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Cold summer weather, constrained restoration, and very low birth weight in Sweden

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ABSTRACT

In higher latitudes, relatively cold summer weather may constrain outdoor activities that provide relief from chronic stress. Chronic stress can affect human birth outcomes, including the length of gestation and so the birth weight of the infant. We tested the hypothesis that, in Sweden, the odds of very low birth weight (VLBW; <1500 g) vary inversely with mean monthly temperature for the summer months. We applied time-series modeling methods to nationally aggregated data on singleton births during the 456 months from January, 1973, through December, 2010. We found elevated odds of VLBW among male infants for relatively cold June and August temperatures. Unpleasant weather may figure in stress-related health outcomes, not only as a stressor, but also as a constraint on restoration.

1. Introduction

Concerns about adverse effects of weather on human health have increased as evidence of global climate change has mounted (McMichael et al., 2006). Concern has centered on the temperature extremes, violent storms, and heavy rains that can quickly injure or kill people who lack suitable shelter. Yet, even when people can protect themselves from its extreme forms, weather may affect health through its effects on behavior. In the present paper we focus on the constraint of psychological restoration as one behavioral pathway through which weather can affect health. We consider how constrained restoration can engender very low birthweight, an outcome with long-lasting and far-reaching implications for the individuals involved and for the society in which they live (Gäddlin, 2011).

The definition of constrained restoration refers to the general causes of chronic stress. Stress arises when environmental demands tax or exceed a person's adaptive resources (Cohen et al., 1997). It becomes chronic in part because of persistent demands and in part because of a persistent lack of adaptive resources. The lack of resources can follow from an inability to acquire new resources, to more effectively apply those one has, or to restore those depleted in efforts to cope. We focus here on the last of these reasons for resource insufficiency. If a person cannot adequately restore depleted resources because of prevailing environmental conditions, then the situation has one of the defining characteristics of constrained restoration. Another defining characteristic involves a distinction between conditions that constrain restoration and those that evoke stress. People would not ordinarily appraise the constraining condition as a stressor, but in a context dedicated to restoration they would nonetheless evaluate it negatively.

We argue that weather can indirectly affect health by discouraging participation in outdoor activities that support restoration. If weather constrains restorative activities over an extended period, then chronic stress may go unrelieved. Chronic stress can cause mental and physical health to suffer in a variety of ways (Lovallo, 2005). In the present study, we consider the possibility that, at higher latitudes, relatively cold summer weather can lead to adverse birth outcomes by denying pregnant women sufficient relief from chronic stress. Using time-series analytic methods with nationally aggregated data for Sweden, we estimate the association between mean monthly temperature and the odds of very low birth weight for each of the summer months, looking across the years 1973–2010. In performing this test, we build upon a study which found that the dispensation of antidepressants in Sweden varied inversely with mean monthly temperatures for July across the years 1991 through 1998 (Hartig et al., 2007).

We see several advantages in using Swedish data to study the constraint of restoration due to poor weather. Sweden has the dark and difficult winters characteristic of higher latitudes, and Swedes

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value the summer as a season for outdoor leisure activities. The evolution of Swedish vacation legislation reflects this positive regard for the summer. Statements about the superiority of a summer vacation for recreation and restoration appear in legislative proposals (e.g., Kunglig Majestäts propositionen no. 286, 1938, as cited in Andra Lagutskottet (1953) and Kunglig Majestät (1951)), inquiries commissioned by the government (Statens Offentliga Utredningar, 1944, 1967, 1975), and reports from legislative committees (Andra Lagutskottet, 1951) that span several decades. Swedish vacation legislation currently enables employees to take four consecutive weeks of paid vacation during the period June 1-August 31 (Ericson and Gustaffson, 1977). It thus ensures widespread access to restorative activities during the months in focus here, although in terms of the time needed and not the environmental conditions that some of those activities may require. In line with the vacation law, vacationing in Sweden shows strong seasonality, with a pronounced spike during the summer months.

In keeping with the preferences acknowledged in the vacation legislation, population surveys show that Swedes generally do engage in more outdoor activity during the summer months than during cooler months (Statens Offentliga Utredningar, 1964; Statistiska Centralbyrån, 2004; cf. Matthews et al., 2001; Pivarnik et al., 2003). Similarly, observations of different outdoor spaces in one major city, Gothenburg, found that the number of people present varied with temperature across the year, and that temperature had a stronger association with the number of people present than did either the amount of cloud cover or wind speed (Eliasson et al., 2007). Presence outdoors also varies with the weather within the summer months. For example, during afternoons in one July, Thorsson et al. (2004) observed that the number of people resting in a large park in Gothenburg varied strongly with temperature.

Despite the preference for warm weather during the summer, we do not regard relatively cold summer temperatures as stressful, given the readily available means to maintain thermal comfort (e.g., stay indoors, wear more clothing, and drink hot coffee). Rather than a stressful exposure, we view cold summer temperature as a condition that hinders activities that help people to recover from efforts to deal with role obligations and other stressful demands. Some demands may persist continuously over many months, and so underlie stress that has become chronic prior to the opportunities for restoration that open during the summer months.

As a dependent variable, very low birth weight (VLBW) offers a crucial advantage for our study, in that much previous research has linked it with chronic stress (Hobel et al., 2008; Wadhwa et al., 2002). Research has pointed to several sources of persistent demands that may affect birth weight, including low socioeconomic position, racial discrimination, residence in an insecure neighborhood, and stressful work (Hobel and Culhane, 2003; Hogue et al., 2001; Katz, 2012). These circumstances can affect birth weight through increasingly well understood physiological mechanisms (Wadhwa et al., 2001). The elevated corticosteroid levels that attend chronic stress may make the "clock" for delivery run faster, leading to a preterm delivery (Hobel and Culhane, 2003). Elevated corticosteroid levels may also suppress immune function, allowing latent infections to become active and thereby increasing the risk of preterm delivery (Coussons-Read et al., 2007). Aside from preterm delivery, chronic stress may affect birth weight by restricting intrauterine growth (Hobel et al., 2008); however, more than 90% of very low weight infants come preterm (Crouse and Cassady, 1994).

Like other people, pregnant women might suffer from constraints on restorative outdoor activities due to cold summer weather. Advice on vigorous physical activity during pregnancy has varied over the period under study because of differing opinions about the potential for harm to the fetus. The activity of interest here however may impose only modest demands. As for other people, activities such as walking can offer restorative benefits to pregnant women (Da Costa et al., 2003), especially when done in pleasant outdoor surroundings (Hartig, 2007). Even women who must cope with the discomfort, functional limitations and other demands of late-stage pregnancy (Otchet et al., 1999) may benefit from access to the outdoors under agreeable weather conditions. Simply sitting in an outdoor space, especially one with a natural character such as a park, may offer restorative advantages over staying inside; the pregnant woman can passively enjoy the surroundings and gain psychological distance from stressful demands in the home or workplace (Hartig, 2007; Donovan et al., 2011). To the extent that their choices of activities and locations depend upon weather conditions, pregnant women may lose access to environments with relatively high restorative quality in times of cold summer weather.

Another feature of pregnancy that supports our selection of dependent variable involves the possibility of escaping cold weather. Particularly in the third trimester, many women want to remain close to familiar medical facilities and expertise. Late-term pregnant women also face restrictions on air travel that might otherwise bring them to satisfactory places with relatively greater speed and comfort than possible with other modes of transportation (American College of Obstetricians and Gynecologists, 2001). For these reasons, even pregnant women of high socioeconomic status may not escape activity limiting weather late in pregnancy.

Finally, relatives and friends who have planned to provide support as a woman nears the end of her pregnancy also have their mobility constrained. For some of them, providing support may mean taking on more domestic work. These conditions may hold during the time they take for vacation and also during that period of the summer during which, though not formally on vacation, they want to enjoy outdoor activities, with or without the pregnant woman. Similarly, should the woman already have children, she might have to contend with stressful consequences of their activity restrictions. Such household circumstances may feed stress contagion among those involved (Rook et al., 1991).

In sum, a very low weight birth may follow chronic stress that has persisted because cold summer temperatures have constrained access to restorative outdoor environments by a pregnant woman, her family and her friends. Accordingly, we test the hypothesis that the odds of VLBW in Sweden have a negative association with temperature during the summer months.

2. Materials and methods

2.1. Variables

As the dependent variable for our analyses, we used the natural logarithm of the monthly odds of live male and female infants in Sweden weighing less than 1500 g (i.e., the clinical definition of very low birth weight). We obtained the data from the Swedish Medical Birth Registry, aggregated by month to avoid problems with small numbers and attendant concerns about anonymity violations. We began our analyses with the first month of data availability (January, 1973). Our analyses ended with December, 2010, the most recent month for which we could obtain data at the time of our request. Swedish women delivered an average of 8240 live infants each month over the 456 test months. Of these, an average of 44 infants per month weighed less than 1500 g. Female infants had a risk (5.33 per 1000) similar to males (5.34 per 1000) of very low weight. Table 1 provides additional statistical detail concerning VLBW during the test period, broken out by the sex of the infant. Figs. 1 and 2 display the variation in the logarithm of the monthly odds of VLBW over the test period for males and females, respectively.