Increases in gonorrhea among high school students following hurricane Katrina

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ABSTRACT

Objective: To determine the prevalence of *Neisseria gonorrhoeae* in a student population before hurricane Katrina and after their residential neighbourhoods were devastated in the wake of the hurricane.

Methods: Students in a New Orleans public high school were offered urine screening for *N gonorrhoeae* and *Chlamydia trachomatis* using nucleic acid amplification tests before (n = 346) and after (n = 333) hurricane Katrina. Based on studies showing gonorrhea clustering in physically deteriorated neighbourhoods, it was hypothesised that the post-Katrina gonorrhea prevalence would be higher among students whose neighbourhoods still showed signs of deterioration in the aftermath of the hurricane.

Results: Before and after hurricane Katrina, the prevalence of gonorrhea increased from 2.3% (8/346, 95% CI 1.3% to 4.6%) to 5.1% (17/333, 95% CI 3.1% to 8.2%), respectively (one-sided p = 0.027). In logistic regression of gonorrhea controlling for gender, age, chlamydia infection and exposure to hurricane-affected residential neighbourhood conditions, gonorrhea was significantly associated with female gender (odds ratio (OR) 2.6, 95% CI 1.0 to 6.3; p = 0.04) and with chlamydia infection (OR 9.2, 95% CI 3.9 to 21.7; p<0.001). Although of weak statistical significance, there was a strong independent positive trend toward testing positive for gonorrhea after the hurricane (OR 2.2, 95% CI 0.9 to 5.4; p = 0.09).

Conclusions: The analysis indicates that the odds of testing positive for gonorrhea more than doubled among students after the hurricane, indicating that surveillance activities should be restored to monitor sexually transmitted infections (STIs) among at-risk populations. Redoubled efforts should be put into STI screening programmes as soon as possible following natural disasters to prevent resurgent STI incidence rates.

> If things haven't changed by our next visit, we may have to announce a revolution.—Mikhail Gorbachev, Former Soviet President, while touring the Lower-Ninth Ward in New Orleans on 5 October 2007

Populations affected by a natural disaster face health threats that include the spread of communicable diseases. The risks of communicable diseases following a natural disaster are particularly higher among displaced populations and are proportional to population density. Watson and colleagues from the Humanitarian Emergencies Program at the World Health Organization recently reviewed communicable disease outbreaks that have affected populations displaced by natural disasters around the world.[1] Displaced populations following earthquakes, floods, tsunamis, volcanoes, typhoons or hurricanes have suffered outbreaks of diarrhoeal diseases, acute respiratory infections, measles, meningitis and malaria among others.[1] It is estimated that between 60% and 95% of reported deaths among refugees and displaced populations are attributed to malnutrition, diarrhoeal diseases, measles, acute respiratory infections and malaria.[2 3]

In addition to these health threats to displaced populations, the physical damage to residential neighbourhoods and to public health and clinical care infrastructures force individuals temporarily displaced who return in their disaster affected areas and those who do not evacuate to live for months or years, depending on the pace of recovery, in neighbourhoods characterised by a certain degree of deterioration with inadequate access to primary healthcare services. Studies have reported associations between physically deteriorated neighbourhoods and poor health.[4–6] These associations suggest that the neighbourhood physical deterioration in the wake of a natural disaster can increase the vulnerability of affected populations to poor health.

Applying the boarded-up housing characteristics of the US Census Bureau and the broken windows theory in sexually transmitted disease (STD) research, Cohen *et al* found a clustering of gonorrhea cases in physically deteriorated neighbourhoods in 107 US cities, independent of individual factors that included race, poverty, unemployment, marital status, level of education and lack of insurance.[6 7] Although, in disaster emergency response, communicable diseases of primary concerns are diseases associated with high transmissibility, high morbidity and high mortality such as waterborne, airborne or vectorborne diseases, in the long term, the ecological studies by Cohen *et al* provide grounds for considering an association between deteriorated neighbourhood conditions in the wake of a natural disaster and STDs. Despite expressed concerns for sexually transmitted infections (STIs) as risk factors for human immunodeficiency virus (HIV) infection in emergency preparedness and response,[2 3] we were unable to find any published study reporting on the prevalence of STIs before and after a natural disaster.

On 29 August 2005, hurricane Katrina (which oftentimes will be referred to herein as the hurricane) made landfall on the Louisiana–Mississippi border, prompting massive evacuations of the US Gulf coast and causing significant structural damage along the coast. The city of New Orleans, 49% built below sea level, was

estimated to be approximately 80% flooded.[8] On 24 September 2005, hurricane Rita sent heavy rains that reflooded much of New Orleans before the city had completely been drained of Katrina floodwaters. Nearly 2 years later, only approximately half of the pre-Katrina New Orleans population was estimated to have returned, many in residential areas still characterised by certain proportions of homes with structural damage, graffiti, homes or cars seemingly abandoned, as not everyone had returned, streets with trash,[9] all that resembles neighbourhood physical conditions that were independently associated with clusters of gonorrhea cases years before hurricane Katrina.[7]

Since the school year 1996–7, a school-based screening for chlamydia and gonorrhea documented prevalences of gonorrhea among New Orleans public school students that remained consistently in the range of 2.5% until hurricane Katrina struck.[10 11] The screening resumed 15 months after the hurricane, providing the opportunity to monitor gonorrheal infections among students before and after hurricane Katrina. We report on the prevalence of gonorrhea among students who participated in the chlamydia and gonorrhea screening during the school year 2004–5, the full school year before hurricane Katrina and during the school year 2006–7, the first uninterrupted school year after hurricane Katrina. Based on the reported clustering of gonorrhea in physically deteriorated neighbourhoods,[6 7] we hypothesised that the post-Katrina prevalence for gonorrhea would be higher among students who were living in neighbourhoods that, overall, still showed signs of deterioration in the aftermath of the hurricane.[9]

METHODS

Setting

During the school year 2006–7, two public high schools were operating in a New Orleans neighbourhood served by three public high schools before hurricane Katrina. One of the two schools participated since the school year 1997–8 in a chlamydia and gonorrhea screening first implemented in the school district in the 1995–6 school year.[10] This school was selected for participation in the screening because available funding after the hurricane only allowed the performance of no more than 400 chlamydia and gonorrhea tests in school.

Screening procedures

Approximately 1 week before testing began and following the same procedures as before hurricane Katrina,[10 11] consent was obtained in writing or verbally by telephone from parents or guardians of students younger than 18. Students aged 18 years or older could provide their own consent in writing. During the testing period, entire classes of students were escorted to the designated testing area. Each student was individually counselled regarding the opportunity to participate in the testing. Students whose parents did not provide consent and those who were not willing to be tested were sent back to their classroom. Students who had consent and were willing to participate provided a urine specimen that was tested for both *Neisseria gonorrhoeae* and *Chlamydia trachomatis* using a strand displacement amplification assay (BD ProbeTec, Sparks, Maryland), regardless of sexual activity or symptoms of STDs. Students testing positive were considered infected. They were treated with a single dose of 500 mg of oral ciprofloxacin for gonorrhea or 1 g of oral azithromycin for chlamydia at school by a clinician under directly observed therapy. Students treated were encouraged to refer their sex partners for treatment and STD evaluation to the city STD clinic. Named partners who attended the same school were treated at school with the index-infected student. As before hurricane Katrina, the screening after the hurricane was approved by the Institutional Review Board of the Louisiana State University Health Sciences Center, by the school district and by the principal at the participating school.

Students' participation

During the school year 2004–5 before the hurricane, 985 students in grades 9–12 were enrolled in the participating school. Testing was conducted for 21 days during regular class hours between 25 October and 9 December 2004, during which time 334 students (33.9%) were screened. During the school year 2006–7 after the hurricane, 845 students in grades 9–12 were enrolled in the participating school; of these, 333 (39.4%) were screened for 13 days between 29 November 2006 and 25 January 2007. Twelve of these 333 students were also screened during the school year 2004–5 while they attended other schools. During the two school years, a total of 646 students were screened at least once, including 313 screened before the hurricane, 300 screened after the hurricane and 33 screened before and after the hurricane.

Data analysis

We calculated the pre- and post-Katrina gonorrhea prevalence among the 646 students screened before and/or after the hurricane by dividing the number of students who tested positive by the total number of students tested during the school years 2004–5 and 2006–7, respectively. Because gonorrhea prevalence remained consistently stable before the hurricane[10 11] and was hypothesised to increase after the hurricane, post-Katrina prevalence was considered significantly higher only at a p value of less than 0.05 using a one-sided χ^2 test. Next, we determined whether being screened after the hurricane, that is, being exposed to hurricane-affected residential neighbourhood conditions, was associated with an increased probability of testing positive for gonorrhea by univariate and multivariate logistic regression analyses controlling for chlamydia infection and other potential confounding factors in our analyses.

RESULTS

Participants' characteristics

The gender and age characteristics of the 346 students screened before the hurricane (60.1% males; median age 17.0 years, interquartile range (IQR) 2.0 years; mean age 17.3 years, standard deviation (SD) 1.4 years) were similar to those of the 333 students screened after the hurricane (54.1% males; median age 17.0 years, IQR 2.0 years; mean age 17.2 years, SD 1.5 years); however, significantly more non-African–Americans were screened before (3.8%) than after the hurricane (0.6%; p = 0.005) (table 1).

Prevalence of gonorrhea and chlamydia before and after hurricane Katrina

Before and after hurricane Katrina, the prevalence of gonorrhea among all participants increased from 2.3% (8/346, 95% CI 1.1% to 4.7%) to 5.1% (17/333, 95% CI 3.1% to 8.2%), respectively (one-sided p = 0.027) (table 1). The prevalence of chlamydia varied only slightly from 12.4% before hurricane Katrina (43/346, 95% CI 9.2% to 16.5%) to 14.1% after hurricane Katrina (47/333, 95% CI 10.7% to 18.4%) (one-sided p = 0.26) (table 1). Among African–American students, the prevalence of gonorrhea was 2.4% (8/333) before the hurricane and 5.1% (17/331) after the hurricane (one-sided p = 0.032).

Table 1 Screening participation, demographic characteristics and prevalence of gonorrhea and chlamydia among participants before and after hurricane Katrina

Screening participants	Before hurricane Katrina (2004–5) (n = 346)	After hurricane Katrina (2006–7) (n = 333)
Gender, n (%)		
Males	208 (60.1%)	180 (54.1%)
Females	138 (39.9%)	153 (45.9%)
Race/ethnicity, n (%)		
African–American	333 (96.2%)*	331 (99.4%)*
Other	13 (3.8%)	2 (0.6%)
Age, years		
Median	17.0	17.0
Interquartile range	2.0	2.0
Gonorrhea infection, n (%)		
Males	2 (1.0%)	6 (3.3%)
Females	6 (4.3%)	11 (7.2%)
Total	8 (2.3%)**	17 (5.1%)**
Chlamydia infection, n (%)		
Males	20 (9.6%)	20 (11.1%)
Females	23 (16.7%)	27 (17.6%)
Total	43 (12.4%)	47 (14.1%)

*p = 0.005 for comparison of race/ethnicity before and after hurricane Katrina using a two-sided χ^2 test; **p = 0.027 for comparison of gonorrhea infection before and after hurricane Katrina using a one-sided χ^2 test.

During the observation period, gonorrhea infection was statistically significantly associated with female gender and with chlamydia infection in univariate and multivariate logistic regression analyses (table 2). Although of weak statistical significance, there was a strong positive trend toward testing positive for gonorrhea after the hurricane with a doubling of the odds of infection (crude odds ratio: 2.1, 95% CI 0.9 to 4.8; p = 0.10) which persisted after controlling for gender, age and chlamydia infection in multivariate logistic regression (adjusted odds ratio: 2.2, 95% CI 0.9 to 5.4; p = 0.09) (table 2).

Table 2 Crude and adjusted odds ratios for a positive gonorrhea test result during school years 2004–5 and 2006–7 by univariate and multivariate logistic regression analyses, respectively (n = 646)

Variables	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Gender		
Male	1.0	1.0
Female	2.9 (1.2 to 6.8)*	2.6 (1.0 to 6.3)*
Race/ethnicity		
African–American	1.0	–
Other	0.0 (0.0 to –)	
Age at first participation	1.2 (0.9 to 1.7)	1.2 (0.9 to 1.7)
Chlamydia infection		
No	1.0	1.0
Yes	10.9 (4.7 to 25.2)*	9.2 (3.9 to 21.7)*
Screened after hurricane Katrina		
No	1.0	1.0
Yes	2.1 (0.9 to 4.8)	2.2 (0.9 to 5.4)**

Odds ratios for gonorrhea were adjusted for gender (male as reference), age (as continuous variable), chlamydia infection (no infection as reference) and participation in screening after the hurricane (no, ie, participation before the hurricane as reference) in multivariate logistic regression analysis.
*p<0.05; **p = 0.09.
CI, confidence interval.

DISCUSSION

Nearly 2 years after hurricane Katrina, only approximately 265 000 people from a population of 496 936 before Katrina were estimated to populate New Orleans, many living in neighbourhoods still showing signs of physical deterioration in the wake of the hurricane.[9] The overall public school enrolment in the city was 26 165 students in 2007 down from 78 041 in 2000.[9] Thus, the 14% decreased school enrolment in 2006–7 (n = 845) compared with 2004–5 (n = 985) in a community that lost one high school to hurricane Katrina reflected the decreased population and overall school enrolment in New Orleans in the aftermath of the hurricane. Amid the decreased school enrolment, the prevalence of gonorrhea among students more than doubled after hurricane Katrina.

Since the school year 1996–97, the prevalence of gonorrhea among students in the school district has been based on small numbers of cases,[10 11] consistent with the eight cases on which the pre-Katrina prevalence in this study was based. These small numbers substantially limit our ability to detect statistically significant differences where such differences exist. Nevertheless, they established a stable 9-year trend from which no noticeable departure was observed before the hurricane came through. Although the doubling of odds in gonorrhea infection after the hurricane in this study was based on just 17 cases with a p value greater than 0.05, its 95% confidence interval is sufficiently skewed away from unity to suggest that the odds of infection may have increased considerably after the hurricane.[12]

This increase in the odds of gonorrhea infection cannot be causally linked to the hurricane and may be compatible with participation bias due to the possibility that high-risk students stayed or returned to town and low-risk students did not return, or also a result of self-selection of students who, for some reasons possibly associated with their Katrina-related experiences, disproportionately seized the opportunity to be tested for STIs at school. The direction of any possible selection bias in this study cannot be determined, and approval for collecting data on students' sexual behaviours or their personal Katrina-related experiences could not be obtained.[13] However, gender, a factor that was associated with gonorrhea infection in this student population,[10 11] remained similar among students screened before and those screened after hurricane Katrina. Although the proportion of non-African–Americans decreased significantly among participants after the hurricane, a significant increase in the prevalence of gonorrhea after the hurricane persisted in stratified analyses restricted to African–Americans only, while the odds of infection among African–Americans was not significantly different from that of non-African–Americans.

In addition to these individual attributes, social attributes such as low perception of social cohesion among neighbours have been associated with high rates of gonorrhea in impoverished urban neighbourhoods.[14] Despite extensive efforts put forth to reunite family members who were separated during the massive and chaotic evacuation that followed Katrina landfall,[15] at the time of our post-Katrina screening, there were persistent reports in the school of a sizeable number of students who were still not living with their parents or their legal guardians 15 months after the hurricane. This suggests that many may have been forced to live for an extended period of time in neighbourhoods with neighbours with whom they may not feel socially connected, possibly without the supervisory care of an adult relative. Complex mechanisms are certainly at work in the aftermath of a hurricane, although this study was not designed to examine them, which is another of the study limitations. Such mechanisms may include the interactions between

deteriorated physical structures and deteriorated social structures that both can create situational or spontaneous exposures that may affect health behaviours, all of which may in turn influence health.[6]

The Region VI Infertility Prevention Project of the Centers for Disease Control and Prevention in Louisiana recently reported increases in gonorrhea positivity among STD clinic patients in New Orleans and the surrounding parishes from 6.8% to 10.1% among females and from 16.3% to 19.3% among males before and after hurricane Katrina, respectively.[16] Similar Katrina-related gonorrhea increases were also observed in STD clinic patients outside New Orleans.[16] These observations were made between January 2004 and June 2005 before hurricane Katrina and between January 2006 and June 2007 after hurricane Katrina, periods during which students were screened for gonorrhea in schools. At the same time, cases of early latent syphilis reported to the New Orleans Health Department increased from 10 per 100 000 before hurricane Katrina to 41 per 100 000 after hurricane Katrina, and HIV positivity rates observed at the city STD clinic increased from 1.1% in 2005 before hurricane Katrina to 2.1% in 2006 after hurricane Katrina.[17] These simultaneous increases in gonorrhea and other STIs among STD clinic patients around the city are in agreement with the increased gonorrhea rates we report among students following hurricane Katrina.

In addition to the associations of gonorrhea with neighbourhood physical conditions in several US cities,[6 7] other social factors that have consistently been correlated with neighbourhood deteriorations include violence and crimes[18–22] which, in New Orleans, are not post-Katrina phenomena. Still, the escalation of crimes as New Orleans recovers from hurricane Katrina remains at the forefront of news reports. Compared with 2005, the US Attorney's Office reported a 32% increase in violent crime prosecutions in 2006,[23] and a police count indicated at least 207 murders in 2007 compared with 161 in 2006.[24 25] Given the relationship between neighbourhood deterioration and poor social and health outcomes reported in several studies,[4–7 18–22] the rates of gonorrhea we report among students should be interpreted not in isolation but rather in light of other indicators of social disorganisation as New Orleans continues to recover from hurricane Katrina.

The prevalence of chlamydia did not vary markedly before and after hurricane Katrina among students. The lack of differences in chlamydia positivity before and after Katrina was also observed among STD clinic patients in New Orleans.[16] These may be explained by different epidemiologies between chlamydial and gonococcal infections with earlier studies having reported that gonorrhea is transmitted more efficiently than chlamydia,[26] is geographically more concentrated[27 28] and is more likely to be accompanied by a coinfection with chlamydia than gonorrhea coinfection among individuals infected with chlamydia.[11]

Researchers have estimated that it will likely take between 8 and 11 years to reconstruct New Orleans.[29] With the slow pace of recovery, several locations in New Orleans residential neighbourhoods still show signs of deterioration in the wake of hurricane Katrina, with families still living in trailers pitched next to their damaged homes. These neighbourhoods, for better or for worse, will inevitably affect the lives of their residents.[4–7 18–22 30 31]

Because HIV positivity reportedly increased at the city STD clinic[17] and gonorrhea increases the risk of HIV transmission,[32] the gonorrhea infection rates in this study in the aftermath of hurricane Katrina can be considered sentinel health events that, from a public health standpoint, indicate that surveillance activities should be restored to monitor STI trends and the possibility of drug resistance, particularly the resistance of the gonococcus to fluoroquinolones.[33] Because many STIs including gonococcal infections may remain asymptomatic,[10 11] redoubled efforts should be put into STI screening programmes as soon as possible following natural disasters in order to prevent resurgent STI incidence rates, especially in high-prevalence areas. Active STI surveillance would also be indicated in areas that receive a massive influx of displaced populations from high STI prevalence areas, such as cities that received large numbers of New Orleans residents relocated in the aftermath of hurricane Katrina, in particular if these cities are of traditionally low or moderate STI rates. Future studies should seek to determine factors that contribute to increased gonorrhea rates in physically deteriorated neighbourhoods, including neighbourhood deteriorations caused by natural disasters.

Key messages

- Populations affected by a natural disaster face health threats that include the spread of communicable diseases, particularly waterborne, airborne or vectorborne diseases.
- This study demonstrates that the threat of communicable diseases among populations affected by a natural disaster may also include sexually transmitted infections (STIs).
- Following a natural disaster, it is important to restore public-health STI-prevention services as soon as possible to prevent resurgent STI incidence rates.

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Contributors: MJN, SNT and DHM designed the study; MJN, SNT and BSS conducted the study; DHM oversaw laboratory testing; MJN, SNT and DHM interpreted the data; MJN analysed the data and wrote the paper; all authors contributed to the successive revisions of the manuscript.

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