ORIGINAL ARTICLE

Racial Differences in Seasonal Variation in Election and Non-election Years in the Male-to-Female Ratio at Birth in the United States

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ABSTRACT

Objective: *In humans, male births exceed female births. This ratio is conventionally expressed as M/F and is influenced by a large number of factors, including stress. This study was carried out in order to ascertain whether the known seasonal variation in M/F in the United States of America (USA), peaking in June, is affected by the quadrennial elections (November), and whether any such influences vary by race.*

Methods: *Births by gender and by race for the period 2003–2013 were obtained from the website of the Centers for Disease Control and Prevention for the four available races: White, Black/African American, Asian/Pacific Islander and American Indian/Alaska Native. Election years were 2004, 2008 and 2012. Seasonality tests were carried out for the entire group and for White and Black/African American births.*

Results: *This study analysed 45 138 496 live births (23 102 106 males, 22 036 390 females, M/F: 0.51180). Overall, M/F was the lowest in election years, rising, then falling Asian/Pacific Islander births but not for Black/African American or American Indian/Alaskan Native births. Overall and for White births, only election year plus 3 (year just before election) showed seasonal variation (*$p < 0.01$*).*

Conclusion: *Seasonality may have been disturbed/reduced in most years due to the elections. Black births may have been unaffected due to chronic stress caused by socio-economic dampening of M/F trends.*

Keywords: Birth rate/trends, infant, newborn, periodicity, seasons, gender ratio, United States

INTRODUCTION

In humans, male births exceed female births and this ratio is conventionally referred to M/F, denoting male births divided by total births. The male-to-female births ratio (M/F) may be influenced by a large number of factors (1) and has been shown to exhibit seasonal variation in various parts of the world (2). Early studies had shown a low M/F in February and March and a high M/F in summer in various parts of the world (3) with similar patterns in the United States of America (USA) more recently (4).

The Trivers–Willard hypothesis proposes that individuals who are able to influence their offspring gender ratio in accordance with their environment are likelier to procreate, thereby dispersing these advantageous genes. In polygynous species, only the fittest males reproduce. For this reason, parental investment in a 'good-quality' son may yield greater numbers of descendants than an equivalent investment in a 'good-quality' daughter. It is thus advantageous for a mother to reproduce sons when she has good resources, and daughters when she does not. This is known as the Trivers–Willard hypothesis (5). For the same reasons, it has been postulated that the findings that stress reduces M/F may be explained by the Trivers–Willard hypothesis.

The above-mentioned seasonal patterns of live births support the Trivers–Willard hypothesis since the birth of offspring in favourable seasonal conditions increases the chances of said offsprings' survival. It has also been recently shown that in the USA, for the

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 DOI: 10.7727/wimj.2016.204

period 2003–2013, M/F was the highest in Asian/Pacific Islanders, followed by White, American Indian/Alaska Native and Black/African American births, with these differences occurring at statistically significant levels (4). Significant seasonality was present overall in the USA, with a peak in June, for Whites more than Black/African American, and absent in the rest. It was conjectured that the traditionally lower M/F found in Black/African and American Indian/Alaskan births may be stress related in that these races are overall socio-economically underprivileged and hence chronically stressed (6). It was therefore also hypothesised that the dampened seasonality noted in Black/African American births might also be due to this phenomenon (4).

In the USA, election day is set by the law for the general election of public officials. The event and the associated political campaigns have been shown to engender significant stress in the populace (7, 8). Election day always occurs on the Tuesday after the first Monday in November (November 2nd to the 8th) and the Presidential Elections occur every four years. This provides a unique opportunity to ascertain whether the election campaigns and the elections themselves exert any influence on M/F (9).

This study was carried out in order to ascertain whether the seasonal variation in M/F in the USA is influenced by the Presidential Elections and whether there are any racial variations.

SUBJECTS AND METHODS

Data and definitions

Births by gender and by race for the period 2003–2013 were obtained from the website of the Centers for Disease Control and Prevention in the CDC Wonder section (http://wonder.cdc.gov/natality.html). The data was available for four races: White, Black/African American, Asian/Pacific Islander and American Indian/Alaska Native. Ethical approval was irrelevant as this analysis comprised a large and completely anonymous dataset. For the same reason, informed consent was unnecessary.

Election years were 2004, 2008 and 2012. Election years plus one were 2005, 2009 and 2013. Election years plus two were 2006 and 2010. Election years plus three (pre-election years) were 2003, 2007 and 2011. Seasonality tests were carried out on the above-mentioned year groups for all Americans, White Americans and Black/African Americans. American Indian/Alaskan Native and Asian or Pacific Islander were not analysed for seasonality due to the (relatively) small numbers of these births.

Statistical analysis

Prior to any use of statistical tools, a series of tests were done on the data to check for homogeneity of variance, independence of observations and normality. Data were also plotted to check for obvious outliers.

Seasonality was analysed using Demetra (version 1.0.4.323) and a model-based method (X12) was operated to fit an Autoregressive Integrated Moving Average (ARIMA) model to the data. A series of seasonality tests were carried out on each time series after the ARIMA model was determined. These included non-parametric tests for stable seasonality using the Friedman and Kruskall–Wallis tests, a test for the presence of seasonality assuming stability, evolutive seasonality test and combined seasonality test. The combined seasonality test passes if the first three tests pass at the 1% ($p < 0.01$) level and if the evolutive seasonality test fails at the 20% ($p > 0.2$) level.

Further tests on seasonality using analysis of variance (ANOVA) were carried with the null hypothesis showing no statistically significant difference between the means of each month. An ANOVA was carried out with Statistical Package for the Social Sciences (SPSS, International Business Machines Corporation, New York, USA). A p-value < 0.05 was taken to represent a statistically significant result.

The quadratic equations of Fleiss were used to calculate the exact 95% confidence limits (10). Chi tests were used for trend testing of male and female births using the Bio-Med-Stat Excel add-in for contingency tables (Peter Slezák, Bratislava, Slovakia) (11).

RESULTS

This study analysed a total of 45 138 496 live births as 23 102 106 males and 22 036 390 females (M/F: 0.51180, 95% CI: 0.51166, 0.51195) born over the period 2003–13. Annual totals by race for election years (2004, 2008, 2012), election years plus one (2005, 2009, 2013), election years plus two (2006, 2010) and election years plus three (pre-election years: 2003, 2007, 2011) are shown in Table 1.

Overall, M/F was the lowest in the election years, rising then falling again in the election year. This pattern was present for White and Asian/Pacific Islander births but not for Black/African American or American Indian/Alaskan Native births. These trends were not statistically

Table 1: Annual totals by race and male-to-female birth ratios for amalgamated years (election, election +1, +2 and +3)

	Election year	Election year + 1	Election year + 2	Election year + 3	Total
			American Indian/Alaskan Native		
Male	70 992	71 034	47 981	70 925	260 932
Female	68 565	68 435	46 500	67 989	251 489
Total	139 557	139 469	94 481	138 914	512 421
UCL	0.51132	0.51194	0.51103	0.51320	0.51058
M/F	0.50870	0.50932	0.50784	0.51057	0.50921
LCL	0.50607	0.50669	0.50464	0.50794	0.50784
			Asian or Pacific Islander		
Male	388 955	385 772	252 057	376 193	1 402 977
Female	366 155	362 098	235 874	353 413	1 317 540
Total	755 110	747 870	487 931	729 606	2 720 517
UCL	0.51622	0.51696	0.51799	0.51676	0.51630
M/F	0.51510	0.51583	0.51658	0.51561	0.51570
LCL	0.51397	0.51469	0.51518	0.51446	0.51511
			Black or African American		
Male	976 945	977 766	663 794	970 152	3 588 657
Female	944 064	947 746	639 112	938 272	3 469 194
Total	1 921 009	1 925 512	1 302 906	1 908 424	7 057 851
UCL	0.50927	0.50850	0.51033	0.50906	0.50883
M/F	0.50856	0.50780	0.50947	0.50835	0.50846
LCL	0.50785	0.50709	0.50861	0.50764	0.50809
			White		
Male	4 862 592	4 811 220	3 267 340	4 908 388	17 849 540
Female	4 634 319	4 577 124	3 112 283	4 674 441	16 998 167
Total	9 496 911	9 388 344	6 379 623	9 582 829	34 847 707
UCL	0.51234	0.51279	0.51254	0.51252	0.51238
M/F	0.51202	0.51247	0.51215	0.51221	0.51222
LCL	0.51170	0.51215	0.51176	0.51189	0.51205
			All		
Male	6 299 484	6 245 792	4 231 172	6 325 658	23 102 106
Female	6 013 103	5 955 403	4 033 769	6 034 115	22 036 390
Total	12 312 587	12 201 195	8 264 941	12 359 773	45 138 496
UCL	0.51191	0.51218	0.51228	0.51207	0.51195
M/F	0.51163	0.51190	0.51194	0.51179	0.51180
LCL	0.51135	0.51162	0.51160	0.51152	0.51166

UCI = upper confidence interval; LCI = lower confidence interval.
Election years: 2004, 2008 and 2012
Election years plus one: 2005, 2009 and 2013.
Election years plus two: 2006 and 2010.
Election years plus three (pre-election years): 2003, 2007 and 2011.

significant, even when data were pooled for White and Asian/Pacific Islander births.

Monthly M/F for the entire period is shown in Fig. 1. The same data for election years (2004, 2008 and 2012), election years plus one (2005, 2009 and 2013), election years plus two (2006 and 2010) and election years plus three (pre-election years: 2003, 2007 and 2011) are shown in Figs. 2–5, respectively.

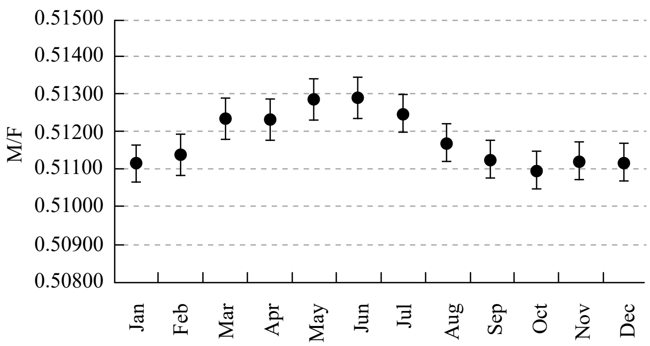

Fig. 1: Monthly M/F for 2003–13.
M/F = male-to-female ratio.

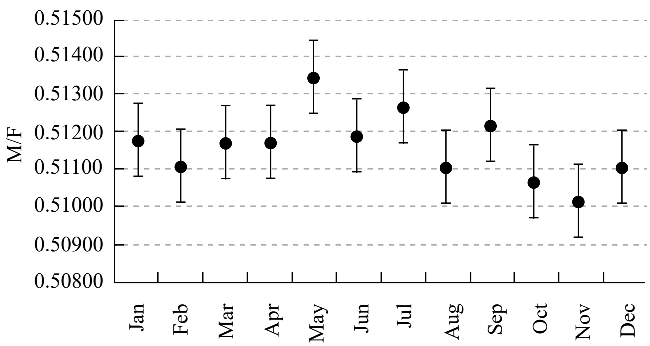

Fig. 2: Monthly M/F for election years (2004, 2008 and 2012).
M/F = male-to-female ratio.

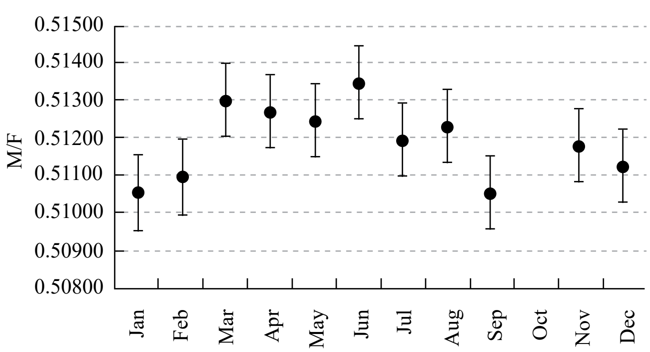

Fig. 3: Monthly M/F for election years plus one (2005, 2009 and 2013).
M/F = male-to-female ratio.

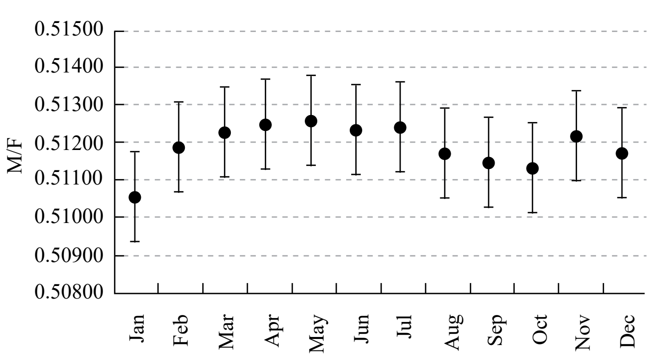

Fig. 4: Monthly M/F for election years plus two (2006 and 2010).
M/F = male-to-female ratio.

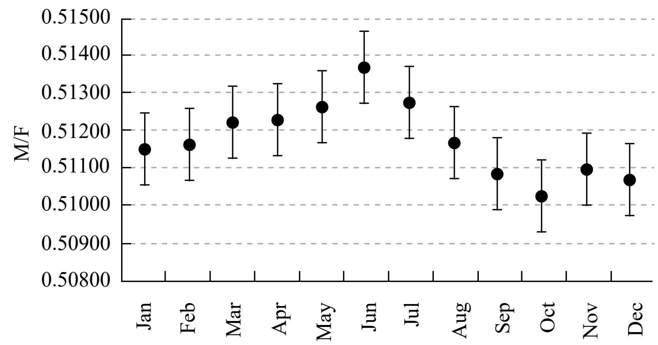

Fig. 5: Monthly M/F for election years plus three (pre-election years: 2003, 2007 and 2011).
M/F = male-to-female ratio.

The ARIMA (0, 1, 1) (0, 1, 1) was fitted on all data and for three of the four time series being analysed. For the total American population, that is, including all four races, of all four time series, election year plus three exhibited a seasonal variation at $p < 0.01$. Combined seasonality was absent in election years and election years plus one (Table 2). Nevertheless, ANOVA results show significant differences between months at $p < 0.05$ for all years under the study.

For election years plus two (2006 and 2010), the time series was too short for the ARIMA modelling. Additionally, the data violated the assumptions for ANOVA testing. The Kruskall–Wallis test was used instead to check for seasonality for summated quarterly rather than monthly data. Seasonality was not present at even for quarterly data.

White American births exhibited the same seasonal pattern as total Americans, with seasonal variation present in the election years plus three (time series at $p < 0.01$). Similarly, ANOVA results for White American births confirmed the seasonality pattern for the time series grouping mentioned earlier. Seasonality was absent in Black/African American births for all time-series combinations under the study. For the other two races (Asian/Pacific Islander and American Indian/Alaska Native), the dataset was too small to attempt to perform seasonality analysis.

DISCUSSION

Overall

A previous study has shown significant seasonality in the USA overall, with an M/F peak in June (4). For the total population (all four races), the ANOVA showed significant differences between months at $p < 0.05$ for all years under the study.

Table 2: ANOVA and five seasonality test results on all four American races, and on separately on White and Black/African births

	ANOVA and five seasonality tests	**All races**	**Whites**	**Black/ African**
All years	ANOVA	< 0.0001	< 0.0001	0.005
	Friedman test	< 0.0001	< 0.0001	0.0005
	Kruskall–Wallis test	< 0.0001	< 0.0001	0.0006
	Test for presence of seasonality assuming stability	< 0.0001	< 0.0001	0.0009
	Evolutive seasonality test	0.7993	0.4233	0.4649
	Combined seasonality test	SP	SP	SP
Election years (2004, 2008 and 2012)	ANOVA	0.001	0.006	0.533
	Friedman test	0.006	0.0191	0.3142
	Kruskall–Wallis test	0.0195	0.0316	0.3944
	Test for presence of seasonality assuming stability	0.001	0.0073	0.4215
	Evolutive seasonality test	0.9973	0.7674	0.1174
	Combined seasonality test	SA	SA	SA
Election years plus one (2005, 2009 and 2013)	ANOVA	0.01	0.008	0.109
	Friedman test	0.0069	0.0027	0.1986
	Kruskall–Wallis test	0.0243	0.0322	0.1233
	Test for presence of seasonality assuming stability	0.0032	0.0032	0.103
	Evolutive seasonality test	0.4851	0.5399	0.254
	Combined seasonality test	SA	SA	SA
Election years plus three (2003, 2007 and 2011)	ANOVA	0.0001	0.001	0.211
	Friedman test	0.0013	0.0002	0.1216
	Kruskall–Wallis test	0.0081	0.0063	0.1576
	Test for presence of seasonality assuming stability	0.0001	0.0001	0.1209
	Evolutive seasonality test	0.8634	0.7954	0.4627
	Combined seasonality test	SP	SP	SA

SA = seasonality absent; SP = seasonality present.
The Kruskall–Wallis test was used for election years plus two (2006 and 2010).

However, analysis by amalgamated years showed that only election years plus three exhibited a significant seasonal variation. It may be hypothesised that seasonality was absent and therefore possibly disturbed or reduced by stress engendered by the electoral campaigns in election years and election years plus one. However, it is difficult to extend this explanation to election years plus two. A possible explanation for this is a type 2 error, since there were less data (one less year) in this group.

This socio-economic dampening effect on M/F is supported by the observed rise in M/F in what may be a recovery from stress after election years and a decline back down as the elections approach, since this is only observed in the more socio-economically privileged groups, White and Asian/Pacific Islander, but not for Black/African American or American Indian/Alaskan Native births.

Racial differences

A previous study had also shown significant seasonality in M/F for Whites more than Black/African American, and absent seasonality in the rest (4). It had also been shown that M/F was significantly highest in Asian/Pacific Islander ($p < 0.0001$), followed by White ($p = 0.002$), American Indian/Alaska Native ($p = 0.04$) and Black/African American births ($p = 0.04$) (4).

In this study, White American births exhibited the same seasonal pattern as the above-mentioned totals. This was the largest population and hence the group least likely to result in a type 2 error.

Seasonality was absent in Black/African American births for all time series combinations. This may be due to the fact that Black births were far less than White births, and therefore the possibility of a type 2 error cannot be discounted. However, it is possible that seasonality is truly absent in Black births since both ANOVA and combined seasonality testing indicate absence of seasonality. This may be because, as already alluded to, this population is chronically stressed due to socio-economic circumstances. Seasonality may therefore be dampened, and M/F effects due to election campaigns/elections may therefore not be manifest.

AUTHORS' NOTE

There is nothing to disclose. There was no financial assistance whatsoever for the production of this paper. There are no potential conflicts of interest, financial or otherwise.

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