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Psychological Stress and Birth Outcomes in Amish Women Before and After the Nickel Mines Shooting

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Abstract: *Objective*: To evaluate the impact of the Nickel Mines shooting October 2, 2006 on the psychological stress and birth outcomes of Amish women living in proximity to the event. *Methods:* Data are from a population-based cohort study of 202 Amish women of childbearing age interviewed at baseline (winter 2004-2005) and 3 years later (winter 2007-2008). Data are also from Pennsylvania Department of Health birth records 2004-2008. *Results*: There was no apparent impact of the shooting on depression, social support, stress, number of diagnoses, sleep, doctor visits, number of medications, or anxiety. Nor was there an apparent impact on these outcomes when the distance of homes from the Nickel Mines school was taken into account. Timing of birth relative to the shooting apparently did not affect birthweight, gestation length or the probability of a low birthweight baby. *Conclusions*: Although the Nickel Mines shooting had a profound impact on the Amish community, we found no difference in Amish women's health, mental health, or birth outcomes when comparing pre and post shooting measures. This may reflect the very high levels of social support among these women. [Abstract by authors]

Keywords: Amish; Nickel Mines shooting; trauma and birth outcomes

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INTRODUCTION

On October 2, 2006, a man entered a one-room Amish schoolhouse at the crossroads of Nickel Mines, Lancaster County, Pennsylvania and shot 10 girls, killing five, and then killing himself (Itkowitz 2006). The Nickel Mines "happening," as the Amish families refer to the incident, was a major, unforgettable event within the Amish community.

While the effects of stressors on birth outcomes in the Amish community are largely unknown, short term stress during pregnancy has increased the likelihood of preterm birth and low birthweight in other population groups. For example, the prevalence of low birthweight increased after an earthquake in Taiwan (Chang, et al. 2002). Women pregnant and living and working in Manhattan at the time of the World Trade Center attack delivered infants smaller and earlier compared to controls (Lederman, et al. 2004). Arab-named women living in California were at increased risk of delivering a low birthweight infant after the 2001 World Trade Center attack compared with before the attack (Lauderdale 2006). Danish women who experienced the death of a relative during pregnancy were more likely to have a preterm birth and a smaller baby (Khashan, et al. 2008; Khashan, et al. 2009). The odds of low birthweight increased after the 2008 economic collapse in Iceland (Eiriksdottir, et al. 2013). The prevalence of low birthweight increased after exposure to Hurricane Katrina in New Orleans (Xiong, et al. 2008). Mothers exposed to the 1999 bombing of Belgrade, Serbia, gave birth to smaller infants (Maric, et al. 2010).

Low birth weight and preterm birth are important risk factors for infant mortality (Blencowe, et al. 2013; Kochanek, et al. 2016) and of adverse effects that extend into adulthood (Barker 1997; Hack, et al. 2002; Saigal and Doyle 2008). Stress over the life-course has been implicated in the high prevalence of low birthweight, preterm birth, and infant mortality among racial minorities in the United States (Kramer, et al. 2011).

In this study, we evaluate the impact of the Nickel Mines shooting on the psychological stress and birth outcomes of Amish women. We analyze mothers' mental health and babies' birth weights before and after the event and by proximity to the event. We assume that proximity reflects the likelihood of knowing victims of the shooting and, therefore, the risk of being impacted by the event. We hypothesize that measures of women's mental health would be lower and stress higher, especially for women living close to the school, compared with measures taken before the shooting. We further hypothesize that the proportion of low birthweight and preterm births among Amish women would increase after the shooting, especially among women living close to the school.

METHODS

Study 1

Between November 2004 and June 2005, we surveyed 288 randomly selected Amish women ages 18-45 years living in Lancaster County, Pennsylvania as part of the Central Pennsylvania Women's Health Study. We estimated the prevalence of behaviors and exposures that may affect pregnancy outcomes in this group. The study was approved by the Institutional Review Board of Franklin & Marshall College. Details of the sampling strategies have been published (Yost, et al. 2005; Weisman, et al. 2006; Miller, et al. 2007).

We found that, compared with women in the general population, Amish women rated their mental health much higher, had fewer diagnoses of depression, perceived themselves to experience less stress, less intimate partner violence, less unfair treatment due to gender, and to have higher levels of social support. Additionally, Amish women were half as likely to have had a low birthweight infant despite having had more children, compared with women in the general population (Miller, et al. 2007).

Between October 2007 and January 2008, 202 (70.1%) of the original Amish women were resurveyed. The 202 Amish women who were available for follow-up had the same sociodemographic characteristics as the original group: the same age distribution adjusting for the four years between surveys, the same distribution of educational attainment, the same distribution of number of adults and children in the home, and the same distribution of number of pregnancies (adjusting for pregnancies between surveys). Seventy-four of the original participants declined to participate in the second interview; 6 were no longer at the same address; 5 were never reached; 1 was deceased. We have no information about why women who declined to participate did so.

To examine the influence of the Nickel Mines happening on Amish women and their babies we compared women's scores on depression, functional social support, stress, objective health, sleep, doctor visits, medications, and anxiety using paired t-tests for women's values before and after Nickel Mines. Analyses were performed using SPSS version 24 and R version 3.4.3.

Symptoms of depression were measured using the Center for Epidemiologic Studies Depression Scale (Radloff 1977). Higher scores indicate a higher number of depressive symptoms. Social support was measured with a subset of 8 questions from the 19-question Medical Outcomes Study Social Support Survey (Sherbourne and Stewart 1991). Higher scores indicate higher levels of support. Psychosocial stress was measured using the 12-item Psychosocial Hassles Scale that assessed how much common stresses like money worries, family problems, pregnancy, and feeling overwhelmed were perceived as stressful during the previous 12 months. Higher scores indicate higher levels of stress. The scale was modified from Misra, O'Campo, and Strobino (2001) who adapted it from Curry, et al. (1994). Objective health status was judged from the number of diagnoses from a series of 28 questions about diagnoses made by physicians of health concerns that may affect pregnancy outcomes. Sleep was the self-reported number of hours of sleep per night. Doctor visits were the number of visits in the past year. (For the second survey, this was the number of visits in the past 2 years; we divided this by 2 for the comparison.) Medications were the mean number of women taking any prescription medication. Anxiety was the mean number of women diagnosed with anxiety or depression. Discussion of instrument validity is in Weisman, et al. (2006).

We estimated the distance from homes to the Nickel Mines school using addresses and ArcGIS. We examined the change in scores as a function of the distance of a woman's home from the Nickel Mines school. Using simple linear regression, we examined the change in depression, functional social support, stress, objective health, and anxiety as a function of the distance in feet from the woman's home to the school.

We also categorized the distance of women's homes from the school into miles. Using ANOVA, we examined the influence of the (categorized) distance on the change in scores for depression, functional social support, stress, objective health, and anxiety. We also examined the influence of distance on infant birthweight divided into those born before and after the happening. In a similar way, we examined the influence of depression score and birth timing (before vs. after) on birthweight, and the influence of social support and birth timing on birthweight.

We divided women into 3 age groups, separating younger and older women at greater risk because of their age from a middle group at less risk (young: 18-22 years, n=12; middle: 23-32 years, n=78; older: 33-40 years, n=31) (Weisman, et al. 2006) and examined the weights of babies born to women between the surveys and before and after the happening.

We examined the gestation length of babies born before and after the happening using an independent samples t-test. We also divided baby's birthdates arbitrarily into categories (1 year prior, over a year prior, and 3, 6, 9, over 10 months after) and used ANOVA to examine the effect on gestation length.

We compared birthweight and gestation length for babies born to women who had babies both before and after the happening using paired t-tests.

Study 2

We obtained information from the birth certificates for all babies born in Lancaster County, Pennsylvania in 2004 through 2008 from the Pennsylvania Department of Health including the names and addresses of the mothers. There were 34,261 singleton live births recorded in those five years. To identify births to mothers who were Amish, we found mothers who were married, had an eighth grade education or less, were not Hispanic, who self-identified as white, who did not receive WIC supplemental food, and whose last name matched one from a list of Amish last names in Lancaster County. We used these criteria to separate Amish women from other women in Lancaster County. We then matched the address of the mother with those in the *Amish Church Directory* (Gallagher and Beiler 2002) or the *Amish Address Book* (2001). This research was approved by the Institutional Review Board of Franklin & Marshall College.

Of women who met all 6 criteria, 93% could be reliably coded as Amish through matches with the Amish directories. Of women who matched only 5 criteria, and received WIC food supplements, 83% could be reliably coded as Amish through address matches. Of women who matched only 5 criteria, and had more than an eighth grade education, 53% could be reliably coded as Amish through address matches. Only 3% of women who matched only 4 criteria could be reliably coded as Amish.

We compared the weights of babies born in the six months after the shooting (October 2, 2006 – April 2, 2007) to the weights of babies born in the same six months the previous year (October 2, 2005 – April 2, 2006).

We used linear regression to predict the weights of babies based on the mother's age, the gender of the baby, the weight gain of the mother during her pregnancy, whether the baby was a first birth, and whether the baby had been born in the six months after the shooting or in the same six months the year before it. These are important predictors of birth weight (Weisman, et al. 2006).

We used logistic regression to estimate the probability that a baby was born at low birthweight (<2500g) based on the mother's age, the gender of the baby, the weight gain of the mother during her pregnancy, whether the baby was a first birth, and whether the baby had been born in the six months after the shooting or in the same six months the year before it.

Using the longitude and latitude of the mother's home, we calculated the straight-line distance from the home to the Nickel Mines school using ArcGIS tools. We examined the influence of distance from the school on the birthweights of babies born in the six months after the shooting or in the same six months the year before it.

RESULTS

Study 1

Women's scores on depression, functional social support, stress, objective health, sleep, doctor visits, medications, and anxiety before and after Nickel Mines are in Table 1. The number of diagnoses is significantly lower after Nickel Mines; no other differences were significant by paired t-test. Functional support is slightly lower, and stress, doctor visits, and anxiety slightly higher after Nickel Mines and these approach significance. The effect sizes of all these differences are very small. More detailed work on the health of Amish women from these surveys is in Miller, et al. (2007) and Miller, et al. (in review).

After the Nickel Mines happening, 30 women had a diagnosis of anxiety, while only 20 had that diagnosis before the happening. Eleven women who had the diagnosis before also had the diagnosis after; 19 women who did not have the diagnosis before had the diagnosis after the happening. The odds of a woman having anxiety after Nickel Mines were 10.5 times the odds of a woman having anxiety before the happening. Nevertheless, fully 81% of women did not have anxiety before or after the happening.

After the Nickel Mines happening, 22 women were on prescription medication, while only 17 were on prescription medication before the happening. Eleven women who were on medication before were still on medication after the happening; 11 women who were not on medication before were on medication after the happening. The odds of a woman being on prescription medication

Table 1: Values for Psychological and Physical Health at Baseline and After Nickel Mines

Variables	n	Mean (SD)	P-value[a]
Depression[b]			
baseline	198	2.6 (2.38)	0.77
after		2.7 (2.51)	
Functional support			
baseline	201	37.1 (3.81)	0.08
after		36.6 (4.12)	
Stress			
baseline	201	14.8 (2.95)	0.08
after		15.1 (2.72)	
Objective health			
baseline	202	1.3 (1.26)	<.001
after		0.89 (1.09)	
Sleep			
baseline	202	7.8 (5.73)	0.26
after		7.3 (0.90)	
Doctor visits			
baseline	202	5.3 (9.03)	0.06
after		6.6 (6.88)	
Medications			
baseline	202	.08 (0.28)	0.23
after		0.11 (0.31)	
Anxiety			
baseline	202	.10 (0.30)	0.06
after		.15 (0.36)	

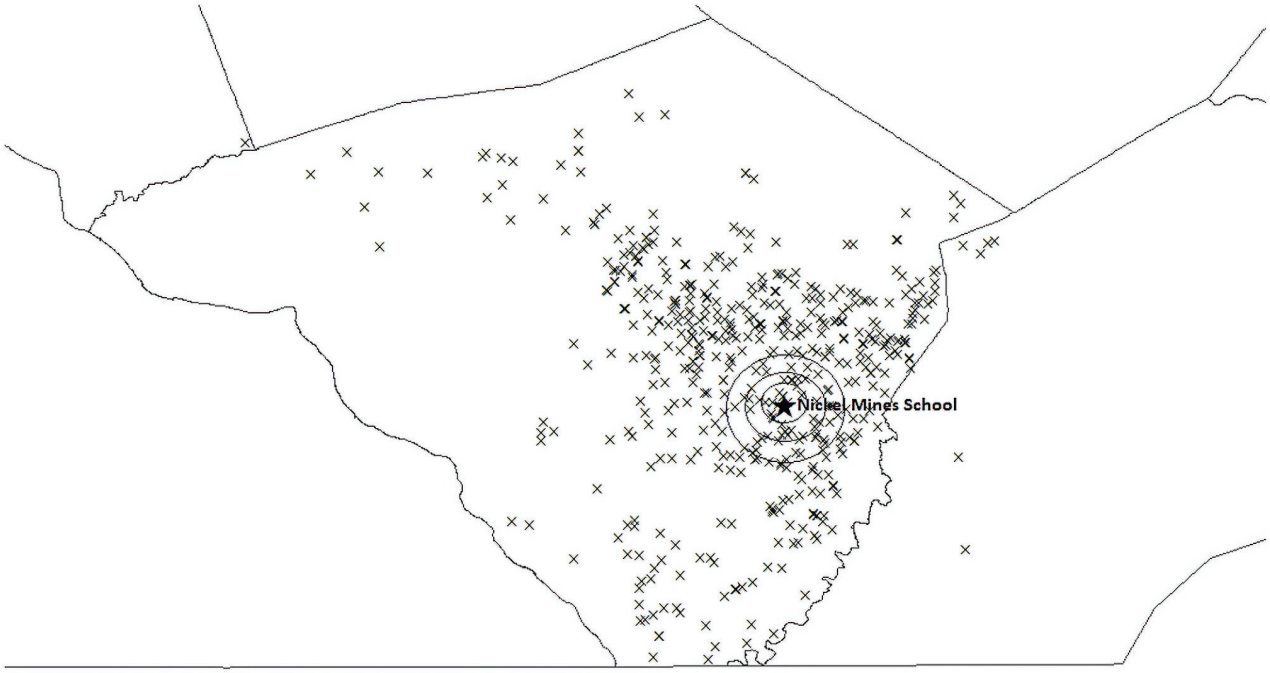
SD standard deviation
0 respondents reported "poor" health status.
[a] Based on paired t-tests
[b] For 6 items from the CES-D scale, scores range from 0-6, higher scores indicate more depressive symptoms

after the Nickel Mines happening were 29 times the odds of a woman being on medication before it. Nevertheless, fully 86% of women were not on medication before or after the happening.

The locations of women's homes relative to the school are mapped in Figure 1. None of the regressions of the change in scores as a function of distance from the school were significant. The change in depression score as a function of the distance from the school had a slope indistinguishable from 0 and R^2=.004. This was also true for the change in stress score (R^2=.004), the change in functional support score (R^2=0), the change in objective health score (R^2=.017), and the change in anxiety score (R^2=.02).

In ANOVA, the change in depression score was not significantly associated with the (categorized) distance from the Nickel Mines school (p=.86); nor was the change in stress score (p=.77), the change in functional support (p=.59), or the change in anxiety (p=.79). The change in objective health was marginally influenced by distance (p=.03) but post-hoc Bonferroni analysis found

Figure 1: Lancaster County, Pennsylvania with the Location of the Nickel Mines School and the Homes of Surveyed Amish Women



Circles enclose homes located 1, 3, and 5 miles from the school.

no differences between groups residing different distances from the school.

There was no statistically significant association with distance, or whether the baby was born before or after the happening, or their interaction, on the weights of babies ($F_{5,110}$=.81, p=.54; $F_{1,110}$=0, p=.98; $F_{2,112}$=0, p=.99, respectively).

There was no evidence that depression score, or whether the baby was born before or after the happening, or their interaction, was associated with the weights of babies ($F_{5,112}$=1.0, p=.42; $F_{1,112}$=.07, p=.79; $F_{2,115}$=.73, p=.49, respectively).

There was no evidence that social support, or whether the baby was born before or after the happening, or their interaction was associated with the weights of babies ($F_{6,65}$=.60, p=.73; $F_{1,65}$=1.2, p=.28; $F_{6,65}$=1.1, p=.35, respectively).

There was no evidence that age group, or whether the baby was born before or after the happening, or their interaction, was associated with the weights of babies ($F_{2,115}$=2.7, p=.07; $F_{1,115}$=.07, p=.79; $F_{2,115}$=.73, p=.49, respectively).

There was no evidence that being born before or after the happening was associated with gestation length (t_{110}=.31, p=.75). There was no apparent association between birth timing and gestation length when timing was categorized in ANOVA ($F_{5,132}$=1.3, p=.28).

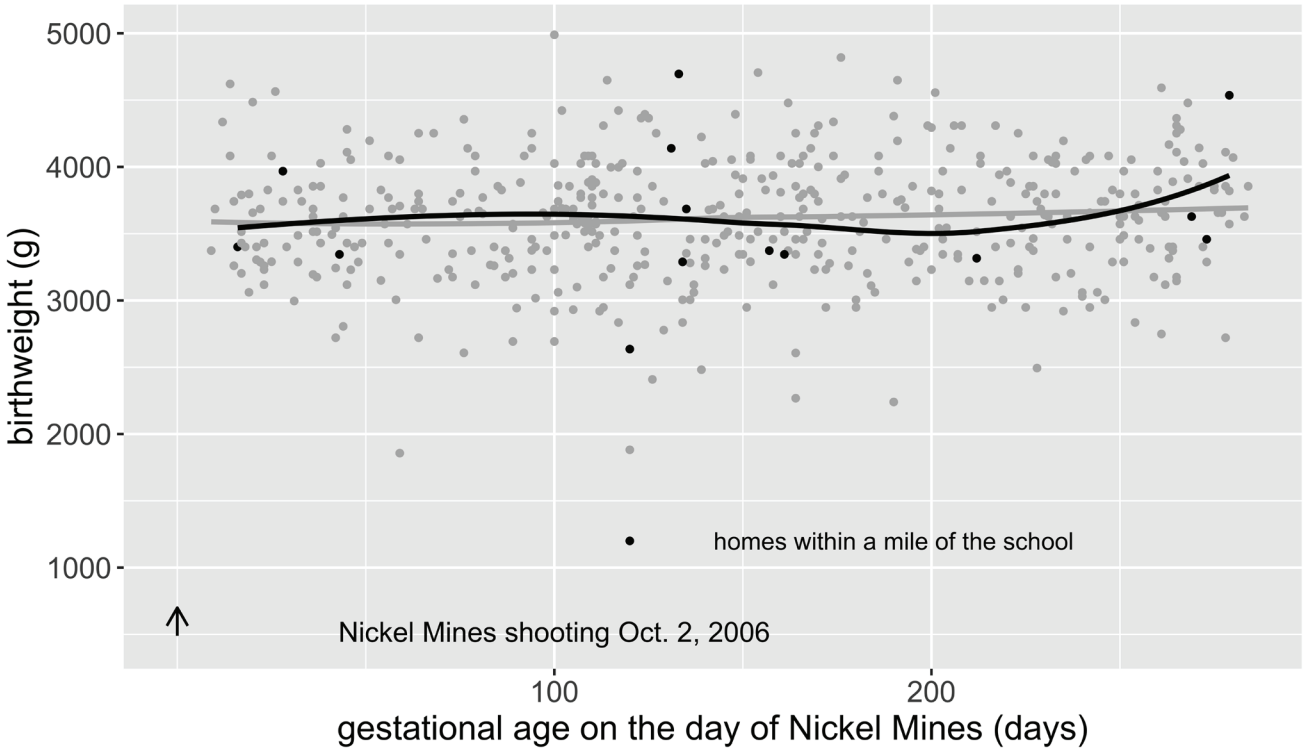
For women who had babies both before and after the happening, there was no statistically significant difference in birthweight or gestation length (t_{48}=.86, p=.40; t_{52}=1.1, p=.26, respectively) (mean birthweight before=3669g, after=3615g; mean gestation length before=39.6 weeks, after=38.6 weeks).

Study 2

Of 34,261 births in Lancaster County in 2004-2008, 4431 (12.9%) were to women we identified as Amish. The Amish population in Lancaster County was estimated to be approximately 30,000 in 2010 (Donnermeyer, Anderson, and Cooksey, 2019) or about 6% of the 2010 County population.

An independent samples t-test—testing the null hypothesis that there was no statistically significant difference in the birthweights of babies born in the six months after the shooting com-

Figure 2: Birthweight as a Function of Gestational Age for Amish Babies *in utero* at the Time of the Nickel Mines Shooting



Darker symbols represent babies whose homes are within 1 mile of the school. Added to the plot are loess curves for the two groups with span parameter = 1.

pared with those born in the same six months the year before—was not significant (t_{860}=.66; p=.50). The 424 babies born in the six months after the shooting had an average weight of 3575g; the 466 babies born in the same six months the year before averaged 3600g. There was also no apparent impact on birthweight of distance of the home from the school.

In linear regression models with one predictor variable, birthweight was predicted by mother's age, baby's gender, mother's pregnancy weight gain (but not her pre-pregnancy weight), and if the birth was a first birth. In a model with these potential predictors, and whether the baby was born in the six months after the shooting or in the same six months the year before, mother's age, baby gender, and mother's weight gain were significant predictors of birthweight, while whether the baby was a first birth and whether the baby was born in the six months after the shooting or in the same six months the year before were not significant predictors of birthweight. Every year of mother's age added 16g to birthweight; boy babies were an average of 177.5 g heavier; and every pound of mother's weight gain added 6.7g to birthweight; R^2=.07.

In a logistic regression model predicting the probability of a low birthweight baby (<2500g) from mother's age, baby's gender, mother's pregnancy weight gain, if the birth was a first birth, and whether the baby was born in the six months after the shooting or in the same six months the year before, none of these potential predictors were significant predictors of the probability of low birthweight. Of 418 babies born in the six months after the shooting, 16 were low birthweight (3.8%); of 465 babies born in the same six months the year before, 12 were low birthweight (2.6%).

Figure 2 shows the birthweights of babies *in utero* at the time of the shooting indicating babies with homes within 1 mile of the school. The confidence interval for the loess curve describing babies with homes more than a mile from the school is completely within the interval of the curve for babies with homes within a mile of the school.

DISCUSSION

Traumatic events such as the Nickel Mines shooting have been shown, in many cases, to affect the outcomes of births to women who were pregnant at the time or who conceived shortly thereafter. Nevertheless, there was apparently little impact of the Nickel Mines happening on the health and mental health of Amish women or on their birth outcomes. There was no association with depression, social support, stress, number of diagnoses, sleep, doctor visits, number of medications, or anxiety.

Women did report slightly less support, slightly more stress, slightly less sleep, and slightly more doctor visits, and a modest improvement in objective health; 19 more women reported a diagnosis of anxiety; 11 more women were on medication. But there was no association with proximity to the school or on the weight or gestation length of babies born.

The Amish community is divided into church districts that approximate the number of households that can fit into a home for Sunday worship. Districts are generally a buggy ride in diameter and children generally walk to school. Children from three Amish church districts attended the Nickel Mines school. The distance of a home from the school should reflect the likelihood of knowing victims of the shooting. But there were no apparent differences between the distance of homes from the Nickel Mines school and changes in depression, social support, stress, number of diagnoses, or anxiety. Nor when distance was categorized into miles from the school was there any apparent association with depression, social support, stress, number of diagnoses, or anxiety.

There was also no association between the weights of babies born before and after the happening in study 1, nor was there an apparent effect of the timing of birth relative to the happening on gestation length. There were no overall changes of birthweight or gestation length of babies born to mothers who had births both before and after the happening in study 1. In study 2, there was no apparent association between the shooting and birthweight or the probability of a low birthweight baby, and no apparent association between distance from the school and birthweight.

Lancaster County Amish women have more pregnancies, more of their pregnancies result in live births, and more of their babies are of healthy weight and age than among women in the broader culture (Miller, et al. 2007). Lancaster County Amish women have better than expected birth outcomes, despite being rural, having limited formal education, relatively low incomes, and many children, confounding the relationship of birth to socioeconomic variables in this culture.

Why might Amish women have better pregnancy outcomes than their non-Amish neighbors? Amish society is egalitarian (Kraybill 2001, pp. 109-10, 317) and perhaps the relative lack of differences in social status explains the relatively good outcomes of Amish pregnancies (Marmot 2005; Pickett and Wilkinson 2014), as societies that are unequal or that have rigid ranks of social status may have worse health outcomes than societies that view themselves as more equal or that do not have rigid social ranking. Members follow the *Ordnung*, a code of expectations for behavior that members pledge to abide by at (adult) baptism (Hostetler 1993; Kraybill 2001). Thus, individuals are cautious, focus on prevention, and self-regulate (Gelfand, et al. 2011); perhaps these cultural characteristics lead to better pregnancy outcomes.

In Miller, et al. (2007), we found that Lancaster County Amish women almost all score very high on questions about social support and substantially higher than women in the general population. Amish women also report less depression and much less unfair treatment due to cultural background or gender compared with women in the general population. Perhaps these findings account for better birth outcomes in this group.

The social and cultural norms of the Lancaster County Amish offer a strong explanation for their positive birth outcomes in the face of an undeniable stressor, as Jolly (2017) suggests. The Amish community responded to the shooting with forgiveness of the killer and comfort for his family (Kraybill, Nolt, and Weaver-Zercher 2007). The Amish community and their non-Amish neighbors supported the families of the victims with mutual aid, just as they would support the family of an ill child. This apparently increased the connection between the Amish and their non-Amish neighbors in southeastern Lancaster County.

Although we made every effort to bridge the cultural barriers between what we intended with our questions and Amish women's understanding of the questions in the surveys (Yost, et al.

2005; Miller, et al. 2007), the differences between what we intended and what they understood are a limitation of our study. Furthermore, some of the measures, particularly of psychological and social variables, have not been validated in Amish culture, and may not be culturally relevant to the Amish, although the consistency of both the birth outcomes and indicators of psychological stress suggest these measures may work sufficiently well in this population. In addition, many of our tests have limited power to detect a difference, if there is one. In Study 1, we have no information about why women who declined to participate did so and this is another limitation of our study.

Future work should continue to explore the link between Amish social and cultural characteristics and positive birth outcomes and how these links might be used to improve birth outcomes among the broader public. Our next steps will be to quantify Amish birth outcomes beyond self-reports and to establish methods to estimate Amish infant and maternal mortality.

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