Title: Income inequality and sexually transmitted infections in the United States: Who bears the burden?

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Abstract

Three causal processes have been proposed to explain associations between group income inequality and individual health outcomes, each of which implies health effects for different segments of the population. We present a novel conceptual and analytic framework for the quantitative evaluation of these pathways, assessing the contribution of: (i) absolute deprivation – affecting the poor in all settings – using family income; (ii) structural inequality – affecting all those in unequal settings – using the Gini coefficient; and (iii) relative deprivation – affecting only the poor in unequal settings – using the Yitzhaki index. We conceptualize relative deprivation as the interaction of absolute deprivation and structural inequality. We test our approach using hierarchical models of 11,183 individuals in the National Longitudinal Study of Adolescent Health (Add Health). We examine the relationship between school-level inequality and sexually transmitted infections (STI) – self-reported or laboratory-confirmed Chlamydia, Gonorrhoea or Trichomoniasis. Results suggest that increased poverty and inequality were both independently associated with STI diagnosis, and that being poor in an unequal community imposed an additional risk. However, the effects of inequality and relative deprivation were confounded by individuals' race/ethnicity.

Keywords: United States; sexually transmitted infections; income inequality; income; relative deprivation; Add Health

Introduction

There is a growing body of evidence that higher levels of income inequality both across and within countries are associated with worse health outcomes (Kondo et al., 2009; Wilkinson & Pickett, 2006). Multiple causal processes relating income inequality to health have been proposed (Kawachi, 2000), but there is considerable debate as to whether these relationships are truly causal, and if so how the mechanisms might vary by health outcome (Deaton, 2003; Gravelle, 1998).

Theoretically, socioeconomic status (SES) can pattern sexually transmitted infection (STI) risk in multiple ways. These include affecting whom one selects as a partner, and thus how likely the partner is to be infectious, and the actions an individual takes within a relationship (e.g. number of partners, sexual behaviour with each partner) (Bärnighausen & Tanser, 2009; Boerma & Weir, 2005; Poundstone et al., 2004).

Causal mechanisms that explain an empirical association between inequality and health have been divided into three broad categories (Leigh et al., 2009; Nilsson, 2009), each of which implies different segments of the community will be affected. It is possible to envisage pathways leading from inequality to STIs that are specific to each category.

Causal mechanisms linking inequality to STIs

First, the absolute deprivation hypothesis (ADH) posits that inequality is associated with ill-health for the poorest through its relationship with the distribution of income in a community. Ceteris paribus, more unequal communities will have more individuals living at both high and low income levels than similar, more equal communities. Given the empirically observed concave relationship between resources and health, such that there are positive but diminishing marginal returns health returns to additional income, greater inequality at any given mean level of income thus leads to lower average health, since decreased income harms the poor in the unequal community more than increased income benefits the rich (Leigh et al., 2009).

ADH mechanisms relating inequality to STIs, might include access to sexual health education and care, which are likely to be lower for poorer individuals and partner choices – since income affects where one can afford to socialize. If both mechanisms act in concert, differential distribution of knowledge and care resources across social strata would reinforce high STI rates amongst the poorest.

Second, the structural inequality hypothesis (SIH) focuses on the idea that the structure of unequal societies harms the health of everyone within them. Greater inequality may cause weaker social bonds and less social cohesion. Weak social ties can lead to lower levels of public good provision, either due to failure to work together to secure such goods or because community members have less in common, thus lowering the likelihood of a majority supporting provision of any given good (Kawachi & Berkman, 2000; Leigh et al., 2009).

Additionally, heterogeneity in economic circumstances may reduce interaction between community members. This can affect health by reducing the diffusion of healthy behaviours, limiting informal social control of unhealthy behaviours or by generating distrust leading increased anxiety or depression – each of which can lead to poorer physiological and behavioural outcomes (Kawachi & Berkman, 2000; Kubzansky & Kawachi, 2000). For example, if lower social bonds lead to increased propensity to commit crime against others, this might lower physical mobility within neighbourhoods, increase stress levels and of course increase violence-related ill-health.

Community heterogeneity may also ensure increased assortativity of social mixing by increasing the proportion of unlike people who are socially or geographically proximate. This may lead to increased diffusion of behaviours or infections, if disease prevalence or health behaviours differ systematically by social groups. The direction of effect in such a situation is ambiguous, since those with poorer health might impact the healthier, or vice versa. In the case of infectious diseases, mixing of heterogeneous risk groups has been shown theoretically to lead to slower disease spread but ultimately higher total prevalence (Doherty et al., 2006; Garnett & Anderson, 1996).

SIH mechanisms might include reduced provision of sexual health services – perhaps because there is inadequate funding to support their provision. Alternatively, differential sexual mixing patterns, specifically more mixing between high and low SES groups in more unequal communities, would increase the spread of STIs across social strata within these communities.

Finally, the relative deprivation hypothesis (RDH) suggests that inequality affects the worst-off in unequal communities uniquely, by increasing their social distance from their relevant reference group – others living nearby (Spriggs et al., 2009). This reference group provides an expectation for normative living standards and behaviours (Runciman, 1966; Webber, 2007). When the worse-off are unable to achieve this standard of living due to limited resources, the resulting stress and shame may lead to worse health through either psychosocial or behavioural pathways (Kondo et al., 2008). RDH mechanisms linking relative deprivation to STIs seem most likely to arise through behavioural mechanisms. For example, the perceived gap between individuals and their better-off neighbours could lead to increased use of alcohol and other substances, leading in turn to more risky sexual behaviour.

It is notable that each set of mechanisms predicts different segments of the population will be affected (Figure 1). ADH mechanisms will put the poor at increased risk relative to the rich, regardless of the level of community inequality. SIH mechanisms place all those living in more unequal communities at increased risk, relative to those living in more equal communities. Finally, RDH mechanisms will affect only the poor within unequal communities. Of course, some, all, or none of these mechanisms may be present in a given context. Understanding where the burden lies is essential for careful targeting of prevention and treatment interventions.

Empirical links between SES and STIs

Empirically, sexual behaviour and STI rates have been shown to be associated with socioeconomic conditions at the individual and group levels in North America and Europe, both due to individual factors such as poverty and education, and group-level factors such as high neighbourhood poverty, deprivation and social disorganization, and low social capital and collective efficacy (Bauermeister et al., 2011; Browning et al., 2004; Dupéré et al., 2008; Hogben & Leichliter, 2008; Holtgrave & Crosby, 2003; Krieger et al., 2003; Ramirez-Valles et al., 1998).

These associations are particularly notable amongst women (Zierler & Krieger, 1997) and in the African-American community (Adimora & Schoenbach, 2002). The effect-modification of SES by race/ethnicity and gender is unsurprising, given that both factors strongly pattern partner choices, sexual experiences and STI risk (Adimora & Schoenbach, 2005). Previous studies of the association of STIs with education and poverty have found effects to vary by race and gender (Annang et al., 2010; Newbern et al., 2004).

Research on the relationship between income inequality and STIs in the United States has been limited. To date, the only two analyses have been ecological: one of neighbourhood-level inequality in Massachusetts and Rhode Island (Krieger et al., 2003) and the other of state-level inequality nationally (Holtgrave & Crosby, 2003). Both studies found inequality to be positively associated with reported STI rates.

In the present study we examined whether the three mechanisms explain any association between income inequality and STI acquisition risk amongst young adults in the United States. To do this we propose a novel approach linking commonly used economic measures to specific theoretical causal mechanisms.

Methods

We conducted a secondary data analysis using Waves I to III of the National Longitudinal Survey of Adolescent Health (Add Health). Add Health is a nationwide survey which sampled adolescents from 80 US high schools and 52 of these schools' largest feeder schools (Harris et al., 2009), and followed them into young adulthood. Schools were selected so as to ensure coverage across regions, levels of urbanicity, school sizes and types, and race/ethnicity. Wave I (1994-95) surveyed a sample of all enrolled students in grades 7 through 12 at home, Wave II (1996) re-surveyed those who had been in grades 7 through 11 at Wave I, and Wave III (2001-02; ages 18-26) re-interviewed all Wave I respondents. Understanding sexual behaviour and health was one of the primary interests in the design of Add Health (Resnick et al., 1997).

The study sample for this analysis comprised all respondents who were at minimum interviewed at Waves I and III, whose parents provided information on family income, household size and parental education, and who were affiliated with one of the 132 core Add Health schools at Wave I interview. Ethical approval for the Add Health survey was obtained from the Institutional Review Board (IRB) at the University of North Carolina, Chapel Hill. This analysis was exempted by the IRB of the Harvard School of Public Health as a secondary analysis of existing data.

Measures

The outcome for this study was STI diagnosis. At Wave III, respondents were asked to provide a urine sample for Chlamydia trachomatis, Neisseria Gonorrhoeae and Trichomonas vaginalis testing. Also at Wave III, respondents were asked whether a health professional had within the past 12 months told them that they were infected with each of these STIs. At Wave II respondents were asked whether they had been diagnosed since Wave I and at Wave I they were asked if they had ever been diagnosed. For our primary analysis, the outcome was a binary measure of whether respondents had any self-reported or laboratory-confirmed STI at Wave II or III.

Three economic exposure measures were used for this analysis, each reflecting one of the three hypothesized mechanisms relating income inequality to STI acquisition risk. All were based on parental reports of 1994 total pre-tax family income at Wave I (in $1000 increments, top-coded at $999,000). Absolute deprivation was measured using each respondent's family per-capita equivalent income. To arrive at a per-capita equivalent figure that reflected household economies of scale, family income was divided by the square root of the number of individuals in the household – the "Luxembourg Income Study Scale" approach (Atkinson et al., 1995).

Structural inequality was measured using the Gini coefficient of per-capita equivalent income for all respondents within the same school, reflecting community inequality. The Gini coefficient is a measure of the gap between each person's income and that of each other person in their community, standardized to a value between 0 – everyone has the same income – and 1 – one person has all the income (Cowell, 2011).

Relative deprivation was measured using the Yitzhaki index (Yitzhaki, 1979), reflecting the difference between an individual's circumstances and the normative level in their community. The Yitzhaki index defines relative deprivation for an individual as the sum of the income gaps between them and all those ranked above them in their reference group, normalized by the size of the reference group. In this analysis, this meant summing the differences in income between the respondent and all other respondents in the same school with a higher per-capita income, and then dividing this total by the number of respondents in the school.

As potential confounders, we considered: respondents' sex, age (in years) at Wave I, primary self-reported racial/ethnic identification (White non-Hispanic, Black non-Hispanic, Hispanic, and all others; hereafter: White, Black, Hispanic, Other); their parent's highest level of education (less than High School completion, High School completion or GED, some tertiary, completed college, any postgraduate); and their school's urbanicity (urban, suburban or rural), regional location (West, Midwest, South, Northeast) and type (public or private).

Analytic methodology. Analyses were conducted using two-level hierarchical models where each individual 'i' was nested within the school 'j', which they were attending at Wave I. Bivariate relationships between the outcomes and each independent variable were examined using logistic regression to generate odds ratios (OR) and 95% confidence intervals (CI). After running an empty model, we re-established the bivariate relationship between income inequality and the primary outcome. Next we added absolute income and relative deprivation variables to quantify how much of the inequality-STI relationship might be attributable to each mechanism. We then added covariates for own age and sex, parental education and school-level urbanicity, region and public/private type. Finally we added own race/ethnicity to the model, which led to final model of the form:

$$y_{ij} \sim Binomial\left(n_{ij}, p_{ij}\right)$$

$$ln\left[\frac{p_{ij}}{1-p_{ij}}\right] = \beta_{0j} + \beta_2 Income_{ij} + \beta_3 Yitzhaki_{ij} + \beta_4 Age_{ij} + \beta_5 Sex_{ij}$$

$$+ \beta_6 ParentalEducation_{ij} + \beta_7 Race/Ethnicity_{ij}$$

$$\beta_{0j} = \beta_0 + \beta_1 Gini_j + \beta_8 Urbanicity_j + \beta_9 Region_j + \beta_{10} SchoolType_j + u_{0j}$$

$$u_{0j} \sim N(0, \sigma_{u0}^2) \qquad e_{ij} z_{ij}\ , z_{ij} = \sqrt{\frac{\hat{p}_{ij}\left(1-\hat{p}_{ij}\right)}{n_{ij}}}, \sigma_e^2 = \pi^2/3$$

Analyses were conducted using SAS version 9.3 (SAS Institute; Cary, NC), using the NLMixed procedure. All statistical tests were two-sided at α=0.05. The reference category for each economic variable was the quintile expected *a priori* to be lowest risk (low inequality, high income, low relative deprivation); for covariates we used either the most common category or one expected to be lowest risk.

Given prior expectations of potential effect-modification, we reran the models: (i) stratified by sex; (ii) stratified by race/ethnicity; and (iii) considering each STI separately as an outcome. We also conducted three robustness analyses: first, given a low likelihood of reverse causation, we included as cases any individuals who reported having been diagnosed with an STI at their Wave I interview; second, in case those individuals responding at Wave II systematically differed from the overall sample, we removed those respondents who were not interviewed at all three waves; and third, since the impact of school might be expected to exert its strongest effect during adolescence, we restricted the analysis to self-reported STI diagnosis at Waves I or II.

Results

A total of 14,808 respondents were interviewed at both Waves I and III and affiliated with one of the core schools. Family income was missing for 3,596 (24.3%), parental education for a further 31 (0.2%) and two respondents declined both to report their STI history and to provide a valid urine sample. The analytic sample size was thus 11,183.

Respondents were almost all aged between 13 and 18 at baseline (3.8% were aged 11 or 12, 1.4% aged 19-21) with a roughly even gender split (Table 1). Respondents were markedly more White (55%) and less Black (20%) and Hispanic (15%) than the nation as a whole, and than their schools, reflecting the purposive oversampling of racial/ethnic minorities in Add Health.

Almost 90% of respondents had at least one parent who had completed high school, and one-third had a parent who had completed a college degree. Median adjusted per-capita income was a little below $20,000 with a wide range. The median family had an average per-capita income gap from themselves to families above them at the same school (Yitzhaki index) of almost $6,400 and the median school Gini coefficient in the sample was 33.7, somewhat lower than the national value based on raw household income data. Figures for males and females were very similar to one-another (Supplementary Table 1). Across Waves II and III, 10.5% of respondents either reported a recent diagnosis of, or tested positive at Wave III for, at least one of the STIs of interest. The most common diagnosis was of Chlamydia (7.8%), followed by Trichomoniasis (3.0%) and then Gonorrhoea (1.6%).

All three measures of economic wellbeing were inversely associated with STI diagnosis in bivariate analysis (first column, Table 2). Individuals in the most unequal quintile had 2.5 times the odds of an STI diagnosis compared to those in the least unequal quintile, and there was significantly increased risk for those in the three most unequal quintiles. Similarly, the odds of STI infection for the poorest quintile was double that of the richest, and those who were most relatively deprived had 50% increased odds of STI compared to the least relatively deprived. Supplementary Table 2 provides details of the bivariate associations between STIs and covariates.

Adding income to the income inequality model (Model 2, Table 2) lead to an attenuation of the inequality relationship by approximately one-third but had little impact on the income-STI relationship. Further adding the Yitzhaki index to this model (Model 3, Table 2) had little impact on the inequality relationship; relative deprivation (in a model already adjusted for income and inequality) was associated with lower STI risk.

Relationships between economic variables and STIs were essentially unchanged by adjustment for baseline age and sex, parental education and school characteristics (Model 4, Table 2). After adjustment for individual race/ethnicity, however, neither inequality nor relative deprivation was associated with STI risk (Model 5, Table 2).

Stratification by sex showed a slightly steeper inequality gradient for women than for men, both in bivariate analysis and after adding income and relative deprivation (Table 3). Stratification by race/ethnicity suggested that most of the unadjusted association between income inequality and STI risk was due to Hispanics and Others, although these associations were non-significant due to small sample sizes and case counts (Table 4). Low income was associated with STI risk in all groups except Hispanics. Relative deprivation exhibited a large, but non-significant, positive adjusted effect for Others, suggesting a positive multiplicative interaction between income and inequality in this group. Modelling each STI outcome separately suggested that income inequality was most strongly associated with higher rates of Trichomoniasis, although power to detect effects was low (Supplementary Table 4).

The first two robustness checks – adding Wave I outcomes and excluding individuals missing Wave II interviews – had a negligible effect on inequality and STI relationship (Supplementary Table 5). However, restricting the analysis to Waves I and II exposures and outcomes changed the results somewhat: although the number of cases was considerably lower, income inequality was more strongly associated with STIs, even in models containing race/ethnicity (2nd most unequal quintile: OR: 1.65, 95%CI: 1.01-2.69; most unequal quintile: OR: 1.48, 95%CI: 0.88-2.49). It was also notable that age was a strong predictor in this adolescent sample and that racial/ethnic differentials were attenuated.

Discussion

This study proposes a novel analytic framework for understanding the relationship between income inequality and health, and applies it to data on STI risk amongst adolescents and young adults in the United States. Our framework explicitly connects three sets of theoretical inequality-related causal mechanisms (absolute income deprivation; structural inequality; relative deprivation) to three economic measures (personal income; community Gini coefficient; Yitzhaki index) to empirically test which sections of the population are affected by inequality (the poor; all in unequal settings; the poor in unequal settings). We find our proposed framework is feasible for examining STI diagnosis in the setting of US school-based communities.

Empirically we found that worse values of all three economic measures were crudely associated with increased STI risk, and that these relationships remained in adjusted models allowing for one-another. However, both structural inequality and relative deprivation were confounded by race/ethnicity. All these associations were stronger for school-aged than for young adult time periods, and inequality effects were greater for women and for those of Hispanic ethnicity and non-Black, non-White race.

***Examining inequality*.** In bivariate analysis we find more income inequality to be strongly associated with higher risk of STI diagnosis amongst US youth. This is consistent with two previous ecological studies of income inequality and STIs in the United States, both of which found strong positive associations between group-level inequality and group-level STI rates (Holtgrave & Crosby, 2003; Krieger et al., 2003).

Two arguments have been proposed to suggest that any observed inequality-health relationship does not reflect the structural effect of inequality on health, but rather relates to other economic factors. First, the ADH suggests that individuals' incomes confound the relationship. In this study, adding income to the model partially attenuated the inequality-STI association, but a significant relationship remained. Second, the RDH suggests that relative deprivation may mediate the effect of inequality on health, by generating stress and thus affecting physiology or behaviour. This does not appear to be the case in these data: although in bivariate analysis relative deprivation is positively associated with STI risk, adding the Yitzhaki index to the bivariate Gini-STI model has almost no impact on the inequality-STI relationship (Supplementary Table 6).

Once all three economic variables are included in the same model (Model 3, Table 2), we can look at the distribution of STI risk across income and inequality jointly. In particular, we can look at the risk for those living both in poverty and inequality. To do so, however, we cannot merely look at the coefficient on the Yitzhaki variable since those who are relatively deprived are mechanistically likely to also be poor and living in unequal settings (see Figure 1), since in order to be relatively deprived they must by definition have richer schoolmates whose family incomes is considerably greater than their own. Instead, in order to compare someone who is relatively deprived to someone who is not, we must also adjust for absolute income and group income inequality: relative deprivation is conceptually similar to an interaction term for income and income inequality. A true comparison of someone in the least deprived quintile for all three economic measures (i.e. richest, least relatively deprived, attending the most egalitarian school) to someone in the most deprived quintile for all measures involves summing the parameter estimates for all three economic measures. Doing this, we find the most deprived had 3.60 (95%CI: 2.48-5.22) times the odds of STI diagnosis of the least deprived. The risk for the most deprived was significantly higher than for the richest quintile in the most unequal settings (OR: 1.81, 95%CI: 1.42-2.30) and non-significantly higher than for the poorest quintile in the most equal settings (OR: 1.39, 95%CI: 0.87-2.23). This highlights two effects: first, that the poor were at increased risk in all communities; and second that the strongest effect of unequal communities appears to be for the richer quintiles.

These results suggest that the crude relationship seen between the Gini coefficient and STIs partly reflects associations arising from the ADH and SIH, but not the RDH. While such findings are preliminary, they might point us towards further investigation of inequality-STI pathways that relate to absolute deprivation and structural inequality. For example, the ADH suggests that those with fewer resources will have more risky sexual behaviours and potentially less health knowledge, while the SIH suggests that more unequal communities will have higher levels of mixing across socioeconomic strata, or have lower levels of preventative care provision. These are testable hypotheses. The limited finding with regards to the RDH suggests that social comparison factors may play a relatively small role in determining risk for STIs amongst young US adults, and in combination with the finding of a robust income effect suggests that material concerns might play a stronger role than psychosocial ones in this setting.

While the interaction of inequality and income can be included mechanically using an interaction term, the use of a measure of relative deprivation, such as the Yitzhaki index, provides two benefits. First, the Yitzhaki index has a clear interpretation as the average economic distance of an individual from those above him or herself in a community. This should help in translating findings to community and policy arenas, by presenting a readily comprehensible construct to non-specialists. Second, in an analysis which uses measures of income and inequality more nuanced than continuous or binary form, such as this one, the Yitzhaki index reduces the number of model terms (in this case we use 12 – four for each economic model; an interaction model would require 24), increasing the power to detect effects. Indeed, running models including fully interacted income and inequality quintiles gave us unstable, if qualitatively similar, results (not shown).

The role of race/ethnicity. The addition of an individual's race/ethnicity as a potential confounder to our analysis consistently reduced the relationship between inequality and STI risk to negligible levels (OR comparing most to least unequal quintile in the bivariate model with race/ethnicity added: 1.12, 95%CI: 0.86-1.45; Supplementary Table 6). This was less markedly the case for models that included only infections diagnosed prior to leaving school (Supplementary Table 5). This null finding is in line with other research on school-level income inequality in the Add Health dataset; previous studies have found changes in inequality to be weakly linked to change in racial test-score gaps (Campbell et al., 2008), and depressive symptoms to be (negatively) associated with school income equality only in models excluding individual-level covariates (Goodman et al., 2003).

The role of race/ethnicity as a potential confounder of an observed crude relationship between inequality and health has been extensively debated in the literature (Deaton & Lubotsky, 2003; Lynch et al., 2003; Mellor & Milyo, 2001; Subramanian & Kawachi, 2003). African-Americans are at very substantially elevated risk for STI acquisition in the United States, as a result of assortative partnering by race/ethnicity and relatively disassortative partnering by behavioural risk (Adimora & Schoenbach, 2005; Aral, 1999). There is not strong evidence that US Blacks live in more unequal (as opposed to poorer or more segregated) communities, however our findings suggest that race/ethnicity may indeed confound the inequality and STI relationship in the United States.

One alternative understanding of race/ethnicity in this study is as a modifier of inequality effects on health. This arises if race/ethnicity modifies the mechanisms through which inequality affects STI risk. Such an explanation is congruent with the evidence that partnership patterns differ by race/ethnicity, if it can also be shown that they differ within racial/ethnic groups by level of inequality.

Subgroup analyses

While inequality was not associated with STIs across the whole population after adjusting for race/ethnicity, notably stronger associations were seen: (i) for women, compared to men; (ii) for Hispanics and Others, compared to White and Blacks; (iii) for Trichomoniasis, compared to Chlamydia and Gonorrhoea; and (iv) for Waves I and II, compared to Wave III.

Two of these findings should be considered jointly: Trichomoniasis was the most feminized of the three infections (Supplementary Table 4). This finding reinforces the suggestion that inequality plays a stronger role for women than men. The stronger result for women stands in contrast to a Indian study of income inequality and HIV, where inequality was positively associated with prevalent infection in men, but not in women (Perkins et al., 2009). Epidemiological studies for Trichomoniasis are limited to date, with six general population surveys reported worldwide as of 2008 (Johnston & Mabey, 2008), of which the only US study used the Add Health dataset (Miller & Zenilman, 2005). Careful analysis is needed to connect the epidemiology of specific STIs to social dynamics that might explain why inequality is particularly risky for specific racial/ethnic/gender strata. These factors are likely to vary by geography and time period (Aral et al., 2006), and strong analysis will require intentional sampling to ensure sufficient power to make comparisons between subgroups.

The stronger association between inequality and STIs at Waves I and II than once Wave III outcomes were included is unsurprising for several reasons. First, school-level measures of community economic circumstances are likely to be more relevant while respondents are still in school; all respondents were still of school age at Wave II, since respondents in grade 12 at Wave I were excluded. This is especially likely for causal explanations of STI risk based on social comparisons or partnership-mixing. Second, any time-invariant, community-based measure is likely to become less valid over time: Wave II outcomes were measured only one year after family income data collection, and geographic mobility will lead to ever-increasing levels of misclassification regarding respondents' relevant community. Third, community economic factors may truly play a stronger role amongst younger individuals, and such factors may decline in importance as young people pass into their twenties. Alternatively, community economic factors may play a stronger role in determining risk for STI diagnosis than for actual acquisition, since only at Wave III do we have a laboratory-confirmed diagnosis. More complete measures of geographic location, individual and community SES are needed to disentangle these explanations.

Strengths and Limitations

There are a number of potential limitations to our analysis. First, this study makes the working assumption that socioeconomic comparisons and effects at the school level are germane to the sexual behaviour and health of adolescents through into young adulthood. This may be incorrect for two reasons. In adolescence schools may not be the appropriate unit for community effects – e.g. if peer groups are formed across educational boundaries. This concern is partially allayed by evidence that a very high proportion of romantic relationships are formed within schools in the Add Health study (Raley & Sullivan, 2010), and that neighbourhood factors influence adolescent sexual behaviour by affecting the nature of school environments, rather than directly (Teitler & Weiss, 2000). Perhaps more worryingly, residential and scholastic location at Wave I may be a poor proxy for community six years later, given the considerable mobility of young US adults. This may explain the stronger results for Wave I and II outcomes, compared to analyses including Wave III. Gathering information on the geographic location of respondents over time, and linking these locations to time-sensitive measures of socioeconomic structure would be an important extension to this study.

Second, STI outcome measures in Add Health are incomplete. Respondents report any STIs diagnosed up to Wave II and within one year of their Wave III interview, while laboratory testing captures any unresolved STI at Wave III, Thus any diagnosed and treated cases arising in the gap between Wave II and one year prior to Wave III are not captured by the survey. This issue is however mitigated by the multiple cohort structure of Add Health: since six cohorts are interviewed, there are respondents of every age from 12 to 24 across the two waves, so no specific age-range is missed (although sample sizes are insufficient to allow for a cohort-specific analysis). Nevertheless cases may have been missed, contributing to reduced power to detect true effects.

Third, although we have considered multiple inequality measures in this study, it may be that our results are specific to the measures of SES considered. Further research looking at other measures – for example, subjective measures of inequality (Atkinson, 1970) – will be important in identifying exactly what forms of social stratification affect disease risk. Furthermore, it was not within the scope of this paper to analyze how or if specific social processes mediate these associations, but future work could usefully consider whether those pathways outlined above do in fact mediate the SES-STI relationships seen.

Fourth, as is common in survey-based analyses, there is considerable missingness of data relating to SES: 13.9% in the case of education and 24.3% for income. STI risk is not systematically different by missingness (Supplementary Table 7), and there is no clear reason to believe that STI risk within levels of SES variables is likely to differ depending on whether parents did or did not report their SES, however this remains an untestable assumption.

Finally, it is not clear whether our findings can be safely generalized to older age groups, to other STIs or to settings other than the United States in the 1990s, a time when Gonorrhoea rates were in decline, Chlamydia rates were rising and Trichomoniasis was probably stable (Aral et al., 2007). Care should be taken to understand the dynamic STI environment prior to generalizing these results.

This study has, however, a number of important strengths. The analysis is based on a prospectively interviewed, longitudinal cohort, which should limit concerns regarding the temporality of any effects seen. While attrition is a generic concern in cohort studies, it was relatively low in Add Health and analysis suggests it has had limited effect on estimates (Chantala et al.). Furthermore, we are able to combine laboratory STI testing (which allows us to avoid biases arising from non-random variation in healthcare access and testing) and self-report data (which allows us to move beyond currently prevalent infection to include treated cases). Additionally, any social desirability bias in reporting should be limited both by the audio-computer-assisted interview method used and by the knowledge that respondents are being laboratory-tested at the same time.

Conclusions

This study tested alternative hypotheses regarding how income inequality affects health, and who is affected. Our analysis found potential roles for absolute deprivation, structural inequality, relative deprivation, race/ethnicity and gender, reminding us that when considering the effects of social and economic factors on sexual health outcomes in the United States, there is a complex interplay of individual and group factors placing individuals at risk of infection.

Our analysis has important methodological and practical implications. Methodologically, we believe that the joint use of measures capturing absolute deprivation, structural inequality and relative deprivation is a potentially fruitful one for partitioning the effects of different causal mechanisms on health. In providing a feasible analytic framework for operationalizing theoretical mechanisms long discussed in the inequality and health literature, this study should encourage further careful analysis of the range of possible pathways connecting socioeconomic factors to health outcomes. Additionally, this framework should help to direct analyses of the mediating processes themselves. In the case of STI risk in the United States, next steps could include analyses of sexual partnership patterns by socioeconomic status, and how behaviours vary according to income or disparity level.

Practically, our approach provides a straightforward correspondence between causal mechanisms and sections of the population in which we should expect to see worse health outcomes. This should both assist those observing worse health in certain groups (e.g. the poor in unequal communities) in their search for putative causes (e.g. stress caused by social exclusion), and those finding empirical relationships in data (e.g. an association between the Yitzhaki index and STI risk) in pinpointing which parts of which communities are most likely affected.

References

Adimora, A. A., & Schoenbach, V. J. (2002). Contextual factors and the black-white disparity in heterosexual HIV transmission. *Epidemiology, 13*(6), 707-712.

Adimora, A. A., & Schoenbach, V. J. (2005). Social context, sexual networks, and racial disparities in rates of sexually transmitted infections. *Journal of Infectious Diseases, 191*(Suppl 1), S115-122.

Annang, L., Walsemann, K. M., Maitra, D., & Kerr, J. C. (2010). Does education matter? Examining racial differences in the association between education and STI diagnosis among black and white young adult females in the U.S. *Public Health Reports, 125*(Suppl 4), 110-121.

Aral, S. O. (1999). Sexual network patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible. *Sexually Transmitted Diseases, 26*(5), 262-264.

Aral, S. O., Fenton, K. A., & Holmes, K. K. (2007). Sexually transmitted diseases in the USA: temporal trends. *Sexually Transmitted Infections, 83*(4), 257-266.

Aral, S. O., O'Leary, A., & Baker, C. (2006). Sexually transmitted infections and HIV in the southern United States: an overview. *Sexually Transmitted Diseases, 33*(7 Suppl), S1-5.

Atkinson, A. B. (1970). On The Measurement of Inequality. *Journal of Economic Theory, 2*, 244-263.

Atkinson, A. B., Rainwater, L., & Smeeding, T. M. (1995). *Income distribution in OECD countries: evidence from the Luxembourg Income Study*. Paris: Organisation for Economic Co-operation and Development.

Bärnighausen, T., & Tanser, F. (2009). Rethinking the role of the local community in HIV epidemic spread in sub-Saharan Africa: a proximate-determinants approach. *HIV Therapy, 3*(5), 435-445.

Bauermeister, J. A., Zimmerman, M. A., & Caldwell, C. H. (2011). Neighborhood disadvantage and changes in condom use among African American adolescents. *Journal of Urban Health, 88*(1), 66-83.

Boerma, J. T., & Weir, S. S. (2005). Integrating demographic and epidemiological approaches to research on HIV/AIDS: the proximate-determinants framework. *Journal of Infectious Diseases, 191*(Suppl 1), S61-67.

Browning, C. R., Leventhal, T., & Brooks-Gunn, J. (2004). Neighborhood context and racial differences in early adolescent sexual activity. *Demography, 41*(4), 697-720.

Campbell, M. E., Haveman, R., Wildhagen, T., & Wolfe, B. L. (2008). Income inequality and racial gaps in test scores. In K.A. Magnuson, & J. Waldfogel (Eds.), *Steady Gains and Stalled Progress: Inequality and the Black-white Test Score Gap* (pp. 110-136). New York, NY: Russell Sage Foundation.

Chantala, K., Kalsbeek, W. D., & Andraca, E. (n.d.). *Non-Response in Wave III of the Add Health Study*. Retrieved from http://www.cpc.unc.edu/projects/addhealth/data/guides/W3nonres.pdf

Cowell, F. A. (2011). *Measuring Inequality*: Oxford University Press.

Deaton, A. (2003). Health, Inequality, and Economic Development. *Journal of Economic Literature, 41*(1), 113-158.

Deaton, A., & Lubotsky, D. (2003). Mortality, inequality and race in American cities and states. *Social Science and Medicine, 56*(6), 1139-1153.

Doherty, I. A., Shiboski, S., Ellen, J. M., Adimora, A. A., & Padian, N. S. (2006). Sexual bridging socially and over time: a simulation model exploring the relative effects of mixing and concurrency on viral sexually transmitted infection transmission. *Sexually Transmitted Diseases, 33*(6), 368-373.

Dupéré, V., Lacourse, E., Willms, J. D., Leventhal, T., & Tremblay, R. E. (2008). Neighborhood poverty and early transition to sexual activity in young adolescents: a developmental ecological approach. *Child Development, 79*(5), 1463-1476.

Garnett, G. P., & Anderson, R. M. (1996). Sexually transmitted diseases and sexual behavior: insights from mathematical models. *Journal of Infectious Diseases, 174*(Suppl 2), S150–161.

Goodman, E., Huang, B., Wade, T. J., & Kahn, R. S. (2003). A multilevel analysis of the relation of socioeconomic status to adolescent depressive symptoms: does school context matter? *Journal of Pediatrics, 143*(4), 451-456.

Gravelle, H. (1998). How much of the relation between population mortality and unequal distribution of income is a statistical artefact? *British Medical Journal, 316*(7128), 382-385.

Harris, K. M., Halpern, C. T., Whitsel, E., Hussey, J., Tabor, J., Entzel, P., et al. (2009). *The National Longitudinal Study of Adolescent Health: Research Design*. Retrieved from http://www.cpc.unc.edu/projects/addhealth/design

Hogben, M., & Leichliter, J. S. (2008). Social determinants and sexually transmitted disease disparities. *Sexually Transmitted Diseases, 35*(12 Suppl), S13-18.

Holtgrave, D. R., & Crosby, R. A. (2003). Social capital, poverty, and income inequality as predictors of gonorrhoea, syphilis, chlamydia and AIDS case rates in the United States. *Sexually Transmitted Infections, 79*(1), 62-64.

Johnston, V. J., & Mabey, D. C. (2008). Global Epidemiology and Control of Trichomonas Vaginalis. *Current Opinion in Infectious Diseases, 21*, 56-64.

Kawachi, I. (2000). Income inequality and Health. In L.F. Berkman, & I. Kawachi (Eds.), *Social Epidemiology* (pp. 76-94). New York, NY: Oxford University Press.

Kawachi, I., & Berkman, L. F. (2000). Social Cohesion, Social Capital, and Health. In L.F. Berkman, & I. Kawachi (Eds.), *Social Epidemiology* (pp. 174-190). New York, NY: Oxford University Press.

Kondo, N., Kawachi, I., Subramanian, S. V., Takeda, Y., & Yamagata, Z. (2008). Do social comparisons explain the association between income inequality and health?: Relative deprivation and perceived health among male and female Japanese individuals. *Social Science and Medicine, 67*(6), 982-987.

Kondo, N., Sembajwe, G., Kawachi, I., van Dam, R. M., Subramanian, S. V., & Yamagata, Z. (2009). Income inequality, mortality, and self rated health: meta-analysis of multilevel studies. *British Medical Journal, 339*, b4471-b4471.

Krieger, N., Waterman, P. D., Chen, J. T., Soobader, M.-J., & Subramanian, S. V. (2003). Monitoring socioeconomic inequalities in sexually transmitted infections, tuberculosis, and violence: geocoding and choice of area-based socioeconomic measures--the public health disparities geocoding project (US). *Public Health Reports, 118*(3), 240-260.

Kubzansky, L., & Kawachi, I. (2000). Affective States and Health. In L.F. Berkman, & I. Kawachi (Eds.), *Social Epidemiology* (pp. 213-241). New York, NY: Oxford Univeristy Press.

Leigh, A., Jencks, C., & Smeeding, T. M. (2009). Health and economic inequality. In W. Salverda, B. Nolan, & T.M. Smeeding (Eds.), *The Oxford Handbook of Economic Inequality* (pp. 384-405). New York, NY: Oxford University Press.

Lynch, J., Harper, S., & Davey Smith, G. (2003). Commentary: Plugging leaks and repelling boarders--where to next for the SS income inequality? *International Journal of Epidemiology, 32*(6), 1029-1036.

Mellor, J. M., & Milyo, J. (2001). Reexamining the evidence of an ecological association between income inequality and health. *Journal of Health Politics, Policy and Law, 26*, 487-522.

Miller, W. C., & Zenilman, J. M. (2005). Epidemiology of Chlamydial Infection, Gonorrhea, and Trichomoniasis in the United States - 2005. *Infectious Disease Clinics of North America, 19*, 281-296.

Newbern, E. C., Miller, W. C., Schoenbach, V. J., & Kaufman, J. S. (2004). Family Socioeconomic Status and Self-Reported Sexually Transmitted Diseases Among Black and White American Adolescents. *Sexually Transmitted Diseases, 31*(9), 533-541.

Nilsson, T. (2009). *Inequality, Globalization and Health*.(Doctoral disseration). Lund University. Retrieved from http://www.nek.lu.se/NEKTNI/Avhandling_T.Nilsson.pdf.

Perkins, J. M., Khan, K. T., & Subramanian, S. V. (2009). Patterns and distribution of HIV among adult men and women in India. *PLoS ONE, 4*(5), e5648.

Poundstone, K. E., Strathdee, S. A., & Celentano, D. D. (2004). The social epidemiology of Human Immunodeficiency Virus/Acquired ImmunoDeficiency Syndrome. *Epidemiologic Reviews, 26*, 22-35.

Raley, R. K., & Sullivan, M. K. (2010). Social-Contextual Influences on Adolescent Romantic Involvement: The Constraints of Being a Numerical Minority. *Sociological Spectrum, 30*(1), 65-89.

Ramirez-Valles, J., Zimmerman, M. A., & Newcomb, M. D. (1998). Sexual risk behavior among youth: modeling the influence of prosocial activities and socioeconomic factors. *Journal of Health and Social Behavior, 39*(3), 237-253.

Resnick, M. D., Bearman, P. S., Blum, R. W., Bauman, K. E., Harris, K. M., Jones, J., et al. (1997). Protecting adolescents from harm: Findings from the National Longitudinal Study on adolescent health. *JAMA, 278*(10), 823-832.

Runciman, W. G. (1966). *Relative Deprivation and Social Justice*. London: Routledge & Kegan Paul.

Spriggs, A. L., Halpern, C. T., Herring, A. H., & Schoenbach, V. J. (2009). Family and school socioeconomic disadvantage: Interactive influences on adolescent dating violence victimization. *Social Science and Medicine, 68*(11), 1956-1965.

Subramanian, S. V., & Kawachi, I. (2003). The association between state income inequality and worse health is not confounded by race. *International Journal of Epidemiology, 32*(6), 1022-1028.

Teitler, J. O., & Weiss, C. C. (2000). Effects of Neighborhood and School Environments on Transitions to First Sexual Intercourse. *Sociology of Education, 73*(2), 112-132.

Webber, C. (2007). Revaluating relative deprivation theory. *Theoretical Criminology, 11*(1), 97-120.

Wilkinson, R. G., & Pickett, K. E. (2006). Income inequality and population health: a review and explanation of the evidence. *Social Science and Medicine, 62*(7), 1768-1784.

Yitzhaki, S. (1979). Relative Deprivation and the Gini Coefficient. *Quarterly Journal of Economics, 7*(4), 321-324.

Zierler, S., & Krieger, N. (1997). Reframing women's risk: social inequalities and HIV infection. *Annual Review of Public Health, 18*(70), 401-436.

Figure 1: Conceptual map of economic disadvantages

	Non-poor Family	Poor Family
Equal Community		Absolute deprivation
Unequal Community	Structural inequality	Absolute deprivation Structural inequality Relative deprivation

Table 1: Univariate descriptive statistics of a sample of respondents from Waves I to III of Add Health

	Entire sample	
	N	**%**
Number of respondents	11,183	
Self-reported or lab-confirmed STI at Waves II or III	1,170	10.5
Age at baseline		
<14	1,823	16.3
14	1,671	14.9
15	2,085	18.6
16	2,184	19.5
17	2,054	18.4
>17	1,366	12.2
Sex		
Male	5,833	52.2
Female	5,350	47.8
Parental Education		
< High School graduate/GED	1,250	11.2
High School graduate/GED	2,693	24.1
Some college	3,460	30.9
Completed 4-year college	2,051	18.3
Any post-graduate	1,729	15.5
Urbanicity of school		
Urban	3,148	28.1
Suburban	5,994	53.6
Rural	2,041	18.3
Region of country		
West	2,630	23.5
Midwest	2,957	26.4
South	4,085	36.5
Northeast	1,511	13.5
Type of school		
Public	10,344	92.5
Private	839	7.5
Individual Race/Ethnicity		
White non-Hispanic	6,448	57.7
Black non-Hispanic	2,261	20.2
Hispanic	1,656	14.8
Other non-Hispanic	818	7.3
	Median	**IQR**
School Gini coefficient	33.7	[29.5-38.6]
Per capita family income ($[†])	18,475	[10,500-28,868]
School Yitzhaki index ($[†])	6,387	[3,126-10,833]

STI: Diagnosis of Chlamydia, Gonorrhoea or Trichomoniasis. GED: General Educational Development tests. IQR: Inter-quintile range.
[†] All income-based measures use an equivalence scale such that these figures are family income divided by the square root of the number of family members.

Table 2: Multivariable regressions of income inequality as a predictor of STI diagnosis at Waves II or III of Add Health

	Bivariate Models		Model 2		Model 3		Model 4 (adjusted†)		Model 5 (adjusted†)	
School Gini coefficient										
Most equal quintile	1.00		1.00		1.00		1.00		1.00	
2nd most equal quintile	1.06	[0.76-1.49]	1.05	[0.77-1.44]	1.06	[0.79-1.44]	1.19	[0.83-1.70]	0.96	[0.74-1.23]
Middle quintile	1.84	[1.32-2.57]	1.69	[1.23-2.31]	1.61	[1.19-2.18]	1.63	[1.16-2.29]	0.89	[0.68-1.18]
2nd least equal quintile	2.24	[1.65-3.04]	1.98	[1.46-2.67]	1.87	[1.39-2.52]	1.82	[1.35-2.47]	1.14	[0.89-1.46]
Least equal quintile	2.50	[1.82-3.45]	2.12	[1.55-2.89]	1.99	[1.47-2.70]	2.00	[1.44-2.78]	1.06	[0.81-1.38]
Per-capita family income										
Poorest quintile	2.04	[1.64-2.54]	1.94	[1.56-2.41]	2.58	[1.88-3.56]	2.42	[1.68-3.47]	1.64	[1.18-2.27]
2nd poorest quintile	1.57	[1.26-1.96]	1.53	[1.22-1.91]	1.89	[1.43-2.52]	1.76	[1.29-2.40]	1.39	[1.04-1.86]
Middle quintile	1.38	[1.10-1.72]	1.37	[1.09-1.71]	1.60	[1.23-2.07]	1.49	[1.13-1.97]	1.29	[0.99-1.69]
2nd richest quintile	1.32	[1.05-1.66]	1.33	[1.06-1.67]	1.43	[1.13-1.81]	1.35	[1.06-1.73]	1.28	[1.00-1.63]
Richest quintile	1.00		1.00		1.00		1.00		1.00	
Family Yitzhaki index										
Least relatively deprived quintile	1.00				1.00		1.00		1.00	
2nd least deprived quintile	1.10	[0.90-1.35]			0.86	[0.69-1.08]	0.86	[0.69-1.08]	0.93	[0.74-1.16]
Middle quintile	1.26	[1.03-1.53]			0.83	[0.65-1.06]	0.80	[0.62-1.03]	0.89	[0.69-1.13]
2nd most deprived quintile	1.28	[1.04-1.57]			0.73	[0.55-0.95]	0.71	[0.53-0.94]	0.81	[0.62-1.05]
Most relatively deprived quintile	1.49	[1.21-1.85]			0.70	[0.51-0.96]	0.67	[0.48-0.94]	0.78	[0.58-1.04]
Individual Race/Ethnicity										
White non-Hispanic									1.00	
Black non-Hispanic									4.93	[4.14-5.88]
Hispanic									1.84	[1.45-2.35]
Other non-Hispanic									1.98	[1.48-2.64]
Akaike Information Criterion (AIC)			7,247.7		7,249.6		7,203.9		6,892.2	
Intraclass correlation (ICC)			0.073		0.065		0.055		0.009	

All models are two-level hierarchical models of 11,183 individuals nested in 132 schools. Figures are odds ratios with 95% confidence intervals in brackets. † Models 4 and 5 are adjusted for individual baseline age, sex and parental education and for school-level urbanicity, region and public/private type.

Table 3: Multivariable regressions for income inequality and STI diagnosis in Add Health: sub-group analyses by sex

	Male						Female					
School Gini coefficient												
Most equal quintile	1.00		1.00		1.00		1.00		1.00		1.00	
2nd most equal quintile	1.37	[0.88-2.14]	1.35	[0.89-2.05]	0.99	[0.69-1.41]	1.27	[0.83-1.93]	1.22	[0.83-1.79]	0.99	[0.72-1.36]
Middle quintile	1.46	[0.92-2.33]	1.34	[0.87-2.08]	0.76	[0.52-1.10]	1.61	[1.08-2.40]	1.50	[1.01-2.21]	0.97	[0.68-1.36]
2nd least equal quintile	1.85	[1.19-2.88]	1.74	[1.16-2.63]	1.12	[0.79-1.58]	1.99	[1.36-2.92]	1.81	[1.26-2.61]	1.19	[0.87-1.63]
Least equal quintile	2.03	[1.26-3.26]	1.90	[1.21-2.98]	0.90	[0.62-1.32]	2.44	[1.60-3.71]	2.18	[1.46-3.26]	1.14	[0.81-1.61]
Per-capita family income												
Poorest quintile			2.54	[1.53-4.23]	1.28	[0.77-2.14]			2.86	[1.81-4.53]	1.88	[1.22-2.89]
2nd poorest quintile			1.56	[0.99-2.44]	1.02	[0.64-1.61]			2.25	[1.51-3.36]	1.72	[1.17-2.52]
Middle quintile			1.50	[1.00-2.24]	1.15	[0.76-1.75]			1.67	[1.16-2.40]	1.40	[0.98-2.00]
2nd richest quintile			1.19	[0.82-1.71]	1.15	[0.79-1.67]			1.55	[1.11-2.15]	1.47	[1.06-2.04]
Richest quintile			1.00		1.00				1.00		1.00	
Family Yitzhaki index												
Least relatively deprived quintile			1.00		1.00				1.00		1.00	
2nd least deprived quintile			0.69	[0.49-0.98]	0.93	[0.64-1.35]			0.97	[0.71-1.30]	1.04	[0.77-1.41]
Middle quintile			0.70	[0.48-1.01]	0.87	[0.58-1.32]			0.83	[0.60-1.15]	0.92	[0.67-1.26]
2nd most deprived quintile			0.52	[0.34-0.79]	0.82	[0.53-1.27]			0.77	[0.53-1.10]	0.90	[0.63-1.27]
Most relatively deprived quintile			0.47	[0.29-0.76]	0.71	[0.44-1.14]			0.72	[0.47-1.09]	0.86	[0.59-1.25]
Individual Race/Ethnicity												
White non-Hispanic					1.00						1.00	
Black non-Hispanic					5.10	[3.95-6.59]					5.07	[4.03-6.36]
Hispanic					1.87	[1.31-2.66]					1.80	[1.32-2.47]
Other non-Hispanic					1.36	[0.85-2.19]					2.51	[1.75-3.60]
No. of individuals (level 1)	5,350		5,350		5,350		5,833		5,833		5,833	
No. of schools (level 2)	132		132		132		132		132		132	
Akaike Information Criterion (AIC)	3,038.0		3,036.3		2,907.0		4,214.8		4,202.8		4,003.9	
Intraclass correlation (ICC)	0.068		0.046		-		0.068		0.052		0.009	

All models are two-level hierarchical models, and also adjust for individual baseline age, sex and parental education and for school-level urbanicity, region and public/private type.
Figures are odds ratios with 95% confidence intervals in brackets.

Table 4: Multivariable regressions for income inequality and STI diagnosis in Add Health: sub-group analyses by race/ethnicity

	White non-Hispanic		Black non-Hispanic		Hispanic		Other non-Hispanic	
School Gini coefficient	1.00		1.00		1.00		1.00	
Most equal quintile	0.92	[0.67-1.25]	0.92	[0.53-1.63]	1.10	[0.48-2.51]	1.82	[0.56-5.92]
2nd most equal quintile	0.91	[0.63-1.32]	0.71	[0.40-1.26]	1.54	[0.71-3.35]	1.87	[0.62-5.67]
Middle quintile	0.99	[0.71-1.38]	0.99	[0.57-1.70]	1.92	[0.91-4.02]	2.04	[0.72-5.78]
2nd least equal quintile	1.15	[0.76-1.73]	0.94	[0.55-1.60]	1.25	[0.53-2.93]	3.46	[0.97-12.4]
Least equal quintile								
Per-capita family income	1.68	[0.98-2.90]	1.62	[0.95-2.77]	1.03	[0.40-2.60]	1.87	[0.53-6.57]
Poorest quintile	1.53	[0.96-2.42]	1.37	[0.85-2.22]	1.05	[0.45-2.43]	0.79	[0.25-2.48]
2nd poorest quintile	1.29	[0.85-1.94]	1.16	[0.74-1.82]	1.23	[0.55-2.73]	1.19	[0.42-3.33]
Middle quintile	1.31	[0.91-1.88]	1.22	[0.81-1.86]	1.32	[0.62-2.81]	1.02	[0.38-2.72]
2nd richest quintile	1.00		1.00		1.00		1.00	
Richest quintile								
Family Yitzhaki index	1.00		1.00		1.00		1.00	
Least relatively deprived quintile	0.80	[0.55-1.16]	0.97	[0.67-1.39]	0.99	[0.54-1.82]	1.38	[0.52-3.67]
2nd least deprived quintile	0.92	[0.62-1.37]	0.81	[0.55-1.20]	0.99	[0.51-1.92]	1.52	[0.55-4.22]
Middle quintile	0.78	[0.51-1.19]	0.71	[0.46-1.10]	1.17	[0.58-2.37]	1.77	[0.56-5.60]
2nd most deprived quintile	0.58	[0.36-0.93]	0.83	[0.52-1.34]	1.07	[0.48-2.41]	2.15	[0.62-7.38]
No. of individuals (level 1)	6,448		2,261		1,656		818	
No. of schools (level 2)	126		97		107		99	
Akaike Information Criterion (AIC)	2,793.6		2,531.7		1,129.4		535.6	
Intraclass correlation (ICC)	-		0.009		0.006		-	

All models are two-level hierarchical models, and also adjust for individual baseline age, sex and parental education and for school-level urbanicity, region and public/private type. Figures are odds ratios with 95% confidence intervals in brackets.

Supplementary Table 1: Univariate descriptive statistics of a sample of respondents from Waves I to III of Add Health: stratified by gender

	Entire sample		Male		Female	
	N	%	N	%	N	%
Number of respondents	11,183		5,350		5,833	
Self-reported or lab-confirmed STI at Waves II or III	1,170	10.5	455	8.5	715	12.3
Age at baseline						
<14	1,823	16.3	801	15.0	1,022	17.5
14	1,671	14.9	771	14.4	900	15.4
15	2,085	18.6	984	18.4	1,101	18.9
16	2,184	19.5	1,066	19.9	1,118	19.2
17	2,054	18.4	1,037	19.4	1,017	17.4
>17	1,366	12.2	691	12.9	675	11.6
Sex						
Male	5,833	52.2				
Female	5,350	47.8				
Parental Education						
< High School graduate/GED	1,250	11.2	582	10.9	668	11.5
High School graduate/GED	2,693	24.1	1,251	23.4	1,442	24.7
Some college	3,460	30.9	1,692	31.6	1,768	30.3
Completed 4-year college	2,051	18.3	1,003	18.7	1,048	18.0
Any post-graduate	1,729	15.5	822	15.4	907	15.5
Missing						
Urbanicity of school						
Urban	3,148	28.1	1,458	27.3	1,690	29.0
Suburban	5,994	53.6	2,888	54.0	3,106	53.2
Rural	2,041	18.3	1,004	18.8	1,037	17.8
Region of country						
West	2,630	23.5	1,277	23.9	1,353	23.2
Midwest	2,957	26.4	1,389	26.0	1,568	26.9
South	4,085	36.5	1,978	37.0	2,107	36.1
Northeast	1,511	13.5	706	13.2	805	13.8
Type of school						
Public	10,344	92.5	4,938	92.3	5,406	92.7
Private	839	7.5	412	7.7	427	7.3
Individual Race/Ethnicity						
White non-Hispanic	6,448	57.7	3,082	57.6	3,366	57.7
Black non-Hispanic	2,261	20.2	1,014	19.0	1,247	21.4
Hispanic	1,656	14.8	831	15.5	825	14.1
Other non-Hispanic	818	7.3	423	7.9	395	6.8
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**
School Gini coefficient	33.7	[29.5 - 38.6]	33.7	[29.5 - 38.6]	33.7	[29.5 - 38.7]
Per capita family income ($†)	18,475	[10,500 - 28,868]	18,898	[10,614 - 28,868]	18,031	[10,392 - 28,868]
School Yitzhaki index ($†)	6,387	[3,126 - 10,833]	6,265	[3,085 - 10,833]	6,456	[3,168 - 10,833]

STI: Diagnosis of Chlamydia, Gonorrhea or Trichomoniasis. GED: General Educational Development tests. IQR: Inter-quintile range.
† All income-based measures use an equivalence scale such that these figures are family income divided by the square root of the number of family members.

Supplementary Table 2: Bivariate relationships between covariates and self-reported or laboratory-confirmed STI at Wave II or III of Add Health

	Entire sample		Male		Female	
School Gini coefficient						
Most equal quintile	1.00		1.00		1.00	
2nd most equal quintile	1.06	[0.76 - 1.49]	1.27	[0.78 - 2.02]	1.28	[0.87 - 1.94]
Middle quintile	1.84	[1.32 - 2.57]	1.69	[1.07 - 2.66]	1.48	[1.01 - 2.18]
2nd least equal quintile	2.24	[1.65 - 3.04]	2.02	[1.29 - 3.18]	2.23	[1.51 - 3.29]
Least equal quintile	2.50	[1.82 - 3.45]	2.02	[1.28 - 3.18]	2.43	[1.59 - 3.72]
Per-capita family income						
Poorest quintile	2.04	[1.64 - 2.54]	1.73	[1.25 - 2.40]	2.61	[1.94 - 3.50]
2nd poorest quintile	1.57	[1.26 - 1.96]	1.19	[0.85 - 1.67]	2.08	[1.55 - 2.79]
Middle quintile	1.38	[1.10 - 1.72]	1.22	[0.88 - 1.71]	1.60	[1.18 - 2.16]
2nd richest quintile	1.32	[1.05 - 1.66]	1.10	[0.78 - 1.56]	1.56	[1.15 - 2.11]
Richest quintile	1.00		1.00		1.00	
Family Yitzhaki index						
Least relatively deprived quintile	1.00		1.00		1.00	
2nd least deprived quintile	1.10	[0.90 - 1.35]	0.91	[0.66 - 1.24]	1.29	[0.98 - 1.70]
Middle quintile	1.26	[1.03 - 1.53]	1.08	[0.80 - 1.47]	1.38	[1.06 - 1.81]
2nd most deprived quintile	1.28	[1.04 - 1.57]	0.99	[0.72 - 1.36]	1.48	[1.13 - 1.94]
Most relatively deprived quintile	1.49	[1.21 - 1.85]	1.09	[0.79 - 1.51]	1.76	[1.32 - 2.35]
Age at baseline						
<14	0.77	[0.58 - 1.02]	0.48	[0.33 - 0.71]	0.99	[0.72 - 1.34]
14	0.93	[0.72 - 1.21]	0.69	[0.49 - 0.98]	1.15	[0.86 - 1.53]
15	1.00	[0.82 - 1.23]	0.83	[0.61 - 1.12]	1.10	[0.85 - 1.43]
16	1.00					
17	0.76	[0.62 - 0.94]	0.67	[0.49 - 0.91]	0.84	[0.64 - 1.11]
>17	0.74	[0.58 - 0.94]	0.56	[0.39 - 0.81]	0.90	[0.66 - 1.22]
Sex						
Male vs. Female	0.66	[0.58 - 0.75]				
Parental Education						
< High School graduate/GED	1.11	[0.90 - 1.37]	0.91	[0.65 - 1.28]	1.32	[1.01 - 1.72]
High School graduate/GED	1.00		1.00		1.00	
Some college	0.90	[0.74 - 1.09]	0.76	[0.56 - 1.03]	1.01	[0.78 - 1.30]
Completed 4-year college	0.58	[0.46 - 0.73]	0.57	[0.40 - 0.82]	0.57	[0.41 - 0.78]
Any post-graduate	1.38	[1.25 - 1.51]	1.42	[1.20 - 1.69]	1.50	[1.22 - 1.84]
Urbanicity of school						
Urban	0.73	[0.51 - 1.05]	0.75	[0.45 - 1.25]	0.76	[0.50 - 1.14]
Suburban	1.00		1.00		1.00	
Rural	0.76	[0.55 - 1.04]	0.68	[0.48 - 0.99]	0.91	[0.68 - 1.22]
Region of country						
West	0.59	[0.45 - 0.78]	0.53	[0.37 - 0.75]	0.84	[0.51 - 1.40]
Midwest	0.78	[0.56 - 1.08]	0.53	[0.36 - 0.78]	0.82	[0.55 - 1.23]
South	1.00		1.00		1.00	
Northeast	1.35	[1.23 - 1.48]	1.30	[1.10 - 1.53]	1.45	[1.14 - 1.84]
Type of school						
Private vs. Public	1.41	[1.28 - 1.55]	1.42	[1.20 - 1.67]	1.60	[1.29 - 1.98]
Individual Race/Ethnicity						
White non-Hispanic	1.00					
Black non-Hispanic	5.53	[4.70 - 6.50]	3.89	[1.00 - 1.00]	5.66	[4.58 - 6.99]
Hispanic	2.05	[1.66 - 2.54]	1.76	[1.00 - 1.00]	2.07	[1.56 - 2.74]
Other non-Hispanic	1.91	[1.44 - 2.52]	1.26	[1.00 - 1.00]	2.42	[1.72 - 3.42]

STI: Diagnosis of Chlamydia, Gonorrhea or Trichomoniasis. GED: General Educational Development tests.

Supplementary Table 3: Multivariable regressions of income inequality as a predictor of STI diagnosis at Waves II or III of Add Health: Full covariate results

	I		II		III		IV		V	
School Gini coefficient										
Most equal quintile	1.00		1.00		1.00		1.00		1.00	
2nd most equal quintile	1.06	[0.76 - 1.49]	1.05	[0.77 - 1.44]	1.06	[0.79 - 1.44]	1.19	[0.83 - 1.70]	0.96	[0.74 - 1.23]
Middle quintile	1.84	[1.32 - 2.57]	1.69	[1.23 - 2.31]	1.61	[1.19 - 2.18]	1.63	[1.16 - 2.29]	0.89	[0.68 - 1.18]
2nd least equal quintile	2.24	[1.65 - 3.04]	1.98	[1.46 - 2.67]	1.87	[1.39 - 2.52]	1.82	[1.35 - 2.47]	1.14	[0.89 - 1.46]
Least equal quintile	2.50	[1.82 - 3.45]	2.12	[1.55 - 2.89]	1.99	[1.47 - 2.70]	2.00	[1.44 - 2.78]	1.06	[0.81 - 1.38]
Per-capita family income										
Poorest quintile			1.94	[1.56 - 2.41]	2.58	[1.88 - 3.56]	2.42	[1.68 - 3.47]	1.64	[1.18 - 2.27]
2nd poorest quintile			1.53	[1.22 - 1.91]	1.89	[1.43 - 2.52]	1.76	[1.29 - 2.40]	1.39	[1.04 - 1.86]
Middle quintile			1.37	[1.09 - 1.71]	1.60	[1.23 - 2.07]	1.49	[1.13 - 1.97]	1.29	[0.99 - 1.69]
2nd richest quintile			1.33	[1.06 - 1.67]	1.43	[1.13 - 1.81]	1.35	[1.06 - 1.73]	1.28	[1.00 - 1.63]
Richest quintile			1.00		1.00		1.00		1.00	
Family Yitzhaki index										
Least relatively deprived quintile					1.00		1.00		1.00	
2nd least deprived quintile					0.86	[0.69 - 1.08]	0.86	[0.69 - 1.08]	0.93	[0.74 - 1.16]
Middle quintile					0.83	[0.65 - 1.06]	0.80	[0.62 - 1.03]	0.89	[0.69 - 1.13]
2nd most deprived quintile					0.73	[0.55 - 0.95]	0.71	[0.53 - 0.94]	0.81	[0.62 - 1.05]
Most relatively deprived quintile					0.70	[0.51 - 0.96]	0.67	[0.48 - 0.94]	0.78	[0.58 - 1.04]
Age at baseline										
<14							0.79	[0.62 - 1.00]	0.79	[0.63 - 0.99]
14							0.95	[0.76 - 1.19]	0.95	[0.77 - 1.19]
15							1.01	[0.83 - 1.23]	0.98	[0.81 - 1.20]
16							1.00		1.00	
17							0.77	[0.63 - 0.95]	0.77	[0.62 - 0.95]
>17							0.74	[0.58 - 0.93]	0.74	[0.58 - 0.94]
Sex										
Male vs. Female							0.67	[0.59 - 0.76]	0.67	[0.59 - 0.77]
Parental Education										
< High School graduate/GED							0.98	[0.79 - 1.21]	1.05	[0.84 - 1.30]
High School graduate/GED							1.00		1.00	
Some college							0.99	[0.83 - 1.17]	0.95	[0.80 - 1.13]
Completed 4-year college							1.02	[0.83 - 1.25]	0.98	[0.80 - 1.21]
Any post-graduate							0.71	[0.55 - 0.91]	0.69	[0.53 - 0.89]
Urbanicity of school										
Urban							0.75	[0.57 - 0.99]	0.89	[0.70 - 1.14]
Suburban							1.00		1.00	
Rural							1.02	[0.82 - 1.27]	1.01	[0.85 - 1.21]
Region of country										
West							0.84	[0.63 - 1.12]	0.90	[0.72 - 1.13]
Midwest							0.88	[0.68 - 1.14]	1.13	[0.92 - 1.38]
South							1.00		1.00	
Northeast							0.65	[0.47 - 0.90]	0.86	[0.67 - 1.10]
Type of school										
Private vs. Public							1.25	[0.78 - 1.99]	1.12	[0.82 - 1.54]
Individual Race/Ethnicity										
White non-Hispanic									1.00	
Black non-Hispanic									4.93	[4.14 - 5.88]
Hispanic									1.84	[1.45 - 2.35]
Other non-Hispanic									1.98	[1.48 - 2.64]
Akaike Information Criterion (AIC)	7,278.5		7,247.7		7,249.6		7,203.9		6,892.2	
Intraclass correlation (ICC)	0.084		0.073		0.065		0.055		0.009	

All models are two-level hierarchical models of 11,183 individuals nested in 132 schools. Figures are odds ratios with 95% confidence intervals in brackets.

Supplementary Table 4: Multivariable regressions for income inequality and STI diagnosis in Add Health: secondary outcomes of specific STIs

	Chlamydia				Gonorrhoea				Trichomoniasis			
School Gini coefficient												
Most equal quintile	1.00		1.00		1.00		1.00		1.00		1.00	
2nd most equal quintile	1.23	[0.87 - 1.75]	1.03	[0.79 - 1.33]	1.38	[0.72 - 2.64]	0.94	[0.52 - 1.70]	1.46	[0.83 - 2.58]	1.10	[0.66 - 1.85]
Middle quintile	1.31	[0.94 - 1.83]	0.93	[0.70 - 1.22]	1.49	[0.71 - 3.14]	0.79	[0.42 - 1.51]	1.59	[0.92 - 2.77]	1.03	[0.59 - 1.79]
2nd least equal quintile	1.76	[1.29 - 2.42]	1.19	[0.92 - 1.54]	1.83	[0.98 - 3.42]	0.99	[0.54 - 1.80]	1.62	[0.94 - 2.80]	1.08	[0.64 - 1.81]
Least equal quintile	1.80	[1.26 - 2.56]	0.98	[0.74 - 1.31]	1.65	[0.82 - 3.30]	0.68	[0.35 - 1.31]	2.46	[1.42 - 4.25]	1.31	[0.77 - 2.23]
Per-capita family income												
Poorest quintile	2.65	[1.77 - 3.96]	1.76	[1.24 - 2.51]	3.36	[1.46 - 7.72]	1.70	[0.77 - 3.75]	2.95	[1.60 - 5.45]	1.77	[0.96 - 3.25]
2nd poorest quintile	1.93	[1.37 - 2.73]	1.51	[1.09 - 2.07]	2.34	[1.12 - 4.90]	1.58	[0.77 - 3.21]	2.12	[1.24 - 3.62]	1.54	[0.90 - 2.62]
Middle quintile	1.59	[1.17 - 2.17]	1.37	[1.02 - 1.84]	1.39	[0.69 - 2.81]	1.08	[0.54 - 2.15]	1.57	[0.96 - 2.55]	1.29	[0.80 - 2.10]
2nd richest quintile	1.36	[1.03 - 1.80]	1.29	[0.98 - 1.69]	1.22	[0.63 - 2.35]	1.11	[0.58 - 2.12]	1.34	[0.86 - 2.08]	1.25	[0.80 - 1.93]
Richest quintile	1.00		1.00		1.00		1.00		1.00		1.00	
Family Yitzhaki index												
Least relatively deprived quintile	1.00		1.00		1.00		1.00		1.00		1.00	
2nd least deprived quintile	0.87	[0.67 - 1.12]	0.93	[0.73 - 1.20]	1.08	[0.61 - 1.90]	1.24	[0.71 - 2.18]	0.70	[0.47 - 1.04]	0.77	[0.52 - 1.15]
Middle quintile	0.79	[0.59 - 1.05]	0.87	[0.67 - 1.14]	0.95	[0.52 - 1.76]	1.16	[0.63 - 2.11]	0.55	[0.35 - 0.86]	0.64	[0.41 - 1.00]
2nd most deprived quintile	0.69	[0.50 - 0.95]	0.79	[0.59 - 1.06]	0.78	[0.40 - 1.54]	1.06	[0.56 - 2.01]	0.50	[0.31 - 0.82]	0.62	[0.38 - 1.01]
Most relatively deprived quintile	0.63	[0.43 - 0.91]	0.75	[0.55 - 1.01]	0.48	[0.22 - 1.04]	0.67	[0.33 - 1.36]	0.55	[0.32 - 0.95]	0.72	[0.42 - 1.24]
Age at baseline												
<14	0.88	[0.68 - 1.15]	0.83	[0.65 - 1.06]	0.99	[0.59 - 1.67]	1.00	[0.61 - 1.65]	0.62	[0.40 - 0.95]	0.61	[0.40 - 0.93]
14	1.09	[0.85 - 1.40]	1.04	[0.82 - 1.32]	0.90	[0.53 - 1.52]	0.91	[0.54 - 1.51]	0.82	[0.55 - 1.22]	0.81	[0.55 - 1.20]
15	1.08	[0.86 - 1.35]	1.03	[0.82 - 1.29]	1.04	[0.65 - 1.68]	1.03	[0.64 - 1.65]	0.94	[0.67 - 1.33]	0.91	[0.65 - 1.29]
16	1.00		1.00		1.00		1.00		1.00		1.00	
17	0.77	[0.61 - 0.98]	0.77	[0.61 - 0.98]	0.79	[0.48 - 1.31]	0.81	[0.49 - 1.36]	0.76	[0.53 - 1.10]	0.77	[0.53 - 1.11]
>17	0.74	[0.57 - 0.97]	0.75	[0.57 - 0.99]	0.51	[0.26 - 0.99]	0.52	[0.27 - 1.01]	0.95	[0.65 - 1.40]	0.96	[0.65 - 1.42]
Sex												
Male vs. Female	0.68	[0.58 - 0.78]	0.68	[0.59 - 0.79]	1.13	[0.83 - 1.53]	1.18	[0.87 - 1.61]	0.56	[0.45 - 0.71]	0.57	[0.45 - 0.72]
Parental Education												
< High School graduate/GED	0.92	[0.72 - 1.18]	0.97	[0.76 - 1.25]	1.02	[0.63 - 1.64]	1.19	[0.73 - 1.92]	1.01	[0.70 - 1.46]	1.07	[0.73 - 1.55]
High School graduate/GED	1.00		1.00		1.00		1.00		1.00		1.00	
Some college	1.05	[0.86 - 1.27]	1.01	[0.83 - 1.23]	0.85	[0.57 - 1.27]	0.80	[0.54 - 1.20]	0.88	[0.65 - 1.19]	0.84	[0.62 - 1.13]
Completed 4-year college	1.12	[0.89 - 1.40]	1.09	[0.87 - 1.38]	0.63	[0.36 - 1.09]	0.58	[0.34 - 1.01]	0.91	[0.63 - 1.32]	0.87	[0.60 - 1.27]
Any post-graduate	0.78	[0.59 - 1.05]	0.76	[0.57 - 1.01]	0.79	[0.43 - 1.46]	0.71	[0.39 - 1.31]	0.83	[0.54 - 1.30]	0.81	[0.52 - 1.26]
Individual Race/Ethnicity												
White non-Hispanic			1.00				1.00				1.00	
Black non-Hispanic			4.52	[3.73 - 5.48]			7.34	[4.74 - 11.36]			4.80	[3.50 - 6.60]
Hispanic			1.94	[1.49 - 2.51]			1.63	[0.84 - 3.14]			1.69	[1.07 - 2.67]
Other non-Hispanic			1.87	[1.36 - 2.58]			0.91	[0.31 - 2.67]			1.89	[1.08 - 3.30]
Akaike Information Criterion (AIC)	5,927.9		5,707.8		1,766.7		1,664.7		2,931.4		2,833.8	
Intraclass correlation (ICC)	0.038		-		0.060		-		0.101		0.063	

All models are two-level hierarchical models of 11,183 individuals nested in 132 schools, and also adjust for school-level urbanicity, region and public/private type. Figures are odds ratios with 95% confidence intervals in brackets.

Supplementary Table 5: Multivariable regressions for income inequality and STI diagnosis in Add Health: robustness checks

	Check 1: Add Wave I outcomes				Check 2: Require presence at Waves II & III				Check 3: Use only Wave I and Wave II outcomes			
School Gini coefficient												
Most equal quintile	1.00		1.00		1.00		1.00		1.00		1.00	
2nd most equal quintile	1.18	[0.84 - 1.68]	0.97	[0.76 - 1.25]	1.22	[0.89 - 1.69]	0.95	[0.72 - 1.24]	1.33	[0.77 - 2.30]	1.08	[0.65 - 1.79]
Middle quintile	1.55	[1.10 - 2.20]	0.89	[0.68 - 1.16]	1.37	[0.98 - 1.93]	0.80	[0.59 - 1.08]	1.30	[0.76 - 2.23]	0.93	[0.55 - 1.59]
2nd least equal quintile	1.85	[1.37 - 2.51]	1.15	[0.90 - 1.47]	1.74	[1.28 - 2.38]	1.15	[0.88 - 1.50]	2.29	[1.36 - 3.83]	1.65	[1.01 - 2.69]
Least equal quintile	1.97	[1.42 - 2.74]	1.05	[0.80 - 1.37]	1.93	[1.36 - 2.73]	0.98	[0.73 - 1.31]	2.40	[1.38 - 4.14]	1.48	[0.88 - 2.49]
Per-capita family income												
Poorest quintile	2.42	[1.71 - 3.42]	1.66	[1.20 - 2.29]	2.54	[1.72 - 3.75]	1.56	[1.08 - 2.24]	3.03	[1.63 - 5.62]	1.95	[1.05 - 3.62]
2nd poorest quintile	1.71	[1.26 - 2.31]	1.36	[1.02 - 1.81]	1.83	[1.30 - 2.57]	1.35	[0.97 - 1.86]	1.67	[0.95 - 2.94]	1.29	[0.73 - 2.27]
Middle quintile	1.49	[1.15 - 1.95]	1.30	[1.00 - 1.68]	1.61	[1.19 - 2.18]	1.33	[0.99 - 1.80]	1.26	[0.74 - 2.14]	1.06	[0.62 - 1.79]
2nd richest quintile	1.38	[1.09 - 1.74]	1.30	[1.03 - 1.65]	1.48	[1.12 - 1.94]	1.38	[1.05 - 1.82]	1.33	[0.83 - 2.12]	1.26	[0.79 - 2.02]
Richest quintile	1.00		1.00		1.00		1.00		1.00		1.00	
Family Yitzhaki index												
Least relatively deprived quintile	1.00		1.00		1.00		1.00		1.00		1.00	
2nd least deprived quintile	0.83	[0.67 - 1.04]	0.90	[0.72 - 1.12]	0.87	[0.68 - 1.12]	0.94	[0.73 - 1.21]	0.65	[0.41 - 1.01]	0.69	[0.44 - 1.08]
Middle quintile	0.80	[0.62 - 1.01]	0.88	[0.69 - 1.11]	0.85	[0.65 - 1.12]	0.97	[0.74 - 1.27]	0.83	[0.53 - 1.31]	0.95	[0.60 - 1.49]
2nd most deprived quintile	0.69	[0.53 - 0.91]	0.79	[0.61 - 1.03]	0.71	[0.52 - 0.97]	0.88	[0.65 - 1.18]	0.58	[0.35 - 0.97]	0.75	[0.45 - 1.24]
Most relatively deprived quintile	0.65	[0.47 - 0.89]	0.74	[0.56 - 0.99]	0.62	[0.43 - 0.88]	0.81	[0.58 - 1.11]	0.52	[0.29 - 0.91]	0.69	[0.40 - 1.20]
Baseline age												
< 14	0.73	[0.57 - 0.92]	0.72	[0.57 - 0.90]	0.74	[0.57 - 0.95]	0.74	[0.58 - 0.94]	0.22	[0.12 - 0.40]	0.22	[0.12 - 0.39]
14	0.90	[0.72 - 1.12]	0.89	[0.72 - 1.10]	0.99	[0.78 - 1.25]	0.97	[0.77 - 1.22]	0.51	[0.33 - 0.79]	0.49	[0.32 - 0.77]
15	1.00	[0.82 - 1.21]	0.97	[0.80 - 1.18]	1.03	[0.84 - 1.28]	1.00	[0.80 - 1.24]	0.70	[0.48 - 1.01]	0.69	[0.48 - 0.99]
16	1.00		1.00		1.00		1.00		1.00		1.00	
17	0.84	[0.69 - 1.02]	0.84	[0.69 - 1.03]	0.86	[0.68 - 1.09]	0.86	[0.68 - 1.09]	1.56	[1.13 - 2.16]	1.58	[1.14 - 2.19]
> 17	0.93	[0.75 - 1.15]	0.94	[0.75 - 1.17]	1.03	[0.76 - 1.40]	1.03	[0.76 - 1.41]	1.67	[1.11 - 2.51]	1.70	[1.13 - 2.57]
Individual Race/Ethnicity												
White non-Hispanic			1.00				1.00				1.00	
Black non-Hispanic			4.95	[4.17 - 5.87]			4.78	[3.93 - 5.81]			3.44	[2.47 - 4.78]
Hispanic			1.81	[1.44 - 2.28]			1.93	[1.47 - 2.52]			1.56	[1.01 - 2.42]
Other non-Hispanic			1.82	[1.37 - 2.42]			2.03	[1.47 - 2.80]			0.89	[0.46 - 1.69]
No. of individuals (level 1)	11,183		11,183		8,754		8,754		10,932		10,932	
No. of schools (level 2)	132		132		132		132		132		132	
Akaike Information Criterion (AIC)	7,633.2		7,298.9		5,745.7		5,507.3		2,584.2		2,528.2	
Intraclass correlation (ICC)	0.057		0.012		0.044		0.009		0.052		0.021	

All models are two-level hierarchical models, and also adjust for individual baseline age, sex and parental education and for school-level urbanicity, region and public/private type.
Figures are odds ratios with 95% confidence intervals in brackets.

Supplementary Table 6: Multivariable regressions for income inequality and STI diagnosis in Add Health: unadjusted models of economic measures

			Bivariate models		Multivariable models							
	Bivariate models		with race/ethnicity[†]		III		IV		V		VI	
School Gini coefficient												
Most equal quintile	1.00		1.00		1.00		1.00				1.00	
2nd most equal quintile	1.06	[0.76 - 1.49]	0.97	[0.75 - 1.26]	1.05	[0.77 - 1.44]	1.01	[0.71 - 1.44]			1.06	[0.79 - 1.44]
Middle quintile	1.84	[1.32 - 2.57]	0.94	[0.72 - 1.23]	1.69	[1.23 - 2.31]	1.88	[1.33 - 2.65]			1.61	[1.19 - 2.18]
2nd least equal quintile	2.24	[1.65 - 3.04]	1.24	[0.97 - 1.58]	1.98	[1.46 - 2.67]	2.22	[1.63 - 3.03]			1.87	[1.39 - 2.52]
Least equal quintile	2.50	[1.82 - 3.45]	1.12	[0.86 - 1.45]	2.12	[1.55 - 2.89]	2.44	[1.74 - 3.43]			1.99	[1.47 - 2.70]
Per-capita family income												
Poorest quintile	2.04	[1.64 - 2.54]	1.60	[1.29 - 1.99]	1.94	[1.56 - 2.41]			3.18	[2.27 - 4.46]	2.58	[1.88 - 3.56]
2nd poorest quintile	1.57	[1.26 - 1.96]	1.38	[1.10 - 1.72]	1.53	[1.22 - 1.91]			2.18	[1.62 - 2.93]	1.89	[1.43 - 2.52]
Middle quintile	1.38	[1.10 - 1.72]	1.30	[1.04 - 1.62]	1.37	[1.09 - 1.71]			1.73	[1.33 - 2.26]	1.60	[1.23 - 2.07]
2nd richest quintile	1.32	[1.05 - 1.66]	1.31	[1.04 - 1.64]	1.33	[1.06 - 1.67]			1.48	[1.16 - 1.88]	1.43	[1.13 - 1.81]
Richest quintile	1.00		1.00		1.00				1.00		1.00	
Family Yitzhaki index												
Least relatively deprived quintile	1.00		1.00				1.00		1.00		1.00	
2nd least deprived quintile	1.10	[0.90 - 1.35]	1.09	[0.88 - 1.34]			1.10	[0.89 - 1.35]	0.83	[0.66 - 1.04]	0.86	[0.69 - 1.08]
Middle quintile	1.26	[1.03 - 1.53]	1.17	[0.95 - 1.43]			1.24	[1.01 - 1.51]	0.78	[0.60 - 1.00]	0.83	[0.65 - 1.06]
2nd most deprived quintile	1.28	[1.04 - 1.57]	1.13	[0.92 - 1.39]			1.23	[1.00 - 1.51]	0.66	[0.49 - 0.87]	0.73	[0.55 - 0.95]
Most relatively deprived quintile	1.49	[1.21 - 1.85]	1.17	[0.95 - 1.45]			1.42	[1.15 - 1.76]	0.60	[0.43 - 0.83]	0.70	[0.51 - 0.96]
Akaike Information Criterion (AIC)					7,247.7		7,274.3		7,273.8		7,249.6	
Intraclass correlation (ICC)					0.073		0.091		0.068		0.065	

All models are two-level hierarchical models of 11,183 individuals nested in 132 schools. [†] Coefficient values for race/ethnicity not shown.
Figures are odds ratios with 95% confidence intervals in brackets.

Supplementary Table 7: A comparison of Add Health respondents at Wave II or III with Missing and Non-Missing family incomes at Wave I

	Most equal	2nd most equal	Middle	2nd least equal	Least equal	All non-missing	Missing	χ^2 test	p-value
No. of respondents	2,417	2,355	2,171	2,284	1,956	11,183	3,625		
Amongst the Missing	518	620	968	632	887				
Proportion testing positive for any STI	6.7%	8.5%	10.3%	13.4%	14.3%	10.5%			
Amongst the Missing	6.0%	8.9%	9.4%	15.8%	16.0%		11.6%	3.43	0.064
School Gini coefficient									
Most equal quartile						21.6%	14.3%		
2nd most equal quartile						21.1%	17.1%		
Middle quartile						19.4%	26.7%		
2nd least equal quartile						20.4%	17.4%		
Least equal quartile						17.5%	24.5%	245.89	<.0001
Per-capita family income									
Poorest quintile	9.4%	14.5%	17.4%	27.2%	31.7%	19.8%	0.3%		
2nd poorest quintile	17.4%	21.6%	20.1%	21.8%	19.1%	20.0%	0.2%		
Middle quintile	23.9%	23.8%	22.0%	18.4%	11.9%	20.4%	0.1%		
2nd richest quintile	28.7%	23.5%	19.0%	17.9%	11.0%	19.6%	0.1%		
Richest quintile	28.6%	21.9%	18.5%	16.9%	14.0%	20.3%	0.1%	9.44	0.051
Missing							99.1%		
Family Yitzhaki index									
Least relatively deprived quintile	26.1%	21.1%	19.7%	20.5%	12.6%	20.0%	0.1%		
2nd least deprived quintile	24.7%	22.9%	19.2%	19.6%	13.7%	20.1%	0.1%		
Middle quintile	19.1%	21.7%	20.3%	21.1%	17.9%	20.0%	0.1%		
2nd most deprived quintile	19.8%	19.2%	20.2%	20.6%	20.2%	20.0%	0.2%		
Most relatively deprived quintile	18.4%	20.4%	17.8%	20.4%	23.1%	20.0%	0.3%		
Missing							99.1%	9.07	0.059
Individual Race/Ethnicity									
White non-Hispanic	31.6%	26.4%	13.6%	17.6%	10.8%	57.7%	41.7%		
Black non-Hispanic	5.0%	14.2%	22.1%	26.9%	31.8%	20.2%	24.4%		
Hispanic	10.0%	13.2%	29.7%	17.9%	29.2%	14.8%	19.8%		
Other non-Hispanic	12.6%	13.6%	37.3%	29.5%	7.1%	7.3%	14.1%	335.83	<.0001
Sex									
Male	21.6%	20.9%	18.8%	20.6%	18.1%	52.2%	54.4%		
Female	21.7%	21.2%	20.1%	20.2%	16.8%	47.8%	45.6%	5.38	0.020
Age at baseline									
<14	26.4%	23.1%	8.2%	33.2%	9.1%	16.3%	11.5%		
14	27.7%	21.0%	9.7%	28.7%	13.0%	14.9%	11.3%		
15	19.8%	23.4%	19.4%	17.2%	20.2%	18.6%	15.5%		
16	19.2%	18.9%	26.1%	16.2%	19.6%	19.5%	19.3%		
17	18.8%	20.1%	26.0%	14.7%	20.5%	18.4%	20.5%		
>17	18.6%	19.9%	25.8%	13.5%	22.2%	12.2%	21.9%	265.90	<.0001
Highest parental education									
< High School graduate/GED	6.6%	13.4%	25.5%	22.0%	32.5%	11.2%	9.3%		
High School graduate/GED	18.6%	23.4%	16.3%	23.5%	18.2%	24.1%	11.5%		
Some college	24.5%	21.1%	19.6%	21.4%	13.5%	30.9%	10.7%		
Completed 4-year college	26.6%	22.3%	19.9%	16.9%	14.2%	18.3%	6.6%		
Any post-graduate	25.4%	21.6%	18.7%	16.8%	17.5%	15.5%	5.4%	152.29	<.0001
Missing							56.6%		
Urbanicity									
Urban	15.2%	14.2%	14.7%	27.6%	28.4%	28.2%	29.3%		
Suburban	25.4%	18.5%	27.1%	19.5%	9.5%	53.6%	56.1%		
Rural	20.4%	39.3%	4.1%	11.9%	24.3%	18.3%	14.6%	25.16	<.0001
Region									
West	22.9%	18.3%	36.4%	21.1%	1.3%	23.5%	29.2%		
Midwest	22.4%	36.1%	23.5%	10.9%	7.1%	26.4%	19.6%		
South	15.5%	13.5%	10.5%	27.0%	33.5%	36.5%	40.2%		
Northeast	34.7%	16.9%	5.8%	20.1%	22.6%	13.5%	11.1%	109.67	<.0001
Type of school									
Public	18.8%	21.8%	21.0%	21.1%	17.3%	92.5%	93.3%		
Private	56.1%	12.3%	0.0%	11.8%	19.8%	7.5%	6.7%	2.58	0.108