Transit-oriented urban economic development and changes in crime and drug use

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Short abstract

Neighborhood-level interventions provide an opportunity to better understand the impact that neighborhoods have on health. We used an exogenous source of neighborhood change in Medellín, Colombia--the construction of a gondola in 2004 to connect residents in the periphery to the urban center--as a natural experiment to study the effect of neighborhood change on health. The study used a pre-post design with intervention neighborhoods (n=22) matched to control neighborhoods (n=27) and residents (n=599) interviewed in 2003 and 2009. Residents in intervention neighborhoods reported a higher increase in trust in the police, perceived quality of neighborhood infrastructure, and collective efficacy than residents in control neighborhoods. Intervention neighborhood residents also reported a higher decrease in neighborhood violence and lower odds of substance use after the intervention than control neighborhoods. This is one of the first attempts to capitalize on exogenous changes to evaluate the impact that neighborhood characteristics have on health.

INTRODUCTION

The influence of place on health outcomes, and hence the need to better understand the nature of residential contexts that may give rise to a differential distribution of health status, has received increasing attention in the last decade [1-2]. However, most neighborhood studies have used an observational design, which poses important limitations to causal inference. Notably, observational studies do not allow us to separate hypothesized influences of different neighborhood characteristics from differences between the residents themselves—that is, the populations residing in different types of neighborhoods are not exchangeable, as residents may systematically select themselves into neighborhoods with specific characteristics that may influence our outcomes of interest [3-5]. Multivariable control for observed differences between residents in the different types of neighborhoods, as well as more sophisticated approaches such as propensity score matching, allow us to approach population exchangeability. However, even such approaches suffer from limitations such as the inability to control for unobserved confounding, extrapolation and restriction to the comparison between unrepresentative subpopulations [3-4].

Social experiments such as Moving to Opportunity (MTO) [6] have been proposed as ways to overcome selection bias, by randomly assigning families in public housing to housing vouchers in low-income vs. middle-income neighborhoods. Such studies do not, however, use the appropriate unit of assignment to study neighborhood effects on health: they inform us about the effects of moving people into neighborhoods rather than the effect of changing neighborhood conditions.

Social interventions at the neighborhood level allow us to capitalize on naturally occurring changes in neighborhood conditions to evaluate the impact that neighborhood characteristics have on health [3]. In such natural experiments, the "treatment" occurs at the neighborhood level, and is exogenous to the resident population, to the extent that it was implemented as a policy decision and not as a direct result of the neighborhood residents. Such innovations also offer evidence of direct public health value, as they allow us test practicable policy measures that can actually be critically evaluated, improved upon, and replicated [4]. To the investigators' knowledge, no neighborhood-level natural experiment has yet been published.

In 2004, the city of Medellín, Colombia, made a major investment in public transportation infrastructure in some of the most disadvantaged neighborhoods in the city, by building a gondola system to connect residents in neighborhoods in the mountainous periphery with the central city metro line. Investment in public transportation was accompanied by improvement in the neighborhood physical infrastructure and the creation of small businesses. The gondola installation in districts 1 and 2 of the city of Medellín provides an ideal opportunity to use a social innovation to understand neighborhood dynamics, while addressing issues of endogeneity that limit the conclusions we can draw from current observational studies on neighborhoods. Although its non-random selection may pose problems of comparability, we argue that topographically, economically and socially comparable neighborhoods exist in Medellín. This position is reinforced by the fact that the gondola will be installed in such neighborhoods in the coming years.

In this study, we measure the degree to which structural and social characteristics of neighborhoods changed between 2003 and 2009, analyze the extent to which risk

behaviors (violence, drug use and alcohol use) changed between 2003 and 2009, and evaluate the degree to which behavior change can be attributed to the neighborhood change that followed the installation of the gondolas. We hypothesized that the installation of the gondola, and the accompanying program of neighborhood investment, lead to an improvement in local economic opportunities, increased access to safe public spaces, improved police control, and increased levels of neighborhood social cohesion and control. We expected that change in such neighborhood conditions would, in turn, lead to a decrease in levels of neighborhood violence, alcohol and drug use.

METHODS

We used a pre-post intervention/control study design to evaluate the magnitude of neighborhood and risk behavior change that occurred after the installation of the gondola in selected neighborhoods in Medellín. In 2003, before the gondola was constructed, Duque et al.[7] conducted a household survey on neighborhoods, violence and associated risk behaviors in Medellín (PREVIVA), using a representative sample of the non-institutionalized adult population in the city (n=2500). The sample included 172 neighborhoods, with an average of 12 respondents per neighborhood. The study sample included the neighborhoods covered by the gondola, as well as comparable control communities. In 2009, we used hierarchical cluster analysis using survey- and municipal-level data on neighborhood social class, rates of violence, level of social organization, and level of infrastructure, to select neighborhoods that were comparable to those that were within range of the gondola service but had not yet received this service. We then followed up PREVIVA respondents who had lived in the 22 neighborhoods within range of the gondola, as well as PREVIVA respondents who had lived in the 27 matched control neighborhoods, and re-interviewed them in 2009.

We used the survey to document neighborhood conditions such as the quality of neighborhood services (parks, places to practice sports, places to perform educational or artistic activities), level of physical and social disorder in the neighborhood (garbage or broken glass, sale/consumption of drugs, drunk people on the street), perceived trust and quality of policing, collective efficacy, perceived neighborhood violence, self-reported victimization, violent perpetration, alcohol and drug use. We also used municipal registries of neighborhood conditions to obtain pre-/post- data on neighborhood social class and poverty, change in the concentration of businesses, and change in rates of homicide.

We used three-level "difference-in-difference" Rasch models to estimate the differential magnitude of change in survey-reported neighborhood conditions in the intervention and control neighborhoods (survey items nested within persons nested within neighborhoods), and ecological "difference-in-difference" models to estimate the difference in the magnitude of change in municipal sources of neighborhood data in the intervention and control neighborhoods. We controlled for individual covariates in order to address potential sources of residual confounding, including sex, marital status, age, social class, employment, and education. We also used a series of two-level "difference-in-difference" models (of individuals nested in neighborhoods) to estimate the difference in the magnitude of change in individual self-reports of violence, drug use and alcohol use. Given that a low percentage of respondents reported such behaviors, we first used propensity score models to adjust for residual confounding between intervention and control neighborhoods. We used a propensity score model to predict the probability of

residing in a neighborhood that received the gondola intervention, based on individual characteristics. From this model, we obtained an individual probability score, which we divided into quintiles. These quintiles were incorporated as covariates in the main analysis.

RESULTS

The sample originally included 599 respondents to the 2003 PREVIVA survey, of which we were able to successfully follow up 78% five years after the gondola installation (n=465). Of the 465 individuals retained in the study, 14 moved to a different neighborhood between 2003 and 2009, including 4 who moved from an intervention to a control neighborhood. Respondents were 36% male, mean age 37.8 years old (range 18-71). 30.8% were married, 57% owned their home and 78% were classified as low income.

The data for this study have just been cleaned and analyses are currently underway. However, preliminary analyses provide some insight into the types of changes that have occurred in neighborhoods affected by the gondola intervention, in contrast to control neighborhoods. In Table 1 we present results from a series of three-level logistic Rasch models, where binary survey items were nested within persons, who were nested within neighborhoods. Several social and physical neighborhood conditions improved to a greater extent in the intervention than in the control neighborhoods. Residents in intervention neighborhoods were more likely to report an increase over time in the mean propensity to have quality neighborhood services (coeff = 0.31, odds ratio = 1.36) than residents in control neighborhoods. Intervention neighborhoods were also more likely to have a higher increase in trust in the police (coeff = 0.40, odds ratio = 1.49) and in the propensity to rely on the police to solve neighborhood problems (coeff = 0.90, odds ratio = 2.46) than control neighborhoods. The propensity to perceive higher levels of collective efficacy also increased to a greater extent in intervention vs. control neighborhoods (coeff = 0.31, odds ratio=1.36). The risk of perceived violence decreased to a greater extent in intervention vs. control neighborhoods (coeff = -1.66, odds ratio = 0.19). At the same time however, the risk of physical and social disorder was more likely to increase in intervention than in control neighborhoods (coeff = 1.15, odds ratio =3.16), possibly as a result of the increased intra-urban tourism to the intervention neighborhoods, as well as the greater traffic that followed the growth of businesses in the area.

CONCLUSIONS

This is one of the first attempts to use a natural experiment to evaluate the influence of exogenous neighborhood change on health. Preliminary results indicate that some of the key hypothesized mechanisms that would mediate change in health behaviors, such as the quality of the built environment, policing, social organization and public safety, improved with the installation of the gondola in intervention neighborhoods. Analyses are now underway to test the impact that the intervention had on other neighborhood conditions, and more notably, on individual health risk behaviors.

Table 1. Estimated difference in change in neighborhood characteristics in intervention and control neighborhoods, Medellín, 2003-2009 (Three-level Rasch difference-in-difference models)

	Built environment		Quality of policing		Social organization	Safety
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Quality of neighborhood services	Physical/social disorder	Trust in police	Reliance on police to solve problems	Collective efficacy	Perceived neighborhood violence
	Beta (standard error)	Beta (standard error)	Beta (standard error)	Beta (standard error)	Beta (standard error)	Beta (standard error)
Time	0.22 (0.13)*	0.07 (0.09)	0.13 (0.09)	0.89 (0.14)***	0.32 (0.08)***	-1.83 (0.15)***
Treatment (reference is control)	-1.16 (0.32)***	-0.49 (0.14)***	0.53 (0.27)*	-0.73 (0.26)***	-0.15 (0.17)	1.28 (0.35)***
Time x Treatment	0.31 (0.18)*	1.15 (0.14)***	0.40 (0.13)***	0.90 (0.20)***	0.31 (0.12)***	-1.66 (0.23)***

*** <.01 ; **<.05; *<.1

Controlling for age, sex, social class, marital status, home ownership, employment status, and education

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