Title: The effect of stress and depression symptoms on young women's risk of unintended pregnancy

Authors:

1. Kelli Stidham Hall, PhD MS (corresponding)
   Research Investigator and "BIRCWH" NIH K-12 Scholar
   Department of Obstetrics and Gynecology, School of Medicine
   Institute for Social Research, Population Studies Center,
   University of Michigan
   L4000 Women's Hospital, 1500 East Medical Center Dr., Ann Arbor, MI 48109
   (t) 734-930-5621 (c) 859-533-0762 (e) hkelli@umich.edu (f) 734-930-5609
2. Yasamin Kusunoki, PhD MPH, Assistant Research Scientist, Institute for Social Research, Population Studies and Survey Research Centers, University of Michigan, 426 Thompson St. Ann Arbor, MI 48106-1248
3. Heather Gatny, MS, Senior Research Area Specialist, Institute for Social Research, Population Studies and Survey Research Centers, University of Michigan, 426 Thompson St., Ann Arbor, MI 48106-1248
4. Jennifer Barber, PhD, Professor of Sociology, Department of Sociology; Research Professor, Institute for Social Research Population Studies and Survey Research Centers, University of Michigan, 426 Thompson St., Ann Arbor, MI 48106-1248

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Abstract

Depression and stress have been linked with poor contraceptive behavior, but whether existing mental health symptoms influence women's subsequent risk of unintended pregnancy is unclear. We prospectively examined the effect of depression and stress on young women's pregnancy risk over one year. We used panel data from a longitudinal study of 992 U.S. women ages 18-20 years who reported a strong desire to avoid pregnancy. Weekly journal surveys measured relationship, contraceptive, and pregnancy outcomes. We examined 27,572 journal surveys from 940 women over the first study year. Our outcome was self-reported pregnancy. At baseline, we assessed moderate/severe depression (CESD-5) and stress (PSS-4) symptoms. We estimated the effect of baseline mental health symptoms on pregnancy risk with discrete-time, mixed-effects, proportional hazard models using logistic regression. At baseline, 24% and 23% of women reported moderate/severe depression and stress symptoms, respectively. Ten percent of young women not intending pregnancy became pregnant during the study. Rates of pregnancy were higher among women with baseline depression (14% vs. 9%, *P*=0.04) and stress (15% vs. 9%, *P*=0.03) compared to women without symptoms. In multivariable models, the risk of pregnancy was 1.6 times higher among women with stress compared to those without stress (aRR 1.6, CI 1.1,2.7). Women with co-occurring stress and depression symptoms had over twice the risk of pregnancy (aRR 2.1, CI 1.1,3.8) compared to those without symptoms. Among women without a prior pregnancy, having co-occurring stress and depression symptoms was the strongest predictor of subsequent pregnancy (aRR 2.3, CI 1.2,4.3), while stress alone was the strongest predictor among women with a prior pregnancy (aRR 3.0, CI 1.1,8.8). Depression

symptoms were not independently associated with young women's pregnancy risk. In conclusion, stress, and especially co-occurring stress and depression symptoms, consistently and adversely influenced these young women's risk of unintended pregnancy over one year.

Key words: unintended pregnancy; mental health; depression; stress; adolescent women

Word count: text (8,322); abstract (298)

Research highlights:

- Women with depression and stress symptoms had high one-year unintended pregnancy rates
- Stress was consistently, adversely associated with an increased risk of pregnancy over one year
- Combined effect of co-occurring stress and depression symptoms most strongly predicted pregnancy
- The independent effect of depression on subsequent unintended pregnancy remains unclear

Introduction

Unintended pregnancy among young women has been attributed to many diverse demographic, social, and cognitive behavioral factors. Young age, low educational attainment, low income, minority race/ethnicity, disrupted childhood family situation, having a mother who had a teenage pregnancy, earlier age at coitarche, more sexual partners, ambivalent pregnancy desire, lack of contraceptive knowledge, misperceptions of side effects, and low self-efficacy are just a few examples of the many factors shown to predict poor contraceptive behavior and unintended pregnancy among young women (Finer & Henshaw, 2006; Frost & Darroch, 2008; Rosenberg, Waugh & Long, 1995). While this research has isolated specific risk factors for unintended pregnancy, studies have often failed to account for the interrelatedness of different dimensions of young women's lives. Notably, the impact of mental health on young women's risk of adverse family planning outcomes has seldom been the focus of rigorous study (Chen, Stiffman, Cheng, & Dore, 1997; Farr, Bitsko, Hayes, & Dietz, 2010; Hall, 2011).

Among the most common mental health problems worldwide, depression, anxiety, and related psychological stress disproportionately impact young and socially disadvantaged women (USDHHS, 2001; NIMH, 2012; APA, 2000). These conditions, which are highly comorbid, are a significant burden to society and contribute to negative biopsychosocial outcomes and reproductive sequelae, including maternal and infant morbidity and mortality (Williams, Marsh, & Rasgon, 2007; Kelly et al, 2002; Alder, Fink, Bitzer, Hosli, & Holzgreve, 2007; USDHHS; NIMH; APA).

A considerable body of research has linked mental health symptomatology with risky *sexual* experiences. Depression and stress symptoms have been associated with

having more sexual partners, earlier coitarche, higher sexually transmitted infections (STI) rates, sex while under the influence of alcohol and drugs, non-consensual sex and intimate partner violence (Chen, Stiffman, Cheng, & Dore, 1997; Silverman, Raj, Mucci, & Hathaway, 2001; Brooks, Harris, Thrall, & Woods, 2002; Lehrer, Shrier, Gortmaker, & Buka, 2006).

More recent studies, using mostly clinic-based samples, have begun to identify associations between women's mental health status and risky contraceptive behaviors including contraceptive nonuse, misuse, discontinuation and less effective method use (Zink, Shireman, Ho, & Buchanan, 2002; Bennett, Culhane, McColuum, & Elo, 2006; Farr, Bitsko, Hayes, & Dietz, 2010; Lee, Casanueva, & Martin, 2005; Ko, Farr, Dietz, & Robbins, 2012; Garbers, Correa, Tobier, Blust, & Chiasson, 2010; Hall, Reame, O'Connell, Rickert, & Weshoff, 2012; [a]Hall, Moreau, Trussell, Barber, 2013; [b]Hall, Moreau, Trussell, Barber, 2013). In a study of 354 young minority urban family planning patients, Hall *et al.* found an association between elevated baseline depression and stress symptoms and 6-month oral contraceptive discontinuation rates. Using clinical data from 2,476 urban, predominantly Black and Latina women, Garbers *et al.* found that women who screened positive for depression had 45% higher odds of selecting condoms and 39% lower odds of selecting hormonal methods at their clinic visit compared to women without depressive symptoms. Similarly, Farr *et al.* used cross-sectional national data from 53,255 women ages 18 and older in the Behavioral Risk Factor Surveillance System and found that low-income women with frequent mental distress had a reduced likelihood of using long-acting/hormonal methods (OR 0.5) and condoms (OR 0.6) than other less effective methods.

Given that inadequate contraceptive use accounts for 90% of the estimated 3.2 million annual U.S. unintended pregnancies, contraceptive (and sexual risk) behavior is indeed a primary mediating factor of unintended pregnancy (Kost, Singh, Vaughan, Trussell, & Bankole, 2008; Trussell & Vaughn, 1999; Finer & Henshaw, 2006). Thus, research describing a link between mental health symptoms and family planning behaviors has been an important scientific contribution, one that appears to have theoretical validity. Within a cognitive behavioral framework, mental health symptoms may interfere with a woman's cognitive capacities for decision-making, including risk assessment, planning and social learning, as well as influence or distort their perceptions of benefits and threats of a health treatment like contraception and their perceived susceptibility to an outcome like pregnancy (Hall, 2011; Maner, & Schmidt, 2006; Yuen & Lee, 2003). While this has not been directly tested to our knowledge, it is reasonable to hypothesize that symptoms of depression or stress, such as decreased motivation or distraction, could impair a woman's ability to use certain methods correctly (e.g. contraceptive pills) or to make suboptimal contraceptive choices (e.g. condom nonuse or method discontinuation), for example.

A potentially more important question, though, is whether the influence of depression and stress symptoms on contraceptive use translates to an actual effect on women's risk of unintended pregnancy. The majority of studies focused on mental health and reproduction have described the prevalence, correlates and treatment of perinatal and postpartum depression among women who have already experienced an unintended pregnancy (Alder, Fink, Bitzer, Hosli, & Holzgreve, 2007; Dennis, Ross, & Grigoriadis, 2007; Grote et al, 2010; Flynn, Walton, Chermack, Cunningham, & Marcus, 2007;

Vesga-Lopez et al, 2008). Other studies that have examined associations between mental health and unintended pregnancy (and related outcomes like abortion) have encountered temporality problems inherent in cross-sectional datasets and retrospective designs (Tenku et al, 2009; Ko, Farr, Dietz, & Robbins, 2012; Steinberg, Trussell, Hall, & Guthrie, 2012). One analysis of data from pregnant Japanese women in a birth cohort study found that women who had been diagnosed with depression were more likely to report that their current pregnancy was mistimed compared to those without depression; women with an anxiety diagnosis were more likely to report that their pregnancy as unwanted (Takahashi et al, 2012). Another study of 5,877 respondents aged 15–54 years in the National Comorbidity Survey found that men and women who reported having an early onset psychiatric disorder had a higher cumulative probability of also having experienced a teenage childbirth compared to those without a psychiatric history (Kessler et al, 1997). So, even some research which has attempted to account for temporal ordering of mental health diagnoses and pregnancy outcomes have been limited by historical data and retrospective reporting (Kessler et al; Takahashi et al).

Moreover, even less is known about unintended pregnancy and the influence of psychological stress, which is prevalent among young women and commonly co-occurs with depression and anxiety. As a distinct condition, stress has been defined as an emotional, psychological, behavioral or physiological response (and a subjective appraisal of this response) to situational demands (Selye, 1956; Larzelere & Jones, 2008). Stress is increasingly recognized as an important and independent contributor to morbidity (APA, 2013; Larzelere & Jones), including reproductive sequelae like preterm birth (Hogue et al, 2013). However, the distinct effect that stress may have on young

women's risk of unintended pregnancy, as well as the effect of co-occurring stress and depression symptoms, has not been studied.

We sought to prospectively estimate the influence of baseline depression and stress symptoms on women's risk of unintended pregnancy over one year. We hypothesized that the proportion of women who experienced a new pregnancy would be higher among women with elevated mental health symptoms at baseline than those without symptoms. We also hypothesized that after taking into account confounding effects of women's sociodemographic characteristics and reproductive histories, the risk of pregnancy would be higher among women with mental health symptoms than those without symptoms. Finally, we hypothesized that both depression and stress would exhibit similar but independent adverse effects on women's pregnancy risk.

Materials and Methods

Sample and Design

In other reports on young women's contraceptive behavior ([a]Hall et al, 2013; [b]Hall et al, 2013), we previously described the study sample and design. Briefly, we used data from a representative population-based cohort study of 992 young women aged 18-20 years residing in a racial/ethnically and socioeconomically diverse Michigan county. Names and contact information were randomly selected from state driver's license and personal identification card registries. Eligible women (ages 18-20 and a county resident) were contacted by mail or phone and asked to participate. Sampling occurred between March 2008 and March 2009. This study was approved by the Institutional Review Board of the [redacted].

After informed consent, a trained research assistant conducted a 60-minute in-person baseline survey interview to elicit information on sociodemographics, relationship characteristics, reproductive attitudes, beliefs and intentions, contraceptive histories, and mental health symptoms. Participants were then invited to participate in the weekly journal-based survey study for a period of 2.5 years. The weekly journal surveys (i.e. entries), which measured contraceptive use patterns, relationship status and pregnancy outcomes, were completed online for participants with internet access or by phone if internet access was unavailable on a particular week. Participants were compensated $1 per weekly survey with $5 bonuses for on-time completion of five consecutive surveys. Ninety-eight percent of women agreed to participate in the study. The response rate for the full baseline interview was 88%; 78% completed 12 months or more of weekly surveys.

Here, we focused on the first 12 months of data given the high response rates during this time and because our mental health symptoms measures were included only at baseline. Because our unit of analysis was woman weeks, we included all women who were not pregnant at baseline and who completed more than one weekly journal survey (so that we had an assessment of mental health symptoms and then at least one subsequent assessment of pregnancy status). Our final sample included 940 women who completed 27,572 journal surveys (i.e. women-weeks) over the first study year.

Measures

Baseline Mental Health Symptoms

We administered standardized depression and psychological stress instruments during the baseline survey interview. The Center for Epidemiologic Studies – Depression Scale-5 (CES-D-5) assesses depressive symptoms over the previous week (Radloff, 1977). Women were asked how often they felt the following five symptoms over the past 7 days: "like you could not shake off the blues," "depressed," "sad," "life was not worth living," and "happy." Responses were scored on a 4-point scale (0=rarely or none of the time, 1=some or little of the time, 2=occasionally or moderate amount of time, 3=most or all of the time); the positively worded item was reverse coded. Items were then summed for a total depression score. Scores range from 0-15; a higher score indicates a higher degree of symptoms. We examined depression as both a continuous score as well as a binary variable using a standardized cut-off of ≥4 points to denote moderate/severe depression symptoms. We also conducted sensitivity tests of different score cut-off points for moderate/severe depression. Overall, findings in relation to pregnancy were similar, so we present results from the binary 4-point moderate/severe depression symptom variable (which captured one standard deviation above our population mean). The CES-D has demonstrated good sensitivity (>0.84), specificity (≥0.80), and high validity (>0.90) in identifying patients classified as depressed by the full 20-item scale (Bohannon, Maljanian, & Goethe, 2003). The CES-D has also demonstrated strong content, concurrent, and discriminant validity and internal consistency (Cronbach's alpha 0.91) (Radloff).

The Perceived Stress Scale (PSS-4) assesses the degree to which one appraises their life situations as stressful, unpredictable, uncontrollable, and overloading over the previous month (Cohen, 1983). Women were asked how often (0=never, 1=almost never,

2=sometimes, 3=fairly often, 4=very often) they felt the following four symptoms: "unable to control important things in life," confident about ability to handle personal problems," "things were going your way," and "difficulties were piling up so high that you could not overcome them." Positively worded items were reverse coded. Items were summed for a total score, which could range from 0-16 with higher scores indicating greater stress. Like the depression measure, we examined continuous PSS scores and well as different cut-off points for binary moderate/severe stress. We present results from the binary stress variable in which we used the standardized cut-off of ≥9 points (one standard deviation above population mean) to denote moderate/severe stress symptoms. The PSS has been correlated with depression, anxiety and physical symptomatology measures in clinical populations but has been shown to measure a distinct, independent construct of appraised stress. High construct validity, internal consistency and sensitivity/specificity (Cronbach's alpha .85) has been demonstrated (Cohen).

First, we used the CES-D and PSS to examine depression and stress symptoms separately (but not exclusively). We also created a 4-point categorical variable to examine the independent and combined effects of having each or both mental health symptom with the following categories: no mental health symptoms, depression symptoms only, stress symptoms only, or co-occurring depression and stress symptoms.

Unintended Pregnancy

In each weekly journal, women were asked if it was possible that she was pregnant and if so, whether a pregnancy test had indicated a positive pregnancy. We operationalized a pregnancy as a newly reported positive pregnancy test during the 12-

month study period. We refer to pregnancy among these women during the first study year as "unintended" in our discussion given that this sample is comprised of adolescent women (a demographic for which pregnancies are overwhelmingly unintended), 98% of whom explicitly stated at baseline that they had no intentions and, in fact, strong desires to avoid pregnancy (5 on an avoidance scale of 1-5).

Sociodemographic, Relationship, and Reproductive Characteristics

We examined the following sociodemographic, relationship and reproductive history characteristics at baseline and each week: age, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, or other), educational attainment (not enrolled in school, still in high school, enrolled in 2 year program, enrolled in 4 year college, or dropped out of high school), employment status (employed or unemployed), parental income level (<$15,000, $15,000-44,999, $45,000-74,999, or ≥$75,000), public assistance recipient (including WIC, FIP, cash welfare or food stamps, yes or no), childhood household/family structure (lived with 2 biological/step parents, 1 parent only, or other), mother's education level (graduated high school or less than high school education), mother's age at first birth (less than 20 years old or ≥20 years old), frequency of religious service attendance (never, <weekly, or ≥weekly), relationship status (married, engaged, in special romantic relationship, having physical/emotional contact with someone or none), cohabitation with marital or non-marital partner (yes or no), sexual intercourse experience (yes or no), age at coitarche, lifetime number of sexual partners, histories of pregnancy, birth control use, unprotected sex, and current birth control use (all yes or no).

Statistical Analysis

We used univariate statistics to describe women's baseline sociodemographic and reproductive characteristics and to estimate the proportions (%) of women with baseline moderate/severe depression and stress symptoms. We also described the proportion of women who experienced a new pregnancy during the one-year study period (i.e. pregnancy rate). We conducted unadjusted bivariate X^2 tests to compare sociodemographic and reproductive characteristics among: 1) women with moderate/severe depression and stress symptoms versus those without depression or stress, 2) women with a new pregnancy versus those without, and 3) women with a new pregnancy, stratified by history of pregnancy (without or with a prior pregnancy).

We further examined the effect of baseline mental health symptoms on women's risk of pregnancy over one year while adjusting for sociodemographic and reproductive history confounders. We used event history methods to model the risk of pregnancy each week and discrete-time methods to estimate the proportional hazard models. Person-weeks of exposure are the unit of analysis. We considered women to be at risk of pregnancy during all weeks that she reported not being currently pregnant. Our mixed effects multivariable logistic regression models included covariate fixed effects and a random effect for the woman, while also controlling for the number of weekly journals completed, number of pregnancy months and number of pregnancy months squared as indicators of time (i.e. effects of repeated exposure to the questionnaire, continued participation in the study and being pregnant). We first estimated the effect of mental health symptoms on pregnancy risk in univariate models, then in multivariable models

(adding sociodemographic first, followed by reproductive history variables), and then in final reduced models controlling only for significant covariates. We also stratified models by history of prior pregnancy. We examined depression and stress as independent variables in models first and then using our combined 4-point categorical mental health symptom variable.

Variables were considered for inclusion in regression models if their p-value in bivariate models was 0.25 or less. For variables that appeared to be collinear (e.g. reproductive and sexual history variables), we retained variables with the strongest associations with our outcome in final models. While we also examined time-varying sociodemographic characteristics, their effects on pregnancy risk were similar to baseline characteristics, so we present baseline models given that mental health was measured at baseline. Finally, we repeated all analyses using the first 18 months of data in order to estimate the effect of mental health on pregnancy risk with a larger sample of pregnancies. Results were similar, so we present the more conservative one year estimates.

We present exponentiated coefficients from regression models as adjusted relative risks (aRR) and corresponding 95% confidence intervals (CI). Two-tailed alphas of $P<0.05$*, $P<0.01$**, and $P<0.001$*** were considered significant. All data were analyzed using Stata 12.0 (StataCorp LP, College Station, TX).

Results

Baseline Mental Health Symptoms

Women's sociodemographic and reproductive history background characteristics are presented in Table 1. For baseline mental health symptoms, 24% of women met criteria for moderate/severe depression symptoms (≥4pts CESD) and 23% met criteria for moderate/severe stress symptoms (≥9pts PSS-4); 15% of women had both depression and stress symptoms. Among women with moderate/severe depression symptoms, 65% also reported stress symptoms; among those with stress, 61% also reported depression symptoms (*P's*<0.001, Pearson's r=0.51).

Having moderate/severe depression symptoms was significantly associated with nearly all sociodemographic and reproductive background characteristics in unadjusted bivariate tests (Table 1). Proportions of depression symptoms were higher among Black women, women who dropped out of high school, women with a low parental income, women receiving public assistance, women without two parents in their childhood household, women with a mother who had less than a high school education and who had given birth as a teen, and women with an early age at coitarche, higher numbers of sexual partners, and histories of pregnancy, birth control use and unprotected sex. Proportions of moderate/severe stress symptoms were higher among women who were not enrolled in school or had dropped out of high school, women without two parents in their childhood household, and women with an early coitarche, higher numbers of sexual partners, and histories of pregnancy, birth control use and unprotected sex.

Pregnancy Rates Over One Year

During the first year of study, 98 women (10%) reported a new pregnancy; 93 women experienced 1 pregnancy and five women experienced 2 pregnancies. Rates of

pregnancy varied by nearly all women's background characteristics (Table 1). Pregnancy rates were higher among Black women, women who were still in high school or not enrolled in school, unemployed women, women with low parental incomes and those receiving public assistance, women without two parents in their childhood household, women with a mother who had given birth as a teen, women who were engaged or cohabiting, and women with an early age at coitarche, higher numbers of sexual partners, and histories of pregnancy, birth control use and unprotected sex. These associations were similar among women with no history of prior pregnancy (n=734, 78%). Among women who had previously been pregnant (n=206, 22%), only cohabitation status was significantly associated with experiencing a new pregnancy during the study ($P<0.001$).

Associations Between Baseline Mental Health Symptoms and Pregnancy Rates

In the unadjusted bivariate analysis (Table 1), rates of pregnancy were higher among women with moderate/severe depression (14% versus 9%, $P=0.03$) and stress (15% versus 9%, $P=0.03$) symptoms than those without symptoms. This finding was also true of women without a pregnancy history, for both depression (13% versus 6%, $P=0.005$) and stress (11% versus 6%, $P=0.04$). Among women with a prior pregnancy, pregnancy rates were similar by depression ($P=0.60$) and stress ($P=0.54$) symptoms.

Results from multivariable logistic regression models are presented in Tables 2-5. Among all women, depression symptoms did not independently predict women's risk of pregnancy over one year (aRR 1.2, CI 0.7,1.9, $P=0.52$). Women with moderate/severe stress symptoms, however, had a 1.6 times higher risk of pregnancy (aRR 1.6, CI 1.1,2.7, $P=0.04$) than those without stress. The risk of pregnancy was highest among women who

had co-occurring stress and depression symptoms (aRR 2.1, CI 1.1,2.8, *P*=0.03) and not significant among the few women who had stress symptoms alone (aRR 1.3, CI 0.5,3.0, *P*=0.61) or depression symptoms alone (aRR 0.7, CI 0.3,1.7, *P*=0.48), compared to women without any mental health symptoms.

We further examined the effect of mental health symptoms on pregnancy risk in models stratified by pregnancy history (Table 4). For women without prior pregnancy, the combined effect of having both stress and depression symptoms was the strongest predictor of pregnancy risk (aRR 2.3, CI 1.2,4.3, *P*=0.01) compared to those with no symptoms. Among women with a prior pregnancy, the effect of having stress alone was the strongest predictor of pregnancy risk (aRR 3.0, CI 1.1,8.8, *P*=0.04).

Other sociodemographic and reproductive factors associated with women's one year pregnancy risk included receipt of public assistance, having a mother who had given birth as a teen, cohabiting with a partner, and experiencing an early coitarche (Tables 2 & 3). In models stratified by pregnancy history (Tables 4), having a teen mother and an early age at coitarche were most strongly associated with pregnancy risk among women without a prior pregnancy, while cohabiting with a partner was most strongly associated among women with a prior pregnancy.

Discussion

In our previous analyses of young women's contraceptive behavior using this same data, we found that young women with moderate/severe baseline depression and stress symptoms were at increased risk of a wide range of risky contraceptive behaviors each week compared to women without depression and stress symptoms (Hall et al,

2013[a]; Hall et al, 2013[b]). More specifically, 10% of weeks during the first study year were not covered by contraceptive use and women with moderate/severe stress symptoms had over twice the odds of not using contraception each week (including any family planning options, ranging from rhythm and withdrawal to intrauterine devices and implants) than women without stress. The odds of consistent contraceptive use was 47% and 69% lower among women with depression and stress than those without symptoms, respectively. Finally, the relative risks of using long-acting methods (rather than oral contraceptives) was 48% and 25% lower among women with depression and stress symptoms than those without symptoms. In addition to contraceptive use, we are also currently examining the role of sexual behavior, including frequency of sexual activity and sexual partnerships, as additional mechanisms that may link mental health symptoms to pregnancy risk. While young women, including those wishing to avoid pregnancy, may have a variety of reasons for having more or less sex or for not using contraception (and indeed contraceptive nonuse is not uncommon (Mosher & Jones, 2010; Frost & Darroch, 2008; Trussell & Vaughn, 1999; Kost et al, 2008)), our collective research suggests that mental health may be one factor that shapes women's family planning behaviors and outcomes. Among our adolescent women wishing to avoid pregnancy, those with moderate/severe mental health symptoms appeared to be at increased risk of behaviors that can lead to unintended pregnancy and for unintended pregnancy itself. Furthermore, the effect of stress on women's pregnancy risk appears to be more consistently present and stronger than that of depression.

Here, we build upon these findings to show the impact of stress on women's risk of unintended pregnancy over one year. Women with baseline stress had a 1.6 times

higher risk of becoming pregnant over time than women without stress. Moreover, women who had co-occurring stress *and* depression symptoms had twice the risk of pregnancy than women without symptoms. In stratified models, in which we attempted to control for the confounding effects of a previous pregnancy (and potentially related post-pregnancy mental health status) and sociodemographic factors (e.g. Black race/ethnicity, receipt of public assistance, and cohabitation), stress was consistently associated with risk of pregnancy among women without and with a pregnancy history. Women who experienced both stress and depression symptoms concurrently appeared to be more strongly related to pregnancy risk among women who had never been pregnant.

Collectively, our findings extend the research on mental and reproductive health and help clarify the temporal order effect of mental health symptoms on not only risky contraceptive behavior but also on actual unintended pregnancy risk, which is arguably the more meaningful outcome. A major contribution of this study is our robust, longitudinal design with weekly measures of pregnancy-related behaviors and outcomes, which we believe advances the methods required to adequately examine complex relationships between mental and reproductive health. This work also illuminates areas for further research to understand the dynamic, causal relationships between the two. Specifically, findings point to the adverse role of stress, and especially co-occurring stress and depression symptoms, in influencing young women's family planning behaviors and outcomes. Additional research is warranted to further disentangle interrelated mental and reproductive health experiences during adolescence and young adulthood (Hall, 2011; Maner, & Schmidt, 2006; Yuen & Lee, 2003).

The independent effect that depression may have on young women's unintended pregnancy risk remains unclear, with statistically insignificant and variable point estimates noted across our analytical models. It is plausible that for some women, especially those with a history of unintended pregnancy, experiencing depression may be a protective factor against subsequent pregnancy (which would be supported by a trend noted in our stratified models, with a 0.5 RR of depression alone among previously pregnant women). Women who have experienced an unintended pregnancy or postpartum mental health conditions may exhibit adaptive coping strategies to avoid another pregnancy. This "active behavioral coping" hypothesis has been suggested by Steinberg *et al.* (2013), who conducted a study of contraceptive method selection among post-abortion patients and found that women with mental distress were more likely to choose more effective methods following their unintended pregnancy than those without distress. Effective contraceptive use may reflect a motivation to prevent rapid repeat pregnancy among depressed women. Unfortunately, small subsample sizes in our stratified regression models resulted in reduced statistical power and limited our ability to adequately analyze these relationships. Additionally, we were unable to determine the onset of the mental health symptoms that we measured only at baseline and whether they may be have specifically related to women's prior pregnancy and postpartum status. Finally, as our own previous research and that of others has shown, stress and depression symptoms (just as with depression, anxiety and other mental health symptomatologies) are highly correlated, which was the case in this sample. While we attempted to measure distinct constructs using validated scales for depression and stress and our findings appear to point to subtle differences in the effects of experiencing "sadness" or

"depressed mood" versus "feeling out of control" or "burdened by life situations" on pregnancy risk, the independent (and interrelated) effects of depression and stress on family planning behaviors and outcomes are not fully clear and require further investigation. Nonetheless, this work is the first of which we are aware to prospectively examine the relationships between mental health symptoms, including co-occurring depression and stress symptoms, and subsequent unintended pregnancy among young women without and with a pregnancy history.

Another limitation of our study is the potential for underreporting of unintended pregnancies, particularly those that may have ended in abortion. We had a relatively wide range of number of journal surveys per woman completed and it is possible that women did not complete surveys in weeks that they experienced a pregnancy or abortion. Such biased reporting could have underestimated our pregnancy rate and undermined our ability to detect associations between mental health symptoms and pregnancy risk. Indeed, self report bias with unintended pregnancy and abortion is a documented problem in population-based survey research (Finer & Henshaw, 2006) and although we believe our weekly assessments of pregnancy are more rigorous estimates than most survey studies are able to achieve, our design was not without limitations. Other previous research has described an effect of preexisting mental health morbidity on women's risk of having an abortion (Steinberg & Finer, 2011). Given that 90% of abortions are the result of unintended pregnancies and women who have abortions are at risk for subsequent unintended pregnancies (Jones et al, 2006; Upadhyay et al, 2012), this may also have led to an underestimate of unintended pregnancy, overall and especially among the women with underlying depression and stress. While pregnancy outcomes are not the

focus of this analysis, our results warrant further study and suggest a more rigorous measurement of mental health status and family planning outcomes in population-based samples is needed.

Additionally, we were unable to assess potential time-varying effects of depression and stress on pregnancy risk over time since our depression and stress measures were administered to all women only at baseline and not each week. It is unclear how changing mental health symptoms may impact changing pregnancy risk (as well as pregnancy intentions) over time. Other researchers have suggested that mental health symptoms are relatively across adolescence and young adulthood and over short periods (e.g. 5-6 years) (Prenoveau et al, 2011; Holson, Kraft, & Vitterso, 2000), but unfortunately we were unable to assess whether this was true of our sample and whether and how dynamic mental health symptoms impact pregnancy risk over time. Finally, our sample, which was young (18-20 years at enrollment) and which was reflective of the demographic composition of a diverse county in Michigan, was not representative of the greater U.S. population, which limits generalizability.

Despite these limitations, our work has highlighted the adverse impact of mental health symptoms, especially stress and co-occurring mental health symptoms, on young women's risk of experiencing an unintended pregnancy over one year. It has also provided preliminary insight into a potential differential effect that depression and stress may have on subsequent pregnancy risk among women who have and have not had a previous pregnancy. Additional research is needed to disentangle the effects of depression and stress symptoms on women's pregnancy risk, especially among women with different reproductive backgrounds and pregnancy-related mental health

experiences. Our ongoing and future work aims to further investigate psychological determinants of women's family planning outcomes, including birth, abortion and postpartum mental health, as well as the behavioral and biological mechanisms that may link mental health with unintended pregnancy. We are also studying the role of adverse social circumstances, which we believe are intrinsically tied to psychological and physical health outcomes and which may further help explain the relationships between mental and reproductive health among young women.

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Table 1. Young women's baseline mental health symptoms and one-year pregnancy rates

	Baseline Mental Health Symptoms					*Pregnancy Rates at One Year, Overall and by Pregnancy History*					
Baseline characteristics	n=940 100%	Depression ≥4pts CESD[a] n=224 24%		Stress ≥9pts PSS-4[b] n=213 23%		All women n=98 10%		Women without a prior pregnancy n=54 7%		Women with a prior pregnancy n=45 21%	
	%	%	*P*[1]	%	*P*[2]	%	*P*[3]	%	*P*[4]	%	*P*[4]
Age			0.17		0.05		0.12		0.13		0.57
18 years	41	23		22		11		9		24	
19 years	50	26		25		11		7		22	
20 years	9	16		12		4		2		12	
Race/ethnicity			0.002		0.37		0.008		0.02		0.61
Non-Hispanic White	59	20		22		9		6		24	
Non-Hispanic Black	31	31		25		15		12		21	
Hispanic	8	31		22		9		7		16	
Asian/Other	2	25		10		0		0		0	
Educational enrollment			<0.001		0.004		0.005		0.01		0.61
Not enrolled	22	29		30		15		11		26	
High school	14	23		20		15		13		22	
2 year college	29	24		22		9		7		17	
4 year college	28	16		16		6		3		28	
High school drop-out	8	40		30		12		6		16	
Employment status			0.19		0.84		0.02		0.008		0.66
Employed	50	22		22		8		5		23	
Unemployed	50	26		23		13		10		20	
Parental income			<0.001		0.06		<0.001		0.004		0.37
<$15,000	14	34		27		20		16		27	
$15,000-44,999	28	25		23		9		8		14	
$45,000-74,999	19	23		26		6		4		17	
≥ $75,000	19	13		15		6		4		29	
Don't know	20	27		23		14		24		25	
Receiving public assistance			0.02		0.47		<0.001		0.002		0.32
Yes	26	29		23		19		14		24	
No	74	22		21		7		6		18	
Childhood family structure			<0.001		0.002		0.001		0.001		0.78
2 parents (biological/step)	52	19		19		7		5		21	
1 parent only	40	28		25		14		11		23	
Other	8	38		35		16		16		17	
Mother's education level			0.004		0.92		0.18		0.08		0.56
Graduated HS	91	23		23		10		7		22	
<HS education	9	37		22		15		14		17	
Mother's age at first birth			<0.001		0.05		<0.001		<0.001		0.53
<20 years old	36	30		26		16		14		23	
≥20 years old	64	20		21		7		4		20	
Religious service attendance			0.97		0.51		0.11		0.10		0.69
Never	22	23		25		8		6		16	
< weekly	52	24		21		12		9		22	
≥ weekly	26	24		23		9		5		24	
Relationship status			0.10		0.19		<0.001		<0.001		0.10
Married	2	19		13		6		13		0	
Engaged	7	35		29		28		23		38	
Romantic relationship	48	23		23		12		9		24	
Physical/emotional	17	27		27		8		5		15	
None	27	20		19		4		3		15	

Cohabitation status			0.68		0.62		<0.001		0.003	<0.001
Cohabitating	17	25		21		24		15	37	
Not cohabitating	83	24		23		8		6	15	
Age at first vaginal intercourse			<0.001		<0.001		<0.001		<0.001	0.47
No sex at enrollment	24	15		15						
< 14 years	16	38		35		22		18	27	
15-16 years	35	29		24		15		13	19	
≥ 17 years	25	17		20		6		4	19	
Lifetime # sexual partners			<0.001		<0.001		<0.001		<0.001	0.46
0	24	15		15						
1	17	16		16		11		6	30	
2	13	23		19		11		7	21	
≥3	46	31		31		16		14	20	
History of pregnancy			0.005		0.03		<0.001			
Yes	22	31		28		21				
No	78	22		21		7				
Ever used birth control			0.003		0.006		<0.001		<0.001	0.53
Yes	75	26		25		13		10	22	
No	25	17		16		3		1	16	
Ever had unprotected sex			<0.001		0.006		0.006		0.03	0.98
Yes	42	32		30		17		14	22	
No	28	19		20		10		8	22	
N/A	30									
Currently using birth control			0.24		0.54		0.07		0.21	0.23
Yes	50	24		24		11		8	19	
No	20	29		26		16		12	27	
N/A	30									
Moderate/severe depression[a]					<0.001		0.03		0.005	0.60
Yes (≥4pts CESD)	24			61		14		13	28	
No (<4pts CESD)	76			11		9		6	32	
Moderate/severe stress[b]			<0.001				0.03		0.04	0.54
Yes (≥9pts PSS-4)	23	64				15		11	32	
No (<9pts PSS-4)	77	12				9		6	27	
Mental health symptoms							0.05		0.02	0.68
None	67					8		6	21	
Depression only	10					10		9	14	
Stress only	8					8		5	31	
Both depression and stress	15					23		15	21	

Results are proportions (%) of all women in sample, women with moderate/severe depression and stress symptoms, and women who experienced a new pregnancy during the first year of study overall and by pregnancy history across sociodemographic and reproductive characteristics. P-values are from unadjusted X^2 analysis comparing sociodemographic and reproductive characteristics among women with and without moderate/severe depression symptoms[1], among women with and without moderate/severe stress symptoms[2], among women who did and did not experience a new pregnancy during the study period[3], among women who did and did not experience a new pregnancy during the study period stratified by history of previous pregnancy[4]. [a]Center for Epidemiologic Studies – Depression Scale (CES-D-5) – 4 point cut-off for moderate/severe depression symptoms. [b]Perceived Stress Scale - 4 (PSS-4) - 9-point cut-off for moderate/severe stress symptoms. Analyses were also conducted to examine associations between mental health symptoms and pregnancy outcomes over an 18-month study period (n=176 pregnancies) and point estimates were similar to those from the 1-year data (not shown).

Table 2. The effect of baseline depression symptoms on young women's risk of pregnancy over one year

	Model 1 (Univariate)		Model 2 (Sociodemographics)		Model 3 (Full)		Model 4 (Final reduced)	
N=940	RR	CI	aRR	CI	aRR	CI	aRR	CI
Depression symptoms[a]								
No (<4pts CESD)	1		1		1		1	
Yes (≥4pts CESD)	1.6	1.0,2.7	1.2	0.7,2.0	1.1	0.6,1.7	1.2	0.7,1.9
Age								
18 years			1		1			
19 years			1.0	0.6,1.6	1.0	0.6,1.6		
20 years			0.5	0.1,1.4	0.4	0.1,1.3		
Race/ethnicity								
Non-Black			1		1			
Black			1.5	0.8,2.6	1.2	0.7,2.0		
Educational enrollment								
Not enrolled			1		1			
High school			1.0	0.5,2.0	1.1	0.6,2.2		
2 year college			0.7	0.4,1.3	0.7	0.4,1.3		
4 year college			0.5	0.3,1.1	0.8	0.4,1.5		
High school drop-out			0.4	0.2,1.0	0.4*	0.2,0.9		
Employment status								
Unemployed			1		1			
Employed			0.7	0.4,1.2	0.7	0.4,1.1		
Receiving public assistance								
No			1		1		1	
Yes			1.8*	1.1,3.0	1.3	0.8,2.3	1.9*	1.2,3.0
Childhood family structure								
2 parents (biological/step)			1		1			
1 parent only			1.5	0.9,2.7	1.5	0.9,2.5		
Other			1.2	0.5,2.7	1.1	0.5,2.4		
Mother's age at first birth								
≥20 years old			1		1		1	
<20 years old			1.9**	1.2,3.1	1.7*	1.1,2.7	2.0**	1.3,3.2
Religious service attendance								
Never			1		1			
< weekly			1.5	0.8,2.8	1.5	0.8,2.7		
≥ weekly			1.3	0.6,2.9	1.7	0.7,3.7		
Relationship status								
Married			1		1			
Engaged			2.6	0.3,26.0	2.8	0.3,25.0		
Romantic relationship			1.6	0.2,14.0	1.7	0.2,14.0		
Physical/emotional			1.2	0.1,11.0	1.4	0.2,12.0		
None			0.6	0.1,6.3	1.2	0.1,10.8		
Cohabitation status								
Not cohabitating			1		1		1	
Cohabitating			2.3*	1.2,4.2	1.8	1.0,3.1	2.2**	1.3,3.7
Age at coitarche								
≥ 16 years					1		1	
<16 years					2.2*	1.1,4.4	4.2***	2.2,7.8
History of pregnancy								
No					1			
Yes					1.5	0.9,2.5		
Ever had unprotected sex								

No	1		
Yes	1.1	0.6,1.9	

Results are adjusted relative risk ratios (aRR) and 95% confidence intervals (CI) from discrete-time, mixed-effects, proportional hazard models using multivariable logistic regression with a random effect for the woman and controlling for number of pregnancy months, pregnancy months squared and number of journals completed. P-values (P) significant for two-tailed alpha at <0.05*, <0.01**, and <0.001***. Outcome is the risk of experiencing a new pregnancy during the 1-year study period among all women (n=940). Self-reported pregnancy status was assessed each week. Depression, stress and covariates were measured at baseline. [a]Center for Epidemiologic Studies – Depression Scale (CES-D-5) – 4 point cut-off for moderate/severe depression symptoms. Regression modeling was also conducted to examine the effect of mental health symptoms on pregnancy outcomes over an 18-month study period (n=176 pregnancies) and point estimates were similar to those from the 1-year models (not shown).

Table 3. The effect of baseline stress symptoms on young women's risk of pregnancy over one year

	Model 1 (Univariate)		Model 2 (Sociodemographics)		Model 3 (Full)		Model 4 (Final reduced)	
N=940	RR	CI	aRR	CI	aRR	CI	aRR	CI
Stress symptoms[a]								
No (<9pts PSS)	1		1		1		1	
Yes (≥9pts PSS)	1.8*	1.1,3.0	1.6	1.0,2.7	1.4	0.8,2.3	1.6*	1.1,2.7
Age								
18 years			1		1			
19 years			1.0	0.6,1.6	1.0	0.6,1.6		
20 years			0.5	0.2,1.5	0.4	0.1,1.4		
Race/ethnicity								
Non-Black			1		1			
Black			1.4	0.8,2.5	1.2	0.7,2.1		
Educational enrollment								
Not enrolled			1		1			
High school			1.0	0.5,2.0	1.1	0.6,2.2		
2 year college			0.7	0.4,1.3	0.7	0.4,1.3		
4 year college			0.6	0.3,1.1	0.7	0.4,1.4		
High school drop-out			0.4	0.2,1.0	0.4*	0.2,0.9		
Employment status								
Unemployed			1		1			
Employed			0.7	0.5,1.2	0.7	0.5,1.2		
Receiving public assistance								
No			1		1		1	
Yes			2.0*	1.1,3.3	1.4	0.8,2.3	2.0**	1.3,3.2
Childhood family structure								
2 parents (biological/step)			1		1			
1 parent only			1.5	0.9,2.6	1.4	0.8,2.5		
Other			1.1	0.5,2.5	1.0	0.5,2.3		
Mother's age at first birth								
<20 years old			1		1		1	
≥20 years old			1.9**	1.2,3.0	1.7*	1.1,2.8	1.9**	1.2,3.0
Religious service attendance								
Never			1		1			
< weekly			1.5	0.8,2.8	1.4	0.8,2.7		
≥ weekly			1.4	0.6,3.0	1.6	0.7,3.7		
Relationship status								
Married			1		1			
Engaged			2.6	0.3,25.0	2.6	0.3,24.0		
Romantic relationship			1.6	0.2,14.0	1.7	0.2,14.0		
Physical/emotional			1.2	0.1,11.0	1.2	0.1,11.0		
None			0.7	0.1,6.6	1.0	0.1,8.9		
Cohabitation status								
Not cohabitating			1		1		1	
Cohabitating			2.4**	1.3,4.5	1.9*	1.0,3.5	2.3**	1.4,3.9
Age at coitarche								
≥ 16 years					1		1	
< 16 years					2.9**	1.5,5.6	3.7***	2.0,6.7
History of pregnancy								
Yes					1			
No					1.6	0.9,2.8		
Ever had unprotected sex								

No	1		
Yes	1.3	0.8,2.3	

Results are adjusted relative risk ratios (aRR) and 95% confidence intervals (CI) from discrete-time, mixed-effects, proportional hazard models using multivariable logistic regression with a random effect for the woman and controlling for number of pregnancy months, pregnancy months squared and number of journals completed. P-values (P) significant for two-tailed alpha at <0.05*, <0.01**, and <0.001***. Outcome is the risk of experiencing a new pregnancy during the 1-year study period among all women (n=940). Self-reported pregnancy status was measured each week. Stress and covariates measured at baseline. [a]Perceived Stress Scale - 4 (PSS-4) - 9-point cut-off for moderate/severe stress symptoms. Regression modeling was also conducted to examine the effect of mental health symptoms on pregnancy outcomes over an 18-month study period (n=176 pregnancies) and point estimates were similar to those from the 1-year models (not shown).

Table 4. The effect of baseline mental health symptoms on pregnancy risk over one year among women without and with a history of pregnancy

	Women without a prior pregnancy (n=734)		Women with a prior pregnancy (n=206)	
	aRR	CI	aRR	CI
Mental health symptoms[ab]				
None	1		1	
Depression only	1.0	0.4,2.4	0.5	0.1,1.8
Stress only	0.7	0.2,2.5	3.0*	1.1,8.8
Depression and stress	2.3*	1.2,4.3	1.4	0.5,3.7
Receiving public assistance				
No	1		1	
Yes	1.9*	1.1,3.6	1.3	0.6,3.1
Mother's age at first birth				
≥20 years old	1		1	
<20 years old	2.9***	1.7,5.2	1.0	0.5,2.1
Cohabitation status				
Not cohabitating	1		1	
Cohabitating	1.7	0.9,3.2	2.9*	1.3,6.6
Age at coitarche				
≥ 16 years	1		1	
<16 years	6.0***	2.8,12.8	1.1	0.4,2.8

Results are adjusted relative risk ratios (aRR) and 95% confidence intervals (CI) from discrete-time, mixed-effects, proportional hazard models using multivariable logistic regression with a random effect for the woman and controlling for number of pregnancy months, pregnancy months squared and number of journals completed and significant covariates. P-values (P) significant for two-tailed alpha at <0.05*, <0.01**, and <0.001***. Outcome is the risk of experiencing a new pregnancy during the one-year study period among women without a history of previous pregnancy (n=734) and among women with a previous pregnancy (n=206). Self-reported pregnancy status was measured each week. Depression, stress and covariates were measured at baseline. [a]Center for Epidemiologic Studies – Depression Scale (CES-D-5) – 4 point cut-off for moderate/severe depression symptoms. [a]Perceived Stress Scale - 4 (PSS-4) - 9-point cut-off for moderate/severe stress symptoms. Regression modeling was also conducted to examine the effect of mental health symptoms on pregnancy outcomes over an 18-month study period (n=176 pregnancies) and all point estimates were similar to those from the 1-year models (not shown).