The Effect of Age, Conception Status, and Other Health Risk Factors on Pregnancy Outcomes in the Amish Population

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Abstract

This study uses information from the Central Pennsylvania Women’s Health Study (CePAWHS) to analyze health risk factors for adverse pregnancy outcomes in the Amish population of Lancaster County, Pennsylvania. A survey was conducted with 288 Amish woman and 2002 women from central PA. This study focuses specifically on how age (≤34 vs. ≥35), conception status (preconceptional, pregnant, interconceptional, or postconceptional), and certain health conditions and health behaviors affect the outcome of Amish pregnancies. Additionally, it compares the prevalence of risk factors for poor pregnancy outcomes in the Amish population to the population of central PA, specifically for women in the interconceptional reproductive category. Several health risk factors differ significantly depending upon the age and reproductive category of the woman. Also, Amish woman generally had better health than their central PA counterparts. These results provide valuable information on when interventions would be most useful in
decreasing the numbers of low birth weight infants, preterm infants, and miscarriages in
the Amish population.

**Introduction**

The Old Order Amish community has been relatively successful in resisting
modernization. They seek to separate themselves from the modern world because they
fear that constant changes can result in the disintegration of societies and less emphasis
on family, community, and religion (Kraybill, 1989). These beliefs create a significantly
different living environment that distinguishes the Amish from the general population in
several ways. It is possible that this different way of living has implications on health
issues within the Amish community versus those of the surrounding population. To
explore these differences, this study focuses specifically on the Amish group in
Lancaster, Pennsylvania, which is the oldest of the 175 Amish settlements in the United
States. While this Amish population is relatively large, with a population of 22,300 in
Lancaster in 2000, they were still far outnumbered by the non-Amish in the area
(Kraybill, 1989).

One of the main factors associated with the Amish way of living is the important
emphasis on family, shown by their large family size with an average of 6.6 children,
early triple that of the typical American family (Kraybill, 1989). With a relatively large
and increasing population and a considerably different lifestyle than the non-Amish, the
Amish community in central PA has the potential to provide valuable information
relating to health outcomes resulting from their distinctive way of living. While they tend
to seclude themselves from modern society, the community is open to research when they
feel it is beneficial. However, there has been relatively little research performed in health
care and pregnancy (Miller, 2007). This study seeks to provide more information on these topics by comparing several health risk factors to the outcomes of pregnancies in the Amish versus non-Amish community in central PA. Comparing these two separate lifestyles may lead to the formulation of better health care strategies.

In central PA, health conditions or behaviors that are risk factors related to adverse pregnancy outcomes include but are not limited to gynecologic infections, anxiety or depression, obesity, hypertension, high cholesterol, smoking, binge drinking, low physical activity, nutritional deficits, lack of folic acid use, and vaginal douching (Weisman et al., 2006). Since many of these risk factors are present before the prenatal period, it is essential that women know how to remain healthy before pregnancy and between pregnancies in order to increase their chances for successful outcomes.

The purpose of this study is to examine whether risk factors that have been found to influence pregnancy outcomes in the general population also affect pregnancy outcomes in the Amish community and, if so, are differences due to lifestyle. The results of a survey of 288 randomly-selected Amish women are analyzed and the findings are compared with an identical survey of 2,002 non-Amish women residing in central PA. Once the risks are evaluated, interventions can occur at appropriate times to increase positive pregnancy outcomes and lead to better health of infants.

**Materials and Methods**

**Amish Women Sample and Data Collection**

A survey of 288 Amish women, ages 18-45 living in Lancaster County, Pennsylvania was conducted from November 2004 through June 2005 as part of the Central Pennsylvania Women’s Health Study (CePAWHS). The 2002 Church Directory
of Lancaster County Amish (Gallagher & Beiler, 2002) was used to sample women since it provided the most complete record of Amish families in the area. The population of 25,900 people in the church directory was narrowed, first by randomly selecting 1,106 households and then by selecting only women in these households who were between ages of 18-45 and who resided within Lancaster County. The final sample contained 515 eligible households, resulting in a sample set of 288 Amish women who were willing to participate (Miller et al., 2007). The selected women were all interviewed face-to-face.

The Amish women were all questioned on a range of topics including health status, pregnancy related topics, health habits, stress and exposures, health care access, and sociodemographics. Interviewers were trained to behave appropriately, to respect the Amish culture, and were told to avoid any questions relating to drugs, alcohol, or tobacco usage because they were deemed inappropriate, due to the sensitivity of the issue among the Amish (Yost et al., 2005). Overall, the response rate was 61% and the cooperation rate was 63% for the entire sample (Miller et al., 2007).

**Measures**

Women were divided into one of four categories: preconceptional, interconceptional, pregnant, or postconceptional. Preconceptional was defined as never before been pregnant but still capable of reproducing. Pregnant women were those who were pregnant at the time of the survey. Interconceptional women were those who had been pregnant before and were still capable of giving birth. Postconceptional women were those who were no longer capable of giving birth or have never been capable of giving birth. Additionally, the 288 women were divided into two age groups: 18-34 years
and 35-45 years. Age 35 was chosen as the cutoff age as this is defined as the age of advanced maternal age pregnancy (Koo, 2012).

Several health risk factors known to affect pregnancy outcomes were studied including periodontal disease, gynecological infection, hypertension, high cholesterol, depressive symptoms, BMI, vegetable servings per week, use of a multivitamin with folic acid in the past month, and physical activity in the past month. All of these health risk factors were chosen based upon previous research. For example, Babalola and Omole (2010) found that many studies have concluded that periodontal disease is a risk factor for a poor pregnancy outcome because maternal oral health can affect the health of developing baby. While many biological explanations have been postulated, the specific mechanism by which this works is still being discussed. Additionally, Mustafa et al (1997) found that chronic hypertension is a risk factor for a poor pregnancy outcome because it leads to an increased chance of preeclampsia-ecampsia. Similarly, another well-studied health risk factor is the consumption of folic acid. Scholl and Johnson (2000) discussed why folic acid is essential during pregnancy and reported that it has an important role in nucleic acid synthesis so without it, cell growth and replication is impaired.

A women with a gynecological infection had one or several of the following infections: Chlamydia, herpes, gonorrhea, syphilis, pelvic inflammatory disease, bacterial vaginosis, vaginal yeast infection, HIV/AIDS, and hepatitis. Depressive symptoms were measured using questions from the Center for Epidemiologic Studies Depression Scale, which was condensed into a more concise indicator (Sherbourne et al., 2001). BMI was
calculated from self-reported height and weight and divided into categories underweight (<18.5), normal (18.5-24.99), overweight (25-29.99), or obese (≥30) (Weisman, 2006).

Additionally, several results from each individual birth were analyzed: maternal age at delivery, birth outcome, birthweight, and preterm delivery. Birth outcome was categorized into live birth, miscarriage, stillbirth, or ectopic or tubal pregnancy.

Birthweight was divided into three categories: normal (≥2500g), low birthweight (2500-1500g), and very low birth weight (<1500g) (Koo, 2012). Preterm birth was defined as birth before 37 weeks gestation (Koo, 2012). All results were analyzed using SPSS version 20.0.

After creation of several variables to get information about specific pregnancies, each individual pregnancy for each person along with the corresponding outcome and several health risk factors were transferred to Excel and then re-uploaded to SPSS. Using this method, each row could then be treated as an individual pregnancy rather than an individual person.

Many results were unexpected and so logistic regression was used to see if confounding variables were responsible for the unforeseen results. A logistic regression was chosen because the response variable was binary in all cases; explanatory variables were both categorical and numeric. Additionally, a linear regression was performed to examine the relationship between age and number of pregnancies.

**Results**

The data in table 1 show the proportion of the total Amish sample with each of several health conditions and health behaviors and also the percentages subcategorized by
reproductive stage within two age categories, younger women aged 18-34 and older women aged 35-45. The pregnant category was included in this analysis because a large percentage of the total Amish sample was pregnant (see Weisman et al, 2006). Since pregnancy outcome was the focus of the study, separating this group from interconceptional allowed for more specific analyses to be performed. Overall, the most common health conditions in the total Amish sample were gynecological infection (62.2%), overweight (23.2%) and obesity (13.0%), and periodontal disease (10.1%). A smaller proportion of the population reported having been diagnosed with hypertension (7.7%), high cholesterol (4.5%), and depressive symptoms (2.5%). The most common health behaviors in the population were eating 7 or more vegetable servings per week (63.1%) and taking a vitamin with folic acid (57.3%).

For younger women ages 18-34, preconceptional women were significantly more likely to have had a gynecological infection compared to pregnant, interconceptional, and postconceptional women of the same age. Additionally, preconceptional young women were less likely than young women of other reproductive stages to take a vitamin with folic acid and much more likely to be physically active.

For older women ages 35-45, the only significant findings are that preconceptional women were much more likely than older women of other reproductive stages to have high cholesterol and to be physically active. Although, it is important to note that only four women fit into the older preconceptional category.

For age comparisons within reproductive stages, preconceptional young women were significantly less likely to have periodontal disease, hypertension, high cholesterol,
and depressive symptoms than the older preconceptional women. However, the older preconceptional women were more likely to take a vitamin with folic acid than the younger preconceptional women.

Additionally, the older interconceptional women were significantly more likely to have had a gynecological infection than the younger interconceptional women and they were also significantly more likely to have high cholesterol than their younger counterparts. The only significant difference for pregnant women is that older pregnant women were significantly less likely to be diagnosed with hypertension than the younger pregnant women. There were no significant differences between the younger and older postconceptional women. However, it is important to note that no statistical tests could be run on young versus old postconceptional women in the hypertension, high cholesterol, and depressive symptoms categories because all postconceptional women responded no to all three categories.

Table 2 contains the analysis of each individual pregnancy of each woman and reports the result of the pregnancy, the birthweight category of the infant, whether or not the infant was born preterm, and all of the same health conditions and health behaviors as table 1. Additionally, a row labeled as “adverse pregnancy outcome” is included in table 2 and this represents a pregnancy that resulted in either a miscarriage, a preterm delivery and/or or a low birth weight or very low birth weight infant. Each of these pregnancies is categorized into one of the two maternal age-at-delivery categories.

The results within table 2 show that women who are ≥35 years old have about a 50 percent greater chance of having had a miscarriage as a result of a pregnancy than women who are ≤34 years old. However, older women are also significantly less likely to
have had a preterm birth than younger women. Confounding variables were tested with logistic regression to see if any other factors were affecting this result but no confounding variables were found. Additionally, table 2 shows that there are no significant differences between birthweight and age at pregnancy. Another interesting finding shown is table 2 is that of all pregnancies in women 18-34 years old, about 35% resulted in an adverse pregnancy outcome compared to all the pregnancies in women 35-45 years old where only about 24% resulted in an adverse pregnancy outcome.

Below the outcome of pregnancy, health risk factors for adverse pregnancy outcomes are listed. The only health risk factors that are significantly different depending on age are high cholesterol and BMI. Of the older maternal age group, 16.5% of the women have high cholesterol whereas only 5.3% of the women of younger maternal age have high cholesterol. Additionally, the older women have 8% underweight and 29.4% obese whereas the younger women have only 4.8% underweight and 17.0% obese. It is possible that either or both of these factors may be leading to the increased percentage of miscarriage in the older women. However, none of the health risk factors led to significant differences that would have made the older women less likely to have preterm births. It is possible that the lower preterm birth rate in women ≥35 is a result of a variable that I did not examine.

Table 3 contains the analysis of the same health conditions and health behaviors as tables 1 and 2 but rather than separating the Amish women into age or conception status, it separates their pregnancies by birthweight, preterm birth, and result of pregnancy. This analysis makes it possible to see which variables may be playing a role
in affecting the result of the pregnancy. This table again displays the results of each individual pregnancy of each woman.

No variables were found to be significantly related to birthweight of the infant. The only significant risk factor that was related to an increase in the number of preterm births was depressive symptoms. Of the 222 preterm births, 6.4% were from women who had depressive symptoms whereas of the 777 births that were not preterm, only 2.3% were from women who had depressive symptoms. However, of all pregnancies that resulted in a preterm birth, only 2.7% of the women had high cholesterol whereas of all pregnancies that did not result in a preterm birth, 6.5% had high cholesterol.

Additionally, of all pregnancies that resulted in miscarriage, 50.6% were from women with a gynecological infection whereas of all pregnancies that resulted in a livebirth, 41.2% were from women with a gynecological infection. One last finding from this table is that of all pregnancies that resulted in a miscarriage, 71.2% were from women who took a vitamin with folic acid whereas of all pregnancies that resulted in a livebirth, 62.3% were from women who took a vitamin with folic acid.

To examine this result, a logistic regression was performed to see if other variables were confounding. When accounting for the total number of pregnancies that a woman has had, taking a vitamin with folic acid is no longer significantly associated to the outcome of the pregnancy. This finding is likely associated with older women being more likely to take a vitamin with folic acid and older women also being more likely to have had more pregnancies. When the logistic regression was performed for gynecological infection and number of pregnancies versus outcome, gynecological
infection was still significantly related to the outcome of the pregnancy when accounting for the total number of pregnancies (p=0.039).

Similarly, when a logistic regression was performed for high cholesterol versus preterm birth when accounting for the total number of pregnancies, high cholesterol is no longer significantly related to preterm birth (p=0.127). The logistic regression for depressive symptoms versus preterm birth is still significant when accounting for the total number of pregnancies (p=0.02).

Figure 1 shows the total number of pregnancies as a function of maternal age at delivery. The two variables are correlated with an $R^2$ value of 0.47. The slope of the regression line is 0.33 meaning that for every 3 years, a women has approximately one pregnancy. The equation for the relationship between these two variables is \( \text{Total Number of Pregnancies} = 0.33(Age) - 5.64 \). Since the two variables are correlated, all of the conclusions made for total number of pregnancies can be assumed to be the same for maternal age.

Cook’s distances were calculated to see the effect of removing any individual data point on the regression. In general, any Cook’s Distance >4/n is considered a big influence on the regression line. When using this standard value, every point in the bottom right hand region of the graph, which represents older women who had few pregnancies, had larger Cook’s Distances than the majority of the rest of the data points. Therefore, these data points have a stronger influence on the regression line and are pulling the line further from being equal to an $R^2$ value of 1, which would indicate that all of the variation in number of pregnancies is explained by maternal age.
Table 4 contains the analyses for all of the health conditions and health behaviors in the Amish population along with total number of pregnancies versus ever having had a miscarriage in one’s life.

From this analysis it was concluded that as you increase the number of pregnancies you have, you increase the chance that you will ever have had a miscarriage in your life. The table shows that of the 7 women in the Amish population who have had 11+ pregnancies, all 7 of them have had a miscarriage in their life. Additionally, over half of the women who have had 6-10 pregnancies have had a miscarriage in their life, while only about 28% of them women who have had 1-5 pregnancies have had a miscarriage in their life.

The results from table 4 also indicate that eating 7 or more vegetable servings per week is also significantly related to ever having had a miscarriage. Since this result was unexpected, a logistic regression was run to check for confounding variables. When the total number of pregnancies is taken into consideration, the number of vegetable servings per week is no longer significantly related to ever having had a miscarriage.

Therefore, the data in table 4 support the idea that having ever had a miscarriage in one’s life is due to chance because the only risk factor that is significantly related to having had a miscarriage in one’s life is the total number of pregnancies. As a woman increases the total number of pregnancies she has, she increases the chance that one of all of them will have resulted in a miscarriage. This data supports table 2 because in table 2 the older women had nearly double the percent chance of having had a miscarriage and these older women, as shown by figure 1, are the ones who have had more pregnancies.
Certain health conditions and health behaviors were compared between the Amish population and the population of central PA (Weisman et al, 2006) and the results are shown in table 5. Along with showing the comparisons between the total samples of the two populations, table 5 also displays comparisons between the interconceptional women of the two populations since these are the women who are capable of becoming pregnant at the time of the survey.

When comparing these findings from the Amish population health conditions and health behaviors to the central PA population, several noteworthy differences are evident. In nearly all health condition and health behavior categories the Amish women are much healthier. Amish women have lower percentages of hypertension, high cholesterol, overweight and obesity, and much lower percentages of depressive symptoms. The Amish women also report better health behaviors with more vegetable consumption and more women taking a vitamin with folic acid. According to the USDA dietary guidelines on folic acid consumption, more than half of the Amish population takes the recommended daily amount of folic acid whereas less than half of the central PA population consumes the recommended amount of folic acid. The exception to this better health trend in the Amish population is gynecological infection in which Amish women have a much higher percentage of their population that have had a gynecological infection. Physically activity could not be compared due to different methods of estimating physical activity in the two populations.

The data in table 5 also show the comparison of interconceptional women from both age groups between the two populations and it is evident that Amish women are also more likely to have better health conditions and health behaviors within this reproductive
category. For both older and younger interconceptional groups, Amish women were less likely than central PA women to have high cholesterol and depressive symptoms and were less likely to be overweight or obese. Additionally, both younger and older interconceptional Amish women were more likely to eat 7 or more vegetable servings per week and to take a vitamin with folic acid. However, older and younger Amish women within this reproductive stage were more likely to have periodontal disease and were more likely to have had a gynecological infection. Since the interconceptional women are the people in the population who are capable of giving birth, it is possible that the overall better health conditions and health behaviors of the Amish population makes them less at risk for low birth weight and preterm birth than the central PA population, as shown by Miller et al (2007).

Discussion

This population-based study confirms the hypothesis that the Amish population has certain health risk factors that are known to be associated with poor pregnancy outcomes and that the presence of some of these health conditions and health behaviors make Amish women more likely to have adverse pregnancy outcomes. Additionally, the presence of the health risk factors differs by age and conception status. However, despite the presence of these risk factors in the Amish population, in general the Amish women have fewer risk factors for poor pregnancy outcome than their central PA counterparts.

When the Amish sample was separated into reproductive stage and age groups, the prevalence of several health risk factors differed depending upon reproductive stage within an age group and between the same reproductive stages of different age groups.
This analysis provides information on when Amish women are most at risk due to certain health risk conditions. With this information, interventions can be made at more appropriate times in a woman’s life to provide the best outcome of a pregnancy for an Amish woman.

The differences by age showed that, on average, younger women have better health than older women due to lower percentages of high cholesterol and fewer obese and underweight women. Additionally, the data in table 2 showed that older women had about a 50 percent greater chance of having had a miscarriage. Therefore, by educating women who are greater than 35 years old on the risks of high cholesterol and weight on pregnancy outcome, it is possible that the percentage of miscarriages for the women of advanced maternal age may decrease.

An interesting result that was evident in table 2 was the significantly lower percentage of preterm births in older women than younger women. While younger women have higher percentages of both periodontal disease and hypertension, it may be the higher percentages of hypertension that is leading to this result as table 1 shows that both pregnant and interconceptional younger women have higher percentages of hypertension than their older counterparts. Since these two groups, pregnant and interconceptional, are the women who are currently capable of giving birth, it is more likely that hypertension may be associated with more preterm births than periodontal disease, which is greater in the older interconceptional groups. Just as the intervention with the older women, it is essential to educate younger women on the risks of hypertension for pregnancy outcome and to inform them how to reduce the likelihood of having this health condition.
Alternatively, the lower number of preterm births in the older women may be the result of older women being better adjusted to having a successful pregnancy due to having gone through past pregnancies. Chervenak and Kardon (1991) propose that while risks are associated with pregnancies of advanced maternal age, some positive effects of having pregnancy at that time are also evident such as better adjustment to pregnancy. The final possibility is that the risk factor that is leading to higher percentages of preterm birth in the younger women is not analyzed in this table.

While Weisman et al (2006) found that women at risk of a future pregnancy (preconceptional and interconceptional women) had better overall health conditions than the postconceptional women, this was not the case for the Amish sample. In the Amish population, younger preconceptional, pregnant, and interconceptional women were generally significantly more likely to have had a gynecological infection and less likely to take a vitamin with folic acid and to be physically active than the postconceptional women. Since these women are young and still capable of giving birth, it is absolutely necessary that they are informed of the benefits of protection from gynecological infection and that they know the importance of performing healthy behaviors such as consuming a daily vitamin that is supplemented with folic acid and being physically active.

Another difference between Weisman’s research on the central PA dataset and the Amish dataset is that younger preconceptional women are significantly less likely to take a vitamin with folic acid than the younger women in other conception groups for the Amish sample, but for the central PA sample the younger preconceptional women are significantly more likely to take a vitamin with folic acid than the other groups. This
result suggests that preconceptional Amish women in this area are not sufficiently educated about the health benefits of taking a vitamin with folic acid and therefore more effort needs to be put into informing women about this health risk factor before conception occurs. It is possible that the benefits of consuming a vitamin with folic acid are discussed once a woman is pregnant but not before she becomes pregnant. However, it is essential that Amish women take a vitamin with folic acid at least three months prior to pregnancy, according to research by Wilson et al (2007). Therefore, a method should be implemented to encourage preconceptional women who are planning on becoming pregnant in the future to take a vitamin that is fortified with the recommended levels of folic acid.

Using the information from Weisman’s work with the Central PA population and the results from Miller’s analysis on the Amish versus central PA population, certain results from this research can be applied to their findings. Table 5 shows the comparison of the two populations, specifically the comparison of the interconceptional women who are at risk of future pregnancy. Since the interconceptional women in the Amish population have better overall health conditions for both older and younger women, this may lead to the result that Miller found that Amish women are less likely to have had a low birth weight infant than the women of central PA.

While the analysis of this data is the first step in the task of improving the outcome of pregnancies in the central PA area, the next and equally important step is implementing interventions that make a difference in the community. Starting in 2003, a program called Interventions to Minimize Preterm and Low birth weight Infants through Continuous Improvement Techniques (IMPLICIT) used evidence from research to reduce
the percentages of low birth weight and preterm infants in the Lancaster community and in surrounding areas (Schimberg and Flaherty, 2010). Schimberg and Flaherty discuss the success of the IMPLICIT program in their research where they show that, since 2003, the counties in which the program has been implemented have had a smaller percentage of mothers who were at high risk for a poor pregnancy outcome who had low birth weight or preterm infants compared with the expected numbers based on CDC reports.

Additionally, other programs have found similar results in regard to the positive impact of educating women on risk factors for poor pregnancy outcomes. Kirby et al found that when they reviewed 83 studies on the impact of sex education on the sexual behavior of women under 25 years old all over the world, two thirds of the studies found that educational programs significantly improved one or more sexual behaviors in the population being studied. Similarly, Willhoite et al found that implementing a program to educate both health care providers and women about the risks of diabetes on outcome of pregnancy helped to improve pregnancy outcomes among women with pregestational diabetes. There is a vast amount of related evidence that show the advantages of education on improving pregnancy outcomes.

Since the IMPLICIT program and other programs have been so successful in achieving their goals to lower adverse pregnancy outcomes through educating the public and providing prenatal care, it is essential that programs like these continue to expand into other counties in the area and globally. Ideally, if every county had a program to provide this kind of education, it is likely that nationwide percentages of low birth weight and preterm infants would decrease. Additionally, the success of the programs shows
how beneficial education can be in achieving health goals. If the Amish population is educated on the health risk factors that are most prevalent in their society, it is possible that their percentages of low birth weight and preterm infants will decrease as well. Since the CePAWHS survey was given in 2004, it would be interesting to give the survey again in the future to see if the IMPLICIT program may have lowered the percentages of adverse pregnancy outcomes within the Lancaster community in the past 9 years.

Two of the main limitations of this study are that it uses information that is self-reported and that the information is collected at a moment in time rather than on a periodic basis. The disadvantage of only having one survey to analyze is that women who report a health condition may or may not have had that same health condition during a pregnancy many years before the survey was taken. It is not possible to know from the survey when the health condition started so follow-up surveys that show health changes over time would be beneficial in the future analysis of these populations.

Another limitation is the relatively small region over which the survey was taken. However, although this has its limitations it is also beneficial because more global surveys cannot typically contain the plethora of health related questions that a more specific survey such as the CePAWHS survey was able to do. Additionally, the ability to see in what age group and reproductive category interventions would be most helpful is a tremendous advantage to this type of detailed survey.

Lastly, one other limitation that may affect the results of this research is that the Amish culture and social forces associated with their community may alter their responses to questions in the survey (Miller, 2007).
Literature Cited


