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Research Article

# The relationship between neighborhood-level poverty assessed with geocoding and oral contraceptive continuation

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## Abstract

**Introduction:** Commonly used indicators for socioeconomic status prove challenging in reproductive health research with young women. We investigated whether neighborhood-level poverty as a measure of socioeconomic status was associated with contraceptive continuation.

**Materials and methods:** Young women (n=675) who completed a six-month randomized trial of a daily text message to improve oral contraceptive continuation provided residential addresses at enrollment. We identified a census tract for each participant and linked this to U.S. Census poverty prevalence data. We then assessed oral contraceptive continuation and other demographic factors by quartiles of neighborhood poverty prevalence.

**Results:** Oral contraceptive continuation was not associated with neighborhood-level poverty (p=0.5) even after adjustment for age, race/ethnicity, and reproductive history (odds ratio=1.00). Census tracts with lower neighborhood-level poverty had more white women and more women without a previous pregnancy (p=0.001 and p=0.02, respectively). In contrast, African-American and Hispanic women were overrepresented in census tracts with higher neighborhood-level poverty.

**Conclusion:** Neighborhood-level poverty, as an indicator for socioeconomic status, assessed with geocoding was not associated with oral contraceptive continuation in this study. Finding a meaningful and useful measure of socioeconomic status for young adult women remains a challenge.

## Introduction

Oral contraceptives (OCs) are the most commonly used reversible form of contraception in the United States [1], but six-month OC continuation rates in young women are low at 12% to 58% [2-4]. OC continuation is associated with variables commonly used to measure socioeconomic status (SES): race, education, income and employment [5,6]. These variables are challenging to use in reproductive health research with young women. Race is a problematic variable in very diverse urban areas where its role can be less generalizable to the rest of the country. An education variable does not easily characterize young women whose education is ongoing. Income is difficult to determine because young women are often dependents, cannot provide information about household income, and may have large short-term fluctuations in their income. Given the drawbacks of relying on these variables, we calculated neighborhood-level poverty as a measure of SES and assessed its relationship to OC continuation.

Geocoding or Geographic Information Systems (GIS) can cross-reference an individual's residential address with U.S. Census Bureau data. Doubeni and colleagues found the percentage of households below the Federal Poverty Level (FPL) to be highly correlated with a composite neighborhood socioeconomic deprivation factor [7]. Census tract data are highly correlated with self-reported income and are a more precise proxy of SES than larger divisions, such as zip codes [8,9]. GIS is a readily available tool increasingly used by public health professionals to examine key relationships between population health and both human and physical environmental characteristics. Research using GIS has explored patterns and rates of disease in specific geographic areas, surveyed the relationship of the physical environment on disease prevalence, and mapped disease outbreaks [10].

We performed a secondary analysis of data from an OC continuation trial. In the primary analysis a daily educational text message improved six-month OC continuation compared to routine care in women aged 13-25 years [11]. For this analysis, we used self-reported addresses, GIS, and the percentage of households below the FPL within census tracts. We then assessed whether the calculated neighborhood-level poverty was associated with OC continuation.

## Material and methods

The trial, carried out at an urban family planning health center, included sexually active women up to age 25 who owned a cell phone with text messaging functionality and were beginning or continuing OC use. A baseline questionnaire elicited demographic and socioeconomic characteristics, medical history, prior contraceptive use, relationship status, and cell phone characteristics and usage.

In brief, the study randomized participants (1:1) to receive routine care or routine care plus a daily text message for six months. Routine care

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included contraceptive counseling by staff and an educational handout. Young women in the intervention group also received 180 daily text messages. A follow-up telephone interview assessed OC continuation as a dichotomous variable. We further assessed continuation by asking about missed pills, interruptions in OC use of greater than seven days, and use of the OC at last sexual intercourse.

We mapped self-reported addresses for the participants with six-month follow up data using ArcGIS® 9.0 (Environmental Systems Research Institute, Redlands, California). The mapped addresses were cross-referenced with national census data using the American Fact Finder database from the U.S. Census Bureau [12]. We used 2006-2010 neighborhood-level poverty estimates from the U.S. Census Bureau American Community Survey as these dates most closely matched the study enrollment period. For each participant in this study, we recorded the percentage of households living below the FPL in her census tract.

We tested the hypothesis that OC continuation would be lower in quartiles with higher neighborhood-level poverty. We studied neighborhood-level poverty as a continuous variable and as a categorical variable in quartiles using ANOVA and test for trend to compare neighborhood-level poverty as a continuous variable and Pearson's $X^2$ test to compare categorical variables when describing the population and assessing characteristics associated with neighborhood-level poverty by quartile. To assess OC continuation at six months, we conducted multivariable analyses with logistic regression and included neighborhood-level poverty and variables associated with OC continuation in the primary analysis: age, race, age at coitarche, pregnancy history, prior OC use, and the text message intervention [11]. We evaluated model fit using likelihood ratio tests and partial F-tests. The sample size was based on the goal of the randomized trial to assess the text message intervention and was set at 960 women with an expected 15% loss-to-follow-up.

## Results

Sixty-five percent of eligible women agreed to participate and were randomized (n=962). We obtained six-month follow-up data from 683 (71%). Eight women (1%) did not provide valid addresses on their intake questionnaire; thus, we were able to calculate census tract neighborhood-level poverty for 675 women (70%). Among these women, 0.3% to 66.3% of households were below the FPL. The median prevalence of participant neighborhood-level poverty was 18.4%. Study participants in the lowest quartile with the least neighborhood-level poverty lived in census tracts where 0.3-10.4% of households lived below the FPL. Women in the highest quartile lived in neighborhoods where poverty prevalence ranged from 27.6-66.3% (Table 1).

Two hundred seventy-four women (29%) did not complete a six-month follow-up interview, but provided valid addresses. They were younger (p<0.01), more likely to have been pregnant prior to the study (p<0.01) and less likely to be white (p=0.04) than those who completed follow-up. The neighborhood-level poverty for the women lost to follow-up was similar to the poverty prevalence for women who completed the study (18.8%; p=0.5).

Neighborhood-level poverty was not associated with OC continuation when analyzed as either a continuous variable (p=0.1) or as a categorical (quartile) variable (p=0.5). Participant distribution across levels of poverty prevalence was similar for those who continued their OC use at six months and those who did not (Figure 1).

Poverty prevalence in this study differed by race; white women were more likely to live in a neighborhood of lower poverty prevalence

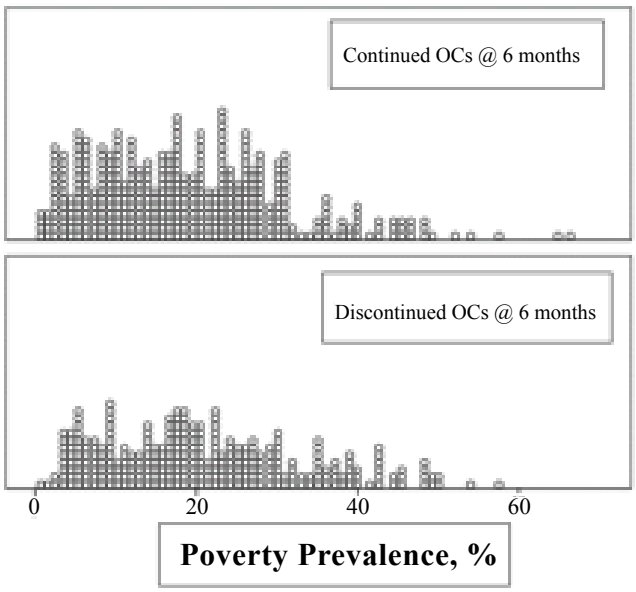


**Figure 1.** OC continuation *vs.* discontinuation across levels of poverty.

and African-American and Hispanic women were more likely to live in a neighborhood of higher poverty prevalence (p=0.001; Table 1). As there were few Asian women (n=35), their numbers were insufficient to fully explore associations with poverty.

Pregnancy history was also associated with poverty prevalence; women who had never been pregnant lived in areas with lower poverty prevalence (p=0.02). Employment and insurance status were not associated with poverty prevalence (p=0.9 and 0.2, respectively) or with OC continuation in the primary analysis. Past OC use was not associated with neighborhood-level poverty, but was a positive predictor of OC continuation in the primary analysis.

We constructed a multivariable logistic regression model including the factors found to be predictors of OC continuation in the primary analysis as well as poverty prevalence as measured by quartiles in one model. We also created a similar model with poverty prevalence as a continuous variable. Neither model found the inclusion of poverty prevalence to be a significant addition (partial F test, p=0.99; likelihood ratio test, p=0.4) (Table 2).

## Discussion

Poverty, as defined here, was not a predictor of six-month OC continuation and the study's text messaging intervention improved OC continuation regardless of a young woman's quartile of poverty prevalence. Race was related to OC continuation in the primary analysis, but given New York City's ever-expanding diversity, generalizability concerns led us to investigate neighborhood-level poverty as an additional SES surrogate [13]. Neighborhood-level poverty in this secondary analysis was related to race, but not related to employment or insurance status, which may highlight the difficulties defining SES among young reproductive age women. The median level of participant neighborhood-level poverty, 18.4%, is comparable to New York City's median of 18.6% [12]. This suggests that our participants may be a representative mix of New Yorkers. This is not, however, generalizable

**Table 1.** Characteristics by quartile of poverty prevalence in 675 participants who completed six-month follow-up and reported valid addresses.

| | Quartile 1 | Quartile 2 | Quartile 3 | Quartile 4 | p-value |
|---|---|---|---|---|---|
| | [0.3-10.4% below FPL] n=169 | [10.5-18.4% below FPL ] n=172 | [18.5-27.5% below FPL] n=167 | [27.6-66.3% below FPL] n=167 | |
| Mean age (years) ±SD | 20.8 ± 2.6 | 21.1 ± 2.4 | 20.6 ± 2.7 | 20.6 ± 2.7 | 0.3 |
| Race | | | | | 0.001 |
| African-American | 55 (20) | 63 (23) | 80 (29) | 75 (28) | |
| Hispanic | 43 (25) | 40 (23) | 35 (20) | 57 (33) | |
| White | 62 (33) | 56 (29) | 43 (23) | 30 (16) | |
| Mean years of school completed ± SD | 13.8 ± 2.1 | 13.4 ± 2.1 | 13.5 ± 2.1 | 13.2 ± 2.1 | 0.09 |
| Employed | 51 (30) | 44 (26) | 50 (30) | 42 (25) | 0.9 |
| Insured | 119 (70) | 127 (74) | 116 (69) | 108 (65) | 0.2 |
| Never pregnant | 113 (67) | 105 (61) | 91 (55) | 85 (51) | 0.02 |
| Prior OC use | 136 (80) | 134 (78) | 127 (76) | 123 (74) | 0.5 |
| OC continuation at 6 months | 106 (63) | 104 (61) | 99 (59) | 91 (54) | 0.5 |
| Text intervention | 48 (65) | 61 (69) | 58 (65) | 52 (58) | 0.5 |
| Control | 58 (61) | 43 (51) | 41 (53) | 39 (50) | 0.4 |

OC = oral contraceptive.
Data are n (% of total) unless otherwise specified.

**Table 2.** Predictors of OC continuation at 6 months; poverty prevalence as a continuous variable.

| | Unadjusted Analysis | Adjusted Analysis* |
|---|---|---|
| Text intervention | 1.54 (1.13-2.10) | 1.44 (1.03-2.01) |
| Age | 1.25 (1.17-1.33) | 1.14 (1.06-1.24) |
| Race | | |
| African-American (ref) | Ref | Ref |
| Hispanic | 1.37 (0.94-2.00) | 1.23 (0.82-1.84) |
| White | 3.37 (2.24-5.06) | 1.91 (1.18-3.09) |
| Age at coitarche | 1.25 (1.15-1.36) | 1.12 (1.01-1.23) |
| Never pregnant | 1.81 (1.32-2.48) | 1.44 (0.99-2.09) |
| Prior OC use | 2.34 (1.62-3.37) | 1.57 (1.02-2.43) |
| Poverty prevalence | 0.99 (0.98-1.00) | 1.00 (0.98-1.01) |

OC = oral contraceptive.
Data are odds ratio (95% confidence interval).
*Simultaneously adjusted for all variables in the model.

to the U.S. where the median neighborhood-level poverty is 13.5%.

Our specific geocoding technique may not be a precise measure of SES or neighborhood-level poverty may be irrelevant to OC continuation. A standardized method of how to use GIS and U.S. Census data to estimate SES is not yet established. Researchers choose different economic and geographic measures. Based on prior studies, we chose to consider the percentage of people living below the FPL in the participant's census tract [7-9]. The distribution of race and pregnancy history by poverty prevalence matched other known SES associations, suggesting that this technique may be a simple and accurate approach to defining SES [14,15]. A limitation of this analysis is that we did not have any measure of household income, and we could thus not compare the neighborhood-level poverty results with self-reported income.

The reliance on self-report of OCP continuation is another limitation of this study because women tend to underreport their missed pills [16]. Another potential limitation in our study is that a census tract can include a heterogeneous mix in this densely populated urban area. For example, dormitories of college students may be next door to public housing. The college students may represent a different socioeconomic group than people living in public housing, but using a census tract could lump them together leading to misclassification.

The use of neighborhood FPL as a definition of poverty will not capture all people who struggle in some socioeconomic way. Income may be a better measure, but relying on self-report of income, particularly among young women, has potential for misclassification as well.

## Conclusion

Receiving a daily text message improves a young woman's OC continuation at six months, regardless of the percentage of people living below the FPL in her neighborhood. Use of geocoding is possible, but is an imperfect indicator of SES for the young women in this study. Geocoding is an appealing way to avoid the pitfalls of self-reported data, but is hindered by misclassification. Census data is thus not sufficient as an indicator for SES and needs to be supplemented with other personal-level data. The use of geocoding should be further investigated with other factors in an attempt to determine a better proxy for SES of an individual.

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