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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ABSTRACTS

Objective: In humans, male births exceed female births. This ratio is conventionally expressed to 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 (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 2003-13 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 for the entire group and for White and Black/African American births.

Results: This study analysed 45138496 live births (23102106 males, 22036390 females, M/F 0.51180). Overall, M/F was lowest in the election years rising, then falling again to the next election year (p=ns). This pattern was present for White and 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 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, sex ratio, United States

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INTRODUCTION

In humans, male births exceed female births and this ratio is conventionally referred to M/F, denoting male births divided by total births. 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 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 be advantageous for a mother to produce 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 abovementioned 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 US, for over 2003-13, M/F was highest in Asian/Pacific Islanders, followed by White, American Indian/Alaska Native and Black/African American births, with these differences occurring as statistically significant levels (4). Significant seasonality was present overall in the US, 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 US, Election Day is set by 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 Presidential Elections occur every four years. This provides a unique opportunity to ascertain whether 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 United States is influenced by the Presidential Elections and whether there are any racial variations.

METHODS

Data and definitions

Births by gender and by race for 2003-13 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 abovementioned 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 was 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 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. ANOVA was carried out with SPSS (Statistical Package for the Social Sciences, 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 exact 95% confidence limits.(10) Chi tests and chi tests for trend were used for trend testing of male and female births using the Bio-Med-Stat Excel add-in for contingency tables (Peter Slezak, Bratislava, Slovakia).(11).

RESULTS

This study analysed a total of 45138496 live births as 23102106 males and 22036390 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 lowest in the election years rising, then falling again to 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 where not statistically significant, even when data was pooled for White and Asian/Pacific Islander births. Monthly M/F for the entire period is shown in figure 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 figures 2 to 5 respectively.

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, i.e. 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 study.

For election years plus two (2006 and 2010), the time series was too short for 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 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 US overall, with an M/F peak in June (4). For the total population (all four races), ANOVA showed significant differences between months at $p < 0.05$ for all years under study.

However, analysis by amalgamated years showed that only election year plus three exhibited significant seasonal variation. It may be hypothesised that seasonality was absent and therefore possibly disturbed or reduced by stress engendered by 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 was 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.(4)

In this study White American births exhibited the same seasonal pattern as the abovementioned 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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Table 1: Annual totals by race and male: 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	70992	71034	47981	70925	260932
Female	68565	68435	46500	67989	251489
Total	139557	139469	94481	138914	512421
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	388955	385772	252057	376193	1402977
Female	366155	362098	235874	353413	1317540
Total	755110	747870	487931	729606	2720517
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	976945	977766	663794	970152	3588657
Female	944064	947746	639112	938272	3469194
Total	1921009	1925512	1302906	1908424	7057851
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	4862592	4811220	3267340	4908388	17849540
Female	4634319	4577124	3112283	4674441	16998167
Total	9496911	9388344	6379623	9582829	34847707
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	6299484	6245792	4231172	6325658	23102106
Female	6013103	5955403	4033769	6034115	22036390
Total	12312587	12201195	8264941	12359773	45138496
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, 2012
Election years plus one: 2005, 2009, 2013.
Election years plus two: 2006, 2010.
Election years plus three (pre-election years): 2003, 2007, 2011.

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).

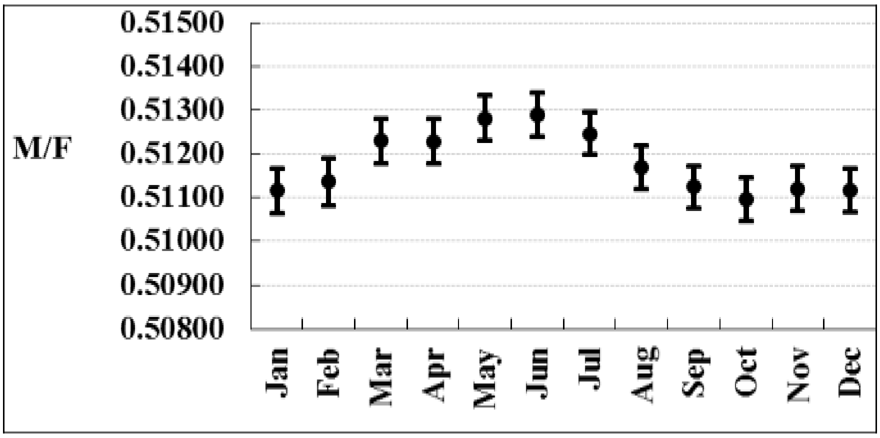

Fig 1: Monthly M/F for 2003-13.

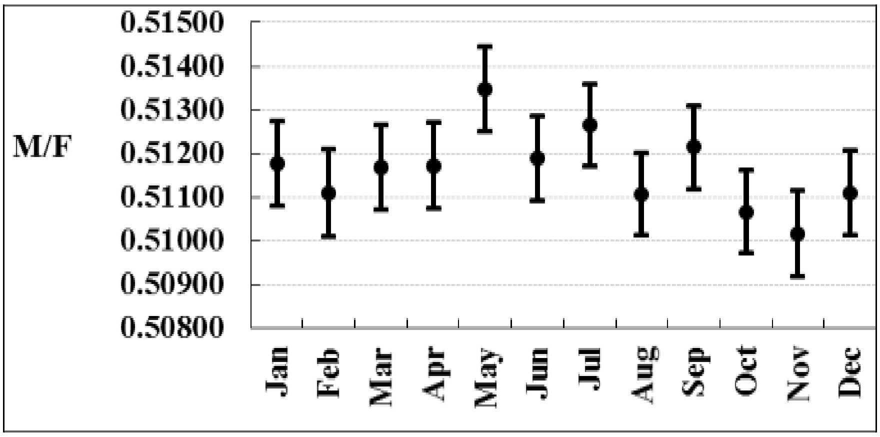

Fig 2: Monthly M/F for election years (2004, 2008 and 2012).

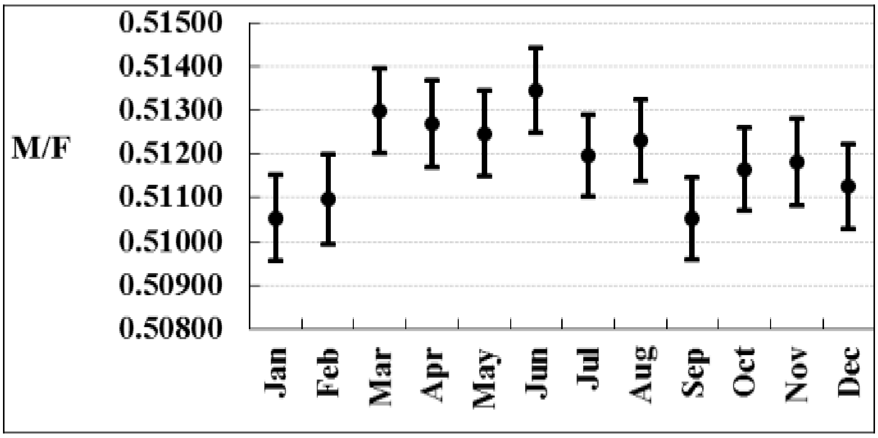

Fig 3: Monthly M/F for election years plus one (2005, 2009 and 2013).

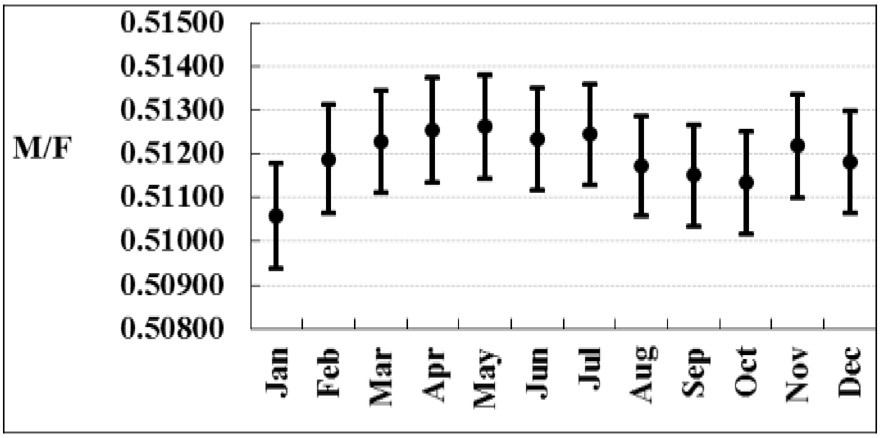

Fig 4: Monthly M/F for election years plus two (2006, 2010).

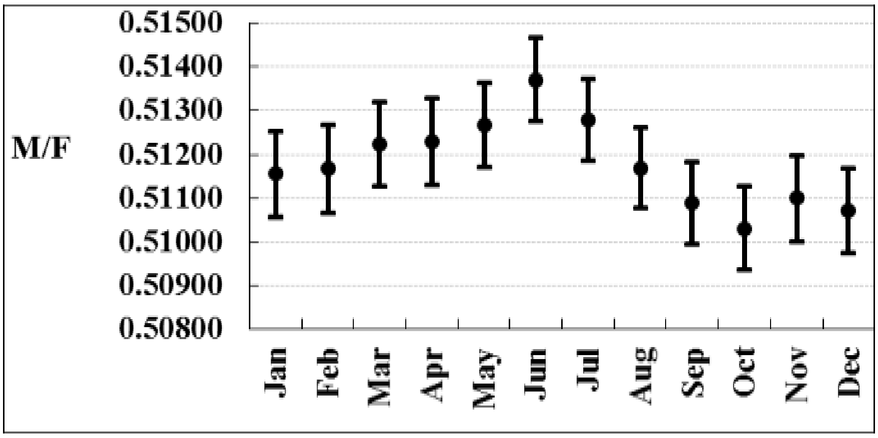

Fig 5: Monthly M/F for election years plus three (pre-election years: 2003, 2007, 2011).