

# Does Neighborhood Status Affect Access to a Healthy Built Environment?

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## Research

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# Abstract

**Background:** When looking to better understand the links between income and health, urban settings add an additional dimension of structural inequity. Without proactive urban planning, some neighborhoods are deprived of essential services, while other neighborhoods enjoy easier access to services and providers. The case of Indore, India was used to explore differentials in available services, infrastructure, and access to goods and services relating to non-communicable disease risk when the data was disaggregated by neighborhood type (slum vs non-slum).

**Methods:** The environmental data for this paper came from a city-wide multi-level survey conducted in 2018, which included a neighborhood environmental assessment tool adapted from pre-validated questionnaires. Wards were randomly selected using a probability proportional to size (PPS) method after stratification by presence of slums. Within each ward, three colonies were then selected by PPS. The environmental data were collected from the same 30 wards and 93% (84/90) of the same colonies as the individual data.

**Results:** The analysis highlighted some expected inequalities by neighborhood status, such as neighborhoods with no parks (62% slum vs 31% in non-slum). In neighborhoods where parks were present, there appeared to be issues with safety within the parks. Regarding walkability, slum neighborhoods generally had a higher prevalence of broken glass, liquor bottles, and stray dogs on footpaths. Non-slum neighborhoods had, on average, more vegetable stores, while slum neighborhoods had more snack and tobacco stores. The ratio of pro-tobacco versus anti-tobacco ads was twice as bad in slums than in non-slums.

**Conclusion:** Better understanding of the access and availability of green spaces, transportation, and food markets between neighborhoods will help local officials, developers, and citizens as they formulate more equitable ways to distribute resources to build healthier environments for all citizens.

## Introduction

The physical environment can significantly impact one's risk of developing non-communicable diseases (NCDs). These risk factors are particularly dynamic in rapidly growing cities in low- and middle-income contexts, where large swaths of cities are transforming from informal to formal building stock, public spaces are being introduced or removed, and the regulation and physical presence of shops and vendors are constantly in flux.

Without proactive urban planning, some neighborhoods may be deprived of essential services such as safe transportation. They may also experience limited access to and utilization of green spaces, and have a disproportionate number of establishments selling alcohol, tobacco, junk food, and other unhealthy substances. Evidence that there is an inverse relationship between these unhealthy substances and the wealth of a neighborhood requires thoughtful planning to address environmental injustices that most

often impact traditionally vulnerable groups including women, children, and the poor (Basu, 2017; Macdonald et al., 2018).

This paper uses a recent NCD survey from Indore City, India to explore whether there is any disparity in these community-level elements of the built environment and access to goods and services that influence NCD risk. This analysis complements two previous papers using this dataset, which explored individual-level risk factors that contribute to NCD risk, including gender, wealth, education, and housing status (Bachani et al., 2021; Pomeroy-Stevens et al., 2020).

## Background

Non-communicable diseases, once thought to be “diseases of affluence,” are now known to affect those with lower socio-economic status (SES) as well (Lumagbas et al., 2018); in India, an estimated 60% of all deaths can now be attributed to NCDs (Nethan et al., 2017; WHO, 2014). A growing body of evidence has shown disparities in NCD risk and outcomes for those living in slums or low-income areas within Indian cities (Anand et al., 2007; Mberu et al., 2016; Mohan et al., 2008; Pomeroy-Stevens et al., 2020; Yadav & Krishnan, 2008). However, the current state of evidence on effective NCD prevention and control suggests that simply addressing NCDs as an individual-level medical concern will not be effective at reducing population-level burden. Several theoretical models looking at NCD causation have identified the built physical environment as one of several layers of potential risk beyond the individual (Caperon et al., 2019; Finegood et al., 2010; Hanson et al., 2011). One example is the socio-ecological model, which suggests five layers (intrapersonal, interpersonal, organizational, community, and public policy) that can affect NCD risk, with built environment factors falling primarily within the community and organizational layers (Caperon et al., 2019; Mahmudiono et al., 2019). One of the most comprehensive mapping exercises of multi-layered, systems risk for an NCD was done by the UK Government in 2008 on obesity, which included built environment as a driver particularly related to physical activity (Jones et al., 2007). A recent update of the map using a more participatory, community-led approach in Australia gave even more importance to the role of the built environment, as well as to social psychology (McGlashan et al., 2018). Walls, et al. (2016) went further to call out the built environment, including urban design, as a set of missing “causes of the causes” of NCD risk that are not included in the World Health Organization’s 25x25 prevention strategy (Walls et al., 2016).

Within the built environment, theoretical models and urban guidelines have tried to categorize the determinants into groupings such as green spaces, transportation, and food availability, as well as factors such as service availability and pollution (Dendup et al., 2018; Franco et al., 2015; Higgs et al., 2019). Figure 1 shows how this paper builds from this existing set of literature, using the socio-ecological model as a foundation but focusing within the community level on factors related to the built environment. The broader work that the BHC project has done at other levels of the socio-ecological framework helped to define key connections and variables at the community level to include in this analysis, but will not be further analyzed within this paper (Bachani et al., 2021; Pomeroy-Stevens et al., 2020).

Turning to the empirical literature, a systematic review of studies primarily conducted in higher-income countries showed that built environment attributes, including street connectivity, residential density, and safe footpaths, were associated with physical activity, while “living in high walkable neighborhoods was associated with a lower prevalence of high body mass index, diabetes mellitus and metabolic syndrome risk” (Malambo et al., 2016). Within Asia, one study conducted in Puducherry, India, found that neighborhood characteristics including walkability, green spaces, noise level, air quality, and types of vendors and eateries had a significant impact on NCD burdens (Sarveswaran et al., 2019). Overall, there is very limited research linking the built environment with NCD outcomes in low- and middle-income countries (Smit et al., 2016).

Our research aim was to better understand disparities in access to these attributes at the community-level, and to see if there was any evidence that these disparities are becoming structurally aligned to certain geographic boundaries within cities. The limited literature we found that explored this topic was primarily focused on green spaces. Research conducted in Mumbai, India found that the quality and accessibility – but not the quantity – of green spaces were associated with neighborhood-level SES, with higher SES neighborhoods having better access to green spaces (Sathyakumar et al., 2019). Qualitative research in New Delhi and Chennai also found that low-income populations reported less access to green spaces, along with lower quality, maintenance, and safety of green spaces (Adlakha et al., 2021).

Most studies on this topic took place in higher income contexts such as Australia, the United States, the Netherlands, and the United Kingdom (Astell-Burt et al., 2014; Dendup et al., 2018; Franco et al., 2015). Further research in low- and middle-income countries, including India, is needed to better understand how changing urban built environments are affecting NCD risk as well as hardening into neighborhood disparities.

## Methods

### Dataset

These data come from a 2018 multi-level research survey on NCD risk and prevalence in Indore City, India, and consist of environmental data from a community-level survey and individual data from a household-level survey. The research was conducted through the USAID-funded Building Healthy Cities project, a five-year learning project focused on testing healthy urban planning approaches in four cities across Asia. The household survey (Pomeroy-Stevens et al., 2020; Bachani et al., 2021) was designed using the WHO STEPS tool (WHO, 2003). The household survey sample comprised 3,070 households from 30 wards and 90 colonies. For this study, the only household variable used was the wealth index.

Environmental data, defined in this research as physical and built environmental attributes, were collected via a neighborhood environmental assessment tool, which was adapted from Environmental Profile of Community Health and Community Health Environment Scan Survey tools and previously validated through a study in Ballabgarh, India (Corsi et al., 2012; Rath et al., 2018; Wong et al., 2011). Wards were

randomly selected using a probability proportional to size (PPS) method after stratification by presence of slums. Within each ward, three colonies were then selected by PPS. The environmental data were collected from the same 30 wards and 93% (84/90) of the same colonies as the individual data. Logistical issues prevented our team from reaching the remaining six colonies.

The survey began with the enumerators conducting an accounting in each community of the key characteristics, including street lengths and the number of shops, advertisements, parks, and pedestrian pathways. In addition, a transect walk of the main thoroughfare in the communities was completed and used to calculate the density of establishments selling food and tobacco products, as well as physical activity sites; the density of advertisements promoting tobacco products, fruits, vegetables, and unhealthy food products; and the walkability of the community.

The types of questions asked directly to vendors in tobacco and food shops included the availability of products, the price of products, compliance to government guidelines, and the presence of nutritional labels. Enumerators were asked to observe the parks and note the hygiene of the surrounding area, use of the park by children and adults, any smoking within the site, security presence, and other characteristics. Observations of restaurants and street food vendors included the availability of fast food, the inclusion of healthy food, the type of oil used for cooking, hygiene of the store and surrounding areas, and the presence of 'no-smoking' signage or separate smoking zones.

Based on advice and definitions from the Indore Municipal Corporation, several categories of colonies were collapsed to generate a dichotomous variable identifying a slum or non-slum designation. When surveying within each colony, the team created a street selection methodology based on a mapping exercise wherein the longest road in each quadrant of the colony was selected to be surveyed.

Table 1 shows the total number of facilities surveyed, disaggregated by slum and non-slum areas. While the colony-level data showed that there were more tobacco stores and brick-and-mortar eateries within the colonies than were ultimately assessed, it is likely that not all shop owners consented to participating in the study. It is also likely that since data collection took place during the month of Ramadan, some shops and businesses were closed during the assessment.

## **Analysis**

Analysis of the final dataset was completed using Stata version 14 (StataCorp, 2015). Colony-level means were calculated for the wealth index in the household file and appended to the environmental module. For the park and food analyses, data within each colony on parks, food establishments, and vendors were re-arranged to allow for analysis within the full cohort sampled for each group. No weights were applied to the sample for analysis. Descriptive statistics were developed for each of the tables and significance tests were run for each of the variables (either t-tests or chi-square tests, allowing for both at 90% and 95% confidence levels to recognize that p-values are not defined by one dichotomous cutoff) (Greenland et al., 2016). Choice of variables was driven by the theoretical relationships noted in the background section, rather than by significance – we use these p-values simply as an additional piece of

information to help in defining correlations, noting that further research would be needed to test exact relationships.

## Results

Table 2 shows colony-level indicators for wealth and population. The data show that slum neighborhoods have a significantly lower wealth index as compared with non-slum neighborhoods, with fewer differences in populations and households.

We found differences in the number of certain amenities between slum and non-slum neighborhoods. Table 3 shows a slightly higher mean for tobacco, snack (*namkeen*), and fruit stores in slums, and a slightly lower mean for parks, vegetable stores, and brick-and-mortar eateries. Overall, within the sample, the highest prevalence of stores was tobacco and namkeen stores.

Within the context of food and exercise deserts, it is informative to look at where there are no healthy food stores or parks. In our sample, slums were significantly more likely to have no parks with 62% of slum neighborhoods having no parks at all versus 31% of non-slums; and there were about half as many parks in slums vs. non-slums (Table 3). There did not appear to be any major differences in the prevalence of food desert neighborhoods between slum and non-slum for fruit or vegetable sellers, though a few non-slums had very high densities of vegetable stores. There was a weakly significant difference in density of namkeen stores, with a mean of about eight stores per neighborhood in slums and five stores per neighborhood in non-slums, and the maximum levels for both namkeen and tobacco stores were higher for slums (45 and 39, respectively).

## Food Access

Table 4 shows differences in brick-and-mortar eateries. In this survey, a brick-and-mortar eatery was defined as a stationary eatery that provided sit-down, takeaway, or fast-food menus. The trends show that slum eateries were generally more likely to offer low oil items, but were less likely to have menus, salad, steamed products, and combo meals. When looking at hygiene and cleanliness factors, eateries in slum neighborhoods generally fared worse, with significantly fewer showing no smoking signs and having soap or hand-drying facilities.

Table 5 shows that street vendors in slum neighborhoods were significantly less likely to have whole fruits available for sale, or to keep the available food covered. Vendors in non-slum neighborhoods were more likely to have garbage observed around the vicinity where they were selling food.

## Green Infrastructure

Figure 2 shows the physical attributes, hazards, and observed use of parks across the sample. While there were many fewer parks in slum areas versus non-slum areas, the parks that did exist in slum neighborhoods were slightly more likely to have streetlights and indoor gym equipment than those in non-slum areas. There was lower free access to the parks for those in slum areas versus non-slum

neighborhoods. In terms of dangerous items in parks, slum neighborhoods were more likely to have gamblers and drug paraphernalia present in the parks. Parks in slum neighborhoods also tended to have slightly more children playing and women and men running, as well as more vendors and security guards present.

## **Transport, Walkability, and Roadways**

Table 6 shows pedestrian safety measures from selected streets in each community. In terms of debris present on footpaths, slums had higher prevalence of broken glass, liquor bottles, and the presence of stray dogs.

Table 6 also shows differences in traffic control devices and pedestrian safety features. Slum neighborhoods were significantly less likely to have footpaths and streetlights as compared to non-slum neighborhoods. Slum neighborhoods were also less likely to see temporary road obstructions and zebra crossings that did not have traffic lights.

Figures 3a and 3b shows differences in distances to public transport options as well as the prevalence of streetlights in each colony. Interestingly, there were no significant differences in terms of distance to public transport between the two types of colonies. There was a more noticeable difference in the presence of streetlights, which potentially speaks to some public safety concerns in transiting to those public transport options.

## **Tobacco and Alcohol Environment**

Prevalence of harmful use of alcohol (heavy episodic drinking) in Indore is low. The authors found a city-wide prevalence rate of 2%, while in slums it was 3% (Pomeroy-Stevens et al., 2020). Overall tobacco use prevalence was 21%, and 31% in slums. Figures 4a and 4b presents data about environmental factors related to tobacco and alcohol sales and consumption.

We first looked at the prevalence of both pro-tobacco and alcohol ads (meaning supporting use of) and anti-substance ads (meaning warnings or awareness campaigns to deter use). We found that slums had almost double the number of advertisements for tobacco as compared to non-slums, but the only statistically significant difference was in the ratio of pro-tobacco versus anti-tobacco ads, which was over twice as bad in slums.

Given how low harmful usage of alcohol is in Indore, further data collection was focused on tobacco. Surprisingly, despite the differential and usage found in the individual dataset, it appears that there were the same or slightly lower numbers of vendors selling beedis, cigarettes, and smokeless tobacco items at food markets in non-slum areas than there were in slum areas. A similar story can be told for street vendors, with no significant difference between the percent of vendors selling these items in either area.

We also collected data on shops that primarily sell tobacco products, as shown in Table 7. There were differences between slum and non-slum areas in terms of the mean number of shops available with, on average, 5 tobacco stores per non-slum colony and 6 tobacco stores per slum colony (as previously

shown in table 3). A significantly greater number of shops in slum areas sold cigarettes, while the number of shops in non-slum areas that sold smokeless tobacco items was slightly higher than in slum areas. The vast majority of shops in slum and non-slum areas sold beedis, half sold zarda pan (betel leaves with tobacco), and there were no significant differences in whether these shops provided signage about not selling to minors, or their distance from schools. Our data show that nearly one-third of tobacco shops were within 100 meters of a school regardless of neighborhood designation.

## Discussion

It is instructive to understand the conclusions from these data against the NCD prevalence data found in the household dataset from the same survey. The multi-level modeling done on the household and environmental data as part of the Pomeroy-Stevens et al., 2020 paper shows that up to 25% of the variation in certain NCD risk factors such as insufficient physical activity, alcohol use, and salt intake could be explained by geographic effects. These would include factors that vary at the community level but not the household such as the built environment, food environments, community safety, and community norms.

Given the generally low rates of physical activity and higher rates of overweight across all of Indore, it is unsurprising to see that regardless of neighborhood status there appeared to be generally regular presence of park hazards and lower access to parks for adults, and greater access to fast foods and namkeen stores than fresh food stores. In line with the literature from New Delhi and Chennai (Adlakha et al., 2021), slum areas in Indore appeared to have lower access to any parks, and when parks were present there appeared to be some additional issues with safety. Past analysis conducted by the Building Healthy Cities team as part of the Health Promoting Schools initiative in Indore showed that, before the COVID-19 pandemic, only 68% of public schools had a playground and 17% had a sports teacher (Bachani et al., 2020; Bakhtawar, 2021). Along with the current research, this suggests that the city could consider some municipality-wide actions to create green spaces that are available to everyone, including children, and support safer uses of outdoor spaces whether it be for physical activity or transport (both vehicular and pedestrian).

In terms of food access, we did not see strong evidence for structural differences between slum and non-slum areas, though food safety measures seemed to be stronger in non-slum areas. On the other hand, footpaths appeared to have more observed debris and fewer pedestrian safety measures in slum areas. Given the lack of evidence on pedestrian attributes and their effect on physical activity in India, and some concern that behavior patterns for walking preferences may differ significantly from higher income country studies (Adlakha et al., 2016, 2018), it may be most beneficial to initiate a study in Indore to better understand these relationships.

Speaking to tobacco specifically, one-quarter to one-third of tobacco sellers were within 100 meters of a school regardless of neighborhood status, and tobacco sellers were one of the most prevalent types of stores found in this survey. While it is prohibited by law to sell tobacco in close proximity to schools, the enforcement of the law is difficult as new schools and tobacco stores are built. The city should consider

how to handle permitting processes going forward to make it easier to enforce this law. Ads supporting tobacco use outnumbered ads showing tobacco's risks by nearly 17 to 1 in slum areas and about 8 to 1 in non-slum areas. From the household data (Bachani et al., 2021; Pomeroy-Stevens et al., 2020) we know that the majority of tobacco users in Indore prefer smokeless tobacco and are primarily men, so as the city considers any public health campaigns to reduce tobacco usage they may want to consider ad campaigns that focus on men and smokeless tobacco.

Some limitations of this study were that, due to the inclusion of this module within a cluster randomized household survey design, we did not include all colonies within the city, which would have provided an opportunity to do a spatial analysis of differences across the city. Another limitation was that we did not include questions on the built environment for clinical health care, including clinics and dispensaries. While we do not have these data from the time of our sample, we were able to merge in data on government-operated ward-level health facilities provided by the District Program Management Unit in Indore from 2021, which showed a large percentage of both slum and non-slum colonies in our sample had neither a health center nor a dispensary located within their ward (57% of non-slum colonies, and 62% of slum colonies). Nineteen percent of non-slum colonies had a dispensary and 24% had a health facility located within their ward. In slum colonies, 15% had a dispensary and 23% had a health facility within their ward. These numbers show low levels of available public healthcare across most of the neighborhoods surveyed. In the absence of accessible public healthcare facilities, the citizens may be seeking paid healthcare services from private facilities. Increasing access to healthcare is obviously a key component of creating healthy cities and is an integral aspect of built environments that can reduce NCD burdens. Further analysis of community-level access and use of healthcare services in Indore would help illuminate which areas and populations are most in need of attention.

## Conclusion

The analysis highlighted some expected inequalities by neighborhood status. As a designated Smart City, Indore can explore how to use data focused on built environment inequities to fund Smart City projects that can address these inequities. Although 30% of Indore consists of slum areas, only 5% of the areas targeted by Smart City projects fall into that category (ISCDL, 2018). In particular, when looking at streetlights and park projects, as of the 2020 Smart City workplan, there are no street light projects and only one-third of park projects specifically target slum areas (ISCDL, 2020). It would also be informative for other Smart Cities to conduct neighborhood environmental assessments to better understand which areas could use more funding.

## Declarations

### **Ethical Approval and Consent to participate**

Approval of the Institutional Review Board (IRB) of Mahatma Gandhi Memorial Medical College in Indore was obtained before conducting this study.

## **Consent for publication**

No consent (beyond the informed consent obtained as per IRB Protocol for survey respondents) was needed for this publication.

## **Availability of data and materials**

The dataset used in this paper has been submitted as per our contractual obligations to the USAID development data library at <https://data.usaid.gov/>. Once USAID has completed the upload process it will be publicly available from this site.

## **Competing interests**

Authors declare no conflicts of interest.

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## **Authors' contributions**

- AG completed analysis and write up of results, wrote background section, and helped with discussion section.
- APS conceived of paper, wrote introduction and discussion, and provided oversight and guidance to AG in completion of manuscript
- NM compiled secondary data used in manuscript, worked with ISCDL to obtain cited documents and data, and helped to review manuscript
- RA and AK led data preparation, cleaning and initial analysis of the dataset, provided inputs for the methods section, and helped to review manuscript
- DB negotiated funding for study, Oversaw enumerator training and data collection, participated in cleaning of data, helped with discussion and acted as a reviewer of the manuscript.

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## Tables

Due to technical limitations, table 1 to 7 is only available as a download in the Supplemental Files section.

## Figures



Source: Adapted from the literature defined above in the background section. Italicized factors are those that the reviewed literature emphasized, but that were not included in this environmental module.

### Figure 1

Adapted Theoretical Framework Source: Adapted from the literature defined above in the background section. Italicized factors are those that the reviewed literature emphasized, but that were not included in this environmental module.

Figure 2: Parks with specific attributes, observed hazards, and observed use, by neighborhood type (slum n=13; non-slum n=54)

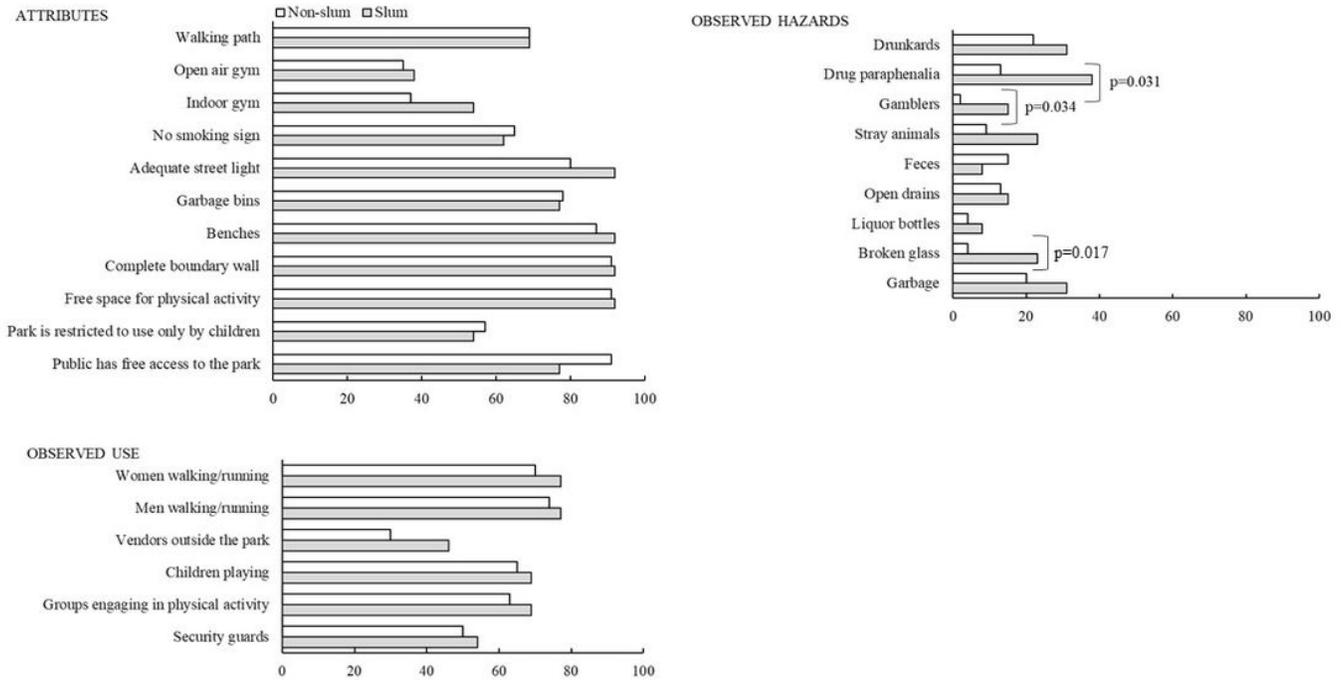


Figure 2

Parks with specific attributes, hazards, and observed use, by neighborhood type (slum n=13; non-slum n=54)

Figure 3a: Mean distances from center of colony to transportation stop in meters, by type of neighborhood (slum n=26, non-slum n=58)

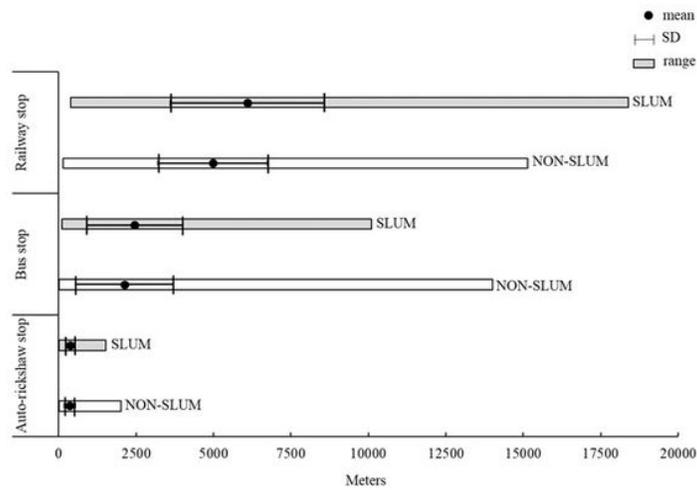
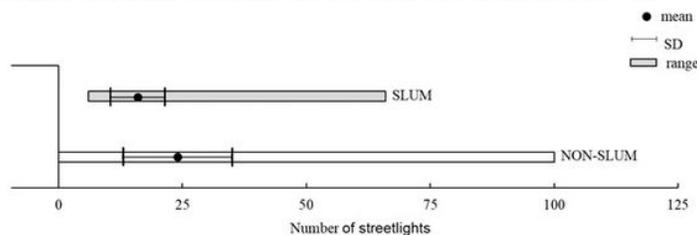


Figure 3b: Number of street lights present, by type of neighborhood (slum n=26, non-slum n=58)



### Figure 3

Mean distances from center of colony to transportation stop in meters, by type of neighborhood (slum n=26, non-slum n=58) \*\*p-value at 95% confidence or better; \*p-value at 90%–94% confidence b: Number of street lights present, by type of neighborhood (slum n=26, non-slum n=58) \*\*p-value at 95% confidence or better; \*p-value at 90%–94% confidence

Figure 4a: Mean tobacco ads per 1,000 meters, by type of neighborhood (slum n=26, non-slum n=58)

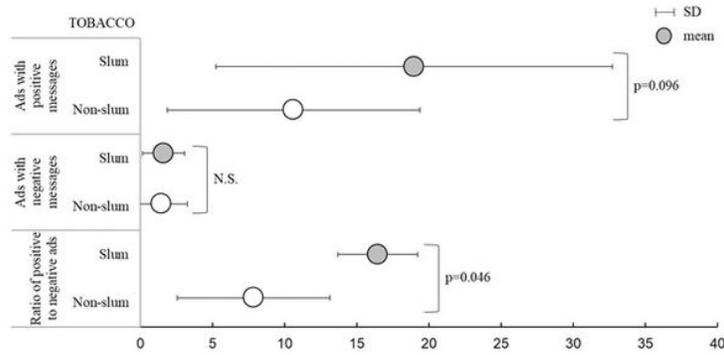
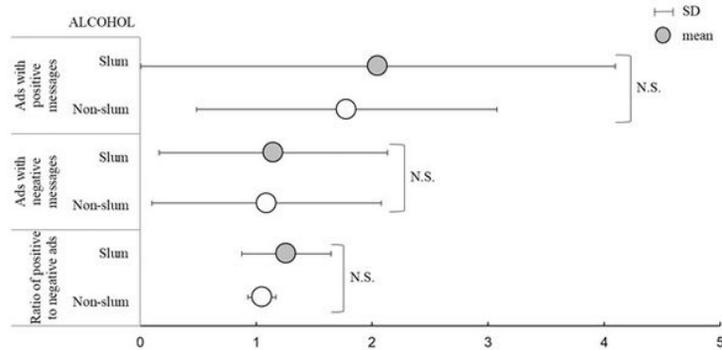


Figure 4b: Mean alcohol ads per 1,000 meters, by type of neighborhood (slum n=26, non-slum n=58)



### Figure 4

a: Mean tobacco ads per 1,000 meters, by type of neighborhood (slum n=26, non-slum n=58) \*\*p-value at 95% confidence or better; \*p-value at 90%–94% confidence b: Mean alcohol ads per 1,000 meters, by type of neighborhood (slum n=26, non-slum n=58) \*\*p-value at 95% confidence or better; \*p-value at 90%–94% confidence

## Supplementary Files

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