Temporal Trends in the Rates of Multiple Maternities in England and Wales

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After a long continuous decrease, the twinning and higher multifetal rates in many developed countries have increased during the last 2 to 3 decades. This change has been attributed to delayed childbearing and to increased use of subfertility treatments, particularly in women over 35 years of age. In this study we analyze how these new trends depend on changes in the effect of maternal age on the rates of multiple maternities. Our study is based on data for England and Wales for the period 1938 to 2003. The temporal variations show a decreasing trend to a trough around 1980 and after that a steady increase. This increase was more marked for higher multifetal rates and was particularly high for quadruplets. Furthermore, we identified changes in the age-specific rates resulting in increased levels for older mothers. These findings are in good agreement with our results from Nordic populations.

Recent studies have shown that since the end of the 1970s, after a long continuous decrease, the rates of multiple maternities and particularly the twinning rates (TWRs) have increased in many developed countries (for details, see Elwood, 1983; Eriksson & Fellman, 2004; Fellman & Eriksson, 2005; Pison & D'Addato, 2006; Simmons et al., 2004). The increased prevalence of multiple maternities during the past 2 to 3 decades is primarily due to the higher childbearing age and increased use of assisted reproductive technologies (ARTs) and non-ART procedures such as intrauterine insemination and ovulation-inducing medications. In Sweden, the number of twin deliveries has increased from 8 to 15 per 1000 between 1973 and 2000 (Fellman & Eriksson, 2005; Odlind et al., 2003). Wennerholm and Bergh (2004) summarized that infertility treatments increase twin birth rates 10- to 20-fold and triplet rates 200- to 500-fold for treated mothers in comparison with mothers in the general population. In this study we analyze how these new trends in the rates of multiple maternities depend on changes in the effect of the maternal age. Our study is based on data from England and Wales for the period 1938 to 2003. Especially, we analyze changes in the age-specific rates. Comparisons with results from other populations (Botting et al., 1987; Elwood, 1983; Fellman & Eriksson, 2005; Pison & D'Addato 2006; Zhang et al., 2002) are performed.

In a forthcoming paper also based on data from the Office for National Statistics (ONS), studies of the stillbirth rates for singletons, twins and triplets in England and Wales are presented (Eriksson & Fellman, 2006).

Material and Methods

The ONS in the United Kingdom has presented data from England and Wales on the website http://www.statistics.gov.uk/. We have included time series data for the period 1938 to 2003 in this study. The time series started in 1938 when the Population (Statistics) Act came into force (Botting et al., 1987).

The data analyzed are grouped into the classes all mothers, married mothers and unmarried mothers. For each of these we consider the age groups under 20, 20 to 24, 25 to 29, 30 to 34, 35 to 39 and 40+ years, and within these age groups we consider both all maternities and multiple maternities. The data published by the ONS also include information about twin maternities, but when the effect of maternal age was studied, we had to restrict ourselves to all multiple maternities.

The data published for the 5-year periods are annual means and, consequently, small rounding errors have to be considered. In addition to rounding errors there are periods when the total numbers of maternities do not equal the sum of the maternities over the maternal age groups. In fact, for some periods we have noted errors in the annual means up to tens and hundreds. However, these discrepancies have to be compared with the annual means of about 700,000 for all mothers, 600,000 for married mothers and 95,000 for unmarried mothers and, consequently, the relative errors are minute. In this study we accepted the age-specific numbers as such and estimated the total number of maternities as the sum of

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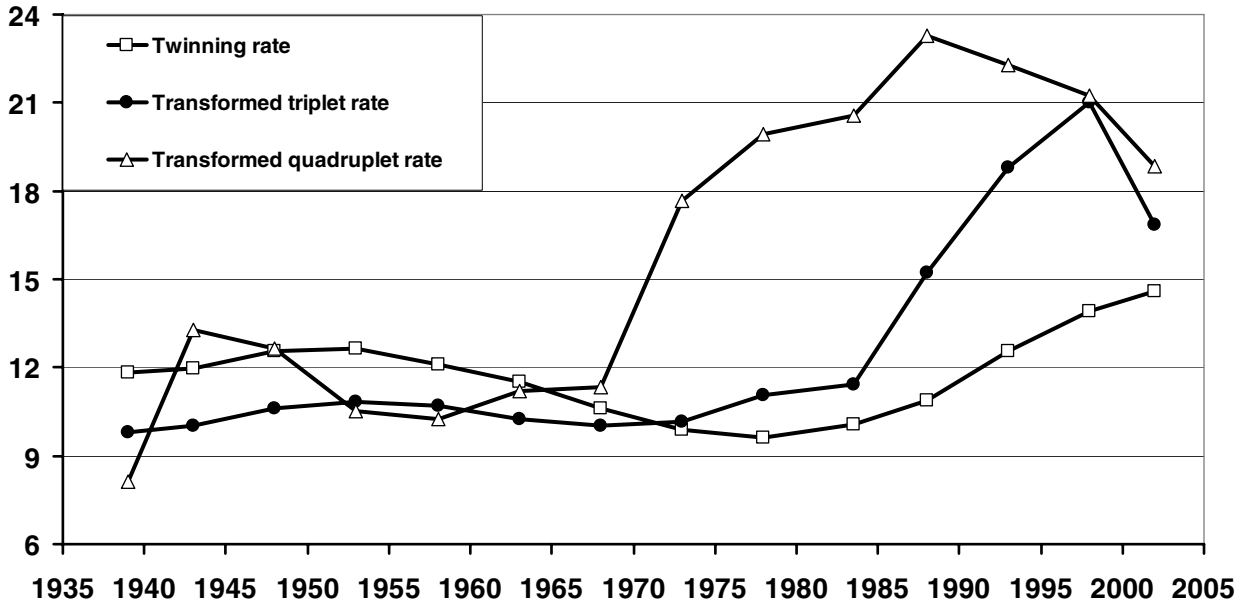

Figure 1

Temporal trends in the rates of twins, triplets and quadruplets in England and Wales, 1938–2003.

Note: The triplet and quadruplet rates are transformed according to Hellin's law (square root for triplet and cubic root for quadruplet rates). The increase in quadruplets starts early and is more marked than for triplets and twins. The increases in the rates coincide with the introduction of subfertility treatments. The decreases in the triplet and quadruplet rates observed after 1985 are in good agreement with changes in the subfertility treatment policies.

the age-specific ones. This enabled us to estimate the mean maternal age. For the year 1981 the age-specific numbers of multiple maternity data are missing. Botting et al. (1987) stated that this lack of information was caused by an industrial action by local registrars of both births and deaths. In order to avoid biased results, the year 1981 is completely ignored. Consequently, the periods considered are 5-year periods with exception of the periods 1938 to 1940, 1982 to 1985 and 2001 to 2003. In this study we applied the indirect standardization techniques proposed by Hill (1971) and used all maternities for the period 1941 to 1945 as the reference population. This period was chosen because it was the first complete 5-year period available. The group of all mothers was chosen in order to maximize the reference population. Indirect standardization was applied because we expected that direct standardization would give less reliable results for the rates of multiple maternities for unmarried mothers (Chan et al., 1988; Fellman & Eriksson, 1990, 2002). The standardization methods proposed by Fellman and Eriksson (1990, 2002) are explicitly developed for twinning rates and cannot be applied to the rates of multiple maternities.

The inclusion of higher multiple maternities causes, compared to the TWR, positive biases, but our opinion is that they are minute. A detailed analysis indicates that the relative bias introduced when the TWRs are replaced by rates of multiple maternities is of the magnitude of 1.5%. For the period 1938 to 1940 the relative bias is 0.8%, but after that it increases to a maximum of 3.2 for the period 1996 to 2000. This increasing trend is mainly due to the relative increases in the triplet and quadruplet rates during the last periods (cf. Figure 1).

Results and Discussion

Age-Specific and Standardized Rates of Multiple Maternities

In Figure 1 we compare the rates of twin, triplet and quadruplet maternities. In order to simplify the comparisons, we have transformed the triplet and quadruplet rates according to Hellin's law, that is, the square root of the triplet rate and the cubic root of the quadruplet rate (Fellman & Eriksson, 1993, 2004). All curves show increasing trends during the latter periods. For the quadruplet rate the increase starts after 1966–1970, for the triplet rate after 1971–1975 and for the TWR after 1976–1980. The quadruplet rate shows the most marked increase. The start of the strong increases in the triplet and quadruplet rates coincides with the introduction of subfertility treatments, mainly ovulation inductions. After 1991–1995 the quadruplet rate and after 1996–2000 the triplet rate show decreasing trends. Simmons et al. (2004) also noted a dramatic decrease in the proportion of triplet and higher order births since 1998. These decreases can be ascribed to changes in the treatment policies discussed below.

In Figure 2 the rates of the multiple maternities show a decreasing trend after 1951-1955 up to 1980. After 1982–1985 an increase begins. The trough in the observed time series cannot be eliminated with

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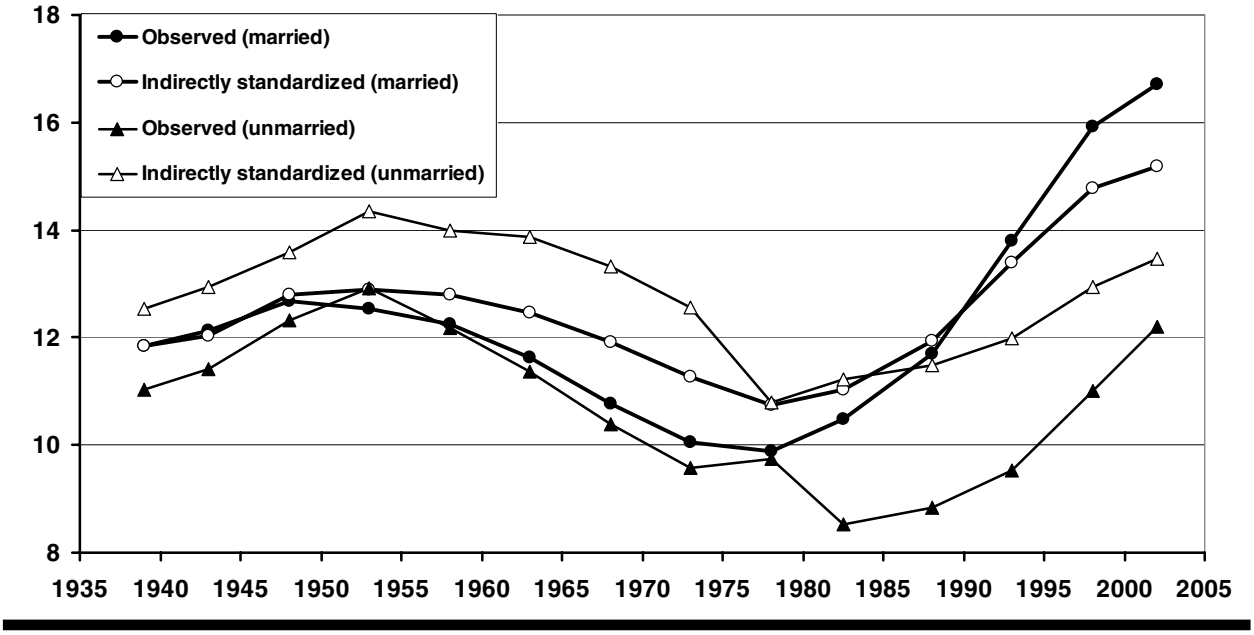

Figure 2

The observed and for maternal age standardized rates of multiple maternities for married and unmarried mothers in England and Wales, 1938–2003.

Note: The trough in the observed time series could not be eliminated with the standardizations. The recent increase in the rates may be caused mainly by subfertility treatments. Up to 1975 the standardized rate is higher for unmarried than for married mothers, but after that this effect of the marital status turned in the opposite direction. This marked change was ascribed to subfertility treatments being more common for married than for unmarried and to an increased proportion of cohabiting — unmarried mothers living as married ones (cf. Figure 5).

standardizations according to maternal age. The recent increase in the rates may mainly be caused by subfertility treatments. This hypothesis is supported by the fact that subfertility treatments may have distorted the normal pattern of the age-specific rates, shown in Figures 3 and 4. This trend was also noted by Botting et al. (1987) for the period up to 1985. Elwood (1983) noted the trough in England and Wales, and also in Canada.

Fellman and Eriksson (2005) also observed increasing TWRs during the last decades of the 20th century in Denmark, Finland, Norway and Sweden. In the Nordic countries, strong declines resulting in marked troughs first, and subsequent strong increases, were observed. However, careful inspection identified some differences between the countries. In Sweden, the decline began from a maximum of 14.8 per 1000 in the period 1901 to 1910, and the trough was very deep. The minimum TWR was only 8.7 during the period 1971 to 1980, and the increase began in the period 1981 to 1990, reaching 14.4 per 1000 in 1991 to 2000. For Denmark and Norway, the decreases began in the period 1921 to 1930 from 15.8 and 14.6, respectively. Their minima were also found in the period 1971 to 1980 (9.4 for Norway and 9.8 for Denmark) and there were subsequent strong increases. For Finland, these changes came later. The maximum TWR was as high as 15.5 and was obtained as late as the period 1951 to 1960. The minimum was still relatively high, 10.8, and was in the period 1981 to 1990. Consequently, an increase was not observed until 1991–2000 (Fellman & Eriksson, 2005).

Up until 1975 the standardized rate in England and Wales is higher for unmarried than for married mothers, but subsequently the effect of marital status changed to the opposite direction. This marked change is ascribed to an increased proportion of cohabiting — unmarried mothers who, consequently, live as married ones (cf. Figure 5) — and to more subfertility treatments for married than unmarried mothers. The effect of marital status on the TWR has been noted by Eriksson and Fellman (1967a, 1967b). Furthermore, Fellman and Eriksson (1987, 2002) noted for Denmark that this marital status effect had disappeared in recent times. This change was ascribed to a diminishing of the socioeconomic differences between married and unmarried mothers. Today one can observe an increased proportion of cohabiting, unmarried mothers which, consequently, are living as married ones.

Figure 3 presents the age-specific rates for multiple maternities for the periods 1941 to 1950, 1982 to 1990 and 1991 to 2003 for England and Wales. For the first period studied, the pattern can be considered normal, but for the period 1982 to 1990, a small reduction in the maternal age effect can be noted. For the age group under 45 years the age-specific rates have decreased, but for the age groups over 45 years a slight relative increase can be observed. In short, the maternal-age effect has levelled to some

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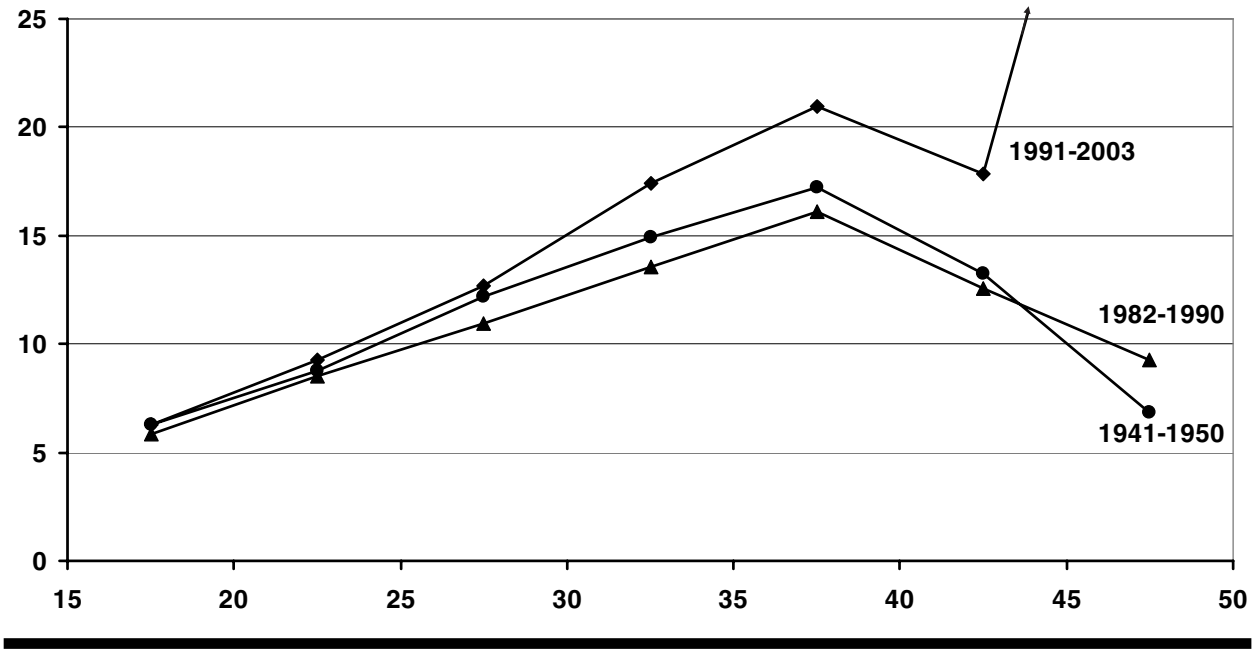

Figure 3

The age-specific rates of multiple maternities in England and Wales for the periods 1941 to 1950, 1982 to 1990 and 1991 to 2003.

Note: For the period 1982 to 1990 one can observe a slight and for the period 1991 to 2003 a marked change in the pattern, particularly for the oldest age groups. For mothers over 45 years the age-specific TWR was as high as 45.5 per 1000. For details, see the text.

extent. For the last period, the changes are marked. The age-specific rates already increase from the age group 30 to 35 years and for the age group over 45 years an extreme age-specific rate (45.5 per 1000) can be observed. Fellman and Eriksson (2005, Figure 3) observed a similar change in the TWR in Finland for the period 1991 to 2000, but this observation was interpreted as mainly caused by random variations in a small dataset.

The strong increase in the rate of multiple maternities for women of 40+ years of age may be a consequence of the fact that some studies have demonstrated that in women over 40 years of age, five embryos is the optimum number to transfer. This practice held at least in the United States during the period 1998 to 2003 (Combelles et al., 2005). However, Simmons et al. (2004) report that in England and Wales from 1997, clinicians and patients responded to increasing concern about multiple births by changing treatment policies, for example, by choosing to place less than three embryos. This change in policy is in good agreement with the decrease in the triplet and quadruplet rates observed after 1990 (cf. Figure 1).

The temporal variation in the total rate of multiple maternities, the age-specific rates and the mean maternal age for married and unmarried mothers in England and Wales, 1938 to 2003, are shown in Figure 4a and 4b. The temporal variations in the total rate show similar variations for unmarried and married mothers. There are slight peaks, 12.7 per 1000 for married mothers in the period 1946-1950 and 12.9 for unmarried mothers in the period 1951 to 1955. In the period 1976 to 1980 there are troughs for both married (9.9) and unmarried mothers (8.5). After these troughs both series show marked increases. The final level is 16.7 for married and 12.2 for unmarried mothers. The difference in the total rates between married and unmarried mothers is, in general, positive. An exception is the period 1951 to 1955, but during this period the difference in the mean maternal age was a minimum, being only 1.4 years. During the last two periods the difference in the rates was extremely high, over 4 per mille units at the same time as the difference in mean maternal age also obtained a maximum, being over 4 years.

One observes marked increases in the age-specific rates of multiple maternities for married mothers over 20 years of age, especially mothers in the age group 40+ years. This increase may be attributed to an excess of multiple births for older females treated for subfertility. A remarkable result is, however, that the same trend can, to some extent, be observed for unmarried mothers. Such mothers, a priori, may not be interested in being treated for subfertility.

The marked increase in the total rates is mainly caused by the strong increases in the age-specific rates for married mothers in the age groups over 30 years, particularly 40+. For unmarried mothers, the age-specific rate for the age group 40+ years also shows an increase, but not as strong as for married mothers.

The temporal pattern in the mean maternal age is the same for married and unmarried mothers. One observes a decreasing trend ending in a marked

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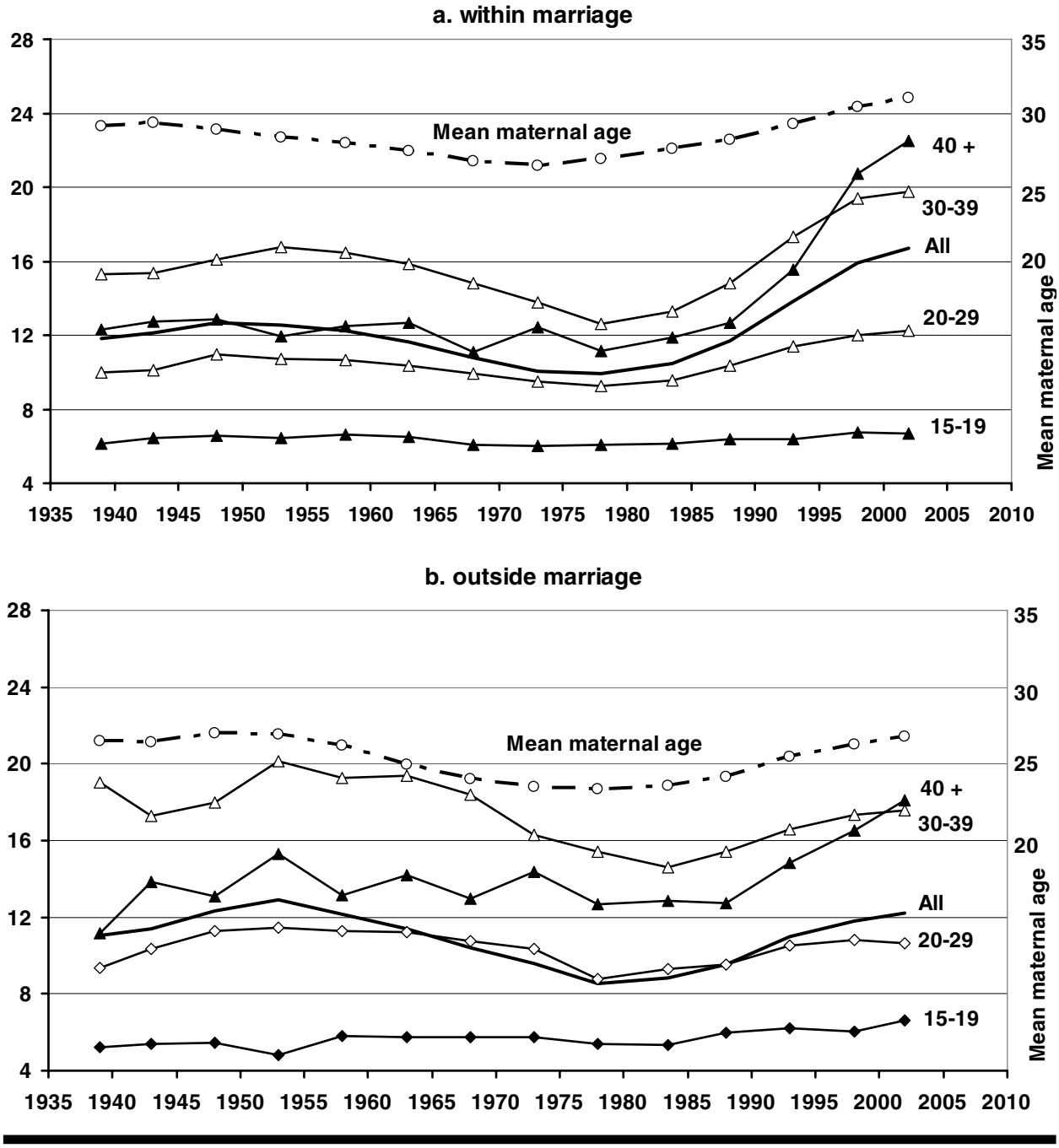

Figure 4

The temporal variation in the total and the age-specific rates of multiple maternities and the mean maternal age for married (a) and unmarried (b) mothers in England and Wales, 1938–2003.

Note: A detailed analysis is given in the text.

minimum in the 1970s and after that an increasing trend for the rest of the period. The difference between the mean maternal age for married and unmarried mothers varies between 1.4 years (1951–1955) and 4.3 years (2001–2003). This increase may to some extent influence the increases in the rates of the multiple maternities. However, Figure 2 shows at least that the maternal age alone cannot explain the temporal variations in the TWRs.

Maternities in unmarried mothers proportionate to all maternities are presented in Figure 5. In 1941–1945 a peak is discernible, particularly for the youngest mothers, obviously caused by World War II. After 1975 the proportion of unmarried mothers increases continuously and quickly. Especially, we observe that today the proportion of unmarried mothers in the age group under 20 years is about 90% and that even in the highest age group of

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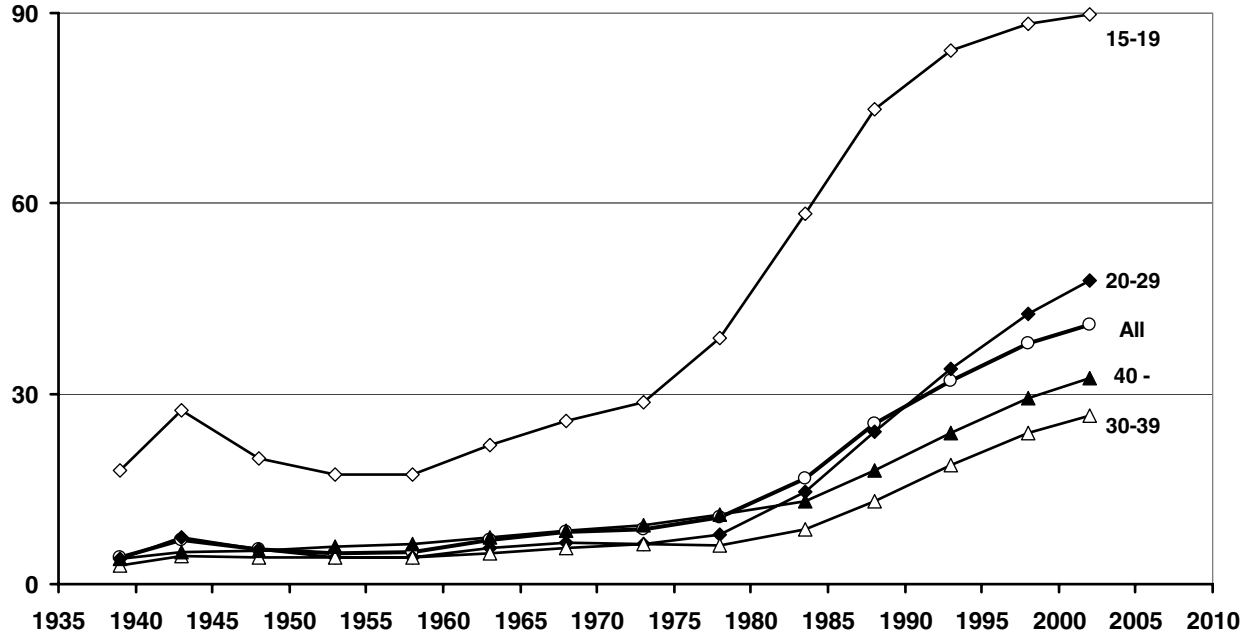

Figure 5

Proportion of unmarried mothers in different age groups.

Note: In 1941–1945, peaks caused by World War II are discernible. After 1975 the proportion of unmarried mothers increases in all age groups. The majority of these mothers may cohabit and consequently live as married ones, having a similar socioeconomic status.

40+ it is high, over 30%. Most unmarried mothers may cohabit and consequently, live as married ones, having a similar socioeconomic status. This may explain that the increasing trends in the age-specific rates for older unmarried mothers, noted in Figure 4, are probably caused by the subfertility treatments of cohabiting women.

Concluding Remarks

The recent increase in the total rate of multiple maternities may be caused mainly by subfertility treatments. This hypothesis is supported by the remarkable increase in the age-specific rate in the age group 40+ years (cf. Figure 4). A surprising result is that the same trend can be observed for unmarried mothers, who are not expected to have received subfertility treatments. However, in Figure 5 we observe that today, even in the highest age group, the proportion of unmarried mothers is high. Consequently, a large part of unmarried mothers may cohabit. Zhang et al. (2002) have observed similar increases in the rates of multiple maternities in older mothers in the United States, 1995-1997, and they also attributed this finding to the increased use of ART.

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