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Original Article

Andrya J. Durr, BS, Elizabeth A. Critch, MBA, M. Paula Fitzgerald, PhD, Kelly M. Devlin, MD, Kylie A. Fuller, MD and Roberta I. Renzelli-Cain*, DO, MHS

Untangling the roots of the West Virginia opioid crisis: relationships in adolescent pregnancy, drug misuse, and future outcomes

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Abstract

Context: West Virginia (WV) is afflicted by high rates of teenage pregnancy and births, opioid usage during pregnancy, and Neonatal Abstinence Syndrome births. Current efforts are ineffective at reducing teenage pregnancy and opioid misuse. While pregnancy and opioid usage may appear to be separate issues, a number of associations suggest adolescent pregnancy, opioid use, and other health-related outcomes are part of a cluster of negative health conditions that should be addressed holistically.

Objective: To determine whether there is an association between teenage pregnancy and negative health outcomes, including opioid misuse, among WV adolescent girls.

Methods: This study was conducted from July 2018 to March 2019. We obtained the most recently-available aggregate data at the county level for each of the 55 WV counties from the WV Department of Health and Human Resources (WVDHHR) on July 30, 2018, and we analyzed it during the fall of 2018. Raw data regarding pregnancy-related outcomes included WV girls between the ages of 15 and 19, was acquired between 2014 and 2017 by county, and was provided by the WVDHHR as a mean taken across all four years. Raw data regarding opioid misuse outcomes and heart-health variables included WV girls and women of all ages, was collected between 2014 and 2017 by county, and was provided by the WVDHHR as a mean taken across all four years, unless stated otherwise. Pearson correlation analysis was utilized to examine the associations between the teenage pregnancy and birth rates, opioid misuse, pregnancy, and heart-health-related statistics, as well as environmental variables.

Results: Teenage pregnancy and birth rates were positively associated with fetal death rates ($r=0.308$, $p<0.05$ and $r=0.261$, $p<0.10$, respectively). The rate of fetal death among mothers aged 15–19 years was higher in counties with higher teenage pregnancy and birth rates. As the pregnancy and birth rates increased, the rate of abortion increased even more ($r=0.434$ and $r=0.304$ respectively, both $p<0.05$). Teenage pregnancy and birth rates were associated with opioid overdose death rates for all WV girls and women (Pearson correlations, $r=0.444$ and 0.418 respectively, both $p<0.01$). WV counties with higher pregnancy and birth rates among girls aged 15–19 years had a greater proportion of women dying from opioid overdose. Teenage pregnancy and birth rates were both positively correlated with obesity, physical inactivity, high cholesterol, and high blood pressure (all $r>0.39$, all $p<0.05$). Neither the high-school dropout rate nor the number of WVDHHR listed clinics were associated with teenage pregnancy or birth rates ($p>0.10$).

Conclusion: Reduction of unintended teenage pregnancy may be viewed as a nontraditional, holistic, method of ameliorating the opioid misuse crisis in the state of WV. This recommendation should be part of a multi-pronged

***Corresponding author: Roberta I. Renzelli-Cain**, DO, MHS, West Virginia National Center for Excellence in Women's Health, West Virginia University, Morgantown, WV, USA; and Department of Obstetrics and Gynecology, School of Medicine, West Virginia University, 1 Stadium Drive, Morgantown, WV, 26506-9186, USA, E-mail: rir0001@hsc.wvu.edu

Andrya J. Durr, BS, West Virginia National Center for Excellence in Women's Health, West Virginia University, Morgantown, WV, USA; and Division of Exercise Physiology, West Virginia University, Morgantown, WV, USA

Elizabeth A. Critch, MBA, West Virginia National Center for Excellence in Women's Health, West Virginia University, Morgantown, WV, USA

M. Paula Fitzgerald, PhD, West Virginia National Center for Excellence in Women's Health, West Virginia University, Morgantown, WV, USA; and John Chambers College of Business and Economics, West Virginia University, Morgantown, WV, USA

Kelly M. Devlin, MD **and Kylie A. Fuller,** MD, West Virginia National Center for Excellence in Women's Health, West Virginia University, Morgantown, WV, USA; and Department of Obstetrics and Gynecology, School of Medicine, West Virginia University, Morgantown, WV, USA

approach to mitigating the opioid epidemic in WV and all of Appalachia.

Keywords: adolescent; drug misuse; heart; Intrauterine Device (IUD); Neonatal Abstinence Syndrome; opioid; pregnancy; prevention; West Virginia.

Teenagers in the United States (US) have the highest teenage pregnancy rates among developed nations, and are more likely to give birth than teenagers in any other industrialized country in the world.[1] West Virginia (WV) ranks as the seventh worst state in the nation for women to reside,[2] eighth in teenage birth rates, and seventh in teenage pregnancy rates.[3] Many individual counties in WV have teenage pregnancy rates above the national average.[3] Moreover, in the southern region of the state, particularly in Mingo and McDowell counties, teenage pregnancy rates are significantly higher, at three times the national average.[3] Yet, the persistently high rates of teenage pregnancy in WV are frequently underrecognized. The mean WV teenage pregnancy rate includes more prosperous counties such as Monongalia and Gilmer where rates are lower, creating a false impression of success in battling high teenage pregnancy rates over time. Even in the context of a country with already-high teenage pregnancy and birth rates when compared with other industrialized nations,[4] WV shows rates of teenage pregnancy, opioid drug misuse among pregnant women,[1,5] and babies born with Neonatal Abstinence Syndrome (NAS)[6] higher than the US average.

The opioid epidemic has become a hallmark of the Appalachian region, but among the states hardest hit by opioid misuse, WV had the highest rate of death due to drug overdose in 2018.[7–10] The typography of the state creates challenges for continuing medical education of its healthcare providers, and the areas of greatest need in WV are tucked away in mountainous terrain, falling short in access to medical care exacerbated by insufficient transportation.[11,12]

In WV, the adolescent population lacks access to preventive health care, including reliable contraception.[11–13] This barrier drastically reduces the availability of long-acting reversible contraception (LARC), the most effective and highly recommended method of contraception for adolescent girls.[14,15] Ultimately, WV adolescents endure the long-term consequences of unprotected sexual encounters and unintended pregnancies.[14,16] Therefore, it is not by accident that WV adolescents are plagued with interruption of education, opioid misuse, high rates of poverty, and opioid overdose-related deaths.[5,17] It appears that adolescents – and particularly girls – in WV have become a vulnerable, at-risk population that has been either overlooked or ignored.[11,14,16]

Due to the life-threating nature of opioid addiction, the focus in WV has been treating those afflicted with opioid addiction and overdose, as well as the prevention of unnecessary opioid prescriptions.[8,18] While treatment remains an invaluable aspect of mitigating the opioid epidemic, the long-term solution lies in prevention. The key to putting out a fire is not to douse the flames, but to aim at the base.

The goal of this study was to identify associations between teenage pregnancy/birth rates and negative health outcomes, including opioid misuse, among WV adolescents. Due to high rates of teenage pregnancy and births, opioid usage during pregnancy, and NAS births, we hypothesized that we would observe significant correlations between teenage pregnancy/birth rates and clusters of detrimental behaviors observed heavily throughout nearly all counties in the state concomitantly challenged by high rates of opioid usage that increases risk of overdose and multiple medical comorbidities. This data presents a necessary contribution to a holistic approach to reduction of the opioid crisis and the potential of that approach to improve the lives of WV adolescent girls.

Methods

We obtained the most recently-available aggregate data at the county level for each of the 55 WV counties from the WV Department of Health and Human Resources (WVDHHR). The data was obtained on July 30, 2018, and analyzed during fall 2018. All authors participated in data review, which was performed in January 2018. Because there was no patient contact, no institutional review board approval was sought or required. Raw data regarding pregnancy-related outcomes included WV girls between the ages of 15 and 19, was acquired between 2014 and 2017 by county, and was provided by the WVDHHR as a mean taken across all four years. Raw data regarding opioid misuse outcomes and heart-health variables included WV girls and women of all ages, was collected between 2014 and 2017 by county, and was provided by the WVDHHR as a mean taken across all four years, unless stated otherwise.

WV teenage pregnancy and birth rates for girls age 15–19 years were calculated based on the ratio of the number of pregnancies or resident births to the estimated population, provided by county, for girls in the same age group. Further, teenage pregnancy rates were derived from the difference in birth and fetal death rates, and included births that occurred outside of the state but were documented to WV residents. This was not the case for abortion rates, as estimates for abortions are provided only for those

that occurred inside the state; abortions performed outside the state were not reported. All drug use, misuse, and overdose data were opioid specific. The data for are aggregate opioid statistics were not distinguished by type, prescription/recreational use, or legal/illegal status of acquisition. Each county level statistic was adjusted to correct for differences in population size using the estimated population of girls aged 15–19 for the respective county from 2014 to 2017.

We were primarily interested in the associations between pregnancy/birth rates and several categories of important health variables: (1) pregnancy-related variables; (2) opioid misuse-related outcomes; (3) heart-health variables; and (4) environmental characteristics. Pregnancy-related variables included fetal death and abortion rates for girls aged 15–19 years. The following opioid misuse-relevant outcomes were included to explore the associations between teenage pregnancy/birth rates and opioid misuse: (1) overdose death rates among WV female residents of all ages; (2) NAS births, calculated as a total percent of resident births for all ages; and (3) percent of mothers using opioids during pregnancy relative to the total number of births for all ages.

Heart-health variables were included for WV adult women to explore the associations between teenage pregnancy/birth rates and common determinants of heart health.[19–23] The variables included: (1) percent of obesity among WV adult women from 2013 to 2017; (2) percent of physical inactivity among WV adult women from 2013 to 2017; (3) mean percentage of WV adult women with high cholesterol in 2009, 2011, 2013, 2015, and 2017; and (4) mean percentage of WV adult women with high blood pressure in 2009, 2011, 2013, 2015, and 2017. Criteria for each variable was defined in the WV Behavioral Risk Factor Surveillance System Report 2017[24]: obesity was defined as a body mass index (BMI) of 30 or greater; physical inactivity was described as participating in no leisure-time physical activity or exercise; high total serum cholesterol levels were considered 240 mg/dL or greater; and high blood pressure was considered 140/90 mm Hg or higher until 2017, when high was redefined as 130/80 mm Hg or more.

Finally, two environmental factors were examined to determine whether they correlated to teenage pregnancy and birth rates: (1) high-school dropout percentage for WV women age 18 years and older (students are required to attend school through age 17) from 2016 to 2017, and (2) number of WVDHHR listed clinics per number of girls aged 15–19 years.

Pearson correlation analysis was used to examine these key associations using the SPSS software analysis program (IBM). Pearson correlation (r) estimates the strength of a linear association between two or more factors. Pearson correlations range between –1 and 1; the larger the absolute value of the Pearson correlation, the stronger the association. These correlations allowed us to examine the association between the rates of teenage pregnancies/births and the rates of other health outcomes across the 55 WV counties. For example, if the teenage pregnancy rate was unrelated to the overdose death rate of all WV women, then the Pearson correlation would not differ significantly from zero. A correlation of zero, in that case, would indicate that regardless of the teenage pregnancy rate in a particular county, the percentage of WV women who suffered an overdose in that county is approximately the same across the state. If that correlation was positive (i.e., greater than zero), then we could conclude that WV counties with higher teenage pregnancy rates had a higher percent of WV women who died from an opioid overdose. The square of the Pearson correlation (r^2) is interpreted similarly to an R^2 value in a linear regression. Specifically, a Pearson square correlation can estimate explained variance. A p-value of up to 0.10 was considered statistically significant, following guidance from the American Statistical Association.[25] Our sample size is small, as there are only 55 counties in WV; thus, statistical power was low. Again, Pearson correlations allowed us to estimate effect sizes, thereby gaining an understanding of how strong each effect was.

Table 1: Minimum, maximum, and mean variable values among female residents of 55 counties in West Virginia (WV).

	Minimum	Maximum	Mean
Pregnancy-related variables[a]			
Fetal deaths	0	5	0.75
Abortions	0	140	9.73
Estimated pregnancies	18	859	130.85
Estimated population	614	20,343	3,867.96
Births	18	718	120.38
Opioid misuse-related statistics[b]			
Overdose deaths	0	164	20.71
Percent NAS births	0.34	9.65	3.63
Percent of mothers using drugs during pregnancy	1.36	15.02	5.94
Heart-health variables[c]			
Percent obesity	27.11	50.33	36.58
Percent physical inactivity	19.88	43.68	32.8
Percent high cholesterol	27.04	52.34	40.26
Percent high blood pressure	24.87	48.54	39.79
Environment characteristics[c]			
Percent of high-school dropouts	0	3.17	0.76

NAS, Neonatal Abstinence Syndrome. [a]Population: girls aged 15–19 years. [b]Population: all female residents of WV. [c]Population: women aged 18 years and older.

Table 2: Correlations between study variables and pregnancy/birth rates.

	Pregnancy rate, girls aged 15–19 years	Birth rate, girls aged 15–19 years
Birth rate[a]	0.989^{+++} Strong	–
Pregnancy-related variables[a]		
Fetal death rate	0.308^{++} Moderate	0.261^{+} Weak
Abortion rate	0.434^{+++} Moderate	0.304^{+++} Moderate
Opioid misuse-related statistics[b]		
Overdose death rate	0.444^{+++} Moderate-strong	0.418^{+++} Moderate-strong
NAS births	−0.219 None	−0.215 None
Percent of mothers using drugs during pregnancy	0.134 None	0.099 None
Heart-health variables[c]		
Obesity rate	0.408^{+++} Moderate-strong	0.431^{+++} Moderate-strong
Physical inactivity	0.429^{+++} Moderate-strong	0.408^{+++} Moderate-strong
High cholesterol	0.391^{++} Moderate-strong	0.394^{++} Moderate-strong
High blood pressure	0.467^{+++} Moderate-strong	0.457^{+++} Moderate-strong
Environmental characteristics		
High-school dropout rate[a]	0.110 None	0.092 None
Number of WVDHHR listed clinics per number of girls aged 15–19 years	0.169 None	0.163 None

NAS, Neonatal Abstinence Syndrome. [a]Population: girls ages 15–19 years. [b]Population: all female residents of West Virginia. [c]Population: women aged 18 years and older. Population: girls ages 15–19 years. $^{+}$significant at p<0.10. $^{++}$significant at p <0.05. $^{+++}$significant at p<0.01.

Results

Table 1 shows the minimum, maximum, and mean values for each variable's raw data (either numbers or percentages) as provided by the WVDHHR. The minimum is the smallest value of the variable in any county. The maximum is the largest value of the variable in any county. The mean reflects pregnancies across all counties. These data points are important because they show wide variability between counties for the same variable while providing a comparative mean across the state. For example, the lowest number (minimum) of pregnancies in girls ages 15–19 recorded in a county was 18 for the study period, the highest (maximum) number of pregnancies in a single counted was 859 (mean, 130.85 pregnancies per county; Table 1.

Pregnancy-related variables

Teenage pregnancy and birth rates were positively associated with fetal death rates (r=0.308, p<0.05 and r=0.261, p<0.10, respectively; Table 2). The rate of fetal death among mothers aged 15–19 years was higher in counties with higher teenage pregnancy and birth rates. These associations are also of practical significance, with an effect size of approximately 7% (Pearson correlation for birth rates and fetal death rates, r=0.261; 0.261^2=0.068; Table 2).The same was true of abortion: as the pregnancy and birth rates increased, the rate of abortion increased even more (r=0.434 and r=0.304 respectively, both p<0.05; Table 2). Counties with higher teenage pregnancy and birth rates had not only a significantly larger absolute number of fetal deaths and abortions (as would be expected), but the percentage of teenage pregnancies that ended in abortion was significantly higher in these counties than in other WV counties with lower teenage pregnancy rates. This was a strong effect, with an effect size of approximately 19% (Pearson correlation for pregnancy rates and abortion rates, r=0.434; 0.434^2=0.188; Table 2).

In Table 2, we report three probability levels: p<0.01, p<0.05, and p<0.10. A p-value over p=0.05 is usually accepted as insignificant, but there was only one correlation that we interpreted as statistically significant at the p<0.10 level, which was the correlation between fetal death rate and birth rate (r=0.261). These associations are of importance to the conclusions of this study, and provide insight into county specific associations. This finding corroborates the significant correlation between pregnancy rates and fetal death rates (r=0.308; p<0.05).

Opioid misuse-related statistics

Teenage pregnancy and birth rates were associated with opioid overdose death rates for all WV girls and women (Pearson correlations, r=0.444 and 0.418 respectively, both p<0.01; Table 2). WV counties with higher pregnancy and birth rates among girls aged 15–19 years had a greater proportion of women dying from opioid overdose. These associations are practically meaningful given that the explained variance is over 17% (the Pearson correlations squared, 0.444^2). There were no statistically significant associations between teenage pregnancy or birth rates and the percent of mothers using opioids during pregnancy

(both p>0.10), nor were there associations between teenage pregnancy or birth rates and the number of babies born with NAS (both p>0.10; Table 2).

Heart-health variables

Statistically significant correlations were observed for all four heart-health variables. Teenage pregnancy and birth rates were both positively correlated with obesity, physical inactivity, high cholesterol, and high blood pressure (all r>0.39, all p<0.05; Table 2). These associations are meaningful; each had an effect size over 15%.

Environment characteristics

Neither the high-school dropout rate nor the number of WVDHHR listed clinics were associated with teenage pregnancy or birth rates (p>0.10).

Discussion

Our results identified numerous associations between teenage pregnancy and birth rates, opioid misuse, and future heart-health outcomes. Significant association was identified between the teenage pregnancy/birth rates and the corresponding opioid overdose death rate in the same county. These results suggest that counties experiencing higher teenage pregnancy and birth rates are also experiencing high rates of overdose and death. While we acknowledge that our data do not provide causative evidence that teenage pregnancy or birth leads to opioid misuse, the correlative analysis results support a linear association between these variables.

Adolescent pregnancy is related to risk of opioid misuse and negative heart-health outcomes in adulthood. Our finding that pregnancy and birth rates were associated with higher fetal death rates reveals a significant negative impact on adolescent health. If a girl between the ages of 15–19 years becomes pregnant in a county with a high pregnancy rate, our results suggest that she is more likely to suffer a fetal death than a girl who becomes pregnant but lives in a county with a lower pregnancy rate. The proportion of fetal deaths was not a stable factor across the state in our data set; instead, the proportion of fetal deaths was positively associated with pregnancy and birth rates such that higher pregnancy and birth rates indicated a higher likelihood of the fetus not surviving. Thus, the practical implications of this general finding are of such importance, that disregarding correlations with probability levels greater than 0.05, but effect sizes of greater than 6%, may lead to more adolescent females suffering loss. In this case, it is important that we be aware of this relationship because the effect size is large enough to warrant attention, even though the p-value would typically be considered insignificant. The relationship between birth and fetal deaths is strong enough to have practical implications for medical interventions. This reveals that the counties with the highest pregnancy and birth rates also have the highest rates of fetal death and abortions, as well as the highest rates of opioid overdose and death.

The significant associations observed in our study between teenage pregnancy and birth rates and all heart-health variables provide additional insight into the status of their respective counties. Based on our results, we conclude that counties experiencing higher rates of teenage pregnancy and birth are likely to have higher percentages of adult women with poor heart-health variables. Because the women included in the data set used for heart-health variable analysis were not verified to be pregnant as teenagers, nor were the same women followed over time, no conclusions can be drawn about the impact of teenage pregnancy or birth on future health outcomes. Instead, it is clear that counties where adult women have poor heart-health indices are also experiencing high rates of teenage pregnancy.

Taken together, our results demonstrate that health outcomes are intertwined. Counties with high rates of opioid misuse, teenage pregnancy and births, fetal death, and abortion rates are also home to women with undesirable heart health indices; the converse is also true. These variables, though their associations are correlative, indicate that the overall health of the county may be predictable, modified, and enhanced by cultivating these interrelated variables.

Our study results are limited because our analysis was correlative, rather than causative. It should be noted that the data collected for heart-health variables for adult women was independent of the data collected regarding teenage pregnancy. Therefore, we cannot conclude that teenage pregnancy itself increases an individual's risk of negative health outcomes. These results indicate that negative health outcomes cluster and need to be treated holistically, emphasizing the importance of healthcare providers in these environments – specifically osteopathic physicians, whose philosophy and training are rooted in deep understanding of interrelationships.

High rates of teenage pregnancy, birth, and opioid misuse are amongst WV's greatest challenges. With current efforts to ameliorate the opioid crisis underway, we suggest

additionally focusing on the reduction of teenage pregnancy as a method to improve overall health in WV. Reducing opioid usage is difficult because misuse is typically secretive and undocumented until there is an overdose. Teenage pregnancy, on the other hand, is a measure that is easier to target due to strong documentation afforded by vital statistics. Additionally, teenage pregnancies are often unintended, and many teenagers would willingly work to prevent pregnancy given the availability of education and access.[26–28]

We argue that WV needs greater focus on preventive programs to mitigate both unintended pregnancy and the opioid crisis. We, the WV National Center of Excellence in Women's Health, are devoted to teenagers and their future well-being. Our goals are to prevent the poverty, hopelessness, and helplessness, all of which may lead to unhealthy coping strategies through opioid misuse and addiction. Reducing unintended teenage pregnancy shows the potential to not only aid in the amelioration of the ever-growing opioid crisis, but to improve the long-term quality of life of adolescents in WV. It should be noted that although it was not the purpose of this study to investigate outcomes or correlation with boys and men, the lives of young men are also deleteriously affected by teenage pregnancy and opioid misuse, with similar outcomes and solutions.

Future directions for this project include the development of a statewide program that would strive to provide education to adolescents, health care providers, and contraception to teenagers to prevent unintended pregnancy. Similar to the methodology conducted in the Colorado project, which showed reduction of teenage births and abortions by 50% between 2009 and 2014 by focusing on education and access to contraception, specifically LARC,[26,27] we aim to reduce unintended teenage pregnancy in both general and drug using populations as a potential means to decrease a number of negative health outcomes that may be a critical step in mitigating the opioid crisis.

We suggest that preventing unintended teenage pregnancy may mitigate overdose deaths and other negative health outcomes. Indeed, reducing teenage pregnancies may sever one of the links in this chain of interrelationships. Our suggestion is similar to the joint Obstetric Care Consensus by the American College of Obstetricians and Gynecologists and the Society for Maternal Fetal Medicine's approach to reducing the cesarean section rate by focusing on prevention on the first Cesarean birth.[28] While teenage pregnancy is a central focus, this recommendation should be part of a multipronged approach to mitigating the opioid epidemic in WV and all of Appalachia.

Again, the goals of this project are consistent with the tenets of osteopathic medicine. Osteopathic care prioritizes the identification and treatment of underlying disease states, as well as symptoms. This principle applies to WV teenage pregnancy and the opioid epidemic described. By nature of our education, osteopathic physicians have a unique medical perspective and view complex medical problems, such as the opioid epidemic, from an overarching and holistic lens. As such, we can lead in mitigating the opioid epidemic in WV and nationally.

Conclusion

In WV, mitigation of the opioid crisis and high teenage pregnancy rates – both of which are significant in the state – has the potential to yield an improved quality of life for all residents. There are foreseeable opportunities for improved education and accessibility to contraception and the choice to prevent pregnancy.

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Competing interests: The corresponding and first author, through collaboration with the West Virginia University Heart and Vascular Institute, the West Virginia University Clinical and Translational Science Institute, the National Institute of Health, and the National Institute of General Medical Sciences, were recently awarded a grant investigating myocardial blood flow in menopausal women through magnetic resonance imaging, with and without hormone replacement therapy. Dr Renzelli-Cain is currently involved in a writers' agreement and is funded by AbbVie Pharmaceuticals. AbbVie Pharmaceutical

manufactures the drug Vicodin, which is used to manage pain. The author's writer's agreement and currently-funded grant with AbbVie Pharmaceuticals pertains to a study and publication with Orilissa (elagolix), a medication used to treat endometriosis and associated pelvic pain and dyspareunia. Dr Renzelli-Cain does not speak on long-acting reversible contraceptives or any other form of contraception. Dr Renzelli-Cain is also an unpaid speaker for Hologic-Cynosure. Her lectures describe the novel use of MONA LISA laser treatment for genitourinary syndrome of menopause and associated dyspareunia. These associations did not influence the methodology, analysis, or conclusions of this article.

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