A time to be born: Variation in the hour of birth in a rural population of Northern Argentina

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Objectives: The present study aimed at investigating the timing of birth across the day in a rural population of indigenous and nonindigenous women in the province of Formosa, Argentina in order to explore the variation in patterns in a non-Western setting.

Materials and methods: This study utilized birth record data transcribed from delivery room records at a rural hospital in the province of Formosa, northern Argentina. The sample included data for Criollo, Wichí, and Toba/Qom women (n = 2421). Statistical analysis was conducted using directional statistics to identify a mean sample direction. Chi-square tests for homogeneity were also used to test for statistical significant differences between hours of the day.

Results: The mean sample direction was 81.04°, which equates to 5:24 AM when calculated as time on a 24-hr clock. Chi-squared analyses showed a statistically significant peak in births between 12:00 and 4:00 AM. Birth counts generally declined throughout the day until a statistically significant trough around 5:00 PM.

Discussion: This pattern may be associated with the circadian rhythms of hormone release, particularly melatonin, on a proximate level. At the ultimate level, giving birth in the early hours of the morning may have been selected to time births when the mother could benefit from the predator protection and support provided by her social group as well as increased mother-infant bonding from a more peaceful environment.

KEYWORDS
birth, delivery, Toba/Qom, Wichí

1 | INTRODUCTION

The expression that nothing good happens after midnight does not seem to apply to human births; peak hours for noninduced vaginal births fall between 1:00 and 7:00 A.M. followed by a decline throughout the day into the evening hours (Bernis & Verea, 2012; Heres, Pel, Borkent-Polet, Treffers, & Mirmiran, 2000; Kaiser & Halberg, 1962; King, 1955). Of course, human infants are born naturally at all hours of the day, but the observed clustering of births in the early morning hours has been proposed to be evolutionarily adaptive for the mother and newborn (Bernis & Varea, 2012; Honnebier & Nathanielsz, 1994; Jolly, 1972; Varea & Fernández-Cerezo, 2014).

A pattern of nocturnal births is observed in most primate species in captivity, excluding orangutans, nocturnal prosimians, and the owl monkey Aotus sp (Jolly, 1973). Nearly all primate species give birth during the time of day that they are least likely to be disturbed (Jolly, 1973), although few individual exceptions have been documented (DeLuypcker, 2014; Douglas, 2014; Duboscq, Neumann, Perwitasari-Farajallah, & Engelhardt, 2008; Yang, Zhang, Huang, Garber, & Li, 2016). Giving birth during the sleeping-period may provide recovery time for both the mother and infant before the troop begins moving for the day (Bowden, Winter, & Ploog, 1967; Dunbar & Dunbar, 1974). It also gives the mother time alone with the infant before other members of the group discover her newborn, and this period to recover and nurse is important for the newborn’s survival in species where other members of the group show interest (and many times succeed) in handling the infant (Bowden et al., 1967; Dunbar & Dunbar, 1974).

Birth during the early morning hours would have provided similar adaptive advantages to hunter-gatherer mothers across human evolution. Giving birth when the group has reunited to rest after foraging or hunting during the day would increase the mother’s safety because labor and delivery activities would decrease awareness of her...
surroundings. Given the difficulty of human birth, the presence of other members of the group, particularly experienced women, during parturition for support or assistance would have also been beneficial for the mother (Jolly, 1972; Rosenberg & Trevathan, 2002; Trevathan, 1987). Other benefits of giving birth during the early morning hours might have included improved neonatal adaption, maternal bonding, and immediate postnatal development due to a more peaceful environment protected from predators or hostile neighbors (Honnebier & Nathanielsz, 1994; Varea & Fernández-Cerezo, 2014).

Most of the available data on the distribution of timing of births across the day come from Western clinical settings and there is scarce information about variation in patterns across different ecologies and cultural environments. The present descriptive study aimed at exploring variation in the timing of birth in a rural population of indigenous and non-indigenous women in the province of Formosa, Argentina. This population was well-suited for this investigation because of its relatively low prevalence of cesarean sections and its multi-ethnic composition, which facilitate the investigation of possible effects of different population histories and cultural backgrounds.

2 | MATERIALS AND METHODS

This study utilized birth record data transcribed from delivery room records at Hospital Provincial Ingeniero Juárez, a rural hospital in the province of Formosa, northern Argentina. The sample included data for Criollo, Wichí, and Toba/Qom women. The Criollo population has been considered to consist of the descendants of Spanish colonizers with some indigenous admixture (Halperín Donghi, 1993). Criollo families in this region are mainly campesinos (small-scale farmers and cattle ranchers). The Wichí and Toba/Qom are two of the traditionally nomadic or seminomadic hunter-gatherer indigenous populations that reside in the Gran Chaco region in northern Argentina (Braunstein & Miller, 1999). The settlement process for these communities has been impacted by land restrictions, partial integration into the labor market, and the influence of Christian missionaries (Braunstein & Miller, 1999); however, the exposures to these influences vary and have led to substantial variation in lifestyles ranging from the traditional, with a strong reliance on hunting and gathering, to a sedentary lifestyle dependent on wage labor and store-bought goods. A public health reform that took place in the 1980s at the provincial level promoted (and sometimes enforced) hospital births for all women in the region. During the period covered by this study, ~90% of newborns were delivered in the hospital (data not published).

The birth records analyzed here include deliveries from October 2001 to December 2004. The collected data consisted of hour of birth; date of birth; gestation length; type of birth (vaginal, C-section, stillbirth); mother’s age and ethnicity; and infant’s sex, weight (g), and length (cm). Only full-term births were analyzed; any cesarean sections, spontaneous abortions, or preterm births were excluded from analysis. The final study sample included n = 2,421 full-term births from 1,278 Criollo mothers, 1,024 Wichí mothers, 86 Toba/Qom mothers, 6 Bolivian mothers, 1 Dominican mother, and 26 of unknown ethnicity. For the analyses of ethnicity, we combined the Wichí and Toba/Qom births in the “indigenous” group and compared it to the births from Criollo women. The other ethnicities were excluded from this analysis due to low numbers.

Statistical analysis was conducted using directional statistics to identify a mean sample direction (Batschelet, 1965). Time of day was converted into angular measurements, transformed into rectangular polar coordinates, and the mean angle was calculated. Angle dispersion, r, was also calculated. Rayleigh’s Z value was calculated and compared to z critical. Chi-square tests for homogeneity were then used to test for statistically significant differences between hours of the day.

The Institutional Review Board at Yale University deemed this study exempt from IRB review (IRB/HSC#: 1606017977).

3 | RESULTS

Neonatal anthropometric measures were in the normal range when compared to the Argentine standards (Lejarraga, del Pino, Fano, Caino, & Cole, 2009, Table 1). In fact, the average overall birth weight coincides with the 50th centile of the standard curves, while length is closer to the 25th centile. Only 4% of Criollo newborns and 5.3% of Toba/Qom or Wichí newborns were categorized as low birth weight (<2500 g). Criollo mothers were slightly older than the indigenous mothers (1.1 years or 4.5%, p = 0.001) and their children were slightly heavier (103 g or ~3%, p < 0.01) and longer (0.8 cm or ~2%, p < 0.01).

Births tended to cluster in the early morning hours. The birth counts per hour are shown in Figure 1. Rayleigh’s Z was 5.28 (p = 0.01) for hour of birth and the mean sample direction was 81.04°, which equates to 5:24 A.M. when calculated as time on a 24-hr clock. Chi-squared analyses showed no statistically significant difference between the mean sample direction of birth hour for the Criollo and Toba/Qom and Wichí populations (p > 0.05). Chi-square analysis of birth counts during the peak hour (2:00–3:00 AM, n = 137 births) ±0.5 hr compared to the hour with the lowest birth counts (7:00–8:00 PM, n = 57) ± 0.5 hr produced a statistically significant value of 12.63

<p>| TABLE 1 | Average values (± SD) for variables collected at the time of birth in the Criollo and the Wichí-Toba/Qom population |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Sample</th>
<th>Maternal age (years)</th>
<th>Weight (g)</th>
<th>Length (cm)</th>
<th>Head circumference (cm)</th>
<th>Gestational length (weeks)</th>
<th>Sex ratio (male/female)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criollo</td>
<td>24.4 ± 7.1</td>
<td>3334 ± 498</td>
<td>48.7 ± 2.3</td>
<td>34.1 ± 1.7</td>
<td>39.6 ± 0.9</td>
<td>50.6/49.4</td>
</tr>
<tr>
<td>Wichí and Toba/Qom</td>
<td>23.5 ± 7.2</td>
<td>3231 ± 495</td>
<td>47.9 ± 2.6</td>
<td>34.2 ± 1.7</td>
<td>39.5 ± 0.9</td>
<td>51.3/48.7</td>
</tr>
<tr>
<td>All births</td>
<td>24.0 ± 7.8</td>
<td>3286 ± 500</td>
<td>48.3 ± 2.5</td>
<td>34.1 ± 1.7</td>
<td>39.6 ± 0.9</td>
<td>50.8/49.2</td>
</tr>
</tbody>
</table>
\[ \text{Birth counts per hour on a 24-hr clock (dark line) and} \]
\[ \text{hypothetical uniform distribution (light gray line) for visual identification of peaks and troughs} \]

\((p = 0.001)\). Expansion of the test to include 2:00–3:00 AM \pm 1 hr compared to 7:00–8:00 PM \pm 1 hr as well as 2:00–3:00 AM \pm 2 hr compared to 7:00–8:00 PM \pm 2 hr also indicated a statistically significant difference.

4 | DISCUSSION

We found no statistically significant difference in the mean sample direction of birth hour between Criollo and indigenous mothers—two culturally and genetically distinct populations. Because the differences observed between morning and evening birth counts in this study match the findings of prior research on human birth hour, this similarity in birth hour across populations appears to reinforce the idea that the observed pattern of births has a universal biological basis among human populations.

Given the consistency of this trend, it seems this pattern may have been selected for in evolutionary history to lead to an increase in the number of births at the most favorable time of day for infant and maternal survival, which appears to be the period of least activity across most primate species. For humans, this would explain the clustering of births in the early morning hours. Parturition during these nocturnal hours would have afforded additional advantages to hunter-gatherer women due to the presence of the reunited group, which would have provided protection and female social support, and the reduced predator activity during this time of day (Jolly, 1972; Varea & Fernández-Cerezo, 2014). These elements are not guaranteed to be available during the day when the group has dispersed to forage.

As Honnebier and Nathanielso (1994) propose, early morning birth might have also improved neonatal adaption, maternal bonding, and immediate postnatal development due to a more peaceful environment when compared to the activity during the day. Study of activity patterns among Ache females, the Hadza, the San, and the Tsimane—all hunter-gatherers or hunter-agriculturalists—demonstrates that these populations appear to be most active in the late morning and rest during the afternoon (Hurtado, Hawkes, Hill, & Kaplan, 1985; Yetish et al., 2015). Yetish et al. (2015) propose that the change in activity pattern observed in the afternoon may be the result of seeking shade to escape the midday sun. The heat of the day combined with the dispersal of the group would make the afternoon a dangerous time to give birth. Thus, the consistent peak in human births during the morning hours appears to minimize predation risk and follow the activity patterns that were likely experienced during human evolution, and this has resulted in the highest birth frequencies during the hours in which the conditions most favorable for a successful delivery would have occurred in evolutionary history.

Despite the consistent observations that full-term, healthy human births cluster in the morning hours, the biological proximate mechanisms to explain the circadian rhythm of births are still under investigation, although research increasingly indicates a central role for melatonin. Melatonin is a hormone produced by the pineal gland and involved in sleep-wake cycles with concentrations increasing in response to darkness and declining as light exposure increases. Longo and Yellon (1998) proposed that the circadian rhythms of hormones that impact myometrial contractility and prostaglandin production in combination with melatonin secretion in response to light rhythms has led to the observed pattern of births. In support of this hypothesis, Kivelä (1991) and Nakamura et al. (2001) found that melatonin levels were significantly higher in late pregnancy. Research has also found that both melatonin and oxytocin receptors are upregulated at the onset of labor, and melatonin and oxytocin function synergistically to induce labor through similar intracellular mechanisms in human myometrium smooth muscle cells (Sharkey, Cable, & Olcese, 2010; Sharkey, Puttaramu, Word, & Olcese, 2009). Therefore, peak melatonin release, which occurs between midnight and 5:00 AM, may be a biologically significant factor associated with the birth clustering observed in the early morning hours.

Thus, current research appears to support the hypothesis that melatonin plays a crucial role in the circadian rhythm of births. An important relationship emerges between the proposed proximate and ultimate causes of birth hour circadian rhythms, where it seems that natural selection for human birth hour has favored (or co-opted) the development of a role for melatonin’s sensitivity to the light-dark cycle and its linkage to oxytocin and uterine contractions, which then leads to peak birth rates in the early morning and likely results in increased mother-infant bonding, predator protection, and social support for the new mother.

5 | CONCLUSION

A significant peak in birth counts was observed in the morning hours between 12:00 AM and 4:00 AM with a mean sample direction equal to 5:24 AM. Birth counts generally declined throughout the day and reached a significant trough around 5:00 PM, which mirrors the findings of previous studies on human birth hour in more industrialized, clinical settings. At the proximate level, this pattern may be associated with circadian rhythms of hormone release, particularly melatonin. At the ultimate level, giving birth in the very early hours of the morning
may have been selected to time births when the mother could benefit from the support and protection of the social group as well as from a more peaceful environment.

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