

Psychosocial implications of unconventional natural gas development: Quality of life in Ohio's Guernsey and Noble Counties



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ABSTRACT

As unconventional natural gas development (UNGD) activities such as “fracking” have proliferated across the U.S., research has begun to examine their impacts on human life. Much scholarship has centered on possible health and environmental impacts. However, a range of plausible psychosocial impacts has begun to emerge. Utilizing grounded theory methods and data from qualitative interviews with residents of two counties in Appalachian Eastern Ohio (Guernsey and Noble), we examined the quality of life (QoL) impacts on residents, who live and work amid UNGD. QoL impacts were reported in five core categories, specifically psychological stress, social stress, environment, physical health, and traffic. Psychological stress was a particularly salient theme, as residents living near UNGD found themselves anxious about the uncertainties of fracking; frustrated by interactions with oil and gas industry officials; stressed about noise or light pollution; and, in some instances, facing the possibility of moving from the region.

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1. Introduction

Communities in Appalachian Eastern Ohio and other areas of the U.S. are experiencing social transitions because of accelerations in unconventional natural gas development (UNGD). Portions of both the Utica and Marcellus shale formations lie beneath the region, and these rich deposits of natural resources combined with new technologies for extraction have led to increased UNGD (Ohio Department of Natural Resources and Ohio Environmental Protection Agency, 2014). One common UNGD activity is hydraulic fracturing, or “fracking.” This is the process by which high volumes of pressurized water combined with a blend of chemical additives are forced into shale rock structures to release natural gas or oil from deposits beneath the formations. Relatively new to Ohio, fracking did not commence in the state until 2011 (Ohio Environmental Council, 2015). Between 2011 and 2016, the number of fracking wells in Eastern Ohio reached 2236 drilling permits secured and 1785 wells drilled (Ohio Department of Natural Resources, 2016).

Community residents living amid UNGD have concerns associated with the activity, including a range of environmental, health-related, social, and psychological impacts (e.g., Powers et al., 2014). Researchers have noted concentrations of potentially dangerous compounds and chemical mixtures present near UNGD sites (Kassotis et al., 2015; Macey et al., 2014), threats to groundwater or well water (Alawattegama et al., 2015; Grant et al., 2015; Harkness et al., 2015; Holzman, 2011; Kassotis, Tillitt, Davis, Hormann, & Nagel, 2013; Mrdjen & Lee, 2015; Vengosh, Jackson, Warner, Darrach, & Kondash, 2014), elevated risk of preterm birth and high-risk pregnancy (Casey et al., 2016), social strain and threats to cohesion (e.g., Morrone, Chadwick, & Kruse, 2015), self-reported skin conditions and respiratory problems (Rabinowitz et al., 2015), and psychological stress and a mounting sense of unpredictability and anxiety concerning the future (Ferrari et al., 2013; Sangaramoorthy et al., 2016).

Despite this evidence indicating that UNGD can have negative impacts on the environment and in communities, the full extent of psychosocial factors is not known. A range of impacts, including noise pollution, odor annoyance, traffic congestion, and crime and violence, have been noted amid other types of industrial activity (Kondo et al., 2014; Nordin & Lidén, 2006; Spencer-Hwang et al., 2014; Stansfeld & Matheson, 2003). Thus, it is not clear whether residents in proximity to UNGD experience similar effects.

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This paper assesses how residents of two adjacent counties undergoing UNGD (Guernsey and Noble Counties, Ohio) are impacted by these activities. We adopted the concept of quality of life (QoL) as a lens through which to frame our study. Generally, QoL reflects individuals' perceptions of their position in life in the context of their society and culture; the construct is dependent upon factors such as a person's physical health, psychological well-being, social interactions, and relationships to salient features of the environment (World Health Organization, 1997). We sought to answer the following research questions: How do residents perceive their QoL amid UNGD, and what factors do residents perceive to be most impactful on their QoL?

Our research relied on grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1998), a systematic method capable of providing an in-depth understanding of QoL issues. We chose to adopt a qualitative grounded theory methodology rather than a quantitative measure (e.g., the WHOQOL-BREF) to capture the full range of QoL issues affecting community residents. Grounded theory has proven successful for studying QoL (e.g., Gee, Pearce, & Jackson, 2003) and particularly in contexts where QoL dimensions are complex, contradictory, or poorly understood (e.g., Tsonis, McDougall, Mandich, & Irwin, 2012). The method has also been employed to study place-based perceptions of residents living amid fracking activity (Sangaramoorthy et al., 2016). This predominantly inductive methodology relies on data from sources such as individual interviews; utilizes theoretical sampling to target people or data sources with information about actions, events, or experiences relevant to the study's emergent themes; and involves the systematic coding and categorizing of qualitative data (Glaser & Strauss, 1967; Strauss & Corbin, 2008).

2. Method

The results presented here stem from semi-structured interviews with residents of Guernsey and Noble Counties. These counties are located adjacent to one another in Appalachian Eastern Ohio (see Fig. 1). We chose to focus on the two-county region given the high number of UNGD sites in each county (see Fig. 2) and the close social and economic ties between them, particularly around the Senecaville Lake region which spans both counties. Human subjects protection approval for this study was granted by the University of Cincinnati College of Medicine's Institutional Review Board.

Our team worked with three key informants to identify interviewees. All informants were community residents. Two were known to the research team prior to study commencement, and the third was introduced by one of the initial informants. Key informants were well-connected long-term community members who were aware of fracking activities in their community. As interviews progressed, we also utilized snowball sampling, asking interviewees to recommend other residents who might have insight into our study topic and then recruiting those residents for possible study participation. We aimed to recruit residents who were living in close proximity to UNGD and/or known to be experiencing QoL impacts associated with UNGD. We recruited a range of interviewees, including residents of various ages and education levels. We included residents who held mineral rights leases as well as residents who did not. This diversity enabled us to obtain a range of perspectives.

Overall, 49 community residents were asked to participate, and 34 completed an interview. Two declined to participate, and 13 did not respond. We provided interested participants with a one-page information sheet describing the study and obtained verbal consent. Participants were offered a one-time fifty-dollar incentive in the form of a gift card to a retail store. Table 1 lists the demographic

characteristics of interviewees. All participating residents had lived in the two-county area for at least two years, a time period which coincides with notable regional increases in UNGD (Mauro et al., 2013) and ensures a reasonable window for possible exposure to UNGD-related QoL factors. Interviewing continued until we reached saturation (Strauss & Corbin, 1998). Three of the 34 participants were interviewed a second time for clarification or elaboration of themes. Interviews occurred in private or semi-private spaces at a community center, a library, and restaurants, or in private residences. They ranged from 20 min to 2 h in duration. With interviewee permission, we digitally audio-recorded the interviews and then transcribed and supplemented them with field notes.

Interview data were analyzed using grounded theory methods (Strauss & Corbin, 1998). Audio recordings of interviews were uploaded into *Dedoose*, a qualitative data analysis program. The first four interviews were coded independently by three researchers and then discussed to resolve any discrepancies in coding. Our result was a scheme of nearly 100 codes pertaining to QoL that was used by the same researchers to code subsequent interviews. A handful of new codes were added to the coding scheme when no predefined code was relevant.

Concordant processes of memoing on codes (and data tagged with specific codes) enabled the elaboration of codes and the clustering of codes into categories. Specifically, the research team first defined the properties and boundaries of codes through in-depth notes, or memos. Next, we categorized codes together when similar properties among codes were observed (e.g., when different codes described a similar type of psychological stress). Throughout this process, we used constant comparative analysis to move back and forth among the data to refine codes and categories, thus repeating the memoing and coding processes as new data emerged and then modifying codes and categories as needed (Strauss & Corbin, 1998). Data were analyzed as they were collected so that emergent results could drive the recruitment strategy via theoretical sampling. As various QoL themes emerged as salient, we aimed to recruit additional participants who had experienced one or more of these QoL issues. The categories constructed in our analysis serve as the overarching QoL themes presented in this paper.

3. Results

Participants reported several changes to their QoL since the introduction of UNGD. Comments fell into one of five *core* categories: psychological stress, social stress, environment, physical health, and traffic. *Subcategories* or themes were established within each core category. All interviewees expressed impacts from one or more of the QoL factors listed in Table 2. A majority reported impacts in three or more of the five core categories. Economic issues were also evident in our data but are not addressed in this paper since economics, per se, are typically defined as "standard of living" and not included in QoL frameworks (World Health Organization, 1997). Likewise, our data reflected perceived increases in crime such as illicit drug use, but these findings are not described here since few interviewees were *directly* impacted by such activity.

Table 3 specifies the number of interviewees reporting one or more QoL impacts within the core categories and dichotomizes these counts based on interviewees' self-reported distance from fracking activities (i.e., greater or less than five miles). This distance was used since several participants lived in a town which is approximately five miles from the nearest fracking well. Thus, this distinction serves to differentiate the town's residents and others living outside of the immediate range of UNGD activity from those living in closer proximity. As illustrated, psychological stress, environmental impacts, and physical health impacts were reported



Fig. 1. Map highlighting Ohio's Guernsey and Noble Counties.

more commonly by interviewees living within five miles of UNGD activity. However, these apparent differences were not tested for statistical significance and should be considered with limitation. While the data are useful for hypothesizing about the role of proximity in resident QoL, the key strength of our findings lies in the rich description of resident experiences of QoL, as described below.

3.1. Psychological stress

Several residents reported psychological stress because of UNGD. Psychological stress is defined as pressure due to daily life or sudden negative changes in life (National Institute of Mental Health, 2016). Several residents viewed UNGD activity as a sudden negative change. Stress related to UNGD was categorized into four emergent themes: experiencing general stress and uncertainty about the future; feeling frustrated and manipulated after interactions with the oil and gas industry; enduring noise or light pollution; and displacement from the region.

3.1.1. Experiencing general stress and uncertainty about the future

Several residents expressed a general sense of stress and uncertainty because of UNGD. For example: "I'm stressed," "Our lives are in such turmoil," and "It's like a slow dying death." A small handful of residents had experienced a psychological toll on their

entire family. For example: "We all sat around and were crying about it, literally." For many residents, stress was related to uncertainty about the future; they worried about not having unpoluted land and water to pass down to their children. Some residents regularly avoided the topic of UNGD to escape feelings of distress.

3.1.2. Feeling frustrated and manipulated after interactions with the oil and gas industry

Several participants felt frustrated with oil and gas industry officials. Many such grievances were related to officials pressuring residents into signing oil and gas leases, ratifying old contracts, or unitizing. The latter reflects a provision in certain states' laws that can force landowners who are reluctant to lease their mineral rights to become part of a "unit," thus enabling legal drilling beneath a non-consenting landowner's property (O'Reilly, 2015). For example, one resident noted: "We held out [on signing] until the very end, and then when they threatened to unitize or force pool us, this is what they said 'We'll just force you.'" Further, residents described a number of manipulation tactics used by the industry, including playing to residents' fears (e.g., of passing up financial opportunity), lying or misleading, and offering residents jobs as a condition of lease signing.

Many residents were also frustrated after lease signing. Some were not fully informed of the details of UNGD activities on or near their property. For example: "That one well over here is supposed to

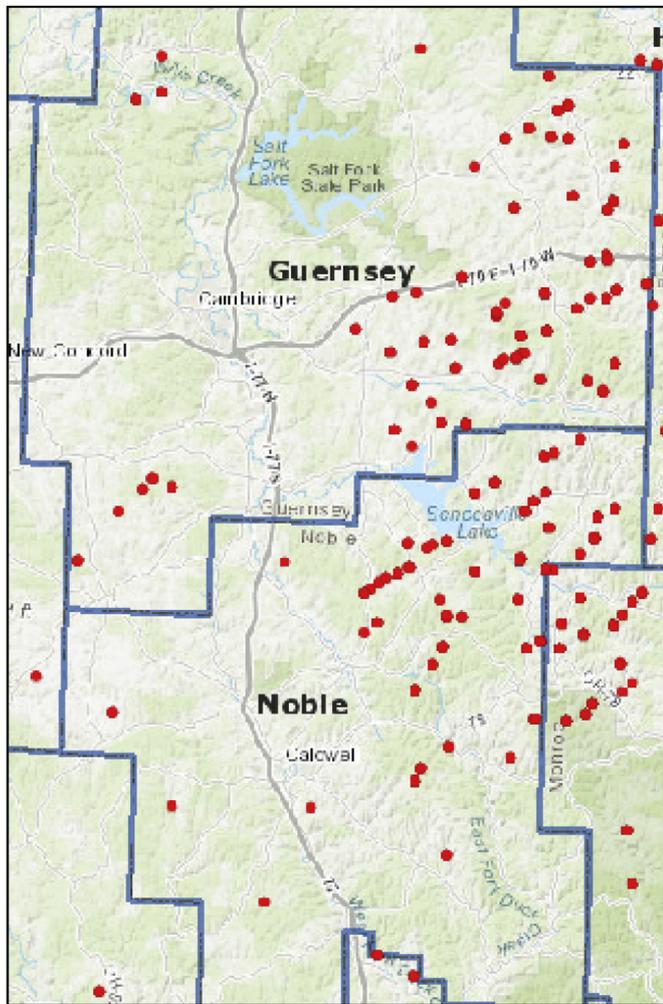


Fig. 2. Map of active or permitted horizontal drilling sites in Guernsey and Noble Counties (October 2017).

be coming under [several] acres of my property right now... But that's all I've heard about that. And I just don't know what's going on." Other residents had not received payment for oil and gas leases or pipeline contracts in a timely manner, nor had they received clear explanation of why they had (or had not) received certain royalties. Frustrated, a handful of residents dreaded interacting with oil and gas industry representatives and regularly attempted to avoid them.

Further, several residents expressed having lost confidence in government officials for not helping to protect them from industry manipulation and QoL impacts associated with UNGD. Frustrations centered on local government organizations, the Ohio Department of Natural Resources, state and federal Environmental Protection Agencies, and other state and federal government leaders.

3.1.3. Enduring noise or light pollution

Many residents endured extreme noise associated with UNGD. Much of the noise was related to loud trucks traveling to and from UNGD sites or equipment at the sites. For example: "[There was] constant dozer work, constant noise all the time." Residents noted that noise levels were particularly high during initial well drilling, but that many sounds, and especially truck-related sounds, continued after drilling. Some residents complained of having trouble falling asleep or being awakened intermittently at night

Table 1
Interviewee demographics.

	n ^a (%)
Total residents interviewed	34
<u>Age (range = 19 to 83 years)</u>	
18–24	2 (6.5)
25–44	13 (41.9)
45–64	13 (41.9)
65 and over	3 (9.7)
<u>Gender</u>	
Male	18 (52.9)
Female	16 (47.1)
<u>Highest Level of Education</u>	
Less than high school	1 (3.2)
High school graduate or GED	6 (19.4)
Some college	9 (29.0)
College degree	13 (41.9)
Advanced degree	2 (6.5)
<u>Housing Status</u>	
Own their home	21 (80.1)
Rent their home	5 (19.2)
<u>UNGD</u>	
Mineral rights leased for UNGD	11 (35.4)

^a n ranges from 26 to 34 for different characteristics.

because of UNGD-related noises, including semi-trucks "jake braking" or equipment likened to the sound of drag racing or jet engines. Such interruptions were at times compounded by dogs barking in response to the noises.

Other residents were enduring more constant noises from nearby compressor stations, which are large round-the-clock mechanical structures built intermittently along natural gas pipelines to ensure continuous forward movement of natural gas resources (U.S. Energy Information Administration, 2016). For example: "By the compressor station, which is a constant noise, I bought my home out there. [There] is nobody where I live... [but] right now there's a rumble." Additionally, some participants were concerned with more intensive, though less frequent, noise and shaking from periodic seismic testing. This procedure employs dynamite or sound wave-inducing devices to create subsurface images and is completed prior to oil and gas drilling (Bamberger & Oswald, 2014).

Residents also expressed discontent with light pollution from UNGD. Fracking wells and compressor stations often involve round-the-clock work that requires intensive lighting. Light pollution was less of a concern than noise and other QoL impacts, but still registered as a nuisance.

3.1.4. Displacement from the region

A handful of interviewees were moving away from Guernsey or Noble County at the time of interview and distinctly because of UNGD. For example, one resident noted: "I'm taking down our little cottage. It looks like the sale did go through... I don't want to leave. There are lots of memories here, lots of really good memories... [but] you feel like you were forced out." Likewise, a handful of other residents were moving because of QoL issues ranging from excessive noise to fears over environmental pollution. For example: "I really don't want to live here. I'm scared because we are surrounded all over by big pipelines, small pipelines, all kinds of pipelines, compressor stations. And [with] all these things something can go wrong."

Some residents with plans to move had factored economic concerns into their decision-making. They feared an eventual decline in real estate values due to decreased QoL and possible environmental pollution. Most residents in the process of relocating were moving to other regions with no UNGD. These residents indicated that the QoL impacts of UNGD were greater than they had initially anticipated. In addition to the handful of residents moving,

Table 2
Quality of life factors impacting some residents living among unconventional natural gas development.

<p>Psychological Stress• General stress and uncertainty</p> <ul style="list-style-type: none"> • Sense of frustration and manipulation • Noise or light pollution • Displacement from the region <p>Social Stress• Families dividing</p> <ul style="list-style-type: none"> • Communities dividing • Social fabric changing 	<p>Environment• Fearing drinking water contamination and filtering or replacing water</p> <ul style="list-style-type: none"> • Observing distressed and dying trees • Ceasing farming and gardening <p>Physical Health• Health issues with questionable UNGD link</p> <p>Traffic• Traffic congestion</p> <ul style="list-style-type: none"> • Insufficient or damaged roadways • Unsafe driving practices or accidents
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Table 3
Number of residents reporting quality of life impacts, by residential proximity to unconventional natural gas development.

Residential Proximity to UNGD	Psychological Stress	Social Stress	Environment	Physical Health ^a	Traffic
Within 5 miles (n = 19)	16 (84.2)	10 (52.6)	16 (84.2)	7 (36.8)	13 (68.4)
Greater than 5 miles (n = 15)	9 (60.0)	10 (66.7)	4 (26.7)	0 (0.0)	14 (93.3)

^a This refers to interviewees' self-reported health problems believed to be fracking-related. It does not include general or non-specific concerns about fracking and health, nor does it include occupational health issues reported by interviewees employed by the oil and gas industry.

others expressed concern about the viability of the community for future generations and had considered the possibility of moving. However, many of these residents had strong generational ties to the region and were reluctant to relocate.

3.2. Social stress

Several residents noted a change in the community's social fabric since the introduction of UNGD. These changes were a cause for concern for many interviewees, and fell under three emergent themes: families dividing, communities dividing, and conflicted over a changing social fabric.

3.2.1. Families dividing

Several residents viewed a family member's divergent perspective on UNGD as damaging or threatening to their relationship. Often, one person was supportive of fracking while another opposed it. Such conflicts existed between husbands and wives and children and parents. For example, one resident stated: "It starts a lot of fights back around the dinner table." Other residents witnessed family conflict specifically over UNGD-related financial issues: "Where the money has driven families apart... It's kind of sad. It all boils down to greed, and the parents aren't willing to share with the kids or vice versa." Typically, residents experiencing family conflict expressed discontent with the situation and a silent lack of resolve.

3.2.2. Communities dividing

Other residents expressed conflict with friends and neighbors. Interviewees who opposed UNGD often felt at odds with those who supported it. For example, a resident who had not leased their land conveyed an interpersonal struggle with a resident who had leased: "[Others] kept saying 'Oh they've leased, they've leased.' And I go 'No, they wouldn't do that... No, they care about [the area]...' And I found out they leased... You know, it totally wrecked our relationship." Some residents noted that others who had not leased were sometimes accused of being greedy, presumably holding out for better lease terms or incentives. Residents also noted that non-compete clauses, which are typically mandated by the oil and gas industry upon lease signing, silenced residents and alienated them from friends and neighbors: "They separated people when they came here... they make everybody sign a non-compete clause. So, you're not allowed to tell your neighbor who you signed with and for how much. That's all secret, or they're going to sue you." Other

residents experienced a more general sense of estrangement from their community rather than specific conflict.

3.2.3. Conflicted over a changing social fabric

Several residents were concerned about the influx of transient workers, many who reportedly came from other states. Indeed, the oil and gas industry often brings thousands of workers to an area for UNGD (Marcin, 2015). Some residents encountered these workers in their daily lives, and many noted that they were pleasant, courteous, and becoming a valued part of the community. For example: "A lot of the people that come in, they're very polite. They give directions. They're cool people." And many business-owning residents valued the workers' disposable income that could be spent at local shops, restaurants, and bars, and described them as good tippers.

Despite often-positive sentiments, threads of potential social conflict—in particular, feelings of distrust and trepidation—were salient. Some residents noticed out-of-state oil and gas workers "showing off" in ways that set them apart from locals. For example: "They're big drinkers, and they're big spenders, and they want to show their money off." Others were disturbed by out-of-towners racing one another in their pickup trucks, particularly at night around bar closing, when perhaps some drivers had been drinking. More generally, residents lamented that because of the influx of transient workers, certain towns in Guernsey and Noble Counties no longer have a small town atmosphere where most everyone knows one another. For example: "[In past years], I walked downtown and knew everybody. Now you go into a restaurant, and you hardly know anybody... We're becoming more of a transient community... of people coming into our community with not much of a vested interest."

3.3. Environment

Several residents were alarmed by potential effects on the environment, including air, water, and plant life. These environmental concerns fell into three emergent themes: fearing drinking water contamination and filtering or replacing water; observing a high number of distressed and dying trees; and ceasing farming and gardening amid questions of contamination.

3.3.1. Fearing drinking water contamination and filtering or replacing water

A number of residents feared that their water supply might be or

become contaminated by the many chemicals used during the UNGD process. In particular, “slickwater” fluid (consisting of water, sand, and chemicals) is pumped into the wellbore during the UNGD process, and residents feared potential leakage or migration from the well into underground drinking water sources. This was a particular issue for residents living in close proximity (i.e., less than five miles) to UNGD and for residents sourcing from well water. For example: “I’m really concerned about my well water, and I don’t have water out my way. There’s no public water.” Moreover, residents expressed concern over possible contamination with radioactive material. For example: “I’m very concerned about not only just the water-soluble radium in the water but the radioactive particulate matter.” Indeed, some UNGD activity has been linked to radioactive elements, since naturally occurring radioactive material can be released from the earth’s crust during drilling (Nelson et al., 2015).

Some residents expressed concern regarding waste disposal procedures and particularly the use of injection wells. In particular, residents feared potential leakage and groundwater contamination near these wells. Injection wells are becoming commonplace in some areas of Eastern Ohio, as oil and gas companies must dispose of the millions of gallons of UNGD wastewater (Prud’homme, 2014). In Guernsey and Noble Counties alone, the number of injection wells had risen to 10 as of early 2016 (Ohio Department of Natural Resources, 2016). Also, Ohio accepts wastewater from neighboring states such as Pennsylvania since its geological conditions are more favorable to wastewater disposal (Prud’homme, 2014).

Residents also expressed concern about potential contamination of local lakes and reservoirs. The process of UNGD requires large amounts of water for injecting slickwater fluid into the well, and much of this water is sourced near oil and gas wells (Prud’homme, 2014). Residents questioned whether the oil and gas industry’s water collection methods might contaminate lakes and reservoirs so they are no longer viable drinking water sources or recreational sites. For example, some residents were concerned about residual chemicals on hoses and equipment inserted into lakes or reservoirs to extract water.

Due to concerns about contamination, a handful of residents had ceased drinking the local water and instead drank water that had been purified or sourced from other areas. They were purchasing bottled water, filtering their tap water, or importing water tanks or “buffalos.” One resident specifically moved to a home that was not sourced by well water largely because of concerns over possible water contamination.

3.3.2. Observing a high number of distressed and dying trees

Some residents noted that trees were unexpectedly losing their leaves or dying. For example: “The tops of them. There’s no leaves. There was nothing left in the tops of them. They start losing their leaves, and then they die.” Residents witnessed these effects after the introduction of UNGD and were unsure whether such conditions might be caused, for example, by air pollution or groundwater pollution. However, a handful of residents noticed that trees along oil or gas pipelines were in particularly poor condition, thus pointing toward the latter as a possible explanation: “The pear trees are really affected by it. I don’t know what’s doing it... but the tops of all my trees on my farm where those laterals went under, the very tips have all died.”

3.3.3. Ceasing farming and gardening amid questions of contamination

Some residents noted that their soil had been ruined by UNGD operations because of runoff from adjacent UNGD sites believed to be contaminated or from underground pipelines thought to be leaking. Still, other residents were concerned with air pollution

from nearby fracking wells or compressor stations. Some such residents noted that the threat of air or water contamination had led them to cease farming and gardening. For example: “We can’t grow anything, we’re farmers, we came here to retire and live off the land... We raised animals, [but now] we can’t raise a garden, we can’t have animals.” Likewise, another resident decided to stop raising livestock specifically because of concerns about possible water contamination: “I’m not carrying any livestock right now because I don’t know whether to, because I don’t know about the water contamination.”

3.4. Physical health: experiencing health problems while questioning their link to UNGD

A handful of residents experienced health problems while questioning their link to UNGD. In other words, residents presented specific symptoms of ailments that had developed subsequent to UNGD in the region. In particular, some residents experienced recurring *headaches*. For example: “You get the headaches and you get the irritation, and it goes away when you get away from [the UNGD].” Others reported *respiratory symptoms*. For example: “I mean we can’t take a deep breath some evenings over at the house. It’ll just send you into a coughing spell.” Still, other residents reported *skin conditions* such as rashes. For example: “I came down with it first and thought it was a detergent rash. Then my husband was just covered with a rash... Now [my child] has a rash. I’m hearing of other people coming down with rashes.” Also, some residents who had worked for the oil and gas industry shared accounts of occupational health threats, including experiencing chemical burns, losing consciousness after smelling noxious chemicals, and sustaining musculoskeletal injuries from being pressured to lift heavy equipment.

Further, some residents observed possible cancer clusters near UNGD activities, though we did not have an opportunity to interview those residents with cancer.

3.5. Traffic

A chief concern of residents was an observed increase in the volume of traffic and its associated impacts. Residents explained that heavy traffic was not a salient issue prior to UNGD but was subsequently seen daily. Traffic concerns fell into one of three emergent themes: experiencing traffic congestion, encountering unsafe driving practices or auto accidents, and noticing insufficient or damaged roadways.

3.5.1. Experiencing traffic congestion

Several residents grappled with traffic congestion due, at least in part, to local oil and gas activity. In many instances, traffic negatively impacted residents’ daily routines and was not welcomed. For example: “Downtown takes you two or three times longer to get through... for a person who has lived here as long as I have, we don’t like that.” Traffic was also considered a problem for pedestrians: “In a given morning walking across the street here [in years past], you wouldn’t even have to look both ways and you could walk across the street... But last summer and the summer before that, you may have to wait five to ten minutes.”

3.5.2. Encountering unsafe driving practices or auto accidents

Nearly all interviewees had experienced dangerous encounters with oil and gas truck drivers. Activities related to UNGD often occur amid winding rural roads, where residents commonly veer or slow to avoid hitting oil and gas trucks. Some residents noted a lack of patience by oil and gas truck drivers, while others explicitly labeled their driving as “reckless.” One resident witnessed several

truck drivers texting behind the wheel. Other residents experienced or witnessed traffic accidents involving truck drivers. For example: “I was at a red light at a busy intersection waiting to proceed when the light turned green. And I had a truck hit me.”

3.5.3. Noticing insufficient or damaged roadways

In addition to concerns about traffic itself, residents suggested that heavy truck traffic had spawned secondary impacts. Notably, residents observed that poor road conditions and potholes have become commonplace. For example, one resident stated: “The roads have become terribly beat up. They’re constantly trying to patch them as cheaply as they can.” More generally, residents suggested that the local roadway infrastructure was not sufficient to handle new traffic patterns. Indeed, many of the state routes and city streets in the area are two-lane roads likely not built to sustain high traffic.

4. Discussion

Our results indicate a range of QoL impacts on Guernsey and Noble County residents living amid UNGD. Factors pertaining to QoL fell into five emergent *core* categories: psychological stress, social stress, environment, physical health, and traffic. We utilized these categories to frame our results, while numerous *sub*-categories emerged through data analysis. We found that many residents had experienced multiple QoL impacts both within and across categories, and that some residents were faced with the option of either adapting to QoL issues or, when feasible, moving away.

Notably, this study captured qualitative accounts of the psychological stress experienced by many residents living amid UNGD. Some of our results mirror earlier studies that have documented issues such as uncertainty about the future, (Sangaramoorthy et al., 2016); feelings of powerlessness, intimidation, or exploitation (Ferrari et al., 2013; Sangaramoorthy et al., 2016); and corruption or dishonesty among government or industry representatives (Ferrari et al., 2013; Sangaramoorthy et al., 2016). But our results go further to indicate that psychological stress amid UNGD can be substantial, felt by entire families, and attributed to multiple compounding issues. Numerous participants reported more than one source of psychological stress, possibly indicating that they could be under extreme emotional pressure as a result of UNGD. A particularly common stressor across interviews was a feeling of frustration or manipulation. This finding complements Bamberger and Oswald’s (2014) discovery that residents were often outraged at irresponsible behaviors of drilling companies and environmental regulatory agencies. Moreover, every resident reporting a psychological stressor also reported a QoL impact in at least one additional category, suggesting that stressors tend to co-occur with and perhaps compound other QoL issues.

In addition, our results elucidate specific types of noise and light pollution that have been documented to a very limited degree by other literature, and indicate that noise pollution can originate from many sources, including compressor stations, fracking wells, and semi trucks. Thus, noise can potentially affect residents living far from and close to such sites. The array of noises experienced by residents, sometimes in conjunction with light pollution, are of particular concern since they were reported as a barrier to uninterrupted sleep. Importantly, sleep deprivation can lead to a range of negative behavioral and physiological consequences (Banks & Dinges, 2007), thus potentially compounding other negative QoL issues.

A handful of residents were in the process of leaving Guernsey or Noble County specifically because of UNGD, while several other residents had considered the possibility of leaving. At least two

scholarly works have documented similar displacement or desires to move (Bamberger & Oswald, 2014; Ferrari et al., 2013), though it is not clear how common this action is across communities with UNGD. Our data indicate that moving could be common, though further research is needed. Importantly, moves induced by UNGD could have negative psychological and social impacts on the residents relocating as well as the broader communities losing residents. Length of residency in areas of Appalachia has shown to be positively associated with a sense of community (Morrone et al., 2015), thus suggesting that losing residents could be socially damaging.

Other types of social stress were also evident in our data, as in previous research on communities with UNGD. Studies have indicated divisions between UNGD supporters and opponents (Korfmaier, Elam, Gray, Haynes, & Hughes, 2014; Prud’homme, 2014), tensions between owners of surface rights and mineral rights (Sangaramoorthy et al., 2016), friction between newcomers and long-term residents (Morrone et al., 2015), and estrangement from the community (Ferrari et al., 2013). Our results reinforce some of these tensions and indicate that UNGD is often a polarizing topic, as some literature suggests (Crowe, Silva, Ceresola, Buday, & Leonard, 2015). Moreover, this study illuminates the potential for conflicts within families in addition to broader communities.

Concerns about potential environmental impacts associated with UNGD were expressed by several interviewees. Due to the rural landscape, many residents relied on well water and feared potential pollution from UNGD. Research has indicated that methane (Osborn, Vengosh, Warner, & Jackson et al., 2011), stray gases (Jackson et al., 2013), and elevated levels of arsenic, selenium, and strontium (Fontenot et al., 2013) have been detected in drinking water from wells near UNGD sites. However, no known studies have confirmed UNGD-related water contamination specifically in Eastern Ohio.

UNGD poses a threat to biodiversity, as was noted by several residents who observed unhealthy trees. Postulated reasons for the dying plant life include the adulteration of groundwater attributed to leaking pipes and potential air pollution stemming from UNGD activity. Limited published data exists on the risks posed to plants by UNGD. However, a case study in West Virginia described immediate and long term impacts on a forest stand that was sprayed with fracking wastewater. Observations included elevated soil concentrations of sodium and chloride, tree mortality, browning leaves, and damage to ground vegetation (Adams, 2011). While we are not aware of such practices in Guernsey and Noble Counties, this study highlights concern over potential damage that could arise from wastewater leaks or misuse.

Due to the location of many shale reserves, UNGD tends to occur in rural locations, where agricultural activities are common (Ong, 2014). In our study, several residents voiced a hesitance to cultivate crops and raise livestock due to UNGD-related pollution. While the majority of potential impacts can only be speculated at the current time, there are case reports of livestock being exposed to UNGD wastewater and experiencing subsequent infertility, stillbirths, and even death (Bamberger & Oswald, 2012). The soil can absorb pollutants from UNGD which could be transported via wind, rain, snowmelt, spills, or drilling sludge (Werner, Vink, Watt, & Jagals, 2015). Soil pollution could contribute to contaminant uptake by crops and consequently unsafe food.

Several interviewees voiced concern over personal health problems and their potential associations with UNGD. These interviewees reported that sometime after the commencement of UNGD they began to experience headaches, respiratory symptoms, or dermatologic conditions. Although we cannot determine whether such health issues are indeed associated with UNGD, it is worth noting that migraines, nasal and sinus symptoms, and

fatigue were linked to UNGD in a large cross-sectional study conducted in Pennsylvania (Tustin et al., 2016), thus reinforcing the plausibility of interviewees' concerns. Another study found increases in hospital utilization in areas of Pennsylvania with UNGD (Jemielita et al., 2015). Importantly, health concerns have the potential to induce or exacerbate psychological stress, particularly in the face of diagnostic uncertainty (e.g., Liao, Chen, Chen, & Chen, 2008).

Traffic related problems were salient and widespread among interviewees. While traffic congestion might merely inconvenience residents, other problems such as damaged roadways and unsafe driving could pose serious threats to personal and public safety or increase psychological stress. One recent study in Pennsylvania found vehicle crash rates to be 15–20% higher in counties with notable oil and gas drilling, when compared to counties with no drilling; while heavy truck crash rates were 61–65% higher (Graham et al., 2015). Our results indicate that increases in accidents might also be occurring in Eastern Ohio, as many interviewees had experienced accidents or near-accidents with industry vehicles. In addition to safety concerns, heavy truck traffic has been shown to result in substantial monetary costs due to roadway damage (Abramzon et al., 2014; Patterson & Maloney, 2016) and thus carry important public policy and economic implications.

Collectively, these results illustrate the wide range of psychosocial impacts facing some residents living among UNGD. Unlike previous research, much of which focuses on one specific issue such as social or environmental impacts, our study was able to capture the compounding nature of experiencing multiple QoL issues at once. In addition, our qualitative methodology enabled rich description of the social processes associated with these QoL impacts. It is worth noting that although every interviewee reported at least one QoL issue, not all were impacted by a multitude of issues. For example, one resident reported being impacted by traffic only; similarly, other residents reported being impacted by traffic plus only one other QoL issue such as psychological stress. This indicates a wide range of experiences for residents, and further research is warranted to determine whether some residents are more prone to QoL impacts than other residents based on factors such as proximity to UNGD.

Importantly, our results should be considered in light of the study's limitations. First, our results rely on qualitative self-reporting of QoL issues and, unlike studies utilizing structured QoL measures, are not quantifiable nor directly comparable to other studies. So, for example, while our results indicate notable psychological stress, we were unable to capture stress in a manner that would enable us to determine exact levels of stress. Second, our recruitment procedures initially included "cold contacting" residents, but we received no response using this method. Thus, our sample is limited to residents either known to one of our three key informants or known to interviewees who referred other residents. Third, while not a limitation per se given the qualitative methods used, our results are not generalizable to a broader range of individuals beyond the sample. Likewise, our sampling strategy aimed to include residents living in close proximity to UNGD activity and/or who were known by other residents to be experiencing QoL impacts associated with UNGD. Thus, these results might not be reflective of the entire population of Guernsey and Noble Counties or other regions with UNGD. Further research is needed to understand the broader QoL impacts.

5. Conclusions

Residents interviewed in Guernsey and Noble Counties reported one or more UNGD-related QoL impacts across five core categories,

specifically psychological stress, social stress, environment, physical health, and traffic. Every participant reported being impacted in some way, even if only by one factor such as traffic. Psychological stress was a particularly salient theme, as many residents living near UNGD found themselves anxious about the uncertainties of fracking; frustrated by interactions with oil and gas industry officials; stressed about noise or light pollution; and, in some instances, facing the possibility of moving from the region. Importantly, this study highlighted that some residents experience multiple negative QoL impacts which compound upon one another and sometimes in life-altering ways. As such, this research illustrates the breadth of UNGD-related issues that warrant further study and should be considered by communities and government agencies considering the possible impacts of UNGD activities.

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