Residential Proximity to Oil and Gas Development and Mental Health in a North American Preconception Cohort Study: 2013–2023

Mary D. Willis, PhD, MPH, Erin J. Campbell, BS, BA, Sophie Selbe, MPH, Martha R. Koenig, MPH, Jaimie L. Gradus, DSc, MPH, Yael I. Nillni, PhD, Joan A. Casey, PhD, MA, Nicole C. Deziel, PhD, MHS, Elizabeth E. Hatch, PhD, MS, Amelia K. Wesselink, PhD, MPH, and Lauren A. Wise, ScD, ScM

Objectives. To evaluate associations between oil and gas development (OGD) and mental health using cross-sectional data from a preconception cohort study, Pregnancy Study Online.

Methods. We analyzed baseline data from a prospective cohort of US and Canadian women aged 21 to 45 years who were attempting conception without fertility treatment (2013–2023). We developed residential proximity measures for active OGD during preconception, including distance from nearest site. At baseline, participants completed validated scales for perceived stress (10-item Perceived Stress Scale, PSS) and depressive symptoms (Major Depression Inventory, MDI) and reported psychotropic medication use. We used log-binomial regression and restricted cubic splines to estimate prevalence ratios (PRs) and 95% confidence intervals (CIs).

Results. Among 5725 participants across 37 states and provinces, residence at 2 km versus 20 to 50 km of active OGD was associated with moderate to high perceived stress (PSS ≥ 20 vs < 20: PR = 1.08; 95% CI = 0.98, 1.18), moderate to severe depressive symptoms (MDI ≥ 20 vs < 20: PR = 1.27; 95% CI = 1.11, 1.45), and psychotropic medication use (PR = 1.11; 95% CI = 0.97, 1.28).

Conclusions. Among North American pregnancy planners, closer proximity to OGD was associated with adverse preconception mental health symptomatology. (*Am J Public Health*. 2024;114(9):923–934. https://doi.org/10.2105/AJPH.2024.307730)

AJPH September 2024, Vol. 114, No. 9

An estimated 17.6 million US residents reside within 1 mile (1.6 km) of an active oil or gas development site,[1] and there is oil and gas activity close to many communities in Canada.[2] A wide range of geographies in both countries are affected by oil and gas development (OGD), although the amount of production varies by region based on geology (OGD production varies based on geology in, e.g., the key states CA, LA, OK, PA, and TX and the key provinces AB and BC).[2,3] This industry is projected to continue its rapid expansion in North America through 2050.[2,3] OGD produces air pollution, water contamination, and excess noise and light,[4–10] all of which may harm human health.[11–14] Previous work has identified associations between residential proximity to OGD and adverse health outcomes,[14] such as asthma exacerbations,[15–17] gestational hypertension,[18] preterm birth,[19–21] decreased birth weight,[22–24] and birth defects.[25,26]

Beyond their environmental hazards, extractive industries, such as OGD, create cycles of boom-and-bust economies, resulting in precarious employment and social disruption for affected communities.[27–29] Although OGD can generate considerable revenue,[30,31] the economic advantages accrue primarily to those who own mineral rights or work in the gas industry. These individuals often do not live near extraction sites.[31] Local communities—the people most exposed to the impacts of OGD—have little input on siting decisions in their communities or on amelioration of extraction-related exposures.[32,33] The confluence of swiftly changing economic, social, and environmental community conditions[34,35] may create stress and anxiety among residents who live nearby (Figure A, available as a supplement to the online version of this article at http://www.ajph.org).[27,31]

Previous work has documented that as OGD enters communities, there is an increased prevalence of psychological stressors[34,35] and symptoms of depression and anxiety.[36–40] This association is stronger among women and pregnant populations.[34,36–38] Although maternal mental health is a growing research area,[41] the preconception period remains understudied relative to the prenatal and postpartum periods.[42,43] Worse preconception mental health has been associated with reduced fecundability,[44,45] irregular menstrual cycles,[46] pregnancy complications,[47] and adverse birth outcomes.[47] Complex environmental, social, and economic exposures, such as those resulting from resource extraction, may be important risk factors for adverse preconception mental health.[48]

We investigated associations of residential proximity to and density of active oil or gas development with markers of psychosocial stress and depressive symptoms using baseline data from a North American preconception cohort study of couples trying to conceive without the use of fertility treatments.

METHODS

Pregnancy Study Online (PRESTO) is an ongoing Internet-based preconception cohort study of pregnancy planners who reside in the United States or Canada[49] and includes participants from every US state and Canadian province. Eligible participants were aged 21 to 45 years, identified as female, and were attempting to conceive without the use of fertility treatments. PRESTO recruited participants primarily through social media and health-related Web sites. After completing an eligibility screener questionnaire, participants completed a detailed baseline questionnaire on sociodemographic, behavioral, clinical, and reproductive factors. We used data from the baseline questionnaire and a cross-sectional study design.

Assessment of Exposure to Oil and Gas Development

We obtained data from a national database of OGD well locations in the United States and Canada: Enverus (formerly known as DrillingInfo, https://www.enverus.com). This database provides information on geographic locations of OGD (i.e., latitude and longitude coordinates), key dates (i.e., spud date, first production date, last production date, completion date), production type (e.g., oil, gas), and drilling type (e.g., horizontal, vertical, directional). Once a site was drilled, we considered the site active until it had an end date for production.

We assigned individual exposure metrics based on the proximity and density of active OGD sites within 20 km of the participant's address reported on their baseline questionnaire (Figure B, available as a supplement to the online version of this article at http://www.ajph.org). Using the date of their completed questionnaire, we also considered different time windows when calculating these metrics. We based metrics on sites active at the time of baseline questionnaire completion and included (1) proximity, defined as distance to the nearest active oil or gas development site; (2) intensity of new OGD, defined as the inverse distance-squared weighted sum of newly drilled OGD sites in the 3 years preceding the baseline questionnaire; and (3) intensity of all oil or gas development, defined as the inverse distance-squared weighted sum of OGD sites. Inverse distance-squared weighting is the standard for measurement in this area of work because it upweights closer sites that are likely more relevant for health.[13,50] Per the existing literature, the 20-km distance measurement is considered relevant to health because of the transport of emitted chemicals and alterations in the landscape.[6,14,28]

Assessment of Mental Health Outcomes

On the baseline questionnaire, participants completed the 10-item version of the Perceived Stress Scale (PSS), a measure of how unpredictable, uncontrollable, and overwhelming individuals find their life circumstances. This measure is reliable for recent stress in the previous 4 to 8 weeks and is highly correlated with acute physical symptoms and health care utilization.[51,52] They also completed the Major Depression Inventory (MDI), a 12-item measure of reported depressive symptoms over the previous 2 weeks. MDI sensitivity is 0.86 to 0.92 and specificity is 0.82 to 0.86, compared with clinician-diagnosed major depression.[53–55] Participants also reported their current use of any psychotropic medications for anxiety, depression, or other indications, such as sleep disorders

AJPH September 2024, Vol. 114, No. 9

(e.g., anxiolytics, anticonvulsants, antipsychotics, atypical antidepressants, benzodiazepines, beta-blockers, mood stabilizers, sedative hypnotics, selective serotonin-norepinephrine reuptake inhibitors, selective serotonin reuptake inhibitors, stimulants, tetracyclic antidepressants, tricyclic antidepressants).

Between June 2013 and July 2023, 17 356 eligible self-identified female participants completed the baseline questionnaire. We excluded participants if they did not complete the baseline questionnaire within 60 days of the eligibility screener (n = 47; 0.3%), provided implausible or missing data on last menstrual period date (n = 217; 1.3%), had more than 6 cycles of pregnancy attempts at time of enrollment (i.e., subfertility, a risk factor for stress and depressive symptoms; n = 3386; 19.5%), had a baseline residential address that could not be geocoded to the street level (n = 1321; 7.6%), or was greater than 50 km from 1 or more active oil or gas development sites (n = 6660; 38.4%). These criteria yielded 5725 participants for analysis.

Statistical Analysis

We examined sociodemographic characteristics of the cohort by exposure. Because of a lack of established clinical cutpoints for the PSS, we dichotomized scores based on distributions in the cohort: less than 20 (no to moderate stress) and 20 or more (moderate to high stress).[45] For MDI, we dichotomized scores following standard categories of depression symptomatology: less than 20 (no to low depressive symptoms) and 20 or more (moderate to severe depressive symptoms).[44,46,55] We dichotomized variables for psychotropic medication use (current vs none). We imputed missing covariate and outcome information (< 5%) using fully conditional specification methods, whereby we generated 20 data sets and statistically combined the standardized parameter estimates and SEs.[56]

For the proximity analysis, we generated restricted cubic splines to explore the nonlinearity in the association between residential proximity to OGD and each outcome variable. For the intensity analyses, we grouped participants into tertiles based on the density of sites (i.e., low, medium, or high), provided the participants resided within 20 km of at least 1 active site. In both the proximity and intensity models, the unexposed comparison group comprised participants living 20 to 50 km from OGD.

We used log-binomial regression models to estimate prevalence ratios (PRs) and 95% confidence intervals (CIs) for each mental health outcome variable. We selected covariates using the existing literature and a directed acyclic graph (Figure C, available as a supplement to the online version of this article at http://www.ajph.org). OGD is a multifaceted exposure and has been associated with many predictors of mental health (e.g., household income, substance use, educational opportunities)[14,27,31]; therefore, many potential covariates are likely mediators of the exposure–outcome relation and should not be included in our models.[57]

Adjusted models included the following covariates: age (< 25, 25–29, 30–34, 35–39, ≥ 40 years); geographic region of residence (Northeast [NY, PA], South [AL, AR, FL, KY, LA, MD, MS, OK, TN, TX, VA, WV], Midwest [IN, IL, IA, KS, MI, MN, MO, NE, OH, SD], West [AK, AZ, CA, CO, NM, UT, WY], Canada [AB, BC, MB, SK]); season of baseline enrollment (winter [December, January, February], spring [March, April, May], summer [June, July, August], fall [September, October, November]); and year of baseline enrollment (between 2013 and 2023).

In accordance with modern statistical methods,[58,59] our approach to interpreting data was based on an evaluation of the magnitude, direction, and precision of the effect estimates, rather than binary significance testing (e.g., *P* values).

Sensitivity Analysis

Given that subfertility can deleteriously affect mental health,[60] to reduce the potential for selection bias and reverse causation bias, we repeated our primary analyses with only the participants who (1) had no history of infertility, and (2) had attempted to conceive for fewer than 3 menstrual cycles at the time of study entry. We also repeated primary analyses with only the participants who reported living at their current address for 1 year or more or provided the same zip code for their previous address, as longer-term residence may indicate inability to relocate or more accrual of adverse social and environmental exposures from OGD.[33,61] We also restricted our participants to those with a baseline household income less than $50 000, as those with fewer monetary resources may not have the ability to move away from OGD if desired.[31]

Statistical Software

We derived spatial exposure measures using R Statistical Software version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria) and conducted geocoding and statistical analyses using SAS version 9.4 (SAS Institute, Cary, NC). We generated restricted cubic splines using the %GLMCURV9 macro in SAS.[62]

RESULTS

The total sample consisted of 5725 participants residing within 50 km of active oil or gas development. The mean age at baseline was 30.0 years, and participants reported a mean of 2.1 cycles of pregnancy attempt at time of enrollment (Table 1). Participants residing closer to OGD were less likely to have a graduate school degree (e.g., 0 to < 5 km: 36.1%; 20 to < 50 km: 40.5%) and to report an annual household income of $150 000 or more (e.g., 0 to < 5 km: 16.9%; 20 to < 50 km: 21.4%). However, other characteristics were similar across distance groups, such as identifying as non-Hispanic White (e.g., 0 to < 5 km: 83.4%; 20 to 50 km: 83.6%) and living in an urban residential location (e.g., 0 to < 5 km: 97.3%; 20 to < 50 km: 97.2%). Residential locations spanned the United States and Canada and included areas with extensive OGD (Figure 1).

We observed the highest perceived stress among those living closest to an OGD site (Figure 2). For example, the PR at 2 km versus 20 to 50 km was 1.08 (95% CI = 0.98, 1.18), and this association was attenuated at farther distances. The prevalence of moderate to high perceived stress was also greatest in the high category for the all-development intensity exposure metric (PR = 1.09; 95% CI = 0.99, 1.21) relative to the 20 to 50 km comparison group (Table 2).

For our continuous measure of distance to the nearest OGD site, we observed the highest prevalence of moderate to severe depressive symptoms out to 10 km, relative to the 20 to 50 km comparison group (Figure 2). The associations were most elevated between 0 and 10 km; for instance, the association at 2 km versus 20 to 50 km was 1.27 (95% CI = 1.11, 1.45). In the intensity models, we observed little evidence of an association between new OGD and depressive symptoms; however, the PR for moderate to severe depressive symptoms was elevated across the low and high, but not the medium, categories of the all-development intensity exposure metric (Table 2).

We observed a weak positive association between distance to nearest OGD site and current psychotropic medication use (Figure 2). For instance, the PR at 2 km versus 20 to 50 km was 1.11 (95% CI = 0.97, 1.28). We observed little evidence of an association for the all-development intensity exposure metrics, but the highest prevalence of current psychotropic medication use was among those living in the highest category of new development exposure intensity (PR = 1.27; 95% CI = 1.03, 1.55) relative to the 20 to 50 km comparison group (Table 2).

Results were similar, although less precise, among participants without a history of infertility (n = 5151) and participants with fewer than 3 cycles of pregnancy attempt at time at enrollment (n = 3741; Table A; Figure D [available as a supplement to the online version of this article at http://www.ajph.org]). We observed somewhat similar but less precise associations among those who resided in their home for 1 or more years (n = 3625) and among lower income participants (n = 1176; Table A; Figure D).

DISCUSSION

Using cross-sectional data from a North American preconception cohort study, we found a greater prevalence of adverse mental health outcomes among participants residing closer to more active OGD. Our study is among the first to examine associations of residential proximity to OGD across the United States and Canada and focused on a population that may be highly susceptible to the health risks associated with the industry.[14,27,31] Specifically, proximity to active OGD was associated with elevated levels of perceived stress and depressive symptoms. Intensity of active OGD was also associated with greater levels of depressive symptoms, whereas intensity of newly drilled OGD was associated with current psychotropic medication use only. These results provide support for the hypothesis that resource-extractive industries, such as OGD, pose a hazard for the mental health of local communities.

Health-protective policies related to OGD often focus on setback distances (i.e., the minimum distance allowed between an oil or gas extraction site and a residential building) from sensitive receptors (e.g., homes, schools, health clinics).[63–65] The associations observed in our analyses persist farther away from the development sites than regulatory setback distances in most communities[63,65] Many states and provinces with extensive OGD activity, such as Colorado, Pennsylvania, and Texas, have had setback distances as small as 200 to 1000 feet (0.06–0.31 km).[63] California has proposed among the most stringent setback regulations in the United States, which would require 3200 feet (0.97 km) between new OGD and sensitive receptors.[66] Similar measures related to setback distances are being implemented in Canada, in Alberta, Manitoba, and Saskatchewan.[67–69] We found associations between OGD and adverse mental health out to 2 km, even as far away as 18 km for depressive symptoms. Our results generally align with a recent expert consensus on

AJPH September 2024, Vol. 114, No. 9

TABLE 1— Baseline Characteristics of Participants by Residential Proximity to Oil and Gas Development: Pregnancy Study Online, United States and Canada, 2013–2023

Characteristic	All Participants	Distance From the Nearest Active Oil or Gas Development Site, km				
		0 to <5	5 to <10	10 to <15	15 to <20	20 to <50
Total participants, no.	5725	1695	1055	678	613	1684
Mean age at enrollment, y	30.0	29.7	30.1	30.0	30.1	30.2
Mean pregnancy attempt time, cycles	2.1	2.1	2.0	2.1	2.0	2.1
Married to partner, %	88.2	87.6	86.7	88.9	89.9	88.5
Race/ethnicity, %[a]						
Non-Hispanic White	82.9	83.4	80.6	83.0	82.5	83.6
Non-Hispanic Black	3.4	3.7	4.0	2.4	2.5	3.5
Hispanic/Latina	7.2	6.5	7.7	8.2	7.7	7.0
Educational attainment, %						
< bachelor's degree	28.2	31.3	27.0	26.5	24.0	28.0
Bachelor's degree	33.5	32.5	37.5	36.0	35.6	31.4
Graduate school	38.4	36.1	37.3	37.5	40.4	40.5
Annual household income, US$, %						
< 50 000	20.5	21.1	20.9	19.3	20.2	20.5
50 000–99 999	36.3	38.4	36.2	34.4	34.3	35.6
100 000–149 999	24.3	23.6	26.3	26.8	25.1	22.4
≥ 150 000	18.8	16.9	16.6	19.5	20.5	21.4
Current smoker, %	6.2	7.9	7.0	4.6	3.9	5.3
No primary care physician visits in the last year, %	13.0	13.0	12.5	10.4	10.9	14.8
Ever been pregnant, %	53.1	54.2	51.8	52.8	49.2	53.7
History of infertility, %	10.0	11.4	9.9	9.1	8.0	9.7
Season of baseline enrollment, %						
Winter	28.4	28.5	26.0	30.7	25.1	29.7
Spring	24.9	24.3	25.0	21.2	27.3	26.1
Summer	23.9	24.0	25.8	24.5	23.8	22.6
Fall	22.8	23.1	23.1	23.5	23.8	21.6
Physician-diagnosed medical conditions, %						
Anxiety	27.2	26.6	27.0	28.8	28.6	26.4
Depression	26.8	28.8	27.4	26.3	28.6	25.8
Diabetes	1.7	2.7	1.3	1.2	1.3	1.3
Endometriosis	3.5	3.5	3.8	4.0	2.6	3.6
Polycystic ovarian syndrome	10.0	9.4	9.6	8.1	9.1	10.5
Thyroid condition	7.4	7.9	5.6	6.9	7.3	7.7
Urbanized residential location, [b] %	97.2	97.3	97.2	97.2	97.2	97.2
Sleeps < 7 h/night, %	25.9	27.9	25.6	25.2	25.6	24.1
Uses anxiety or depression medications, %	16.4	17.5	16.9	15.9	13.7	16.2
Perceived Stress Score ≥ 20, %	30.2	32.0	29.0	29.0	27.4	30.3
Major Depressive Inventory score ≥ 20, %	18.4	19.9	19.4	19.4	15.1	15.7

Note. All participant characteristics were age-adjusted, except for age. Missing covariate and outcome information (< 5%) was imputed via a fully conditional specification method.

[a]Race/ethnicity data were derived via self-identification using categories, allowing participants to select all that apply, and conceptualized as a social and political construct.

[b]Urbanicity was defined differently by country using their respective census data. For the United States, we defined urban addresses as an area with a population density of at least 1000 people per square mile and with a population of at least 2500 people. For Canada, we defined urban addresses as in a census metropolitan area (an area consisting of ≥ 1 neighboring municipalities situated around an urban core with a total population of > 100 000 of which > 50 000 live in the urban core).

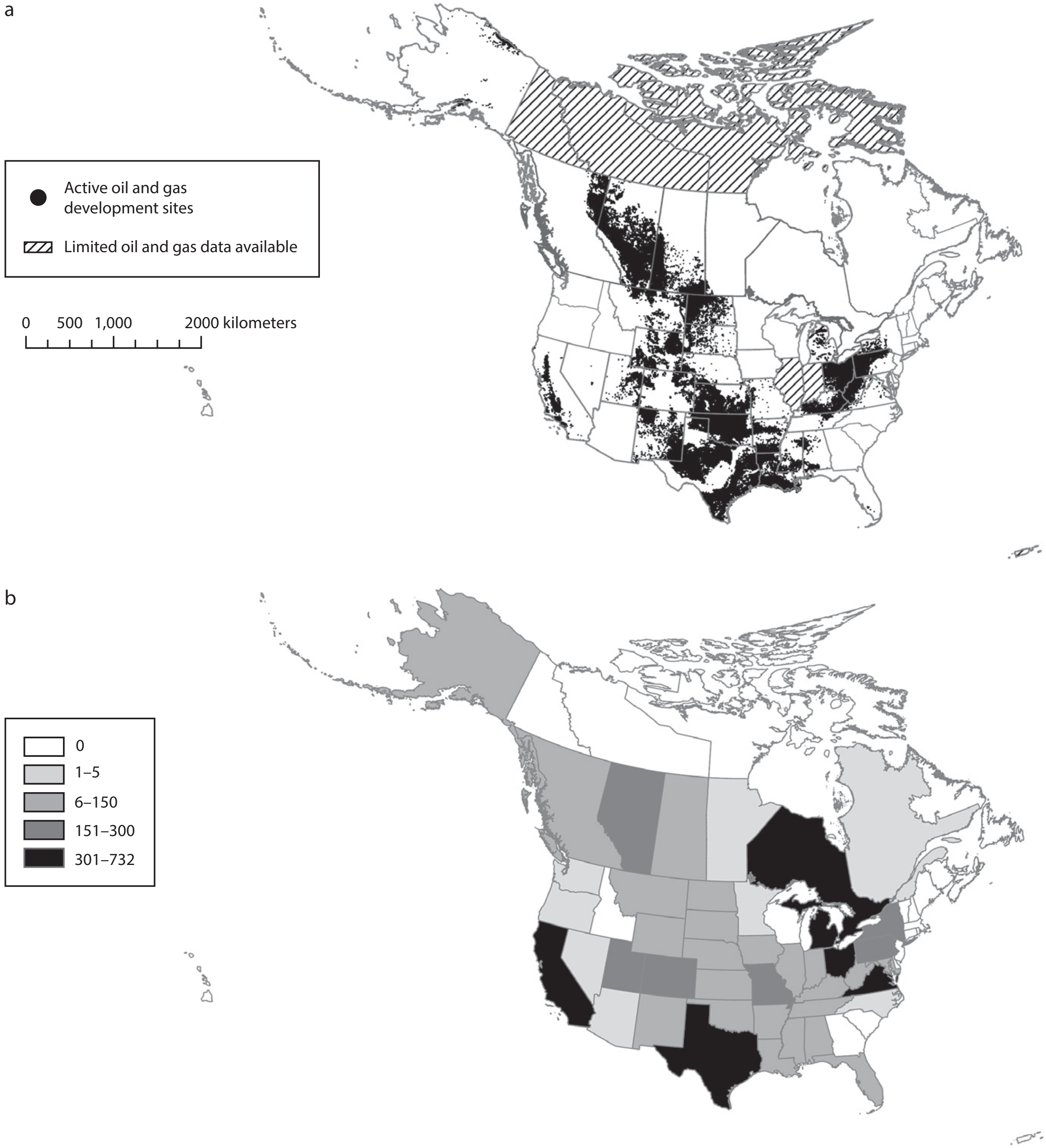

FIGURE 1— Active Oil and Gas Development Sites by (a) Spatial Extent in 2022 and (b) Number of Participants Within 50 km of a Site: Pregnancy Study Online (PRESTO), United States and Canada, 2013–2023

Note. A total of 1 151 504 active oil and gas sites were observed in the United States and Canada in 2022, and 5725 PRESTO participants resided within 50 km of an active oil or gas development site.

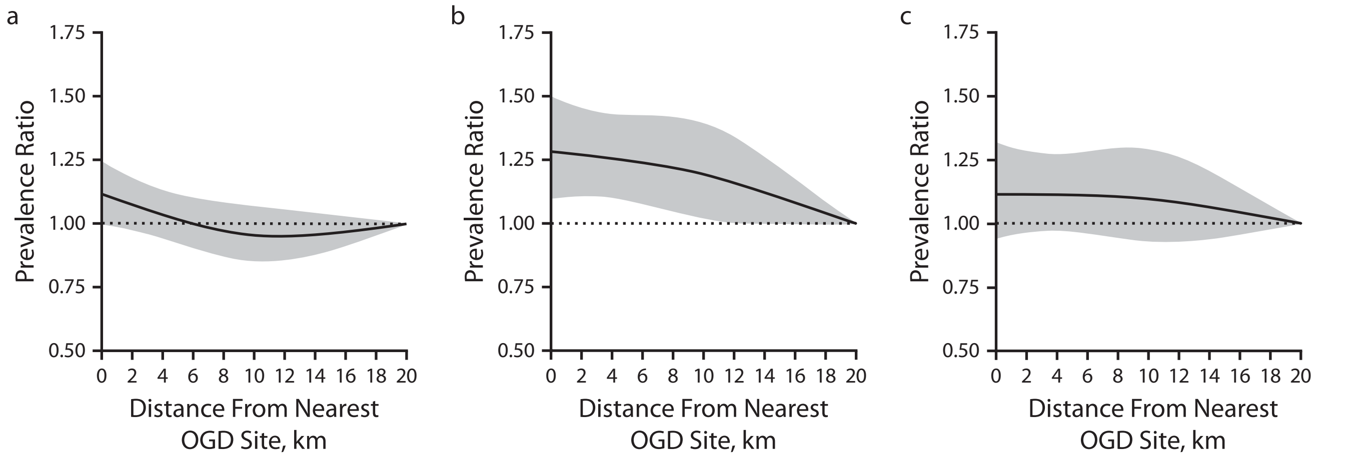

FIGURE 2— Associations Between Residential Proximity to Oil and Gas Development (OGD) Sites and (a) Perceived Stress Scale, (b) Major Depression Inventory, and (C) Current Psychotropic Medication Use: Pregnancy Study Online, United States and Canada, 2013–2023

Note. Results were fitted using restricted cubic splines. Solid line denotes estimates from the restricted cubic spline with corresponding 95% confidence intervals in the shaded bands. Reference group contains participants who had no residential exposure within 20 km of their home (i.e., the participants resided between 20 and 50 km from the nearest OGD site). Adjusted for participant age, geographic region of residential location, season of baseline enrollment, and year of baseline enrollment. Data were trimmed at the 0.5th and 99.5th percentile distance from nearest OGD site. Knots were located at 2.5, 10.0, and 17.5 km. Moderate to high perceived stress defined as PSS-10 scores ≥ 20, and moderate to severe depressive symptoms defined as MDI scores ≥ 20.

appropriate minimum setback distances to protect health.[64] Many of the proposed setback distance zoning policies apply exclusively to new OGD,[70] leaving behind an extensive geographic scope of existing extraction sites that we included in this analysis (i.e., the all-development intensity metric).

Our study population is unique: pregnancy planners enrolled in an Internet-based cohort. To our knowledge, we are the first to focus on the preconception period for OGD, which is of high interest given the existing literature on adverse birth outcomes (there are 25 or more separate studies of perinatal health to date, all of which relied on administrative records).[13,18,20,22,23,25,36] Although understudied relative to the prenatal period, optimizing mental health during the preconception period can improve health outcomes during the perinatal and postpartum periods for pregnant individuals and their infants, respectively.[43] For instance, worse preconception symptoms related to stress, anxiety, and depression are associated with reduced fecundability,[44,45] irregular menstrual cycles,[46] pregnancy complications,[47] and adverse birth outcomes.[47] Given the strong link between maternal mental health and birth outcomes, our results may explain some of the associations seen in the literature on OGD and adverse birth outcomes. Understanding what environmental hazards may harm mental health in the preconception period is critical for determining future prevention programs and informing health-protective policy.

Our results enhance the existing epidemiologic literature focused on perinatal mental health. Two previous quantitative studies found that higher levels of exposure to OGD during pregnancy are associated with adverse mental health outcomes.[36,37] In the broader population, other work has found that the psychological toll of the oil and gas industry is often stronger among women than men.[34,38] Most epidemiological analyses rely on electronic health records and medication orders to ascertain mental health outcomes and therefore may not capture associations with subclinical endpoints. Conversely, in using validated psychometric instruments, our study builds on previous results by showing that the largest magnitude associations were present for depressive symptoms at levels that may not have led to documented clinical care. We observed associations with current psychotropic medication use for the metric for new development exposure but not the metric for older development or for proximity, differing with the existing literature to some degree. Building on previous work in more localized communities (e.g., northeastern PA,[36,38,40] northeastern BC[37]), we captured a wide range of OGD exposure scenarios, as our participants resided across the United States and Canada.

Our findings are supported by a substantial body of work on how resource

TABLE 2— Associations Between Intensity of OGD and Mental Health Outcomes: Pregnancy Study Online, United States and Canada, 2013–2023

Exposure Metric	Participants, No.	OGD Sites Within 20 km, Median (Range)	Moderate to High Perceived Stress[a]		Moderate to Severe Depressive Symptoms[b]		Current Psychotropic Medication Use[c]	
			Prevalence (%)	PR (95% CI)	Prevalence (%)	PR (95% CI)	Prevalence (%)	PR (95% CI)
All OGD intensity[d]								
Comparison[e]	1 684	0 (0–0)	29.9	1 (Ref)	15.5	1 (Ref)	16.3	1 (Ref)
Low	1 339	2 (1–19)	29.6	0.97 (0.87, 1.08)	18.2	1.16 (0.99, 1.37)	14.6	0.96 (0.81, 1.13)
Medium	1 330	35 (1–270)	28.3	0.91 (0.91, 1.02)	17.4	1.07 (0.91, 1.26)	17.4	1.09 (0.93, 1.27)
High	1 372	846 (1–12 949)	33.0	1.09 (0.99, 1.21)	21.7	1.36 (1.17, 1.58)	17.4	1.08 (0.92, 1.28)
New OGD intensity[f]								
Comparison[e]	1 684	0 (0–0)	29.9	1 (Ref)	15.5	1 (Ref)	16.3	1 (Ref)
Low	473	1 (1–7)	31.5	1.03 (0.89, 1.17)	19.7	1.08 (0.90, 1.31)	16.3	1.01 (0.81, 1.25)
Medium	472	8 (1–39)	30.7	0.99 (0.86, 1.15)	18.0	0.99 (0.81, 1.21)	16.3	1.05 (0.85, 1.30)
High	486	52 (1–1 648)	29.8	1.03 (0.89, 1.19)	18.7	1.04 (0.85, 1.26)	18.5	1.27 (1.03, 1.55)

Note. CI = confidence interval; OGD = oil and gas development; PR = prevalence ratio. Adjusted for participant age, geographic region of residential location, season of enrollment, and year of enrollment. Missing covariate and outcome information (< 5%) was multiply imputed using fully conditional specification methods.

[a]10-item Perceived Stress Scale scores ≥ 20.

[b]Major Depressive Inventory scores ≥ 20.

[c]Self-report of current psychotropic medication use.

[d]Inverse distance-squared weighted number of OGD sites within 20 km of the residential location that were currently active at the time of the baseline survey. Low corresponds to the first tertile of exposure, and high corresponds to the third tertile of exposure.

[e]Participants residing 20–50 km from the nearest active OGD site to the residential location.

[f]Inverse distance-squared weighted number of OGD sites within 20 km of the residential location that were drilled in the previous 3 years before the baseline survey. Low corresponds to the first tertile of exposure, and high corresponds to the third tertile of exposure.

extraction (e.g., oil, gas, coal, rare minerals) and other industrial activity influences local populations and societal constructs.[27,61,71,72] Increased psychiatric caseloads often coincide with the introduction of resource extraction in a community,[73] regardless of the specific industrialized resource. This trend may be attributable to distress from experiencing environmental degradation,[34] rapid shifts in community social hierarchies,[61,74] uncertainty in how emissions may influence their health,[61,75] or even inability to influence where this industrial activity occurs.[61,64] Relentless cycles of economic growth and decline (i.e., boom-and-bust phenomena), as is common with resource extraction, create stressful conditions that can adversely affect mental health.[27] Although there are some examples of excellent community resilience,[28] few widely adopted initiatives exist to help communities adapt to the cyclical nature of a resource-oriented economy.[75,76] With this literature in mind, we hypothesized that similar community-level mechanisms may explain the associations observed in our analysis.

Limitations

Although we used an industry-standard spatial database to derive residential exposure estimates,[77] detailed data were unavailable on the operational factors that vary over the life cycle of OGD that may influence exposures (e.g., construction, fracking, production, flaring).[78] We did, however, examine nearest distance to an active site (i.e., key policy information) and intensity of OGD sites nearby (i.e., closer to true exposure). We also acknowledge that this measure imperfectly considers abandoned and orphaned sites. Although the spatial database includes data on most regions with OGD (Figure 1), it lacks detailed exposure information in specific US states (e.g., IL, IN) and Canadian territories (e.g., NT, YT, NU). Therefore, we are likely underestimating exposures on the borders of these areas. Our exposure analysis relied on the residential address reported at baseline, a commonly used proxy in spatial epidemiology,[79] but this decision can introduce exposure misclassification by not accounting for individual time–activity patterns.[80] Results from pregnancy planners also may not generalize to the general reproductive-aged population, as pregnancy planners may differ fundamentally from nonplanners.[81] Furthermore, some participants reported higher socioeconomic status and per household income and education than the general populations of the United States or Canada,[82–85] and more than 80% of our study sample identified as non-Hispanic White.

Conclusions

This geographically diverse study of pregnancy planners revealed an association between residential proximity to OGD sites and adverse mental health symptoms, particularly for depressive symptoms. We conducted the first analysis of preconception exposures to OGD, which may have implications for reproductive, pregnancy, and postpartum health. Regardless of potential causality, these findings can facilitate planning for increased access to mental health services in areas where new fossil fuel extraction is likely to occur. Given that OGD persists across the United States and Canada, future research investigating the mental health implications of resource extraction, including longitudinal follow-up of exposed communities, is warranted. AJPH

ABOUT THE AUTHORS

Mary D. Willis, Erin J. Campbell, Sophie Selbe, Martha R. Koenig, Jaimie L. Gradus, Elizabeth Hatch, Amelia K. Wesselink, and Lauren A. Wise are with the Department of Epidemiology, Boston University School of Public Health, Boston, MA. Yael I. Nillni is with the Department of Psychiatry, Boston University Chobanian & Avedisian School of Medicine, Boston. Joan A. Casey is with the Department of Environmental Health and Occupational Health Sciences, School of Public Health, University of Washington, Seattle. Nicole C. Deziel is with the Department of Environmental Health Sciences, Yale School of Public Health, New Haven, CT.

CORRESPONDENCE

Correspondence should be sent to Mary D. Willis, 715 Albany St, Department of Epidemiology, Boston University School of Public Health, Boston, MA 02118 (e-mail: mwillis1@bu.edu). Reprints can be ordered at https://www.ajph.org by clicking the "Reprints" link.

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ORCID iDs:

Mary D. Willis https://orcid.org/0000-0002-0247-7983

Martha R. Koenig https://orcid.org/0009-0006-8804-9475

CONTRIBUTORS

M. D. Willis and E. J. Campbell curated the data and performed the formal analyses. M. D. Willis, J. L. Gradus, Y. I. Nillni, J. A. Casey, N. C. Deziel, E. E. Hatch, A. K. Wesselink, and L. A. Wise designed the methodology. M. D. Willis, E. E. Hatch, A. K. Wesselink, and L. A. Wise conceptualized the study. M. D. Willis and L. A. Wise acquired funding, administered the project, and supervised the study. E. J. Campbell, S. Selbe, and M. R. Koenig executed data and analysis validation. All authors participated in writing the original draft, reviewed and edited the article, and have read and agreed to the published version of the article.

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CONFLICTS OF INTEREST

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HUMAN PARTICIPANT PROTECTION

The Boston University Medical Campus institutional review board approved our study protocol.

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