

## The Influence of Migration on Secular Trends in Sex Ratios at Birth in Cuba in the Past Fifty Years

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### ABSTRACT

**Background:** Secular trends have been found in the male-female ratio at birth (M/F: male births divided by total births) in various countries and this ratio is anticipated to approximate 0.515.

**Methods:** Annual national data for male and female live births in Cuba with contingency tables were obtained from the World Health Organization and analysed.

**Results:** There were 3 736 718 male and 3 534 270 female births (1960–96). Births declined steadily over the entire period. The male-female ratio at birth remained relatively stable over the period 1960–1985 with significant sharp dips for the years 1966, 1980 and 1985. There was a sharp rise in M/F from 1966 to 1969, another rise after 1985, a steep drop to 1989, and then a sharp rise once more after 1993 (all  $p < 0.0001$ ).

**Conclusion:** The single year dips are associated with the passage of laws in the United States of America (USA) that facilitated Cuban entry to the USA. The increases in M/F tended to be associated with a skew toward an efflux from Cuba that was predominantly male. This paralleled the situation in the Second World War where a surplus of women left behind led to an increase in M/F in belligerent countries. To the author's knowledge, this is the first report of migration influencing M/F.

**Keywords:** Birth rate, Cuba, life change events, sex ratio

## Influencia de la Migración sobre las Tendencias Seculares en las Proporciones de Sexos al Momento del Nacimiento en Cuba en los Últimos Cincuenta Años

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### RESUMEN

**Antecedentes:** Se han constatado tendencias seculares en la proporción de nacimientos masculinos y femeninos (M/F: nacimientos masculinos divididos por el total de nacimientos) en varios países, y se estima que esta proporción se aproxima a 0.515.

**Métodos:** Se analizaron los datos nacionales anuales de los nacimientos vivos en Cuba de varones y hembras, con tablas de contingencia, obtenidos de la Organización Mundial de la Salud.

**Resultados:** Hubo 3,736,718 nacimientos de varones y 3,534,270 nacimientos de mujeres (1960–96). Los nacimientos disminuyeron sostenidamente durante todo el período. La proporción M/F se mantuvo relativamente estable durante el período de 1960–1985, con abruptos descensos significativos en los años 1966, 1980 y 1985. Hubo un fuerte aumento en la relación M/F de 1966 a 1969, otra subida después de 1985, y una caída severa en 1989, seguida de un brusco aumento una vez más después de 1993 (todos  $p < 0.0001$ ).

**Conclusión:** Los descensos producidos en los años específicos señalados están asociados con la aprobación de leyes de los Estados Unidos que han facilitado la entrada de cubanos a ese país. Los aumentos en F/M corresponden a una tendencia inclinada al flujo migratorio hacia afuera de Cuba,

*predominantemente masculino. Esto se asemeja a la situación de la Segunda Guerra Mundial, en la que el superávit de mujeres que quedaron atrás, condujo a un aumento en la relación M/F en los países beligerantes. Hasta donde el autor conoce, éste es el primer reporte de la influencia de la migración en la proporción M/F.*

**Palabras claves:** Tasa de natalidad, Cuba, acontecimientos de cambio de vida, proporción de los sexos

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**INTRODUCTION**

In mammals, including humans, gender is determined at conception. In human live births, males occur slightly in excess in a ratio that approximates 515 males to 485 females (1). This ratio is conventionally expressed as the ratio of male live births divided by total live births (M/F). The reason for this discrepancy is uncertain but several factors have been proposed (2).

Of particular relevance to this study, stress has been shown to decrease M/F (3). There are factors that also increase M/F such as long-duration warfare [eg the World Wars] (1, 4); M/F may also exhibit slow secular changes (5). This study identifies secular trends in M/F in Cuba from a World Health Organization (WHO) dataset that includes the past fifty years, with particular attention to the effect of migration on M/F in Cuba (6). This is because migration, with intermittent upsurges of refugees leaving Cuba for the United States of America (USA), is an overarching theme in the history of the relationship between these two nations (Table 1). The null hypothesis is that there were no significant secular variations in M/F.

**METHODS**

Annual male and female live births were obtained directly from the WHO.

Microsoft Excel was used for data entry, overall analysis and charting. The quadratic equations of Fleiss were used for exact calculation of 95% confidence intervals for ratios (7). Chi-squared tests for trend were used for annual male and female births. These were performed using the Bio-Med-Stat Excel add-in for contingency tables. This add-in is based on the original work by Cochran and Armitage [Dr Peter Slezák, Institute of Normal and Pathological Physiology, Slovak Academy of Sciences; personal communication]

Table 1: Cuban migration, 1959–1980

Period	n
January 1959 – October 1960	26 527
November 1960 – January 1961	60 224
October 1961 – October 1962	153 534
November 1962 – November 1965	29 962
December 1965 – March 1972 (Camarioca boat lift and airlift)	277 242
April 1972 – January 1973	13 977
January 1973 – December 1973	12 579
January 1974 – December 1974	13 670
January 1975 – December 1975	8488
January 1976 – December 1976	4515
January 1977 – December 1977	4548
January 1978 – December 1978	4108
January 1979 – March 1980	3000
April 1980 – May 1980 (Mariel boat lift)	125 000
August 1995 – September 1995 (Balsero Crisis)	30 000

(8, 9). A *p*-value ≤ 0.05 was taken to represent a statistically significant result.

**RESULTS**

There were 3 736 718 male and 3 534 270 female births available for study, totalling 7 270 988 live births for the period 1960–96.

Five-year total live births and sex ratios at birth, in five-year intervals, are shown in Table 2. The number of births declined steadily over the entire period. The male/female ratio remained relatively stable over the period 1960–1985 with some exceptions (Figure). There were sharp dips in M/F for the single years 1966, 1980 and 1985 and all of these were statistically significant when compared to M/F ratios of the preceding and following five years (Table 3).

There was a sharp rise in M/F from 1966 to 1969 (*x* trend = 23.8, *p* < 0.0001; Table 4); M/F was more labile after

Table 2: Five-year births and male/female birth ratio (M/F) for Cuba, 1960–96

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–96
<b>M</b>	631 565	647 542	601 877	432 079	392 992	462 155	418 164	150 344
<b>F</b>	600 035	612 059	568 224	407 570	371 806	438 237	399 237	137 102
<b>Total</b>	237 019	256 014	247 997	226 005	203 066	192 941	187 555	168 960
<b>UCI</b>	0.5162	0.5165	0.5165	0.5163	0.5164	0.5166	0.5166	0.5176
<b>M/F</b>	0.5142	0.5146	0.5146	0.5143	0.5143	0.5144	0.5144	0.5152
<b>LCI</b>	0.5122	0.5126	0.5126	0.5122	0.5121	0.5122	0.5121	0.5129

UCI – upper confidence interval, LCI – lower confidence interval

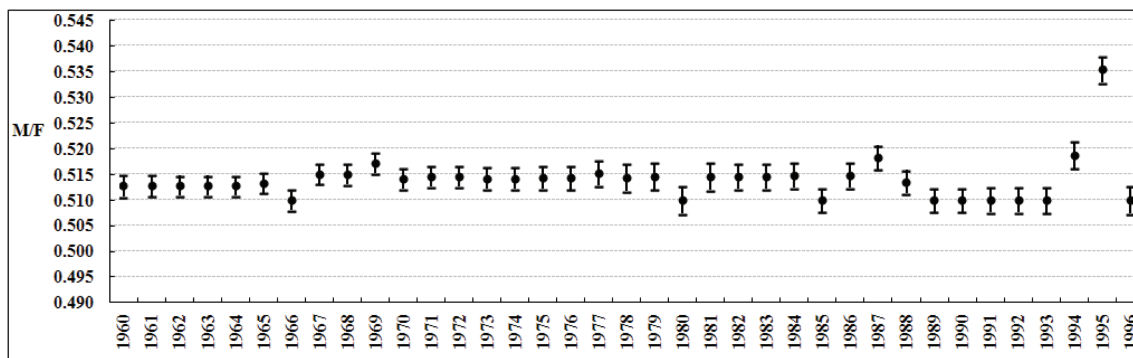


Figure: Male/female birth ratio (M/F) trends in Cuba, 1960–1996.

Table 3: Comparison of male/female birth ratio (M/F) dips in 1966, 1980 and 1985 with the previous and following five-year periods

	1961–65	1966	1967–71	1975–79	1980	1981–85	1980–84	1985	1986–90
<b>M</b>	656 862	130 253	635 399	432 079	69 819	416 027	392 992	92 854	464497
<b>F</b>	623 813	125 160	597 847	407 570	67 081	393 938	371 806	89 213	440486
<b>Total</b>	263 975	255 413	255 311	143 551	136 900	136 211	166 281	182 067	166049
<b>UCI</b>	0.5152	0.5119	0.5170	0.5172	0.5127	0.5173	0.5172	0.5123	0.5172
<b>M/F</b>	0.5133	0.5100	0.5151	0.5147	0.5100	0.5147	0.5148	0.5100	0.5148
<b>LCI</b>	0.5114	0.5080	0.5132	0.5121	0.5073	0.5120	0.5124	0.5077	0.5124
<b>x</b>	7.3		23.4	9.9		6.2	8.7		6.5
<b>p</b>	0.007		<0.0001	0.002		0.013	0.003		0.011

UCI – upper confidence interval, LCI – lower confidence interval

Table 4: Male/female birth ratio (M/F) trends for 1985–89 and 1993–95

Year	M	F	Total	UCI	M/F	LCI
1966	130 253	125 160	255 413	0.5119	0.5100	0.5080
1967	131 513	123 798	255 311	0.5170	0.5151	0.5132
1968	127 118	119 689	246 807	0.5170	0.5151	0.5131
1969	123 160	114 935	238 095	0.5193	0.5173	0.5153
1985	92 854	89 213	182 067	0.5123	0.5100	0.5077
1986	85 482	80 567	166 049	0.5172	0.5148	0.5124
1987	93 023	86 454	179 477	0.5206	0.5183	0.5160
1988	96 502	91 406	187 908	0.5158	0.5136	0.5113
1989	94 294	90 597	184 891	0.5123	0.5100	0.5077
1993	77 639	74 594	152 233	0.5125	0.5100	0.5075
1994	76 394	70 871	147 265	0.5213	0.5188	0.5162
1995	78 803	68 367	147 170	0.5380	0.5355	0.5329

UCI – upper confidence interval, LCI – lower confidence interval

1985. After the M/F dip in this year, M/F rose sharply over the next three years (1985–87;  $x$  trend = 24.9,  $p < 0.0001$ ). It then declined again over the next three years (1987–89,  $x$  trend = 25.1,  $p < 0.0001$ ). The male/female ratio was then stable over the period 1989–93, before rising sharply once more (1993–95,  $x$  trend = 193.6,  $p < 0.0001$ ).

## DISCUSSION

### Stress, radiation and M/F

The Trivers-Willard hypothesis suggests that Darwinian evolution should encourage species to adapt to changing cir-

cumstances by altering the odds of having a child of a specific gender. Parents in good condition, and by inference, living in a time of plenty, would be better off having sons as these have higher reproductive potential than daughters. Conversely, parents in poor condition, and by inference, living in a time of scarcity, would be better off having daughters than sons, as daughters are likelier to survive to reproductive age and do not have to compete as much as males for mating rights (10).

In accordance with this hypothesis, M/F wanes when adverse environmental factors are present. It has been shown, for example, that M/F declines after traumatic events such as earthquakes (11) and other environmental disasters (12). This is because such events appear to encourage stressed females to spontaneously abort male foetuses in excess of female foetuses (13) in accordance with the Trivers-Willard hypothesis (10). Radiation is an exception, in that populations wherein males and females are equally exposed tend to decrease in fertility and also further skew M/F in favour of males (14).

In the 1990s, Cuba experienced a period of extreme economic depression, the so-called “Special Period” (*Periodo Especial*), exacerbated by the economic embargo imposed by the USA (15). For example, over the period 1990–3, the per capita gross domestic product decreased over a third [36%] (16). This has been attributed to having caused a paradoxical rise in M/F (17).

It has also been hypothesized that this rise in M/F could have been caused by radioactively contaminated food imports from Russia by the Chernobyl accident of April 1986 (14), a plausible albeit unproven possibility (18). This hypothesis is supported by the fact that the increase in M/F between 1986 and 1989 is paralleled by a decline in total births over the same period (Table 4). However, a more prosaic explanation has been proposed for this M/F change. Due to the economic troubles, Cuba did not continue to import the customary gummed two-page form that accurately replicated writing onto a copy. This form was used to record birth details of individual births in hospitals. The standard form was therefore replaced with two forms with an interposed carbon paper manually held together. The copy was sent to the Cuban National Statistics Office for central data input. There was a tendency for error to occur in recording a child's gender on the copy, as the sheets could slip with a systematic bias toward the male sex box being ticked (19).

### Migration and M/F

The dips in M/F in 1966, 1980 and 1985 and other abrupt changes described in this paper appear to coincide with migration-related events. Cuba has had a long-standing connection with Florida since this is the closest part of the USA (Cuba is 366 km away from Miami) and is therefore a logical refuge for Cubans who decide to migrate away from their country.

Fidel Castro was sworn in as Prime Minister of Cuba in 1959 and under the regime, Cuba became one of the foremost communist powers, fully supported by the Union of Soviet Socialist Republics (USSR). The nationalization of educational institutions, hospitals, private land and industrial facilities, along with political oppression of the opposition (including imprisonment and execution) prompted the first wave of migration. This first wave constituted over 200 000 individuals (Table 1), including many professional and elite members of society and their families. They were vilified and their properties were confiscated by the state but their migration was relatively orderly and premeditated when compared to the successive waves (6, 20). These Cubans were aided by the passage of the Migration and Refugee Assistance Act of 1962 which was enacted to allow the USA to deal with unexpected and urgent needs of refugees and other persons at risk, worldwide (21). There were no M/F fluctuations in Cuba during this period in the early 1960s.

A second wave was spurred by a Memorandum of Understanding which remained in effect between Cuba and the USA from December 1965 to early 1973. Refugees were ferried by charter flights, so-called twice daily "Freedom Flights" (*Vuelos de la Libertad*) that transferred over a quarter of a million refugees (Table 1). Places were limited to immediate relatives of previous *émigrés*, with waiting periods that exceeded a year (6). This included an efflux from the Cuban port of Camarioca to Key West off the coast of Florida aided by the above-mentioned *émigrés*, using

small boats. These asylum seekers were granted automatic acceptance in the USA (6). Matters were expedited for refugees by the Cuban Adjustment Act of 1966 which facilitated entry and integration of Cuban nationals into the USA (6). The abrupt dip in M/F in 1966 which occurred in the year after the Memorandum, followed by a sharp rise to 1969, coincides with this period.

Under the Refugee Act of 1980, the USA provided political asylum and imposed an annual quota of 19 500 refugees from Cuba (22). This resulted in a third wave of refugees which commenced that same year when a group of Cubans drove a bus through the gates of the Havana Peruvian Embassy and requested (and were granted) asylum. The regime responded by removing Cuban guards from around the embassy, which was promptly inundated by over four thousand refugees. The regime reacted to this by stating that anyone who wished to leave Cuba could do so. Consequently, 125 000 Cubans left the island from the port of Mariel in an improvised flotilla known as the "Mariel boatlift" [Table 1] (6, 23). The dip in 1980 coincides with the introduction of the Refugee Act.

In 1984, the USA and Cuba negotiated an agreement not only to resume normal immigration but also to repatriate individuals who were excludable by USA law. The USA granted Cuba an annual minimum of 20 000 legal immigrant visas, some of which were allocated to Cubans in refugee camps. However, refugees continued to attempt to enter the USA illegally in perilous rafts (*balseros*). Any Cubans found attempting to enter the USA by sea were repatriated. This became known as the "wet foot/dry foot" policy, wherein illegal migrants who are intercepted at sea are returned without fear of persecution while those who reach shore and meet the definitions of asylum seekers are accepted and eventually resettled (6, 24). The M/F dip in 1985 follows this agreement.

The refugees in the 1980s were predominantly young men (25), as occurred in the Second World War where combatants were also predominantly young men. During the Second World War, M/F was noted to rise in belligerent countries (4). In this setting, warfare-related alteration in M/F has been attributed to increased coital frequency. In times of war, an adult sex ratio imbalance prevails, with more males being away from their homes. This results in sexual excesses; "actions [that] were viewed as understandable responses to the Frauenuberschuss", the excess supply of women (26). It has been mooted that in wartime, non-programmed copulation and high coital rates co-exist, with more conceptions occurring early or late in the menstrual cycle, increasing M/F (27). This is due to the fact that M/F follows a U-shaped regression on cycle day of insemination, suggesting that female conceptions result most often from conceptions around ovulation, with male conceptions occurring more frequently at the beginning and end of the menstrual cycle (28). This may provide an explanation as to the sharp rise in M/F for the three years following 1985.



The economic collapse of the USSR and the end of its support to Cuba resulted in a severe depression. This was exacerbated by the further tightening of the USA blockade of Cuba through the Cuban Democracy Act of 1992, also known as the Torricelli Act (6). In 1994, foreign embassies and diplomatic residences in Cuba were invaded by civilians protesting impoverishment and demanding asylum, accompanied by several riots. Over 37 000 Cubans attempted to cross to Florida in improvised vessels, the so-called Cuban *Balsero* Crisis (Table 1). Action from the USA further escalated with the Cuban Liberty and Democratic Solidarity (*Libertad*) Act of 1996 (Helms–Burton Act), strengthening the embargo against Cuba (29, 30). Again, the refugees at this time were predominantly young men, and this coincides with the sharp rise in M/F seen from 1993.

Thus, between 1959 and 1995, US policy was based on an anti-Communist agenda. From the 1962 Migration and Refugee Assistance Act until 1994, over one million Cubans received preferential treatment upon arrival in the USA (29). The male/female ratio has been proposed as a surrogate sentinel health indicator (31). Mass migrations are known to stress populations. More specifically, migration-related stress has been shown to be associated with psychological distress for both Latino men and women, including Cubans, along with poorer physical health for Latina women (32). This is unsurprising when refugees are faced with the prospect of a perilous sea voyage across a substantial stretch of ocean in a fragile and ill-equipped craft, with a known high risk of failure of passage or interdiction by the US coastguard or their Cuban *guardafronteras* equivalents (29).

In conclusion, this paper exposes a temporal relationship between Cuban migration and M/F, with M/F dipping in response to the possibility of leaving Cuba, often followed by sharp rises associated with a predominantly male efflux from the country. To the author's knowledge, no such relationship has ever been noted.

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