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Cost-Effectiveness of a School-Based Chlamydia Screening Program, Duval County, FL

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Abstract

During the 2015–2016 school year, the Florida Department of Health in Duval County hosted Teen Health Centers (TeenHC) at five high schools of Jacksonville providing HIV/STD screening and pregnancy testing. The purpose of this study was to assess the cost-effectiveness of the TeenHC chlamydia screening program and determine at what student participation level, the program can be cost-effective. We assessed the costs and effectiveness of the chlamydia screening program compared with “no TeenHC”. Cost-effectiveness was measured as cost per quality-adjusted life years (QALY) gained. At a program cost of US$61,001 and 3% participation rate, the cost/QALY gained was $124,328 in the base-case analysis and $81,014–$264,271 in 95% of the simulation trials, all greater than the frequently citied $50,000/QALY benchmark. The cost/QALY gained could be <$50,000/QALY if student participation rate was >7%. The TeenHC chlamydia screening has the potential to be cost-effective. Future program efforts should focus on improving student participation.

Keywords

school-based STD screening; chlamydia; cost-effectiveness; student participation

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Li Yan Wang and Kwame Owusu-Edusei contributed to the analysis and interpretation of the data. Li Yan Wang also drafted the manuscript. All authors contributed to the design of the manuscript, made critical revisions, gave final approval, and agreed to be accountable for all aspects of work ensuring integrity and accuracy.

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Background

Many adolescents engage in sexual risk behaviors that place them at risk for human immunodeficiency virus (HIV) infection, other sexually transmitted diseases (STDs), and unintended pregnancy. Incidence and prevalence estimates suggest that young people aged 15–24 years acquire half of all new STDs each year (Satterwhite et al., 2013). Of all age groups, adolescents aged 15–19 years had the highest increase in the rate of reported chlamydia (CT) and gonorrhea (GC) cases during 2016–2017, 7.5% and 15.5%, respectively (Centers for Disease Control and Prevention, 2018). The higher STD epidemic among adolescents may reflect multiple barriers to accessing quality STD prevention and management services (Tilson et al., 2004). In recent years, growing public health efforts have been expended to increase adolescents' access to STD screening and treatment services (Centers for Disease Control and Prevention, 2014; Dittus et al., 2014). School-based mass screening programs have been shown to be a feasible and cost-effective approach to screening and treating large numbers of asymptomatic students on campus (Cohen, Nsuami, Martin, & Farley, 1999; Dunville et al., 2018; Fisman, Spain, Salmon, & Goldberg, 2008; Wang, Burstein, & Cohen, 2002).

In Duval County, FL, among high school students surveyed in 2015 Youth Risk Behavior Survey, 37% reported ever having sexual intercourse, 26% reported having sexual intercourse during the previous 3 months, and 10% reported having more than four partners during their lifetime (Centers for Disease Control and Prevention, 2019). Among those who were currently sexually active, 40% did not use a condom the last time they had sex, 17% did not use any contraceptive method to prevent pregnancy the last time they had sex, and 20% had drunk alcohol or used drugs before last sexual intercourse (Centers for Disease Control and Prevention, 2019). Florida Department of Health (DOH) 2016 data show that 17% of all new CT cases and 12% of all new GC cases reported in Duval County were among adolescents aged 13–18 years, and 8.9 births per 1,000 females aged 13–18 years (DOH, 2019). In addition, CT and GC infection rates have increased from 2014–2016 in both male and female adolescents (DOH, 2019).

Recognizing the need to address adolescent sexual health in the county led to the creation of the Duval Teen Health Centers (TeenHC) Program. Funded by a cooperative agreement from the Centers for Disease Control and Prevention's Division of Adolescent and School Health (Funding Opportunity Announcement PS-13–1308), Duval County Public Schools (DCPS) built a partnership with the Florida DOH in Duval County (DOH-Duval), and Full Service Schools of Jacksonville (FSSJ)[1] to provide sexual health services to youth in high schools. FSSJ provided space for the TeenHC in FSSJ buildings that are located on school campuses. During the 2015–2016 school year, DOH-Duval hosted the TeenHC at five FSSJ locations in areas where there were significant barriers to accessing health care. The TeenHC provided evidenced-based comprehensive sex education, HIV screening, CT/GC screening

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[1] Full Service Schools of Jacksonville is a collaborative partnership led by United Way to serve the therapeutic, health and social service needs of at-risk students and families in Duval County. They are located on school campuses and provide a range of services including individual counseling, family therapy, behavior management, substance abuse counseling, parenting classes, psychological testing, tutoring, legal consultation, and outside agency referrals.

and treatment, and pregnancy testing. All services were available immediately following school dismissals for 2 hr, 1 day per week.

The TeenHC program was introduced and promoted via school announcement, program brochures, social media, student leaders, social workers, and school staff. Students who went to the TeenHC typically started with a group education session and then made a decision about whether they would get tested. Students could also skip the group education and just get tested. To protect student confidentiality, only one student was in the testing laboratory at a time. To determine student risk factors and testing methods, a sexual health questionnaire and risk assessment were conducted confidentially on a one-on-one basis.

From July 1, 2015 to June 30, 2016, of the 8,309 students enrolled in the five schools, 566 (7%) students received key sexual health services. TeenHC staff provided 896 group sex education services, 277 HIV tests (0 positive), 260 CT/GC tests (22 CT positives and 1 GC positive, including 2 CT reinfections), and 62 pregnancy tests (5 positives). When students tested positive for CT/GC, TeenHC staff provided on-site treatment. When youth tested positive for pregnancy, appropriate referrals were made to resources in the community. Although the TeenHC program offered sexual health services on school campus on a weekly basis, only 3% (239/ 8,309) of all enrolled students or 11% (239/[8,309 × 26%]) of all sexually active students were screened for CT and GC during the school year. As a new form of school-based STD screening program, it remains unknown whether this innovative program is better than the status quo.

In this cost-conscious era, cost-effectiveness information is vitally important to policy makers and program planners who must judiciously allocate limited STD prevention resources so as to maximize the number of infections averted. The most frequently asked questions by policy makers and program planners are (1) whether they can afford to implement a program and (2) whether the effects of a program can justify its cost. Conducting a cost-effectiveness study of the TeenHC CT screening will not only assist policy makers making informed resource allocations decisions but also help program staff understand how to improve the program in a cost-effective manner. The purpose of this study was to assess the cost-effectiveness of the TeenHC chlamydia screening program and determine at what student participation level, the program could be cost-effective.

Method

Cost-effectiveness analysis is a way to examine both the costs and health outcomes of one or more interventions. It compares an intervention to another intervention (or the status quo) by estimating how much it costs to gain a unit of a health outcome, such as a life year gained, a quality-adjusted life year (QALY) gained, or a death prevented. We used standard cost-effectiveness analysis methods (Gold, Siegel, Russell, & Weinstein, 1996) to assess the costs and effectiveness of the TeenHC chlamydia screening program compared with a “no TeenHC screening” scenario. We used a societal perspective to count the health effects and costs experienced by all those who are significantly affected by the intervention. Health effects were measured as cases of CT infection prevented, cases of epididymitis and pelvic inflammatory disease (PID) prevented, and QALYs gained. Three types of cost were considered, including program costs; costs of chlamydia testing and treatment in absence of the TeenHC screening; and costs of treatment for epididymitis, PID, and PID sequelae. The time frame for estimating the number of cases of CT infections, epididymitis, and PID was 1 year post the TeenHC screening, and the analytic horizon extended to 20 years after development of PID to incorporate QALY losses and medical treatment cost associated with PID sequelae. Cost-effectiveness was expressed in the form of a cost-effectiveness ratio and was measured as cost per QALY gained compared to “no TeenHC screening.” It was calculated as net program cost (program cost of TeenHC CT screening − CT testing and treatment costs in absence of TeenHC − medical costs averted associated with cases of epididymitis and PID prevented) divided by the number of QALYs gained. Future QALY losses and medical costs were discounted at 3%, and all costs were in 2016 US dollars. All calculations were performed in Excel.

Our base-case analysis was conducted in four steps. Step 1 focused on the group of students who were tested positive at the TeenHC. We developed a disease pathway diagram (Figure S1) to project the expected number of persistent CT infections or reinfections, epididymitis, and PID among this group of students in the coming year in each of the two scenarios. Persistent CT infections are defined as infections persisting to the next year due to treatment failure, not being tested, or having false negatives. A reinfection is a second infection that follows recovery from a previous infection. The differences in the expected cases between the two scenarios were considered as cases averted by the TeenHC screening. Detailed description of the disease pathway (Figure S1), input data used (Table S1), and key assumptions made are provided in the Online Supplemental Material.

Step 2 focused on the uninfected partners of the infected students. Students who had persistent CT infection or reinfection in the next year could transmit infections to their uninfected partners. We developed a separate disease pathway (Figure S2) to assess the impact of the TeenHC program on one-generation CT infection transmission prevented among the uninfected partners of the infected students. The differences in the number of expected CT transmission infections, epididymitis, and PID between the two scenarios were the number of cases prevented. Detailed descriptions of the disease pathway (Figure S2), calculations, input data used (Table S1), and key assumptions made are provided in the Supplemental Material.

Step 3 was to estimate medical costs saved and QALYs gained as a result of cases of epididymitis and PID prevented from Steps 1 and 2. Estimates of the medical cost per case of epididymitis and PID were directly obtained from published studies (see Table S1). The cost per case of PID included the average lifetime cost of PID and its complications (ectopic pregnancy, chronic pelvic pain, and infertility). We multiplied unit costs with the number of cases prevented to calculate total medical costs saved associated with cases of epididymitis and PID prevented. For QALY losses associated with epididymitis, we considered both outpatient and inpatient care. For QALY losses associated with PID, we considered acute PID and PID sequelae—ectopic pregnancy, chronic pelvic pain, and infertility. Table S2 (in Supplemental Material) depicts how we calculated QALY lost per case of epididymitis or PID including data sources and assumptions made. We multiplied QALY lost per case of epididymitis or PID with the number of cases prevented to calculate total QALY gained associated with cases of epididymitis and PID prevented.

Step 4 was to estimate CT testing and treatment costs in each of the two scenarios. In the TeenHC scenario, we first estimated the overall TeenHC program cost including personel, testing kit, medications, supplies, travel, and incentives. To tease out the cost of CT screening, we asked the TeenHC manager "What proportion of staff time was related to CT testing/treatment?" and "What proportion of the supplies, travel, and incentives was needed if only CT screening/treatment was offered?" Based on the proportion estimates provided and the overall TeenHC program cost, we estimated the program cost of CT screening during the 2015–2016 school year (see Table 1). In the "no TeenHC" scenario, we first estimated number of infected students and partners who would be tested or treated in a clinical setting in absence of the TeenHC program. We then estimated their medical costs of CT testing and treatment using published estimates of CT testing and treatment in a clinical setting (Table S1).

We conducted a multivariate sensitivity analysis to assess the robustness of the results to uncertainty in the input parameter values by varying all major parameter values over a wide range that we considered plausible assuming a triangular distribution of values for all parameters. We also performed a scenario analysis to determine at what student participation level or program cost level, the TeenHC CT screening would cost ≤$50,000 per QALY, a benchmark that is frequently used for cost-effectiveness in the United States (Grosse, 2008). In addition, as an alternative approach to the TeenHC screening program, school-based mass screening programs have shown success in screening 35–79% of students (Cohen et al., 1999; Dunville et al., 2018; Fisman et al., 2008). We performed a threshold analysis to determine at what level of program cost, a mass CT screening program can be cost-effective if implemented in the five schools.

Results

As shown in Table 1, the total program cost of the TeenHC CT screening was estimated to be $61,001. Table 2 summarizes the projected number of persistent CT infections and reinfections, epididymitis, and PID in each of the two scenarios as well as the number of persistent CT infections and reinfections averted and the number of epididymitis and PID prevented by the TeenHC CT screening program. Compared to the status quo, the TeenHC CT screening averted 8.5 persistent CT infections or reinfections among students and prevented 2.9 CT infections transmitted to their uninfected partners. As a result, 0.07 cases of epididymitis and 1.1 cases of PID were prevented among infected students, and an additional 0.02 cases of epididymitis and 0.2 cases of PID were prevented among partners of infected students.

Table 3 summarizes the cost-effectiveness results of both the base-case analysis and the sensitivity analysis. Under base-case assumptions, at a program cost of $61,001 and 3% overall student participation rate, the program prevented an estimated 0.1 cases of epididymitis and 1.3 cases of PID, and saved an estimated $5,504 medical costs and 0.5 QALYs, resulting in a cost of $124,328/QALY gained. Using the threshold of ≤$50,000/

QALY for cost-effectiveness, the program as implemented was not cost-effective. Although the results were sensitive to variations in the major parameter estimates, the program as implemented remained not cost-effective ($81,014–$264,271 per QALY gained) in multivariate sensitivity analysis.

Table 4 shows the results of scenario and threshold analysis. There are two ways to improve its cost-effectiveness to meet the threshold of ≤$50,000/QALY—reducing the program cost by 54% without changing student participation rate or increasing student participation rate by 2.3 times without changing program cost. Assuming all students tested were sexually active and the test positive rates reflected the actual CT prevalence among sexually active students, then a mass screening in the five schools can be cost-effective if it can test (1) 25% of sexually active students at a maximum program cost of $60,863, (2) 50% of sexually active students at a maximum program cost of $121,725, or (3) 75% of sexually active students at a maximum program cost of $182,388.

Discussions

Our study demonstrates that the TeenHC CT screening program as implemented was not cost-effective due to a low student participation rate. While 26% of high school students were sexually active in Duval County in 2015, only 3% of enrolled students in the five TeenHC schools were tested for CT/GC. Even if all students tested in the TeenHC were sexually active, only 11% (3%/26%) of the sexually active students in the five schools were tested, and majority of the sexually active students (89%) did not participate in the free testing services available to them at school. However, the TeenHC CT screening program has the potential to be cost-effective by improving the participation rate or reducing program cost. Improving participation rate from 3% to 7% (without increasing program costs) or reducing program cost from $61,001 to $27,823 (without changing student participation rate) would improve the cost-effectiveness to ≤$50,000/QALY saved.

The findings of this study are consistent with those of a recent study of a large-scale chlamydia screening program in the Netherlands (de Wit et al., 2015). The Dutch study found that the program was not cost-effective at low participation rates (16% in the first round and 9% in the third round) and concluded that “large-scale chlamydia screening most likely is not cost-effective if screening is unsuccessful in attaining high uptake in consecutive screening rounds” (de Wit et al., 2015; p. 4). The findings of this study and the Dutch study suggest that participation rates are crucial to the cost-effectiveness of chlamydia screening programs.

Although the TeenHC aim to increase access to key sexual health services, many students continue to experience significant barriers to utilizing these important health services. The major obstacle for students to participate in the TeenHC program was related to transportation issues. The TeenHC program was offered after school hours, but many students reported that they were unable to participate because they rely on school buses for transportation. For most of the students in the five schools, the safest transportation for them to go and from home is the school bus. The program initially offered city bus passes for students who attended the TeenHC but soon realized that most students were not familiar with the public transportation system and parents were concerned about their children's safety. One possible solution is to offer a mass screening during school hours, such as during lunch time, which would be cost-effective if ≥25% of sexually active students were screened at a maximum program cost of $60,863 or ≥50% of sexually active students were screened at a maximum program cost of $121,725. Previous research of school-based mass screening programs found that student participation rates among all enrolled were 35% in Philadelphia, 35–65% in New Orleans, and 79% in Detroit (Cohen et al., 1999; Dunville et al., 2018; Fisman et al., 2008). Such findings suggest that it is highly possible to reach a student participation rate of 25–50% in Duval County if a mass screening is offered. Another possible solution is to make special school bus arrangements to transport students home after attending the TeenHC. For either approach to work, additional support from DCPS is needed. In addition, partner notification and testing for CT infection were not as successful as expected even though all TeenHC staff were trained disease intervention specialists. According to the TeenHC staff, most infected students were unable to provide partner information because most of the sexual acts were casual sex, outside of an ongoing relationship. In this situation, expedited partner therapy may be a better alternative.

Since 2006, several national guidelines have recommended CT and GC screening of all sexually active females under 25 years of age (Centers for Disease Control and Prevention, 2006; U.S. Preventive Services Task Force, 2014; Workowski & Berman, 2010). However, a clear gap exists between the expected level of CT testing and the actual level of testing utilization in clinical settings (Wang, Chang, Burstein, & Hocevar Adkins, 2018). While 31% of high school students were sexually active in New York State (NYS), only 18% of female adolescents and 8.6% of male adolescents were tested for CT in NYS (Wang et al., 2018). If infected male adolescents remain untreated, they may not only develop epididymitis but also transmit infections to their uninfected or cured female partners. School-based STD screening represents a unique opportunity to fill the gap of STD screening in sexually active female adolescents and provide sexually active male adolescents with much needed testing and treatment that are currently lacking.

School-based mass screening can screen and treat a large number of asymptomatic students in a short time. In addition to Philadelphia, New Orleans, and Detroit, several other cities are currently offering school-based mass screenings, including Washington, DC (Furness, Shah, & Kharfen, 2014); New York City (Han, Rogers, Nurani, Rubin, & Blank, 2011); Chicago (Lewis, Dittus, Salmon, & Nsuami, 2016); and San Francisco (Barry et al., 2008). A school-based mass screening event is typically offered during school hours (e.g., during lunch time) and starts with a short educational session on STDs and screening. Subsequently, all students are given a brown paper bag with a urine specimen cup and are asked to enter the bathroom stalls where students may decide to provide a specimen or not. After-ward, all students return the paper bag to the testing person-nel. Because all students go through the same steps, students can choose to be tested without worrying about stigmatization by their peers.

Implications for School Nursing and School Health Services

Conducting school-based mass screening takes coordination and cooperation among schools, health departments, community organizations, parents, and other stakeholders.

School nurses can play a leadership role in initiating, promoting, and coordinating screening efforts. In areas with high STD incidence, school nurses can (1) use local STD rates and trend data to convince community stakeholders (e.g., schools principals, school boards, PTAs) the need for screening; (2) reach out to state or local health departments and local health-care providers (e.g., health centers) to develop partnerships for screening; and (3) schedule and coordinate all activities related to screening events once a collaborative team is formed, including communicating with teachers, students, and parents about the screening event; recruiting students and getting consent from students or parents; conducting the screening; transporting samples; and providing results and treatment to students. School nurses interested in pursuing mass school-based STD screening efforts are encouraged to contact others across the country to access lessons learned, best practices, and ways to garner support from community-wide stakeholders.

As with all model-based cost-effectiveness studies, our study has some limitations. First, our study only assessed the number of CT infections prevented in the year following the TeenHC screening; there may be more transmissions prevented as well as more reinfections over a longer period. To address the concern that the burden of disease may reoccur over a longer period, we used a published estimate of a 5-year reinfection rate among female adolescents attending family planning clinics in our base-case analysis and included the highest published female reinfection rate in our sensitivity analysis (Hosenfeld et al., 2009). Second, there is uncertainty in the major parameter estimates derived in the published studies or this study, although we have conducted sensitivity analysis by varying the major parameter values over a wide range that we considered plausible. Third, our analysis only included one-generation chlamydia transmission.

Our findings not only provide cost-effectiveness evidence for the TeenHC screening program as implemented during the 2015–2016 school year but also demonstrate at what level of student participation and program cost, the program can be cost-effective. Future program efforts should focus on improving student participation, partner notification/testing, and repeated testing for infected students.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Program Cost of the TeenHC Chlamydia Screening (in 2016 Dollars).

Program component	**Costs ($)**
Personnel	
Advanced registered nurse	7,176
Health support technician	9,214
Disease intervention specialist	11,517
Health educator	6,947
Prevention coordinator	10,815
STD coordinator	8,600
Testing kits ($5.32 × 260)	1,383
Medications	100
Supplies	
Outreach supplies	2,000
Office supplies	600
Marketing (handcards, posters, signs)	1,000
Travel	500
Incentives	1,148
Total	61,001

Note. TeenHC = Teen Health Center; STD = sexually transmitted diseases.

Table 2.

Projected Chlamydia, Epididymitis, and PID Cases Prevented.

Outcome	With School Screening	Without School Screening	Number of Persistent CT Infections and Reinfections Averted	Number of Epididymitis or PID Cases Prevented
Number of students infected				
Male	7	7		
Female	13	13		
Number of infected students without persistent infection[a] or reinfection in the coming year				
Male	5.71	2.10		
Female	9.81	4.93		
Number of infected students with persistent infection or reinfection in the coming year				
Male	1.29	4.90	3.62	0.07
Female	3.19	8.07	4.88	1.10
Percentage of infected students who would experience persistent infection[a] or reinfection in the coming year				
Male	0.18	0.70		
Female	0.25	0.62		
Number of infections transmitted from students who had persistent infection or reinfection to uninfected partners				
Female to male	0.95	2.41	1.45	0.02
Male to female	0.50	1.92	1.41	0.20

Note. PID = pelvic inflammatory disease; CT = chlamydia infection.

[a] Persistent infections refer to all infections persisting to the subsequent year due to treatment failure, not being tested, or having false negatives.

Table 3.

Cost-Effectiveness of the TeenHC Chlamydia Screening.

Cost, effectiveness, and cost-effectiveness measures	Base-Case Analysis	Multivariate Sensitivity Analysis
Program costs ($)	61,001	61,001
Number of epididymitis prevented	0.09	0.06–0.18
Number of PID prevented	1.30	0.75–1.64
Costs averted ($)	5,504	3,058–7,800
Total QALYs gained	0.45	0.22–0.68
Cost-effectiveness ratio ($/QALY gained)	124,328	81,014–264,271

Note. TeenHC = Teen Health Center; PID = pelvic inflammatory disease; QALY = quality-adjusted life years.

Table 4.

Scenario and Threshold Analyses.

Scenarios	**Program Costs ($)**	**Cost-Effectiveness Ratio ($/QALY Gained)**
THC screening program		
Base case, 11% of all sexually active students tested	61,001	**124,328**
Program costs reduced by 54%	27,823	**50,000**
Number of students tested increased by 2.3 times	62,744	**49,866**
School-based mass screening program		
25% of sexually active students tested	**60,863**	50,000
50% of sexually active students tested	**121,725**	50,000
75% of sexually active students tested	**182,388**	50,000

Note. TeenHC = Teen Health Center; QALY = quality-adjusted life years. The bold value highlights the result of each analysis.