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Physical attractiveness and reproductive success in humans: evidence from the late 20th century United States☆

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Abstract

Physical attractiveness has been associated with mating behavior, but its role in reproductive success of contemporary humans has received surprisingly little attention. In the Wisconsin Longitudinal Study (1244 women, 997 men born between 1937 and 1940), we examined whether attractiveness assessed from photographs taken at age ~18 years predicted the number of biological children at age 53–56 years. In women, attractiveness predicted higher reproductive success in a nonlinear fashion, so that attractive (second highest quartile) women had 16% and very attractive (highest quartile) women 6% more children than their less attractive counterparts. In men, there was a threshold effect so that men in the lowest attractiveness quartile had 13% fewer children than others who did not differ from each other in the average number of children. These associations were partly but not completely accounted for by attractive participants' increased marriage probability. A linear regression analysis indicated relatively weak directional selection gradient for attractiveness (β=0.06 in women, β=0.07 in men). These findings indicate that physical attractiveness may be associated with reproductive success in humans living in industrialized settings.
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Keywords: Fertility; Interbirth interval; Physical attractiveness; Reproductive success; Offspring sex ratio; Sociobiology

1. Introduction

According to an evolutionary perspective, physical attractiveness functions as a cue of mate quality and reproductive value (Gangestad & Scheyd, 2005; Hume & Montgomerie, 2001; Rhodes, 2006; Rhodes, Simmons, & Peters, 2005; Thornhill & Gangestad, 1999). People have therefore evolved to pay attention to physically attractive individuals and seek them as partners. Aided by this advantage in the mating market, attractive people are expected to enjoy higher reproductive success. Despite this rather straightforward prediction, surprisingly few studies have directly examined whether physical attractiveness is related to fertility, i.e., the number of children, in humans. Pawlowski, Boothroyd, Perrett, and Kluska (2008) found no association between facial attractiveness and fertility in a sample of contemporary Polish women, but due to the small number of participants (N=47) this null finding may reflect insufficient statistical power rather than absence of association. Physical attractiveness has been shown to correlate with higher age-controlled fertility in Ache women (Hill & Hurtando, 1996; see also Apicella, Feinberg, & Marlowe, 2007), indicating that attractiveness may be related to reproductive success at least in hunter-gatherer populations.

Indirect evidence does suggest that physical attractiveness might contribute to fertility differences even in humans living in industrialized settings. Attractiveness predicts more active sexual behavior and higher mating success (e.g.,

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Rhodes et al., 2005; Weeden & Sabini, 2007), and measures of physical attractiveness have also been associated with healthier reproductive physiology, e.g., women's fecundity, i.e., the capability of having children (e.g., Jasienska, Lipson, Ellison, Thune, & Ziomkiewicz, 2006), and men's semen quality (Soler et al., 2003; but see Peters, Rhodes, & Simmons, 2008). Kanazawa (2007), in turn, has argued that parents' attractiveness should bias the sex distribution of their offspring, as daughters are expected to benefit more than sons from their genetically inherited attractiveness.

Studies of attractiveness and mating success have often considered only linear effects (the more attractive the better), but it is possible that very high attractiveness does not increase fertility even if it increases mating success. People searching for a partner to have children with may not be interested in extremely attractive partners, because such partners may be more likely to leave them for another partner or to have extra-pair relationships (see Boothroyd, Jones, Burt, DeBruine & Perrett, 2008; Chu, Hardaker, & Lycett, 2007; Durante & Li, in press; Smith, 1995; Waynforth, 2001). Hence, moderately attractive parent candidates might be favored over very attractive ones. Further complicating the issue is the fact that the reproductive advantage of attractiveness may be suppressed by the influences of modernized lifestyle. In particular, attractiveness is related to higher socioeconomic achievement (Dickey-Bryant, Lautenschlager, Mendoza, & Abrahams, 1986; Harper, 2000) and possibly to parental socioeconomic status (Harper, 2000), which may confound the attractiveness–fertility association.

The ongoing Wisconsin Longitudinal Study (WLS; Wollmering, 2007) has followed a large sample of high school graduates from 1957 onwards, and data on photograph-based attractiveness ratings are available for a subsample of them. These data allowed us to assess whether physical attractiveness in young adulthood predicted adult reproductive success in humans living in the late 20th century United States. We also examined whether adjusting for parental socioeconomic status, educational achievement and life-course marital status modified the association between attractiveness and reproductive success, and whether attractiveness predicted average interbirth interval, i.e., the time between births of two subsequent children, and offspring sex ratio in addition to the number of children.

2. Method

2.1. Participants

The participants were from the ongoing WLS (Wollmering, 2007; http://www.ssc.wisc.edu/wlsresearch/) which has followed a random sample of 10,317 participants (5326 women, 4991 men) who were born between 1937 and 1940 and who graduated from Wisconsin high schools in 1957. After baseline data collection in 1957, survey data were collected from the participants or their parents in 1964, 1975, 1992 and 2004. The WLS sample is broadly representative of white, non-Hispanic American men and women who have completed at least a high school education (among Americans aged 50 to 54 in 1990 and 1991, approximately 66% were non-Hispanic white persons who completed at least 12 years of schooling). It is estimated that about 75% of Wisconsin youth graduated from high school in the late 1950s — everyone in the primary WLS sample graduated from high school (Wollmering, 2007). The present sample included participants who had data on attractiveness assessed from high school yearbooks and on fertility and marital history reported in follow-up phase in 1992 when the participants were 53–56 years of age (N=2241; 1244 women, 997 men).

2.2. Measures

2.2.1. Attractiveness

Data on physical attractiveness have been collected for a subsample of participants based on the graduates' yearbook photos, the participant then being 18.1 years of age, on average. A random sample of schools (n=93; selection probability being proportional to the schools' size, so that all WLS respondents had an equal probability of being selected) was selected, and all participants from these schools were included in the subsample. Yearbooks were scanned and then the participants' senior photographs were extracted. The majority of the yearbook photos were face portraits, so the rated physical attractiveness was based mostly on facial attractiveness.

The attractiveness coding was conducted during the summer of 2004. Participants of the Madison Senior Scholars program were recruited to look at and code a randomly selected sample of three thousand seven 1957 WLS respondent yearbook photos and a subsample of two hundred fifty-eight 1956 WLS respondent yearbook photos. Thirty-three different judges whose ages ranged from 63 to 91 years (average of 78.5) rated the photos. Each yearbook photo was rated by six men and six women using a photo-labeled 11-point rating scale, with end points labeled as *not at all attractive* (=1) and *extremely attractive* (=11). Photos were divided into 10 groups of roughly 300 photos per group and a final group of the 1956 photos. Judges rated one set of 300 per session and were required to have a break of at least 12 h between coding sessions. Several judges coded multiple sets of photos; a few coded all 11 sets of photos. In order to assess possible nonlinear associations between attractiveness and fertility, attractiveness was categorized in quartiles separately by sex, denoted as follows: 1=not attractive, 2=moderately attractive, 3=attractive, 4=very attractive.

2.2.2. Fertility

Reproductive success was assessed on the basis of number of biological children. For up to 10 children, the participants reported the birth year and sex of the child and whether the child was the participant's biological children. We included only biological children in the analyses and created a measure of total number of biological children. Interbirth interval was calculated as the difference between birth years of two consecutive children.

Parental socioeconomic status was assessed on the basis of a factor-weighted composite score of father's years of schooling, mother's years of schooling, father's occupational status and average parental income in 1957.

2.2.3. Marital history

The participants reported the years of beginning and end of up to five marriages, and the participants' marital history was constructed on the basis of these data. At each year, marital status was coded as a dichotomous variable (0=not married, 1=married). First, we created a time-varying indicator of marital status for each year from baseline to end of follow-up. Second, we summed the years of marriage to create a cumulative measure of years of marriage. Because women and men tend to have only few children after ages 40 and 50, respectively, the cumulative measure was calculated for marriage years up to age 40 in women and age 50 in men.

2.2.4. Education level

The participants' own education was assessed on the basis of equivalent years of regular education based on highest degree attained (range from 12=high school to 21=post-doctorate education).

2.3. Statistical analysis

The associations between attractiveness and cumulative years of marriage and completed education were estimated with linear regression analysis, adjusting for birth year and parental SES, i.e., additionally entering these covariates into the model. The association between attractiveness and the number of biological children was assessed with analysis of covariance, fitted separately for women and men, and adjusted for parental SES. These models were then further adjusted for cumulative years of marriage and participant's education. In order to get a more detailed description of age-specific fertility patterns associated with attractiveness, we calculated the sample hazard functions, i.e., the probability of having a child at a given age in participants who had not had their child by that age, of having the first, second, third, fourth child by attractiveness quartiles and determined the cumulative probabilities of having children by a given age (i.e., 1-survival function). The hazard functions were determined from sample life tables (smoothed by 3-year moving averages), and 95% confidence intervals for the cumulative probabilities were calculated by the Greenwood approximation.

We also assessed the strength of the gradient of directional selection for attractiveness in the sample. This was accomplished with a linear regression analysis in which square-root transformed number of biological children was regressed on continuously coded attractiveness score separately in men and women, adjusted for birth year. The standardized beta-coefficients of this analysis provided estimates of linear directional selection gradients.

The association between attractiveness and interbirth interval was assessed with multilevel linear regression analysis. First, we calculated the differences between the years of birth of the first and second child, the second and third child, and so on up to the difference between the ninth and 10th child. These interbirth intervals were then entered as outcomes in a multilevel model in which each interbirth interval was treated as a case (2333 observations of 1019 women, 1692 observations of 814 men), adjusting for the birth order of the child. A similar analysis strategy was applied for the association between attractiveness and offspring sex ratio, i.e., each child was coded as a case (3440 observations of 1112 women, 2580 observations of 888 men) and a multilevel logistic regression analysis predicting the sex of the child (0=girl, 1=boy) was fit to these data (birth order was not associated with offspring sex so it was omitted from the model).

3. Results

3.1. Sociodemographic covariates

Table 1 shows the descriptive statistics for the sample. Parental SES was positively associated with attractiveness in women (r=0.15, p<.001) but not in men (r=0.03, p=.39; correlations calculated for continuously coded rather than for categorized variables). More attractive women were more likely to attain higher education, although this effect was rather small. Attractiveness also increased the cumulative years of marriage in women and men (Table 2). A more

Table 1
Descriptive statistics for the sample

	Women (n=1244)	Men (n=997)
Age at baseline	18.1 (0.5)	18.2 (0.5)
Age at end of follow-up	53.7 (0.7)	53.8 (0.7)
Years of education	13.3 (2.0)	14.0 (2.5)
Age at first childbirth	23.2 (3.6)	25.6 (4.3)
Number of children in adulthood	2.77 (1.64)	2.59 (1.49)
No children[a]	10.6	11.0
One[a]	7.5	7.3
Two[a]	25.5	31.3
Three[a]	27.4	26.5
Four[a]	17.0	14.1
Five or more[a]	12.0	9.7
Interbirth interval (years)	2.8 (2.1)	2.9 (2.3)
Offspring sex (% males)[a]	51.1	51.3
Age at first marriage	22.0 (3.8)	24.0 (4.2)
Number of marriages		
Never married[a]	4.8	3.7
One[a]	81.2	80.0
Two or more[a]	14.0	16.3
Total years of marriage	17.5 (5.6)	24.6 (7.2)

Values are means (and standard deviations) unless otherwise noted.

[a] Values are percentages. Total years of marriage are calculated up to age 40 in women and age 50 in men.

Table 2
Predicting adult sociodemographic and fertility outcomes by adolescent attractiveness

	Predicted outcome			
	Years of marriage	Education	Interbirth interval	Male offspring (%)
Women (n=1244)				
Not attractive	16.7 (16.1–17.3)	13.2 (13.0–13.4)	2.81 (2.57–3.06)	52.9 (49.4–56.3)
Moderately attractive	17.2 (16.2–17.8)	13.2 (13.0–13.4)	2.92 (2.67–3.19)	50.1 (46.5–53.6)
Attractive	18.0 (17.4–18.6)	13.3 (13.1–13.6)	2.82 (2.58–3.07)	50.5 (47.2–53.8)
Very attractive	18.0 (17.4–18.7)	13.4 (13.3–13.6)	3.09 (2.83–3.36)	53.1 (49.7–56.5)
p for linear trend	.001	.05	.05	.89
Men (n=997)				
Not attractive	23.8 (22.9–24.7)	14.2 (14.0–14.5)	3.44 (3.06–3.84)	53.6 (50.3–57.0)
Moderately attractive	24.5 (23.6–25.4)	13.9 (13.6–14.1)	3.30 (2.94–3.68)	52.0 (50.0–54.2)
Attractive	25.2 (24.3–26.1)	14.1 (13.8–14.4)	3.20 (2.85–3.58)	50.4 (48.2–52.5)
Very attractive	24.9 (24.0–25.8)	13.8 (13.5–14.1)	3.26 (3.00–3.75)	48.7 (45.5–51.9)
p for linear trend	.05	.12	.56	.07

Values are predicted mean scores (or probabilities in the case of offspring sex) from linear regression model (years of marriage and education), multilevel linear regression model (interbirth interval) and multilevel logistic regression model (offspring sex). Years of marriage are calculated up to age 40 in women and age 50 in men. Values in parentheses are 95% confidence intervals.

detailed, age-specific analysis indicated that there was an association between attractiveness and increased marriage probability in early adulthood but that this association attenuated with age when more participants became married (data available on request).

3.2. Fertility

Next, we assessed differences in the mean number of children between attractiveness groups at age 53–56 years (Table 3). Compared to the combined group of not attractive and moderately attractive women (average number of children=2.63), attractive and very attractive women had 16% and 6% more children, respectively. Adjusting for education strengthened these differences slightly to 17% and 8%. Marital status, in turn, accounted for part of the higher fertility of more attractive women so that adjusting for years of marriage attenuated the unadjusted differences to 10% and 0%. In men, the least attractive quartile had 13% fewer children than others, who did not differ from each other in the average number of children (Table 3). Adjusting for education attenuated this difference to 12% and adjusting for marital status attenuated it to 8%, indicating that the lower fertility of least attractive men was partly accounted for by their lower marriage probability.

To get a more detailed understanding of attractiveness and timing of childbearing, we calculated the hazard functions (left-hand panels of Figs. 1 and 2) and corresponding cumulative probabilities (right-hand panels) of having the first, second, third and fourth child by attractiveness group. In women, attractiveness increased the probability of having children, but after the second child attractive rather than very attractive women were most likely to have children. For the third and fourth child, very attractive women were as likely to have children as those in the two lowest attractiveness quartiles. In men, the lowest attractiveness quartile was less

Table 3
Predicting the average number of children at age 53–56 years by adolescent attractiveness

	A: Adjusted for age and parental SES	B: Adjusted for A+education	C: Adjusted for A+marital status
Women (n=1244)			
Not attractive	2.67 (2.49–2.85)	2.65 (2.47–2.83)	2.78 (2.63–2.94)
Moderately attractive	2.59 (2.41–2.77)	2.58 (2.40–2.75)	2.63 (2.47–2.79)
Attractive	3.05 (2.87–3.24)	3.06 (2.88–3.24)	2.97 (2.82–3.13)
Very attractive	2.80 (2.61–2.98)	2.82 (2.64–3.00)	2.71 (2.56–2.87)
p	.003	<.001	.02
Men (n=997)			
Not attractive	2.37 (2.19–2.55)	2.38 (2.20–2.57)	2.45 (2.28–2.61)
Moderately attractive	2.65 (2.47–2.84)	2.64 (2.46–2.83)	2.66 (2.50–2.82)
Attractive	2.65 (2.47–2.84)	2.66 (2.48–2.85)	2.60 (2.43–2.76)
Very attractive	2.67 (2.49–2.86)	2.66 (2.48–2.84)	2.65 (2.48–2.81)
p	.07	.10	.26

Values are predicted mean scores from analysis of covariance. Values in parentheses are 95% confidence intervals.

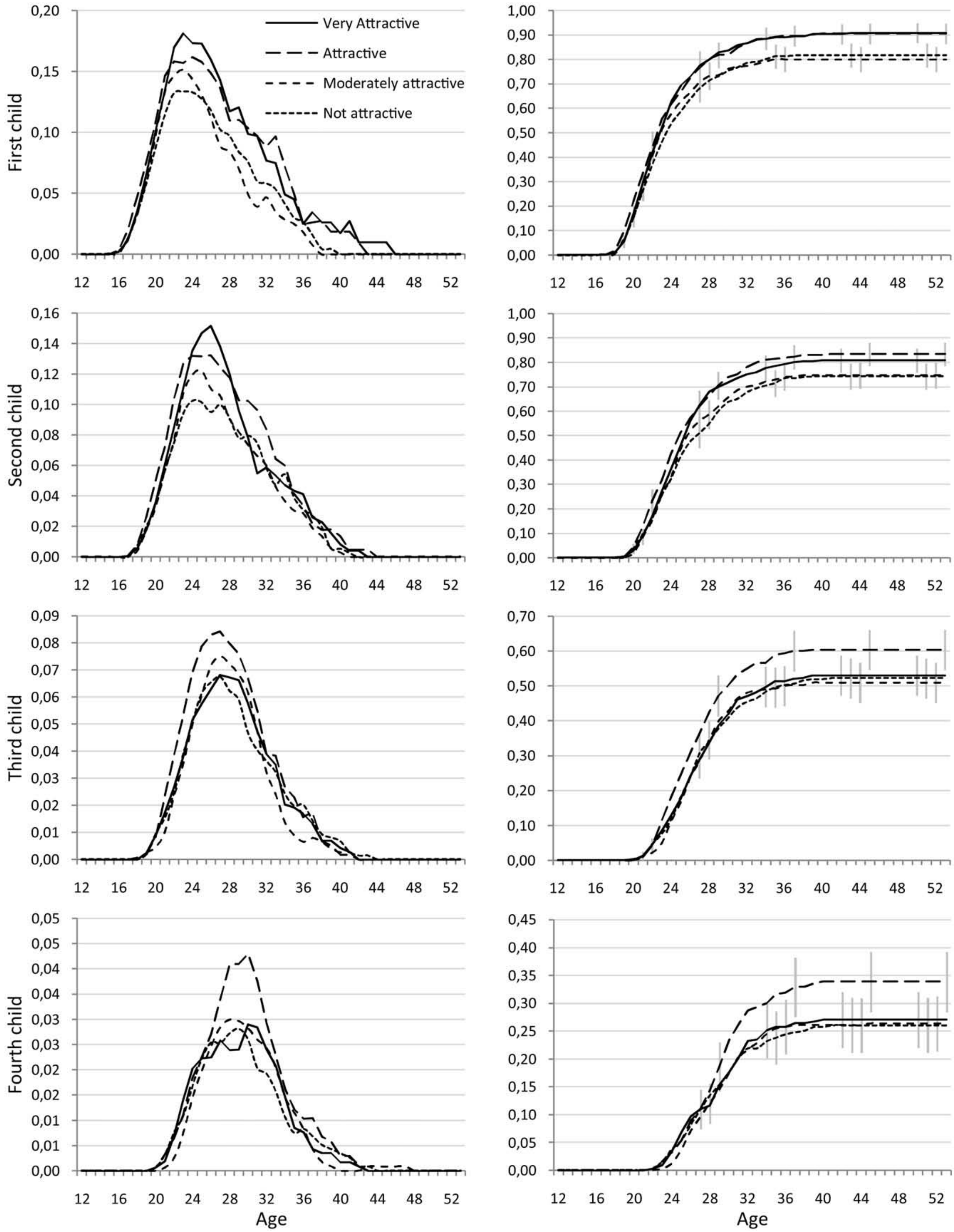

Fig. 1. Women's sample hazard functions (left-hand panels) and cumulative probabilities (right-hand panels) of having the first, second, third and fourth child plotted against age by attractiveness groups. Ninety-five percent confidence intervals are shown for cumulative probabilities. Notice the different *y*-axis scales in the panels.

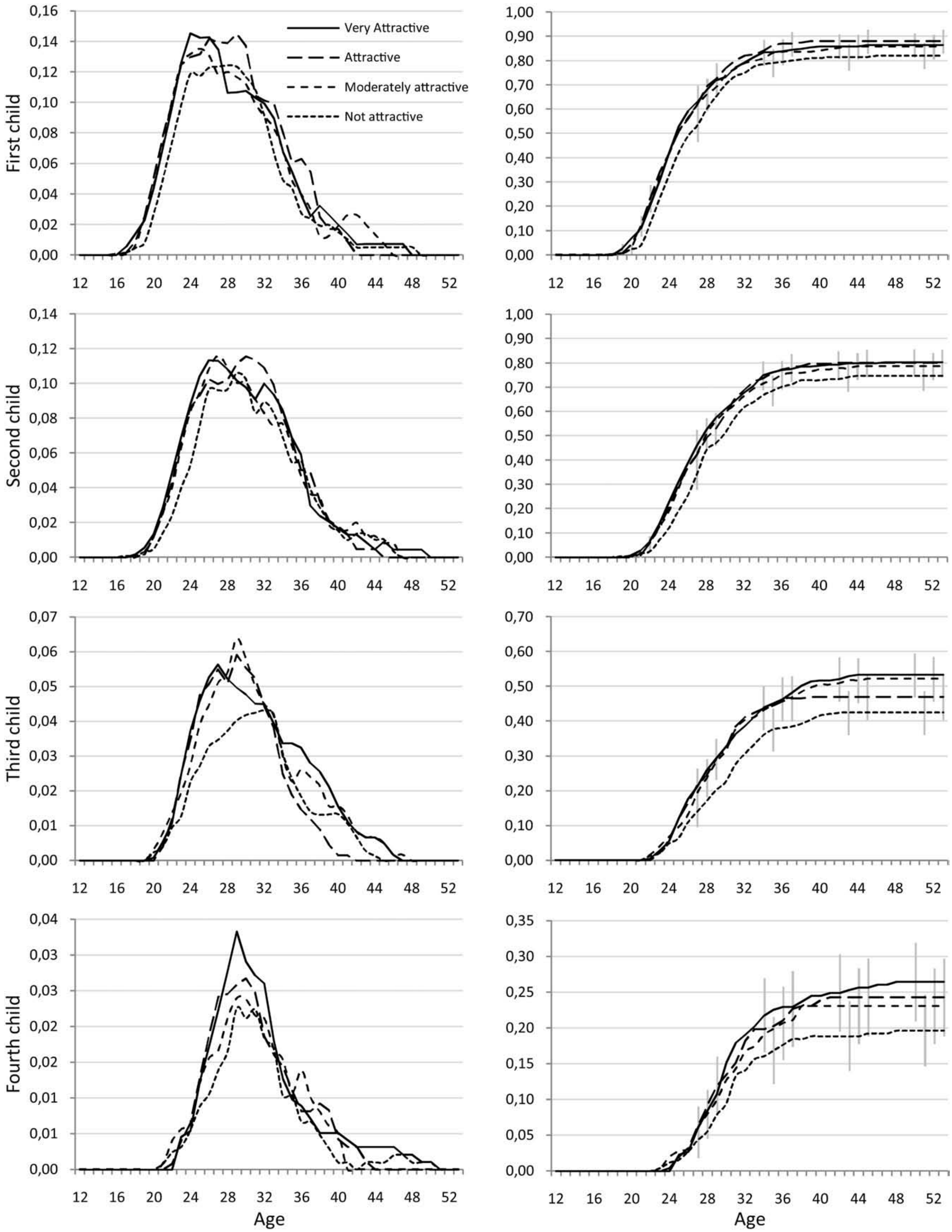

Fig. 2. Men's sample hazard functions (left-hand panels) and cumulative probabilities (right-hand panels) of having the first, second, third and fourth child plotted against age by attractiveness groups. Ninety-five percent confidence intervals are shown for cumulative probabilities. Notice the different *y*-axis scales in the panels.

likely than others to have the first, second and third child, and for the fourth child the results suggested a fairly linear dose–response association for attractiveness.

We then examined the strength of directional selection gradient of attractiveness. In a linear regression analysis, there was an association between continuously coded attractiveness and number of children in women (B=0.03, CI=0.00–0.07, p=.05, β=0.06) and men (B=0.04, CI=0.00–0.06, p=.03, β=0.07). The standardized regression coefficients estimated the linear selection gradient of attractiveness to be 0.06 in women and 0.07 in men. Fitting a quadratic term of attractiveness was significant in men (linear B=0.04, CI=0.01–0.07, p=.008, β=0.09; quadratic B=−0.03, CI=−0.05 to −0.01, p=.009, β=0.08) but not in women (linear B=0.03, CI=0.00–0.06, p=.05, β=0.06; quadratic B=−0.0004, CI=−0.02 to 0.02, p=.97, β=0.001).

3.3. Interbirth interval and offspring sex ratio

A multilevel logistic regression analysis predicting average interbirth interval indicated that very attractive women had longer interbirth intervals than others (Table 2), so that the time between having a new child was 0.28 years (≈3.4 months) longer in very attractive women compared to least attractive women. Attractiveness was not associated with interbirth interval in men. Another multilevel logistic regression model predicting the sex of the children by participants' attractiveness showed no association in women (Table 2). In men, there was a statistically nonsignificant tendency for more attractive men to have more daughters than sons.

4. Discussion

Findings from the WLS suggest that adolescent attractiveness was associated with reproductive success in people living in the late 20th century United States. In women, the association was nonlinear, so that attractive (second highest quartile) women had 16% and very attractive (highest quartile) women had 6% more children than their less attractive (two lowest quartiles) counterparts. This nonlinear pattern was explained by the fact that attractive and very attractive women were more likely to become parents and have the second child than their less attractive counterparts, but that very attractive women were less likely than attractive women to have children beyond the second child. Very attractive women also had longer interbirth intervals than others. In men, the lowest attractiveness quartile had 13% fewer children than others, who did not differ from each other in the average number of children, suggesting a threshold effect for men's attractiveness–fertility association. Men's attractiveness was associated with the probability of having the first, second, third and fourth child.

At the proximate level of explanation, the attractiveness–fertility association may reflect at least four non-exclusive processes. First, attractiveness may be associated with person's fertility preferences and desires. For instance, very attractive women may not want as many children as their slightly less attractive counterparts and attractive men may want more children than nonattractive men. Second, attractiveness may modify a person's mate choice criteria which may lead to fertility differences, e.g., very attractive women may expect more from the potential fathers of their children than less attractive women and this may decrease the potential fertility they could achieve with less stringent criteria. Third, attractiveness may influence how the person is judged as a father/mother candidate by others. For example, men (women) may want to have large families with attractive rather than with nonattractive women (men). Fourth, attractiveness may predict achieved fertility because it is correlated with fecundity, i.e., biological reproductive capacity.

The present study did not have the relevant data to explore all the potential pathways linking attractiveness to fertility, and more research is needed to assess the contributions of the above and other alternatives. The nonlinear patterns suggest that the association may involve multiple mechanisms, some contributing to a positive and other to a negative relationship between attractiveness and fertility. Attractive individuals were more likely to get married, especially in early adulthood, but this association accounted for the attractiveness–fertility association only in part. Attractiveness also predicted higher educational achievement in women but this did not substantially influence the attractiveness–fertility association.

Life-history theory suggests a further perspective to be considered (Gillespie, Russell, & Lummaa, 2008; Hagen, Barrett, & Price, 2006; Mulder, 2000). Namely, physical attractiveness may be related not only to offspring quantity but also to offspring quality — in the evolutionary sense of the word. Perhaps very attractive women are inclined to follow a reproductive strategy in which they allocate their energy to having only few offspring but spend more resources on them than parents on average. This would be in agreement with very attractive women's high probability of having the first and second but not the third and fourth child. Furthermore, the quantity–quality tradeoff could explain the association between attractiveness and long interbirth intervals, as women investing heavily on one offspring need to wait for a longer time to have another child. The present results do not provide a direct test of the relationship between parental attractiveness and offspring quality, but future studies should examine whether attractiveness is related to parental investment and offspring characteristics to further probe the validity of this hypothesis.

Despite the nonlinearities in the attractiveness–fertility associations, it is of interest to estimate whether there is any evidence of directional selection for attractiveness in the sample. The results indicated a weak positive directional selection gradient for attractiveness in women (β=0.06) and men (β=0.07). This is slightly less than half the median gradient (β=0.16) observed in a review of natural selection in 63 studies of nonhuman animals (Kingsolver et al., 2001). If the estimated gradient of ~0.065 were to hold across time and environments, and assuming a heritability of 0.60 for physical attractiveness (McGovern, Neale, & Kendler, 1996) and no genetic correlations with other traits, one would expect attractiveness to increase by ~0.02 standard deviations per generation (R=0.60^2×0.065).

Analysis of offspring sex ratio suggested a tendency for more attractive men to have more daughters than sons, but this association was not statistically significant. In a sample of American youth, Kanazawa (2007) observed the most attractive individuals to be more likely than others to have female offspring, but this finding may not be methodologically robust (Gelman, 2007; Gelman & Weakliem, in press). No sex-specific results were reported in Kanazawa's study. In the present sample, there was no association between attractiveness and offspring sex ratio in sex-combined models (OR=0.97, S.E.=0.02, p=.28). Gelman and Weakliem (2007) found no evidence of a biased offspring sex ratio in a sample of celebrities voted to be "most beautiful" by American magazine readers. In light of random variation observed in other studies of offspring sex ratios (see Gelman & Weakliem, 2007; Palmer, 2000), the potential attractiveness–offspring sex ratio association is best interpreted cautiously before more data are available.

The strengths of the present study include a large sample size, prospective longitudinal study design and objectively assessed attractiveness. However, the findings need to be interpreted within several limitations. First, the sample was based on mainly white high-school graduates from a single US state, which may limit the generalizability of the results. It is even possible that the attractiveness–fertility association has changed in the United States since the 1960s and 1970s as a consequence of changes in rates of marriage, divorce and fertility. Second, ratings based on photographs provide only a limited measurement of attractiveness because other real-life features of physical attractiveness, such as body movement and voice, cannot be evaluated. Imperfections in the measurement of attractiveness may have yielded underestimates of its association with reproductive success. Third, the present study design could not take into account children born unbeknownst the father (e.g., in extra-pair relationships) which may underestimate the association between attractiveness and fertility in men. Assuming that the prevalence of nonpaternity is around 3% (the estimated nonpaternity prevalence in a large Californian sample) (Peritz & Rust, 1972; see Bellis, Hughes, Hughes, & Ashton, 2005), this bias is unlikely to substantially alter the conclusions drawn from the present data. Regarding reporting bias, it is worth noting that studies of fertility are probably less likely to suffer from problems of biased reports encountered in studies of sexual behavior. Unlike in the case of reporting sexual partners, it seems safe to assume that most people do not report children they have never had or leave their known children unreported.

Humans living in modern industrialized societies have ample opportunities to enhance their looks with readily available make-up products and exercise programs, so it is possible that physical attractiveness no longer functions as a reliable cue of individuals' health status (Weeden & Sabini, 2005; but see Grammer, Fink, Moller, & Manning, 2005; Henderson & Anglin, 2003). And with the aid of reliable contraceptive methods, sexual relations can be pursued without actualized fertility outcomes. One would therefore not be surprised if physical attractiveness had lost the reproductive relevance it may have had in the evolutionary past. In contrast to such intuition, the present and previous findings of evolutionarily motivated fertility research (e.g., Hopcroft, 2006; Jokela & Keltikangas-Järvinen, 2009; Jokela, Kivimäki, Elovainio, & Keltikangas-Järvinen, 2009; Nettle & Pollet, 2008) suggest that fertility behavior of modern humans may still be partly under the influence of evolved psychological adaptations.

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