henry found that populations in which there is little voluntary control of births within marriage share a characteristic pattern, by age, of marital fertility; he gave such fertility the name "natural fertility" [4]. The regularity in marital fertility that makes possible a single-parameter model is as follows: marital fertility either follows natural fertility (if deliberate birth control is not practiced), or departs from natural fertility in a way that increases with age according to a typical pattern. In a population in which fertility is voluntarily controlled, marital fertility $r(a)$ is given as the product of natural fertility, $n(a)$, and a multiplier which is also a function of age. Namely,

$$r(a)=n(a)\cdot M \exp\ (m\cdot\nu(a)) \tag{5}$$

The function $\nu(a)$ expresses the tendency for older women in populations practicing contraception or abortion to effect particularly large reductions of fertility below the natural level. The functions $n(a)$ and $\nu(a)$ which were derived from empirical data are assumed to be invariant. They are shown in Fig. 1 [3].

The factor M is a scale factor. Since we are concerned only with the age pattern of fertility (not its level), the value of M is of no significance for the model of marital fertility, and will be omitted hereafter.

Fig. 1. Values of $n(a)$ (Natural Fertility), and $\nu(a)$ (Logarithmic Departure from $n(a)$)



Then a family of marital fertility schedules is obtained by assigning various values to m, from zero, in which case $r(a)$ equals $n(a)$, to a maximum expressing the greatest likely depatrure of fertility from the age pattern of natural fertility resulting from a very high degree of voluntary control of births.

In summary, the age pattern of fertility is given by equation (6);

$$f(a)=G(a)\cdot n(a)\cdot e^{m\nu(a)} \qquad (6)$$

where i) $f(a)$ is age-specific fertility,

ii) $G(a)$ is the proportion ever married, characterized by selected values of the parameters a_0 and k,

iii) $n(a)$ is natural fertility, and

iv) $\nu(a)$ is the characteristic pattern of departure from natural fertility, and m is a measure of the departure.

3. Tabulated Model Fertility Schedules

A large array of model fertility schedules were calculated by assigning various numerical values to three controlling parameters, a_0, k and m in the above model [3]. In each schedule the age-specific fertility rates were given by single years of age, and were normalized so that the total fertility is 1.0; the schedules embody only an age pattern of fertility, and carry no implication with respect to its level.

A total of 795 model schedules were selected to produce mean ages at integral values from 24 to 34 years and values of standard deviation at intervals of half a year. The range of standard deviation is from 4.0 to 7.5.

The first ten entries for each schedule are listed in the first column of Table 4, and explained at the footnote. The table of model fertility schedule was arranged to make it possible to locate (through interpolation among the printed values) a model fertility schedule that matches the observed mean and standard deviation plus the ratio of fertility at ages 15-19 to fertility at ages 20-24 (labeled *R*, in the model table).

4. Fitting a Model Schedule to Korean Census Data

Age-specific fertility rates by five-year age group in Korea, based on the census data for 1960 and 1975, are shown in the second and fourth column of Table 1, and some characteristic values calculated from the census data are listed in Table 2.

Table 1. Age-Specific Fertility Rates by Five-Year Age Group in Korea: 1960 and 1975

Age	1960		1975	
	Census Data*,	Fitted Data+	Census Data*	Fitted Data+
15—19	0.0712	0.0740	0.012	0.0122
20—24	0.2615	0.2676	0.163	0.1657
25—29	0.3309	0.3089	0.273	0.2630
30—34	0.2568	0.2644	0.152	0.1616
35—39	0.1820	0.1874	0.068	0.0687
40—44	0.0785	0.0840	0.023	0.0183
45—49	0.0165	0.0111	0.000	0.0015
Total	1.1974	1.1974	0.691	0.6910
Total Fertility Rate	1.1974×5=5.987		0.691×5=3.455	

Note

* Source: Bureau of Statistics, Economic Planning Board, Republic of Korea

\+ These rates are derived from the estimated single-year fertility rates in Table 3.

Table 2. Some Characteristic Values of Fertility Schedule, Calculated from the Census Data, Korea

Chracteristic Value	1960	1975
Mean Age of Childbearing	29.665	28.730
Standard Deviation in the Ages at Childbearing	6.763	5.184
R_1*	0.2723	0.0736
Skewness	0.3405	0.5625

Note: * $R_1=\sum_{15.5}^{19.5} f(a)/\sum_{20.5}^{24.5} f(a)$, where $f(a)$ represents the age-specific fertility at age a.

Next for the census data of 1960 and 1975, a model fertility schedule is located respectively, which matches the observed values of mean age, standard deviation and R_1, by employing the weighted average of three selected model schedules. The details of selection and interpolation is omitted here. Single-year fertility rates, estimated by fitting a model fertility schedule to the census data, are shown in Table 3 and Fig. 2.

Table 3. Estimated Single-Year Fertility Rates by Model Fertility Schedules: Korea, 1960 and 1975

Age	Fertility Rate		Age	Fertility Rate	
	1960	1975		1960	1975
15	0.0078	0.0000	33	0.2508	0.1347
16	0.0264	0.0008	34	0.2359	0.1150
17	0.0598	0.0046	35	0.2206	0.0972
18	0.1080	0.0157	36	0.2044	0.0811
19	0.1682	0.0397	37	0.1882	0.0670
20	0.2209	0.0790	38	0.1713	0.0546
21	0.2509	0.1238	39	0.1525	0.0435
22	0.2732	0.1710	40	0.1304	0.0332
23	0.2897	0.2125	41	0.1058	0.0240
24	0.3031	0.2422	42	0.0827	0.0167
25	0.3088	0.2633	43	0.0604	0.0109
26	0.3130	0.2753	44	0.0404	0.0065
27	0.3121	0.2720	45	0.0248	0.0036
28	0.3088	0.2624	46	0.0155	0.0021
29	0.3020	0.2421	47	0.0092	0.0012
30	0.2914	0.2139	48	0.0048	0.0006
31	0.2785	0.1855	49	0.0013	0.0002
32	0.2651	0.1590	Total	5.9867	3.4549

Fig. 2. Age-Specific Fertility for 1960 and 1975 in Korea, Estimated by Model Fertility Schedules

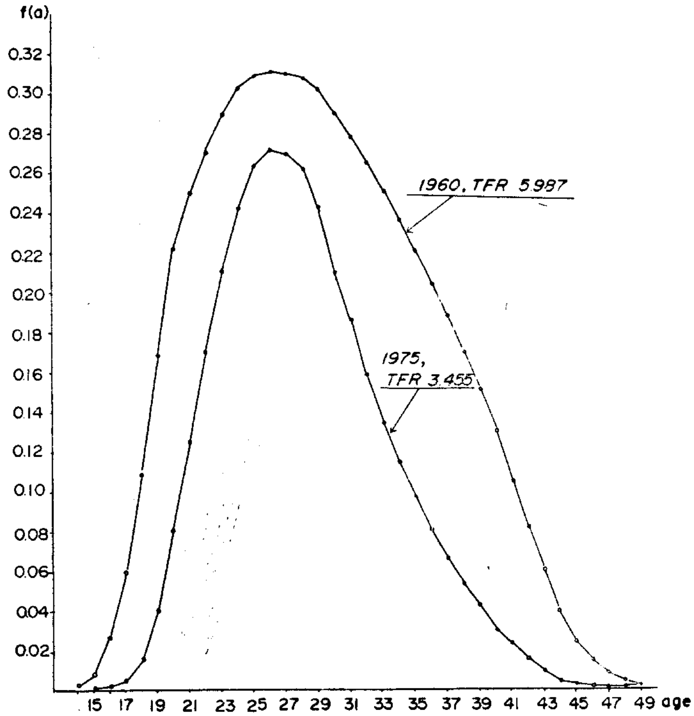


Table 4. Estimated Parameters of Fertility Schedules in Korea: 1960 and 1975

Parameter	Model Fertility Schedule Fitted to 1960 Census Data	Model Fertility Schedule Fitted to 1975 Census Data
Mean Age of Childbearing	29.665	28.73
Standard Deviation in the Ages at Childbearing	6.742	5.16
R_1*	0.2732	0.0731
Median Age of Childbearing	29.09	28.11
Skewness of Age-specific Fertility	0.280	0.559
PAR +	0.1082	0.0295
PAR 2++	0.3989	0.2504
a_0 1)	14.2	16.6
k 2)	0.772	1.238
m 3)	0.531	2.429

Note:

* $R_1=\sum_{15.5}^{19.5} f(a) / \sum_{20.5}^{24.5} f(a)$, where $f(a)$ represents the age-specific fertility at age a.

\+ *PAR* 1=average parity (15-19)/average parity (20-24).

++ *PAR* 2=average parity (20-24)/average parity (25-29).

1) a_0……first age of marriage.

2) k……pace of marriage such that half of the population experiences marriage $10k$ years after a_0.

3) m……measure of fertility control relative to the natural fertility schedule.

These single-year fertility rates are cumulated and divided by 5 for each five-year interval to provide a basis for checking goodness of fit to the observed fertility rates by five-year age group. They are shown in the third and fifth column of Table 1.

Ten parameters of each model schedule are also calculated by employing the same weighted average of first ten entries in the three selected model schedules. They are listed in Table 4.

5. Summary and Conclusion

By examining Table 1, it is confirmed that the two model fertility schedules for 1960 and 1975 are close agreement with the census data in Korea.

The declines of age-specific fertility are more remarkable among older women than among younger, as exhibited in Table 3 and Fig. 2.

A merit of this fitted model schedule as compared to fitted conventional frequency distributions such as the Pearson Type III curve [6], is that the model schedule incorporates combinations of intuitively undestandable demographic factors. The value of m, a measure of fertility control, increased remarkably from 0.531 in 1960 to 2.429 in 1975. Considering the fact that the average value of m for forty-three schedules shown in the 1965 *Demographic Yearbook* [7] was 1.0, and the value of m in England and Wales for 1965 was 1.91, the recent level of fertility control in Korea may be considered higher than generally believed.

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