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Article

Season of birth and depression in adulthood: Revisiting historical forerunner evidence for in-utero effects

Jason Schnittker

University of Pennsylvania, Department of Sociology, 3718 Locust Walk, Philadelphia, PA 19104-6299, USA

ABSTRACT

Evidence showing a relationship between season of birth and adult well-being is long-standing, but is now largely overlooked or dismissed. In light of increasingly compelling evidence for the effects of in-utero conditions on adult health, however, it is instructive to revisit the relationship, with an eye toward resolving the reasons for skepticism. This study uses data from the first National Health and Nutritional Examination Survey to examine the effects of month of birth on adult depression. The data correspond to an important time in history and the analysis points to one reason why enthusiasm for birth seasonality in depression has faded: although there was a strong relationship between month of birth and depression in the early 20th century, with spring and summer month births corresponding to significantly more depression, the relationship was largely eliminated by the 1940 birth cohort. Few adults alive today would be subject to this effect, but when it was apparent it was enormously consequential. Population attributable risk scenarios indicate that among those born between 1900 and 1920 the prevalence of major depression would have been reduced by approximately 22% if all births had been confined to November through March. The percent rises to 26% among those born between 1900 and 1910, and was likely even higher in earlier cohorts. Additional analyses point to the importance of nutritional deficits in explaining these effects. In the early 20th century, the relationship between month of birth and depression was weaker in circumstances where the food supply was less seasonally sensitive. For this reason, the turn-of-the-century relationship between month of birth and depression was much weaker among the well-educated, in Southern states, and in urban areas. Although birth seasonality in depression can be regarded as a historical artefact of diet and nutrition, evidence for its prior existence nonetheless speaks to the significance of other in-utero effects, both past and present.

The idea that season of birth affects health and well-being is ancient, but has mostly faded from the imagination of contemporary scientists. In the US, scientific interest in birth season effects grew following the publication of several provocative studies in the 1930s. These studies found birth seasonality in a host of psychiatric disorders and dimensions of personality (Huntington, 1938). Other studies quickly followed (e.g., Knobloch & Pasamanick, 1958). By the 1960s and 70s, however, enthusiasm for birth season effects had waned as the evidence grew more mixed and inconclusive. Although some studies continued to find a relationship (e.g., Bailar & Gurian, 1965; see Torrey, Miller, Rawlings, & Yolken, 1997 for a review), other studies failed to find a significant effect, prompting skeptics to dismiss the entire idea of birth season effects as an esoteric form of speculation, aligned more or less with astrology (Woodruff, Guze, & Clayton, 1974, p. 926). Pointed skepticism of this sort was perhaps rare but it found a receptive audience, even among scientists with more moderate inclinations. Many scientists, it would seem, were eager to cast the idea of birth seasonality in health to the dustbin of history, focusing their efforts instead on unraveling the many contemporaneous conditions relevant to adult health. The idea of fundamental causes is consistent with this turn (Link & Phelan, 2010).

Yet in the 21st century the credibility of a relationship between season of birth and adult health has grown in light of the growing acceptance of in-utero effects. Although in-utero effects are rarely cast in terms of seasonality *per se*, they do point to the enduring importance of the conditions surrounding gestation and birth, much like the original birth season research did. Perhaps the most influential evidence of this sort stems from the so-called Barker hypothesis, positing a relationship between in-utero conditions, indicated by birth weight, and adult health, especially cardiovascular disease (Barker, 1992; Barker, 1998). Since the initial statement of the idea, the basic parameters of the Barker hypothesis have expanded, encompassing a variety of in-utero insults and an assortment of adult health outcomes, including mental health (Langley-Evans & McMullen, 2010). It requires little stretch to

E-mail address: jschnitt@ssc.upenn.edu.

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see parallels between this contemporary literature and the seemingly more archaic insights of the birth season literature. There is, in fact, already evidence linking month of birth to adult mortality, channeled through some of the same metabolic mechanisms behind the Barker hypothesis (e.g., Doblhammer & Vaupel, 2001).

The present study attempts a rapprochement between earlier and recent evidence. It does so using the lens of history, by exploring the relationship between season of birth and adult depression using survey data drawn from cohorts born in the early 20th century, between 1900 and 1950, and collected when respondents were adults, in the mid-1970s. In particular, this study explores how the relationship between season of birth and depression changed during a particularly important time period. A focus on between-cohort change provides a framework for thinking about the evidence for birth-season effects, while also pointing to the importance of nutritional deficiencies in shaping them. Perhaps one reason contemporary scholars have often failed to find a relationship between season of birth and adult well-being is that the relationship between the two has, in fact, faded over time, especially as the conditions that made it possible have evolved. Evidence for a declining relationship with season of birth does not, however, obviate the significance of in-utero effects altogether, and the conclusion discusses the implications of birth season effects for contemporary research on other in-utero determinants of adult depression.

Background

Although research on birth season effects is often overlooked, much of the early evidence is quite persuasive. Entertaining the idea of birth season effects depends only on recognizing two things: that in-utero conditions can exert a lasting impact on health and that such conditions can be influenced by seasonal factors. Much of the early evidence regarding season of birth and mental illness focused on severe and persistent disorders, especially schizophrenia. In general, this literature finds an elevated risk associated with winter and spring, corresponding more precisely to births between December and March (in the Northern hemisphere) (see Torrey et al., 1997). Although there is less evidence pertaining major depression—and less still with respect to subclinical disorders—what studies exist point to a somewhat later risk period, corresponding to births between March and May. Contemporary reviews are circumspect: they generally regard the birth season effect as small but significant. One systematic review of schizophrenia studies found a population attributable risk for being born during winter and spring months of only 3.3% (Davies, Welham, Chant, Torrey, & McGrath, 2003). Reviews of Southern hemisphere data also conclude the effects of season of birth are significant but, if anything, they demonstrate even smaller effects than are apparent in Northern hemisphere data (McGrath & Welham, 1999).

In addition to seemingly small effects, one reason contemporary audiences are skeptical of the literature is its general inability to identify a precise mechanism. In absence of a mechanism, the literature appears overly speculative. To date, most of the literature has focused on ruling out explanations rather than presenting evidence favoring one mechanism over another. Much of the initial effort, for instance, focused on testing artifactual explanations and, therefore, did not address mechanisms at all. For instance, there are natural patterns in birth seasonality that are apparent in the general population (Martinez-Bakker, Bakker, King, & Rohani, 2014). To the extent that studies employ samples of psychiatric patients without appropriate comparisons or statistical corrections, they risk incorrectly concluding that one season is risker than another when in fact the distribution of birth seasons among patients merely reflects normal seasonal variation in births. Other artefactual explanations focus on the behavior of parents. Some, for instance, have posited that those with certain psychiatric disorders have procreation habits that are seasonal, creating birth patterns but ones that likely reflect genetic influences rather than seasons *per se* (see Bleuler, 1991 with respect to depression). Studies examining the siblings of those with psychiatric disorders generally find no evidence for this interpretation and, in general, explanations focused on assorted behavioral correlates of birth seasonality have not been successful (Pulver et al., 1992).

Subsequent to ruling out artefactual explanations, studies have settled on two types of mechanisms: either seasonal variation in nutrient supply or seasonal variation in infectious disease exposure (Disanto et al., 2012). These explanations differ in the proximate mechanisms they emphasize, whether with respect to the specific infection or the specific nutrient, but are nonetheless united around the idea that some in-utero exposure or deficiency alters developing fetal tissues. One set of hypotheses focuses on seasonal variation in exposure to infections, especially the flu. The regular timing of flu season lends this idea its plausibility. Despite year-to-year variation in the specific strains of influenza that appears there are remarkable regularities in the timing of flu pandemics (Lofgren, Fefferman, Naumov, Gorski, & Naumova, 2007). Flu season generally peaks in February, corresponding, then, to late-term in-utero exposure and, in turn, to additional risk associated with November to March births. Some evidence for the relevance of in-utero influenza exposure is more direct. Some studies, for instance, have linked in-utero exposure to especially significant flu pandemics to the development of schizophrenia in adulthood (e.g., Adams, Kendell, Hare, & Munk-Jørgensen, 1993). To be sure, these pandemics tend to be exceptionally virulent and, therefore, represent an especially powerful dose, but they nonetheless add to the general case that in-utero influenza exposure affects fetal development.

Other hypotheses focus on nutritional deficiencies. Nutritional intake can vary over seasons and studies have posited a variety of relevant influences, including vitamin C, vitamin K, and protein (Susser, Hoek, & Brown, 1998; Thane et al. 2002; Tochigi, Okazaki, Kato, & Sasaki, 2004). The idea that maternal sunlight exposure can also affect fetal development is a different version of the same idea. Seasonal changes in sunlight exposure might affect the availability of vitamin D in pregnant women and, in turn, adversely affect the development of the fetus (McGrath, Burne, Féron, Mackay-Sim, & Eyles, 2010). Beyond seasonal variation, this idea also implies an interaction between season of birth and latitude, as higher latitudes will correspond to even less sun exposure during the winter and early spring. Although the interpretation that birth seasonality in schizophrenia reflects nutritional deficiencies is speculative, there is at least high-quality evidence linking maternal nutritional adequacy to the mental health of offspring (Jacka et al., 2013).

When explaining birth season effects, it is difficult to evaluate the role of nutritional deficiencies directly, but the idea has a number of testable implications. For one, to the extent that birth season effects reflect nutrition, it is likely that the effects have shifted considerably over the course of the 20th century, especially in the early part. In particular, seasons likely played less of a role in nutritional adequacy in the middle of the century than they did earlier and, furthermore, the overall nutritional content of food has improved. These improvements were broad and multifactorial. Food supply, preservation methods, and nutritional content each improved over the early part of the century (Bennett & Peirce, 1961). Refrigerators with freezers, for instance, became available for households during the 1920s, abruptly changing the supply of food families were able to have on hand (Centers for Disease Control, 1999). At the same time, the scientific understanding of nutrition was improving rapidly during this period (see Preston & Haines, 1991 for a review of science and nutrition at the turn of the century). In the early 20th century, little was known about the nutritional content of food or its consequences, apart from a rudimentary understanding of the effects of severe inadequacy. In this context even a well-resourced family was unlikely to maintain perfect nutrition year-round, even if most families were able to maintain adequate caloric intake (Wait, 1909). Among high-income families, the demand for nutritional content *per se* only emerged in the middle of the century, when the benefits of nutrition were more credibly established (Beatty & LaFrance, 2005).