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Birth Seasonality in Yucatan, Mexico

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Introduction

Human birth seasonality is a worldwide phenomenon (Cowgill 1966; Becker 1991; Lam and Miron 1994). The causes seem to vary, but most attention has been paid to characteristics of the physical environment, such as temperature and photoperiod (Roenneberg and Aschoff 1990; Lam and Miron 1991; Lam and Miron 1996).

Several researches have investigated the relationship between seasonal variation of frequency of births in a calendar year and socioeconomic factors (Pasamanick *et al.* 1960; Zelnik 1969; Erhardt *et al.* 1971; James 1971; Chaudhury 1972; Sandahl 1978; Warren and Tyler 1979; Bobak and Gjonca 2001; Buckles and Hungerman 2013; Dorélien 2016). Some studies have documented differences in birth seasonality patterns between social classes or socioeconomic groups (Pasamanick *et al.* 1960; James 1971; Warren and Tyler 1979; Bobak and Gjonca 2001; Buckles and Hungerman 2013; Dorélien 2016), supporting the idea that tangible socioeconomic factors can act as a filter to modulate the influence of environmental rhythmicity (Condon and Scaglion 1982). A limited number of studies have addressed the association between the amplitude of birth seasonality and maternal sociodemographic factors (Sandahl 1978; Bobak and Gjonca 2001; Buckles and Hungerman 2013), including age, education level, and marital status. In general, studies that reported birth seasonality patterns according to socioeconomic status showed inconclusive results in terms of the differences observed in privileged and underprivileged social groups.

Mexico experienced important sociodemographic and economic changes during the twentieth century; from 1950 to 1970 the country's population increased from 25.8 million to 50.7 million people, and by 2000 the population had reached 100.2 million (CONAPO 2014). Mexico is a country with a great socioeconomic disparity; northern and central states show the highest levels of economic growth, while the southern states are characterized by poor development and welfare services (Ramírez Carrilo 2015).

The present study was conducted in the State of Yucatan, Mexico, located in the southeast of the country and characterized by a warm humid climate, with an average annual temperature of 26 °C. The average highest temperatures occur from May to August (27–29 °C) and the lowest from December to February (22–24 °C) (CINVESTAV 2016). By 2010, it had a population of about 2 million people distributed among 106 municipalities including Merida, the capital city, which has more than 42% of the total population of the state (INEGI 2012). Socioeconomic segregation is a distinctive characteristic of the Yucatan population and contributes to noticeable differences in income and access to education and health services.

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The number of studies on birth seasonality in Mexico is very limited (Thompson and Robbins 1973; Malina and Himes 1977) and most have focused on the association between seasonal variation in the frequency of births and agricultural cycles in local populations. In this study, we describe the pattern of birth seasonality in Yucatan between 2008 and 2015 to test our hypothesis that birth rhythmicity varies according to differences in selected maternal sociodemographic characteristics.

Methods

Data on the dates of birth and sociodemographic characteristics of mothers used in this study were provided by the Ministry of Health of the State of Yucatan (SSY). Information about births was obtained from the records of health personnel in private and public hospitals in urban and rural Yucatan. The dataset includes information of 279,417 infants born between 2008 and 2015; we restrict our analysis to those cases where the mothers reside in Yucatan (>98%). We selected mothers' age, education level and marital status, and infants' birth order as independent variables, all used in the form in which they were originally obtained. Maternal decimal age was recorded as a continuous variable and the other predictors were categorical in nature. Maternal education was categorized as: 1) primary school, 2) secondary school, 3) preparatory school, and 4) university. Maternal civil status was either 1) married or 2) unmarried, and birth order was 1) first, 2) second, 3) third, and 4) fourth and higher. The rationale behind our selection of these variables was based on: 1) factors that have been shown to influence season of births in previous studies (Erhardt *et al.* 1971; Sandahl 1978; Bobak and Gjonca 2001; Buckles and Hungerman 2013; Dorélien 2016), and 2) the factors that describe the socioeconomic heterogeneity of the local population.

The pattern of birth seasonality was examined visually by plotting the monthly ratios of observed/expected*100 births. The expected number of births of each month was calculated by dividing the number of births that occurred in the year by total number of days of year, multiplied by the number of days of each month. This process takes into account the variation of the number of days in months. A ratio of observed/expected above 100 is interpreted as a number of births above expected and a ratio of observed/expected below 100 as a number of births below expected (Bobak and Gjonca 2001). We plotted the monthly fluctuation of births for the entire period and by the categories of selected maternal sociodemographic characteristics. The association between maternal sociodemographic factors and the pattern of birth seasonality was analyzed through a model of logistic regression. As results were very similar in all years (2008–2015), the data were pooled. We restricted the logistic regression model to low and high birth rate periods to analyze if sociodemographic factors were more associated with the seasonality. Low and high birth rate periods represent relevant deviations from the expected number of births in a given population (this restriction was not done when the overall pattern was described in plots). In this sense, categories of outcome variable (birth seasonality) were 0 (low birth rate period) when births occurred between February and May (n = 82,792) and 1 (high birth rate period) when births occurred between August and October (n = 81,348). Maternal age was introduced into the model as a continuous variable and the other predictors were introduced having the following categories as references: lower level of education (primary school), being married, and being the first in birth order. The odds ratio, 95% confidence interval and p values are reported for each category of independent variable included in the model. Interactions between predictors were generated and regressed to the outcome to check its effect. Data entry, cleaning, and analysis were done using the Stata/IC 11.1 for Windows statistical package (StataCorp LP 2010). Significance level in all analyses was set at $\alpha = 0.05$.

Results

The months of August, September and October show the highest values in the ratio of observed/expected births and the period between February and May show the lowest number of births (Table 1). These results are consistent with the seasonal fluctuation of births for the full period (Fig.1), which describes a substantial increase in the number of births from August to October with a peak in the month of September for all studied years. The curve is relatively flat for births between February and May, with at least five years (2009–2012, 2014) showing February as the month with the lowest number of births. In general, seasonality of births according to categories of maternal education and marital status and infants' birth order (Figs. 2, 3, and 4) consistently show a pattern very similar to that shown by the entire sample.

In general, independent variables included in the model explain only 4% of variance of outcome. The model shows that the probabilities of giving birth during the peak period (August to October) increase with maternal age and education level (secondary and preparatory compared to primary level), but these findings should be treated with caution given the limited ability of these factors to explain the phenomenon. Maternal marital status and infants' birth order were not significantly associated with the outcome variable and none of the interactions between predictors showed a significant association with outcome variable (Table 2).

Table 1 Absolute and observed/expected[a] numbers of births by month and year

Month*	2008		2009		2010		2011		2012		2013		2014		2015		Total	
	Abs[a]	Obs/Exp[b]	Abs	Obs/Exp	Abs	Obs/Exp	Abs	Obs/Exp	Abs	Obs/Exp	Abs	Obs/Exp	Abs	Obs/Exp	Abs	Obs/Exp	Abs	Obs/Exp
Jan	2338	83.1	2727	92.2	2727	94.3	2726	95.5	2708	90.4	2860	95.5	2777	90.0	3007	96.3	21,870	92.2
Feb	2372	90.2	2286	85.6	2319	88.8	2087	80.9	2462	87.9	2456	90.8	2483	89.1	2581	91.5	19,046	88.9
Mar	2335	83.0	2648	89.5	2640	91.3	2516	88.1	2762	92.2	2830	94.5	2779	90.0	2894	92.7	21,404	90.2
Apr	2515	92.4	2644	92.4	2493	89.1	2402	86.9	2699	93.1	2625	90.6	2809	94.0	2592	85.8	20,779	90.5
May	2575	91.6	2661	90.0	2647	91.5	2503	87.7	2767	92.4	2686	89.7	2967	96.1	2757	88.3	21,563	90.9
Jun	2702	99.3	2663	93.0	2651	94.7	2640	95.5	2751	94.9	2634	90.9	2781	93.1	2797	92.6	21,619	94.1
Jul	3018	107.3	3043	102.9	2902	100.4	3130	109.6	3210	107.2	3116	104.0	3086	100.0	3088	98.9	24,593	103.6
Aug	3200	113.8	3447	116.5	3018	104.4	3340	117.0	3451	115.2	3474	116.0	3280	106.3	3525	112.9	26,735	112.7
Sep	3323	122.1	3455	120.7	3449	123.3	3391	122.7	3371	116.3	3552	122.5	3605	120.7	3782	125.2	27,928	121.6
Oct	3206	114.0	3371	114.0	3289	113.7	3079	107.8	3403	113.6	3335	111.3	3448	111.7	3561	114.1	26,685	112.4
Nov	2848	104.7	3000	104.8	3020	107.9	2929	106.0	2972	102.5	2897	99.9	3204	107.3	3117	103.2	23,987	104.4
Dec	2769	98.5	2884	97.5	2891	100.0	2874	100.7	2811	93.8	2800	93.5	3127	101.3	3052	97.8	23,208	97.8
Total	33,201	–	34,829	–	34,039	–	33,617	–	35,265	–	35,264	–	36,346	–	36,753	–	279,417	–

* Months in a calendar year (abbreviations in the order): January, February, March, April, May, June, July, August, September, October, November, December

[a] *Abs* absolute

[b] *Obs/Exp* Observed/Expected

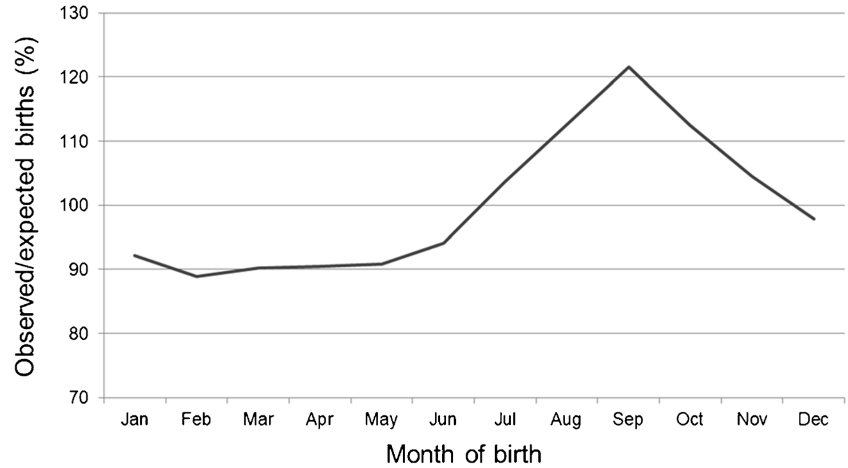

Fig. 1 Seasonal variation in births in Yucatan State during 2008–2015

Discussion

The observed seasonal pattern of births in Yucatan is consistent with the worldwide latitudinal gradient reported by Martinez-Bakker *et al.* (2015), in which birth peaks occur earlier in the year in countries at higher latitudes and later for those closer to the equator.

Our results indicate that maternal sociodemographic factors available to us have a relatively smaller influence on the peak of births; seasonal curves show a consistent pattern with minimal variations according to maternal characteristics. Our results differ from studies that reported marked changes in the pattern of birth seasonality according to differences in maternal sociodemographic characteristics (James 1971; Bobak and Gjonca 2001; Buckles and Hungerman 2013; Dorélien 2016). Some of these studies show that birth seasonality is determined by better or worse living conditions. For example, Bobak and Gjonca (2001) in their study in the Czech Republic found that older, married, and better educated mothers had increased probabilities of giving birth during the local high birth rate period (March–May) (see also James 1971). The authors attributed their results to differences in family planning, suggesting that women in better socioeconomic circumstances are more likely to plan for their pregnancies. In the present context, we found that births to married and primiparous women show the same seasonal pattern to that of the entire sample, which suggests that family planning has no influence on the observed pattern. In contrast, other studies have documented birth seasonality as determined by women that experience adverse living conditions (Buckles and Hungerman 2013; Dorélien 2016). In this context, using census data and birth certificates in the United States during the period of 1944–1980, Buckles and Hungerman (2013) found that young, unmarried, non-white, and less educated mothers showed a more pronounced birth seasonality pattern and were more likely to give birth during winter. As an explanation, the authors hypothesized that women with low socioeconomic status might be more vulnerable to the influence of temperature and other weather-related factors in the summer, which might explain the trough in births during spring. Our findings are consistent with results reported by Zelnik (1969) and Erhardt *et al.* (1971), who found no significant differences

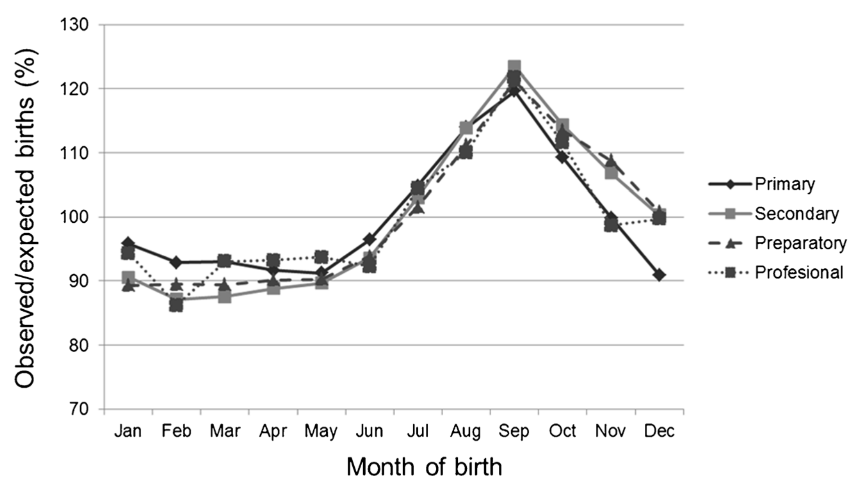

Fig. 2 Seasonal variation in births by maternal educational level

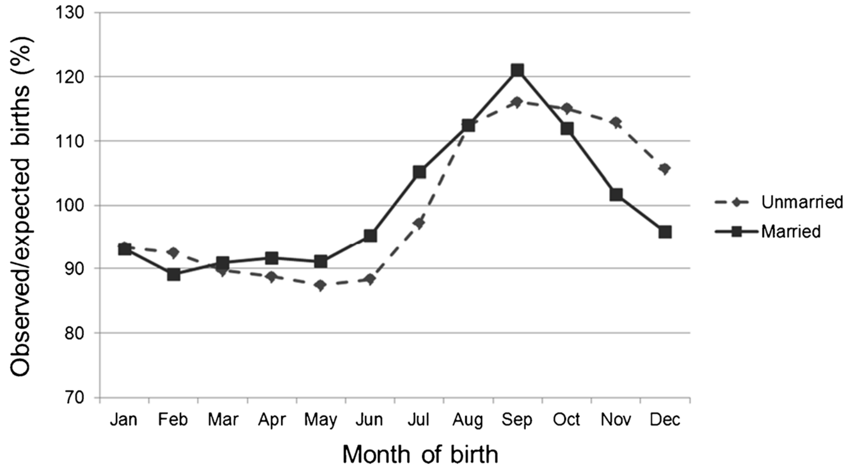

Fig. 3 Seasonal variation in births by maternal marital status

in the distributions of births by socioeconomic groups studying populations from Baltimore during 1961–1965 and New York from 1960 to 1967, respectively. The authors speculated that patterns of marriages and vacations might have played roles in the timing of births.

The limited ability of maternal sociodemographic characteristics to explain the seasonality of births in the present study necessarily suggests that other factors influence the observed pattern. We recognize that some other data on socioeconomic factors that were not available to us, such as family income and paternal occupation, might help to explain the phenomenon. It is well accepted that seasonal variation in births is influenced by physical, environmental, sociocultural, and biological factors, and it has been proposed that the interrelationship among these factors might have impacts through time and space (Bobak and Gjonca, 2001). It seems likely that in the context of Yucatan population, physical, environmental and other factors have more impacts than socioeconomic correlates.

It is also possible that other socioeconomic factors and cultural rhythmicity can at least partially explain the pattern of birth seasonality in Yucatan. We recognize that these alternative explanations are speculative and they should be further tested. The peak of births in our data would correspond to conceptions in November, December, and January and these, in turn, coincide with vacations, celebrations, and a period of high frequency of marriages. The festive season begins on 1st and 2nd of November with the celebration of the Day of the Dead and ends the first week of January. This period includes several celebrations that are highly relevant in the context of traditional Mexican culture, both regional as well as national. Along this period, people socialize and couples tend to spend more time together. Vacations and celebrations have been extensively referred as factors that potentially increase the coital frequency and conceptions in consequence (Johnson *et al.* 1975; Cesario 2001; Caleiro 2010). Variation in the frequency of marriages throughout the year is also consistent with the local sociocultural rhythmicity. The months of November and December registered the highest percentages of marriages during 2007–2015, which may be explained by the increased economic expectations observed in Mexico and elsewhere (Caleiro 2010). Overall, it is possible that all these factors

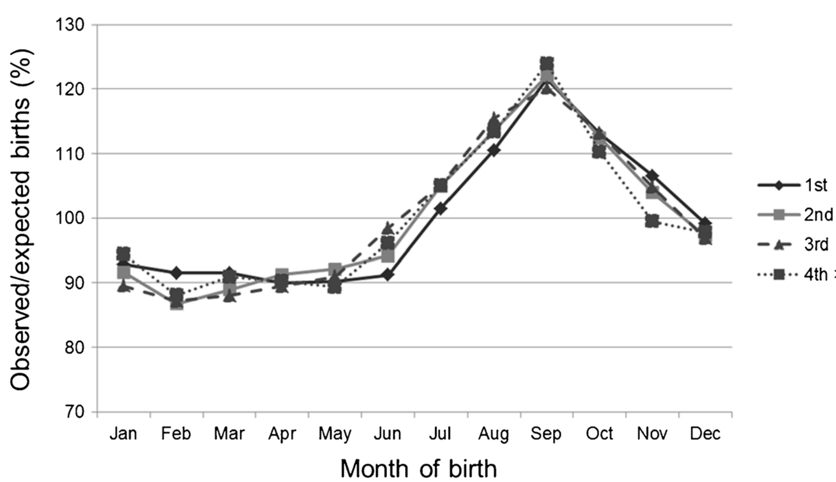

Fig. 4 Seasonal variation in births by birth order

Table 2 Multiple logistic regression model of sociodemographic factors for high births period

	Births	%	Odds ratio (95% CI) of being born in the peak birth period	*p*-value
Total	279,417	100		
Maternal age (years)	278,215	99.6	1.01 (1.00–1.01)	<0.001
Maternal educational level				
Primary	70,349	26	1.00	–
Secondary	103,050	38	1.08 (1.04–1.11)	<0.001
Preparatory	62,607	23	1.05 (1.01–1.08)	0.012
University	34,973	13	0.96 (0.92–1.00)	0.032
Maternal marital status				
Married	174,890	90	1.00	–
Unmarried	18,771	10	0.98 (0.94–1.02)	0.310
Birth order				
1st	108,123	39	1.00	–
2nd	85,737	31	1.00 (0.97–1.03)	0.800
3rd	49,315	17	0.99 (0.95–1.03)	0.520
4th and higher	35,448	13	0.97 (0.93–1.02)	0.256

may be simultaneously interacting along with environmental rhythmicity to account for the expected conceptions during November, December, and January and the peak of births observed from August to October.

Further research is needed to clearly elucidate the factors that contribute to the variation in the frequency of births throughout the year in Yucatan. For now, our findings may be useful to improve and make more efficient the allocation of human and material resources at clinics and hospitals. The quality and promptness of care and procuring resources can benefit from informed planning, which translates to the health and wellbeing of the users.

Conclusion

This study contributes to the scarce scientific literature on birth seasonality in populations residing at the tropical regions of America. The pattern of birth seasonality observed in Yucatan during 2008–2015 shows a clear increase in the number of births during August, September, and October and a trough from February to May during all studied years. This pattern is consistent with those found in populations from other parts of the world in similar latitudes. Our results show that maternal age, education level, and marital status and infants' birth order have limited explanatory value for the peak birth period and that the overall pattern is very consistent regardless of maternal sociodemographic characteristics. Our findings suggest that other factors including sociocultural rhythmicity in Mexican populations may have impacts on the observed pattern across socioeconomic groups.

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Compliance with Ethical Standards We worked with de-identified information of the participants. The data are protected by the Guidelines for Protection of Personal Data of Mexico (INAI).

Conflict of Interest The authors declare no conflict of interest with respect to the present study.

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