

Identification of the Effect of Depression on Risky Sexual Behavior: Exploiting a Natural
Experiment

Susan L. Averett
Yang Wang
Department of Economics
Lafayette College
Easton, PA 18042

November 2011

We thank Dhaval Dave for thoughtful comments on an earlier draft. Any remaining errors are
our own.

Introduction:

Depression has been recognized as one of the 10 leading diseases worldwide (Lopez et al., 2006). The economic costs of depression are substantial. Greenberg et al. (2003), using a human capital approach, estimated the economic costs of depression to be 83.1 billion dollars in 2000 with \$26.1 billion (31%) of direct medical costs, \$5.4 billion (7%) of suicide-related mortality costs, and \$51.5 billion (62%) of workplace costs (CDC, 2010a).

Depression is pervasive in the U.S. Recent data from the BRFSS for survey years 2006 and 2008 revealed that 9 percent of respondents met the criteria for current depression and 3.4 percent met the criteria for major depression. Depression disproportionately affects women, with the same data indicating that women were significantly more likely than men to report major depression (4.0% versus 2.7%) (CDC, 2010a). Women also bear a disproportionate share of the costs. One cost that has received little attention in the economics literature is the potential for depression to cause a woman to engage in risky sexual behavior.

Depression, in actuality, has long been associated with risky sexual behaviors and STDs among youth and young adults in the U.S. Depression may impair cognitive function and memory, decrease one's ability to control impulsive behavior, increase emotional reactivity in peer relationships, reduce motivation and increase fatalism. These effects of depression may inhibit a young adult's clear perception of the risk of contracting an STD and their ability to prevent risky sexual behavior (Khan et al., 2009).

Despite a substantial body of research that links depression and risky sexual behavior for both males and females across a broad age range, the direction of causality remains elusive both theoretically and empirically.¹ One branch of studies presents strong evidence that depression and risky sexual behaviors are positively correlated using cross sectional data (Whitbeck et al, 1992; Shrier et al., 2001). For example, Shrier et al., report that depressed adolescent boys are less likely to use a condom while for girls depressive symptoms were associated with having a Sexually Transmitted Disease (STD). However, such studies are not indicative of causal relationships due to the potential endogeneity of depression. For example, those who engaged in sexual intercourse without a condom may become depressed and those who have an STD may also become depressed.

Other research, mainly in the medical and adolescent health fields, uses the temporal ordering of events to establish the direction of the relationship from depression to risky sexual behaviors. Some of these are small samples that are not generalizable but many researchers have used the

¹ Most of this research, however, concentrates on adolescents while only a few studies include young adults. While the focus on adolescents is certainly warranted, rising age at first marriage coupled with declining age at first intercourse means more women are likely to be taking sexual risks.

National Longitudinal Study of Adolescent Health (AddHealth), which we use in this study. Much of this research suggests that depressed adolescents and young adults are more likely to engage in risky sexual behaviors (Whitbeck, et al., 1993; Harris, et al., 2002; Kowaleski-Jones and Mott, 1998; Longmore et al., 2004; Hallfors et al., 2005; Mazzaferro et al., 2006; Mota et al., 2010 and Kahn et al., 2009), have an increased risk of a sexually transmitted infection (Shrier et al., (2009)), and are less likely to use condoms or use them appropriately (Shrier et al., 2011; Brown et al., 2006; Lehrer et al., 2006; Morrison et al., 2008). Yet even this branch of research, which uses panel instead of cross-sectional data, does not definitively establish causality because there remains the possibility that a third unobservable factor could be correlated with the earlier episode of depression and the current risky sexual behavior.

In this paper, we exploit a unique opportunity in our empirical setting to identify the causal effect of depression, measured by the Center for Epidemiologic Studies Depression Scale (CESD), on young adults' risky sexual behaviors. Specifically, an unexpected event -the September 11 attacks (9/11)-occurred, during the collection Wave III (July 2001 to April 2002) of the AddHealth. Because of its unexpected nature and minimal impact on the continuation of Add Health interviews, 9/11 can be viewed as a natural experiment which randomly assigned young adults interviewed before 9/11 into the "control" group and those after the "treatment" group.² In our data, we find that this "treatment" leads to an exogenous and significant variation in the levels of depression between individuals in the "control" vs. "treatment" group: the latter experienced a significant increase in CESD.³ This exogenous variation therefore provides us a unique opportunity to identify the causal effect of depression (CESD) on risky sexual behaviors.⁴

Risky sexual activities include unprotected vaginal intercourse (particularly without a condom which is the only way to protect against sexually transmitted diseases (STDs)), oral intercourse, and receptive anal intercourse. Oral sex can lead to transmission of STDs and most teens do not use barrier protection during oral sex (Halpern-Felsher et al., 2005). Research has shown that oral sex contact including oral-to-oral and oral-to-genital contact may play a role in the transmission of the Human Papilloma Virus (HPV) which has found to be an important cause of head and neck squamous cell carcinoma (D'Souza et al., 2009).

² Wang and Yang (2010) also explore the exogeneity of 9/11 in their analysis of effects of depression on weight-related behaviors using the same data set. They use a different sample, with a different measure of depression.

³ There is evidence that among disaster workers, 9/11 was associated with depression and Acute Stress Disorder which severely impaired their functioning (Biggs et al., 2010).

⁴ There is also a body of research that posits that risky sexual behavior itself is a cause of depression, even when the sexual behavior is not forced (Monroe et al., 1999; Ethier et al., 2006). While it is entirely plausible that the causality can run in both directions depending on the context and research question asked, the focus of this paper is on establishing the causality from depression to sexual risk taking, therefore we do not explore that literature in detail.

Studies have also found that anal intercourse among adolescents and young adults is often unprotected (Rotheram-Borus et al., 1999; Lescano et al., 2009) and that it is associated with high STD risk among young heterosexual women (Jenness et al., 2003). A recent study among teenage girls noted that only 13.2 percent used a condom the last time they had anal intercourse (Reece et al., 2010). The risk for HIV acquisition or transmission via anal intercourse is compounded by infrequent condom use during anal intercourse (Gorbach et al., 2005). In addition, the incidence of anal intercourse among heterosexuals is increasing. For example, the proportion of a random sample of Seattle residents who reported anal intercourse increased from 4.3% in 1995 to 8.3% in 2004 (Aral et al., 2005). And recent data from the National Survey of Family Growth puts the national figure much higher-among women 25 to 44 years old, 35 percent report having had anal sex and 88 percent report having had oral sex with an opposite sex partner. Unprotected vaginal, oral and/or anal sex facilitates the entry of the herpes simplex into the body which then may lead to infections (Spencer, 2005).

Females bear the brunt of most of the health consequences from risky sexual activities. One in 4 young women between the ages of 14 and 19 in the U.S. is infected with at least one of the most common STDs (HPV, chlamydia, herpes simplex virus, and trichomoniasis) (CDC, 2010b) and of the approximately 19 million new STDs occurring each year in the United States, nearly half occur in adolescents and young adults aged 15 to 24 years (CDC, 2010b).⁵ Recent evidence from the Centers for Disease Control indicates that nearly 30 percent of women aged 20 to 24 are at high risk for HPV (CDC, 2009), the highest risk of any age group among women. Chlamydia infections are highest among individuals aged 15 to 24 years yet experts caution that this is likely an underestimate for this age group due to the asymptomatic nature of this disease, incomplete screening coverage and underreporting (Weinstock et al., 2004).

Furthermore, with the exception of Human Immunodeficiency Virus (HIV), STDs may have more life-threatening consequences for women (e.g., Pelvic Inflammatory Disease, ectopic pregnancy, and cervical cancer) than for men and young women contract STDs more easily than adult women because they have fewer protective antibodies and because cervical immaturity facilitates the transmission of infections. For example, infections due to gonorrhea are a major cause of Pelvic Inflammatory Disease (PID) in the United States. In addition, epidemiologic and biologic studies provide strong evidence that gonococcal infections facilitate the transmission of HIV infection. Evidence suggests that roughly 10-40% of untreated chlamydia cases, like those of Chlamydia, will lead to PID and that as many as 20% of women with PID will develop infertility. Estimates indicate that in 1993 worldwide women lost 12.8 million healthy years due

⁵ Chlamydia and gonorrhea are also the first and second most commonly reported notifiable diseases in the United States. A notifiable disease is any disease that is required by law to be reported to government authorities. The collection of information allows the authorities to monitor the disease, and provides early warning of possible outbreaks. For a list of current notifiable diseases in the U.S. see <http://www.cdc.gov/ncphi/diss/nndss/phs/infdis.htm>.

to PID alone (Landry and Turnbull, 1997; Hillis and Wasserheit, 1996; Hook and Handsfield, 2008; Kolshoi et al, 2008).

Prior to 1996, rates of gonorrhea among men were higher than rates among women. For the eighth consecutive year, however, gonorrhea rates among women and men were similar indicating that rates for women have been rising while rates for men have been stable or falling. In 2008, the gonorrhea rate among women was 119.4 and the rate among men was 103.0 cases per 100,000 population (CDC, 2009). Rates of chlamydia have also been rising from 395.1 per 100,000 women in 1999 to 583.8 per 100,000 women in 2008 and rates are highest for younger women with those 15 to 19 years of age reporting 3,275.8 cases per 100,000 females and 20 to 24 years of age reporting 3,179.9 cases per 100,000 females (CDC, 2009). Forty-two percent of young women were tested for chlamydia in 2007, compared with only 25% in 2000 (AGI, 2009).

The economic burden of STDs is substantial. The costs of the nine million new cases of the most prevalent STDs that occurred among 15 to 24 year olds in 2000 amounted to \$65 billion. HIV and HPV were by far the most costly STDs in terms of total estimated direct medical costs, accounting for 90% of the total burden (\$5.9 billion) (Chesson et al., 2004).

Therefore, in this paper, we focus on identifying the causal effect of depression on risky sexual behaviors for young women, by exploring the unexpected occurrence of 9/11 and its significant effects on depressive mood. Our results show that depression does lead to more engagement in overall sexual activity, oral sex, and sex without a condom. The effect on anal sex, however, is not significant when controls for self-image and risk taking are added to the model.

Data

Our data are from the AddHealth which is a school-based longitudinal study of a nationally representative sample of adolescents in grades 7 to 12 in the United States during the 1994-5 school year.⁶ We use Wave III of the AddHealth for our study with respondents having been interviewed from July 2001 to April 2002. As described in the Introduction, because of the relatively higher risk for contracting an STD and the potentially serious consequences we focus our analysis on women who were not married at the time of interview.

Nine questions asked in Wave III are used to generate a CESD score to measure young women's level of depression: How often did you feel this way during the past week? (1) You were bothered by things that usually don't bother you; (2) You felt that you could not shake off the blues, even with help from your family and your friends; (3) You felt that you were just as good as other people; (4) You had trouble keeping your mind on what you were doing; (5) You felt depressed; (6) You were too tired to do things, during the past seven days; (7) You enjoyed life; (8) You felt sad; (9) You felt that people disliked you. For each question, respondents chose from

⁶ More details on this dataset are available at <http://www.cpc.unc.edu/projects/addhealth/design/designfacts>.

the following numbers as their answers: 0: never or rarely; 1: sometimes; 2: a lot of the time; 3: most of the time or all of the time. All nine questions combined, we obtain a CESD score, ranging from 0 (least likely to be depressed) to 27 (most likely to be depressed).⁷

The CESD score is a common measure of depressive symptoms (Radloff, 1977). Because this score is typically constructed using 20 questions including the nine described above, and because it is typically used as a screening test than a diagnosis for depression, we directly use the total scores (from nine questions) in our empirical analysis instead of (arbitrarily) assigning our samples into depressed vs. non-depressed groups.

Our (binary) outcome variables measuring risky sexual behaviors of single young women in a romantic relationship include: a) whether the young woman is sexually active,⁸ b) whether she engages in oral sex, c) whether she engages in anal sex, and d) whether she uses condoms during sex. These measures, as explained in the Introduction, are highly indicative and predictive of young women's probabilities of getting STDs, and are therefore of particular interest in this paper. The specific questions used to generate these measures can be found in Appendix Table 2.⁹

In our analysis, we also control for these single young women's age, race, ethnicity, years of education, self-rated health status, drinking and smoking behaviors and marijuana use, self-image, and attitudes towards risk or impulsivity. Specifically, for race, we control for whether the young woman self-identifies as White, African American, American Indian or Native American, and/or Asian or Pacific Islander (they are allowed to choose more than one from the list). For ethnicity, we control for whether they consider themselves as having a Hispanic or Latino origin. Self-rated health status is based on a 5-point scale (1 excellent; 2 very good; 3 good; 4 fair; 5 poor). For substance use, we control for whether they drank alcohol during the year before the interview, whether they had ever regularly smoked for 30 days, and whether they used marijuana in the year before the interview. The measure of self-image comes from young women's responses to 9 questions, with a score ranging from 9 to 36 with 9 being having the best self-image and 36 being having the worse self-image. Attitudes towards risk or impulsivity are measured using their responses to 6 different questions, with a score ranging from 6 to 30 with 6 being least risk loving or impulse. Please see Appendix Table 3 for details on questions used to generate some of these variables.

⁷ Appendix Table 1 also provides information on these questions.

⁸ Previous research (Averett et al., forthcoming) has shown the importance of examining not just vaginal intercourse but also other sexual behaviors among young adults.

⁹ Having multiple sex partners could be another risky sexual behavior with substantial health consequences. However, in Wave III AddHealth asked women only about sex within the context of a relationship not the number of concurrent sexual partners. To avoid measurement errors which might point to misleading conclusions, we do not include having multiple sex partners concurrently in our set of outcome variables.

Because Wave III of Add Health started gradually in July 2001 (with a few exceptions), just two months before 9/11, in order to construct comparable "control" and "treatment" groups, we focus on the young women interviewed within one month before and after 9/11. Figure 1 shows the distribution of interview dates, with the vertical line indicating September 11, 2001, and the light-colored areas to the left and right of the vertical line indicating interviews conducted one month before and after 9/11 ---- basically our sample. Note that these two areas are almost of the exact same size, consistent with what AddHealth described as an un-interrupted interview schedule (with the exception of biomarker data due to restrictions on air travel at that time.¹⁰

We focus our analysis on unmarried young women interviewed during Wave III because, as stated earlier, depression is more prevalent in women and women bear most of the costs of risky sexual activity. Respondents for Wave III are asked to compile a relationship roster where they self-identify all romantic relationships they have had since 1995 (wave I of the AddHealth). Fortunately for our use, they also asked if the relationship was currently occurring at the time of the interview. We choose only those respondents currently in relationships at the time of interview because it could be difficult for respondents to accurately recall all the details of previous relationships which could cause measurement error. We also restricted our sample to respondents who were in a relationship at the time of the interview because of the unique identification method we use - the attacks of September 11. If the relationship was too far in the past we would not be identifying the effect of depression on sexual activity accurately given the temporal nature upon which our identification scheme rests. Because the questions about sexual activity in Wave III were asked only of women in relationships, we cannot explore whether or not depression caused these women to engage in sexual activity with someone they did not know well or to engage in sexual activity with strangers.

Table 1 presents summary statistics of all variables used in this study. Most of our respondents are White (68%) or African American (25%). The average years of education are around 13 years and a half, and the average age is 21. 35% smoked for at least 30 days, and during the year before interview, 72% of these women drank alcohol, and 31% used marijuana. The average self-rated health is about 2.05, which is slight worse than 'very good'. The average scores for self-image and risk attitudes/impulsivity are 13.8 and 21.6. The mean CESD score for the 9 questions asked in the Wave III Add Health for our sample is 8.12. As for the outcome variables, more than 95% of these women are sexually active in their relationships. 67% and 11% of them engage in oral and anal sex, respectively. Fewer than 2% of them use condoms.

Econometric Model

In this study, we explore the exogenous nature of 9/11 by using an instrumental variable (IV) identification strategy. Specifically, we use 9/11 as the IV to young women's CESD scores which

¹⁰ Details on effects of 9/11 on biomarker data are available at {<http://www.cpc.unc.edu/projects/addhealth/data/guides/biomark.pdf>}.

can potentially be to endogenous to their risky sexual behaviors. Figure 2 clearly shows that these young women indeed experienced a significant elevation in their depressed mood after 9/11, indicated by their CESD scores; this result is also confirmed by our regression models.

The following econometric model is brought to our data:

$$(1) \quad y_i = \beta_0 + \beta_1 \text{CESD}_i + x_i' \beta_2 + \varepsilon_i$$

where ε_i is the disturbance term for individual i , CESD_i is her CESD score which could be potentially endogenous, x_i is a vector of her characteristics, and y_i , as we mentioned in the Data section, includes 4 binary outcomes for each respondents: (1) whether the young woman is sexually active, (2) whether she engages in oral sex, (3) whether she engages in anal sex, and (4) whether she uses condoms during sex. Our IV, not shown in Equation (1) but used in our 2SLS estimation, is a binary variable set to 1 if the young woman was interviewed on or after the occurrence of 9/11 and 0 otherwise. As is clear from Figure 2, where we graph the weekly average CESD scores (generated using 9 questions in our study) against interview dates, there is indeed a jump in the CESD scores right after 9/11. It means that this IV is very likely to be strong; our "treatment" group is indeed treated in this "natural experiment". The strength of our IV is also confirmed by our estimation results which we discuss below.

To check the robustness of our results and to deal with potential omitted variable bias, we include increasingly more variables in our x_i vector. We start with just basic demographic variables: age, gender, race, ethnicity, and years of education (specification I). Then we add self-rated health status (specification II), followed by some of other health-related behaviors (drinking, smoking, and marijuana use) (specification III), used as a measure of their time preference and self control, and then we add measures for these young women's self-image and attitudes towards risk/impulsivity (specification IV) as the final specification. The two variables added in specification IV might be good measures of these young women's unobserved heterogeneity, because they provide information on their personal traits which are typically unavailable in data. However, we caution that these variables themselves might also be endogenous so we interpret their coefficients cautiously since our main concern is the coefficient on the depression scale.

Results

Tables 2-5 present the OLS estimates for our four outcome variables, respectively. Within each table, four specifications (I to IV) are listed as discussed above. Starting with Table 2, the OLS results for sexual activity, we find that age and education are positive and significant indicating that these women are more likely to be in a relationship involving sexual activity. As we move through the different specifications, we find the age effect is quite robust but the effect of education disappears once we control for self-rated health, drinking, smoking and marijuana use. Those who report themselves in better health are more likely to be in a relationship that involves

sexual activity (recall that lower scores on self-health indicate better self-reported health hence the negative coefficient) and smokers are less likely to be involved in a relationship that involves sexual activity. Of particular note is that the OLS coefficient on depression is quite robust to the addition of a wide array of controls. In the final model we obtain marginal significance of our black and Hispanic variables and we also find that those with a worse self-image are more likely to be engaging in sexual activity within their current relationship. This finding that depression is positively related to sexual activity has been reported by others as summarized in our Introduction section.

The OLS model of anal sexual intercourse yields no significance of depression on the probability of anal intercourse. Age is negatively related suggesting this activity is something for the young. Smokers are less likely to engage in anal sex but those with lower self image are more likely to engage in anal intercourse. With respect to oral sex, in the OLS results there is also no indication that depression plays a role. The only strong predictors of oral sex are being Native American and having a low self-image in the final model.

Finally, depression is also not related to the probability of condom use in the OLS model. This is counter to what some earlier research has found. However, our sample is of young adult women and most previous work has focused on teenagers. Interestingly, our OLS results indicate that more educated women are less likely to use a condom. While that may not mean they are not using birth control, it may signal that they view their relationship as more committed or permanent, all else equal. This result is robust to all controls we add. We do find in the last column, that our measure of risk is negative and significant indicating those who are more prone to risk taking are less likely to use condoms, a finding that is in line with what we would predict.

Moving to the 2SLS estimates (Tables 6-9), it is clear that our instrument is strong as indicated by the F-statistics from the first stage all exceeding 10, and that there is indeed a statistically significant causal relationship between depression and our outcomes (Appendix Table 4 shows the complete set of first stage results). Specifically, not only are young women with elevated depressed mood more likely to be sexually active, they are also more likely to engage in oral and anal sex, and to have sex without a condom. Focusing first on having sex, we see that for every one point increase in CESD scores there is a 2.2 percentage point greater probability of engaging in any type of sexual activity. This is robust to the addition of controls for self-health, drinking and smoking (which are themselves significantly related to the probability of engaging in sexual activity). When we add controls for self image and risk the effect of depression falls to 2.1 percentage points and is only statistically significant at the 10% level. Self-image is a significant predictor of engaging in sexual activity with women who have a lower self-image being more likely to engage in sexual activity in their current relationship.

The pattern of instrumental variables results is remarkably similar for anal intercourse. The effect however, is much larger: a one point move up the depression scale is associated with on average a 3.2 percentage point increase in the likelihood of engaging in anal intercourse. This effect is

quite substantial given that this is reported by 11 percent of the young women in our sample. Older women and smokers are less likely to engage in anal intercourse and when we add controls for risk and self-image the effect of depression on anal sex falls to 2.8 percent and is no longer statistically significant. Self-image is however negatively associated with anal intercourse indicating that those with a better self-image are less likely to engage in this risky behavior. Age is a negative and significant predictor of anal sex even when we have the full set of controls.

The IV results for oral sex tell a similar story. Elevated depressed mood is significantly related to the probability of engaging in oral intercourse and the effect of a one unit increase in our depression scale ranges from 4.5 to 5.5 percentage point increase in the probability of engaging in oral sex. There is no effect of age, except for the last specification. This is an activity Asian's are less likely to engage in. Even when we control for risk and self-image, the effect of depressed mood is significant AND becomes larger by a percentage point. Those reporting better self health and higher self-image are less likely to engage in this behavior.

Finally, the instrumental variables results for condom use also reveal that elevated depressed mood is significantly negatively related to condom use. Racial differences in condom use are quite pronounced and somewhat surprisingly the more educated are less likely to use condoms. Whether education is correlated with some positive aspect of the relationship such as a more committed or monogamous relationship cannot be discerned from our results. Most importantly, the effect of depression on condom use is statistically significant even when we control for risk and self image.¹¹

Our IV results are larger than our OLS results for having sex suggesting that the OLS estimates underestimate the effect of depression on risky sexual behavior. We ran two specification checks on our models. First we wanted to ascertain if 9/11 was a statistically significant determinant of relationship status and we found that it was not a determinant of relationship status. Finally, we also included the 9/11 variable in the fully specified OLS equation and found that it was never statistically significant. Thus, we feel confident that our instrument is legitimately excluded from the second stage.

Conclusion

In this paper we have added to the existing literature by exploiting the timing of 9/11 coincident with the data collection of Wave III of the AddHealth survey to identify the effect of depression on risky sexual activity among young adult women, a group often overlooked in the literature. Furthermore, we make use of contemporary measures of sexual activity such as anal and oral intercourse in addition to vaginal intercourse-these multifaceted and contemporary measures are particularly worthy of study because they are indicative of current sexual practices and they are often performed without barrier protection making them particularly risky. Given the odds and

¹¹ One might hypothesize that the effects of 9/11 were stronger for those living in the Northeast. However, the AddHealth data confidentiality rules do not allow us to control for state or region of residence.

substantial costs of a young adult woman contracting an STD, it is also important to understand the risk factors underlying an STD diagnosis so policymakers can make appropriate policy recommendations.

Our findings indicate that an elevated depressed mood is significantly associated with having sex and with three risky sexual behaviors that are relatively common among young women. To the extent we can make inferences about the effect of self-image, which is also potentially endogenous, it does appear that women with a poor self-image are also prone to these types of behaviors. These findings indicate that initiatives to make mental health care more available to a wider array of the population such as that proposed by President Obama (www.barackobama.com) may also have the benefit of reducing risky sexual activity. As of January 2010, only 22 states plus the District of Columbia mandated mental health care (Kaiser Foundation, 2010).