Pre-Analysis Plan:
Street Food Safety in Megalopolises

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August 25, 2022

Abstract

Street food is an affordable and convenient source of nutrition billions of consumers in low- and middle-income countries every day, as well as a stable source of employment for vendors. However, street food is also considered a threat for public health, being one of the main determinants of foodborne diseases. Here, we aim to understand the factors that can influence the production and consumption of safer food in urban street food markets in Kolkata, India. We conduct an RCT experiment where vendors in both treatment arms receive a set of infrastructure aimed at improving health and safety conditions for food preparation. Vendors in one treatment arm additionally receive weekly food safety training. We collect weekly data in addition to a comprehensive baseline and endline survey on a range of outcomes aimed at understanding both vendors' responses to the treatment and the mechanisms behind any observed responses.

JEL Codes: O12, O17

Keywords: Food Safety, Public Health, Street-Food, Hawkers, Sanitation, Trainings, RCT, Informal Sector.

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1 Introduction

Street vending, the activity of selling goods and services in the streets without having a permanent built-up structure, is a large and growing sector across the developing world: vendors make up between 2 and 24 per cent of total urban informal employment in African, Asian and Latin American cities (Wongtada, 2014; Bonnet et al., 2019). Among street vendors, food sellers represent the most visible group as they provide affordable and nutritional food to 2.5 billion consumers every day, especially to those of low- and middle-incomes (FAO, 2007). However, street-food vendors are also considered a threat for public health, as street food is one of the main determinants of foodborne diseases (Jaffee et al., 2019; World Health Organization, 2022).[1]

Currently, India is the leading country among emerging economies attempting to structurally transform this sector (NPUSV, 2009). The 2014 "National Act for Urban Street Vendors" aims to formalize the unorganized street vending sector through some regulatory measures, including also recommendations concerning health and hygienic standards for vendors selling food.[2] However, implementation of this policy has been hampered by a variety of factors, such as the lack of compliance and enforcement of regulations and poor targeting of scarce public resources (Daniele et al., 2021). Progress is further complicated by the absence of microeconomic details about the activities conducted by the main actors in this market: street vendors and consumers.

In this project, we focus specifically on the public health aspects of the ongoing transformation of the street vending sector. We aim to understand in detail the factors that can influence the production and consumption of safer food in urban street food markets in Kolkata, India. We use this context as our "laboratory" to gain new insights that can be transferred to other cities, states and countries experiencing similar issues in this yet formalized sector.

In collaboration with international and national organizations, we conduct a randomized controlled trial (RCT) experiment, where vendors in both treatment arms receive a set of infrastructure aimed at improving health and safety conditions for food preparation. Vendors in one treatment arm additionally receive weekly food safety training. We collect weekly data in addition to a comprehensive baseline and endline survey on a range of outcome variables aimed at understanding vendors' responses to the treatment. We will also continue to collect data after the intervention period has ended to observe whether any new habits generated throughout the study persist in the medium-term.

We build upon the seminal work by Daniele et al. (2021), which is the most comprehensive (microeconomic) study on the public health issues surrounding the informal street vending sector. We also expand on the existing microbiological literature that has documented harmful pathogens in street food in developing countries and the work that has documented the extent of unsafe food safety practices among street food vendors; see,

[1] According to the last WHO bulletin, the overall burden of such diseases is substantial: "an estimated 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food and 420,000 die every year" (World Health Organization, 2022). Low-income countries in Southern Asia and sub-Saharan Africa bear a disproportionately high burden, accounting for 53% of all foodborne illness and for 75% of related deaths (Kirk et al., 2015).

[2] This is also known as the "Protection of Livelihood and Regulation of Street Vending" 2014 Act. Other measures included in the act are: (i) to provide specific zones to the street vendors, (ii) to provide a proper license and tax system to run their business, and (iii) to provide appropriate civic amenities, capacity development and access to formal financial credit schemes from the banking institutions.

for example, Muinde and Kuria (2005); Chukuezi (2010); Muyanja et al. (2011); Samapundo et al. (2015).[3]

In the following pages, we outline the details of the RCT design, the estimation strategy, and the hypotheses we will be testing.

2 Literature/Background

The WHO estimates that over 200 diseases are caused by eating food contaminated with bacteria, viruses, parasites or chemical substances such as heavy metals (World Health Organization, 2022). One of the most common are diarrheal diseases, which are estimated to cause over 1.7 million deaths per year, the majority of which are children under 5 (Dadonaite et al., 2018). The policy implications of improving food safety are clear: consuming unsafe food leads leads to diseases that are directly linked to malnutrition, and disproportionately affects children (including infants), the elderly, and those with existing illnesses.

A large literature focusing on the microbiological aspects of street food has documented the presence of harmful pathogens in street food across a range of countries; see, for example, Vollaard et al. (2004) for Jakarta, Indonesia, Mustafa and Abdallah (2011) for Khartoum, Sudan, Manguiat and Fang (2013) for Taiwan and the Philippines, Cho et al. (2011) for Korea, Ganguli et al. (2004) for Patiala City, India, Tambekar et al. (2008) for Amravati City, India.[4] Much of the risks associated with street food can be attributable to to the relative lack of infrastructure needed for safe food preparation and cooking; for example, most vendors do not have access to clean water, electricity, or adequate waste disposal. Nizame et al. (2019) found that only 11% of street food vendors in Dhaka, Bangladesh, had soap and water for hand-washing, while Samapundo et al. (2015) notes that flies and animals were found around 60% of food kiosks in Port-au-Prince, Haiti, and 65% did not have access to potable water. Many kiosks are located on busy roads or crowded paths, making it difficult to maintain sanitary conditions.

In addition to poor infrastructure, knowledge regarding safe food practices is an issue among street food vendors. Vollaard et al. (2004) found that 55% of vendors in Jakarta, Indonesia, did not wash their hands before food preparation; Cortese et al. (2016) notes that one-third of vendors did not have any formal training.

A large literature has shown that treated water reduces diarrheal disease in households; see, for example, Fewtrell et al. (2005), Arnold and Colford (2007), and Clasen et al. (2007). However, even when products are provided free-of-charge, it is not always the case that households use these products (or use them incorrectly): Luoto et al. (2014) found that less than 30% of households who were provided with free water treatment products used them, even with additional informational messaging on the benefits.[5] Willingness-to-pay for chlorine-based water treatments is relatively low; see, for example, Ashraf et al. (2010), Kremer et al. (2011), Blum et al. (2014), Ritter et al. (2017).[6]

[3] Abrahale et al. (2019) provides a review of the literature on the microbiological quality of street food.

[4] Sudershan et al. (2012) provides a review of foodborne diseases in India more broadly, documenting outbreaks in foodborne diseases arising from any source.

[5] Dupas et al. (2016) found little difference in usage rates for chlorine treatment between households who were provided with free products and households that had to expend some effort to obtain the product (either for a small fee or to participate in training before receiving the product for free).

[6] Ahuja et al. (2010) provides a review of the earlier literature.

3 Design

3.1 Treatment and Stratification

We focus only on street food vendors selling heavy or medium-heavy food in a permanent built-up structure.[7] Specifically, our sample includes vendors satisfying the following criteria:

- The vendors must be selling cooked food (in the kiosk or other places);
- The vendors must be selling meal or lunch/dinner items;
- The vendors must be selling cooked snacks (at least 3 items).

Treatment Arms

We provide vendors with a set of sanitation-related infrastructure that are likely too costly for vendors to buy and that are not provided by the local authorities. Specifically, we provide (new) a water storage drum, a stainless steel drinking water container with tap, a hand washing basin with a fitted water tank, and an 80L waste bin. In addition to the larger infrastructure, we also provide an apron and, on a weekly basis, a set of "smaller" infrastructure, which includes soap for hands and dishes, hair nets, and chlorine tablets for water purification. This intervention is equivalent to an in-kind transfer worth around 350 USD per vendor, which is roughly 2-months net income in our context.

In an second treatment arm, vendors receive, in addition to the aforementioned infrastructure, training and support regarding food safety through weekly visits, which we refer to as capacity building. This training focuses on explaining why each item is provided as it relates to safe food practices and how to best use it. It also includes a module that lists a short set of rules for safer and more hygienic food practices, where vendors can do short exercises aimed at improving their understanding of these practices and their importance for food safety.

Each week, trainers are given a set of objectives and a list of key messages to convey to vendors, which focus around the use of the infrastructure and the safe food practices. Trainers will track their interactions with vendors, including whether or not vendors were using the infrastructure and how the trainings proceeded.

In sum, our intervention consists of three treatment groups:

- C: all vendors in the cluster receive a personal banner and menu card.
- T1: all vendors in the cluster receive the same as C, plus the infrastructure.
- T2: all vendors in the cluster receive the same as T1, plus capacity building.

Here, the banner and menu card are given to all vendors as a way for our data collectors to easily identify which vendors need to be interviewed, and to more easily track price changes in menu items as the intervention progresses.

[7] We exclude, for example, vendors selling tea, packed food, or uncooked food such as nuts, fruits, or drinks.

Areas

We identified three areas in Kolkata that were suitable for our study: 1) Sector V, 2) Dalhousie and 3) Hazra. Sector V is the IT hub of Kolkata, where consumers have higher income and vendors generally adopt safer practices. Both Dalhousie and Hazra are quite large and diverse areas in Kolkata. Dalhousie is the central business district of Kolkata, so major consumers are employees of larger businesses. This area has a greater number of vendors and a variety of foods available relative to Sector V and Hazra. There are also only food vendors here. Hazra has offices, hospitals, a large and famous religious temple, markets, a cinema hall and a residential area. As such, consumer types in this area are employees, tourists, pilgrims, shoppers, residents, and people visiting the hospital. In comparison to consumers in Dalhousie or Sector, consumers in Hazra are likely to financially less well-off. Hazra has a smaller number of vendors than Dalhousie, a smaller variety of food sold by vendors, and a greater range of non-food vendors, such as vendors who sell garments, shoes, jewellery, etc.

Clusters

In each of the above areas, we divide vendors into three types of natural urban clusters of i) 1 vendor ii) 2 to 3 vendors or iii) 4 to 8 vendors. We define a cluster as:

- If a vendor does not have anyone nearby in a ray of 30 meters forms a cluster on his own. We interpret this vendor as being a "monopolist" of food in his surroundings.

- If a vendor has 1 or 2 neighbours nearby in a ray of 30 meters forms a cluster of 2 or 3 vendors. These vendors are interpreted as "oligopolists" of food in their surroundings.

- In streets where there are many vendors one after the other, we take the distance from the leftmost vendor to the rightmost vendor and consider a cluster the collection of those vendors that are at most 30 meters apart from each other. This means that in some cases we have clusters of 4 vendors or 5 vendors. In rare cases, we have clusters of 6 vendors (1 case) or 8 vendors (3 cases).

In our sample, this yields 111 clusters in total: 36 in Sector V, 54 in Dalhousie, and 21 in Hazra.

Stratification

Our design is a stratified (blocked) random assignment with 2 levels. Stratification is done at the area and cluster size level, following Imai et al. (2009), Imbens (2011), and Blair et al. (2019). With 3 areas and 3 types of cluster sizes, this yields 9 strata in our sampling. Treatment is randomized at the cluster level within each strata, such that each vendor within a cluster receives the same treatment.

Our randomization procedure yields the following group sizes:

- C: 100 vendors, distributed in roughly 37 clusters.

- T1: 90 vendors, distributed in roughly 37 clusters.

- T2: 90 vendors, distributed in roughly 37 clusters.

In total, our sample is made of 284 vendors, in roughly 111 clusters, of 3 different cluster sizes, distributed in 3 areas.

3.2 Data Collection

We collect several different sources of data:

1) Baseline and endline

Baseline data was collected in April 2022, endline data has a planned collection date of September 2022, at the end of our 12 week monitoring and intervention period.

Both surveys collect socio-economic and business data, as well as detailed adoption and food safety practices data. More specifically, we collect information on:

- Vendors' demographic characteristics and household welfare;
- Business practices, including work hours, number of employees, and suppliers;
- Business assets (e.g., stove, plates, pans);
- Business financing, including current loans and savings;
- Vendors' behaviour and awareness about food safety.

The endline data will additionally collect detailed information on how vendors used any infrastructure provided, or whether new health-related infrastructure was purchased. We also collect information on norms regarding food preparation practices.

2) Monitoring data

We additionally collect weekly monitoring surveys which allow us to track changes in vendors' behaviour and their businesses throughout i) the study period, which we refer to as "short-term monitoring" and for 3 months following the treatment, which we refer to as "medium-term monitoring". The short-term monitoring allows us to observe immediate impacts of the infrastructure on a range of outcomes. As part of this, we collect two monitoring surveys before the intervention, and a further ten surveys during the study period. For the medium-term monitoring, vendors are observed fortnightly for 3 months.

Both the short- and medium-term monitoring surveys are focused on quantifying vendor behaviour during busy periods (focusing specifically on behaviours related to safe food practices, such as whether the vendor washes his or her hands before touching food), as well as kiosk cleanliness. To economise on vendor time (given that they are surveyed on a weekly basis), in odd weeks we ask a limited range of questions about the business, including tracking any changes in prices, business profits, or number of customers. In even weeks, we ask a set of questions about food safety norms, such as when vendors think it is appropriate to wash their hands during the work day, or if (and how) they treat water in their primary water container. During the

medium-term monitoring, these two sets of questions (business practices and norms) will be asked at each monitoring round.

3) Water samples

To assess both the quality of the water that the vendors are using as well whether vendors in the treatment group are using the chlorine tablets provided, we collect water samples weekly to test for the presence of chlorine. We collect 10ml of water between 12pm and 2pm. Samples are then tested using a professional chlorine tester,[8] which provides reliable estimates (within 3% range) of the amount of free chlorine in the water. We record both the amount of free chlorine as well as the time and date of the collection of the sample.

Four pre-treatment water samples were collected, and the collection of water samples continues throughout the study period on a fortnightly basis. In line with understanding longer-term impacts of the treatment, we will also collect monthly water samples post-intervention to understand whether vendors continue to treat their water after the end of the study period.

4) Consumer survey data

We conduct a survey among street food consumers who are customers of the vendors that are included in our sample. This data will be collected towards the end of the treatment period, running from mid-late August 2022. We aim to collect data on at least 10 consumers per each vendor, with a total of around 3,000 consumers. The data collection will happen during the busy hours for vendors, between 11 am and 4 pm.

The purpose of the survey is twofold. First, we aim to ascertain customer preferences for safe street food and how that interacts with important dimensions such as price and location. We do this using a series of choice scenarios, in the spirit of a discrete choice experiment (DCE).

We focus on two food items: vegetable thali and chicken thali. These items are chosen as i) they are relatively homogeneous and easily recognizable for consumers ii) there is one vegetarian and non-vegetarian options and iii) the vegetarian option is relatively lower risk in terms of food safety than the chicken option. Each consumer is asked about one food item only, and this item is chosen randomly.

Each consumer will make choices between an option A and option B across 18 different choice scenarios, where the order of the choice scenarios is random across consumers. We have four attributes in total: 3 attributes with 2 levels of options and 1 attribute (prices) with 5 levels of options. The attributes with the two levels are as follows:

- Location
  - Vendor is a 5 minute walk from you (about 400 meters)
  - Vendor is in front of you
- Vendor's personal hygiene

[8] Specifically, we Hanna Instrument Free Chlorine Checker. Link for the product is available here.

    - Appears not very clean and hygienic
    - Appears very clean and hygienic
- Kiosk's hygienic conditions
    - Appears not very professional and hygienic
    - Appears very professional and hygienic

We used a statistically efficient design to chose the options to show to consumers. Statistical efficiency has been defined in terms of D-efficiency, which can be interpreted as minimizing the determinant of the covariance matrix. This ensures minimum variation around the parameter estimates by minimizing the estimated standard errors.

Second, following the DCE, we will also have a short set of questions asking consumers about their experiences with street food and food safety; for example, how often they consume street food and whether they believe they have ever gotten sick from consuming street food. Using this information, we can form a holistic picture of their stated preferences and beliefs, as well as a means of analyzing such preferences as a function of the street vendor's or stall's characteristics.

4 Estimation and Hypotheses

4.1 Estimation

Delivery of the large infrastructure took place over three weeks, with the first group of vendors receiving the items at the start of July. As such, we set our ANCOVA estimation up as an event study, where some vendors will have received the "treatment" earlier than others. The small infrastructure and the training was delivered starting the second week of July.

The main equation to be estimated is:

$$y_{it} = \alpha + \beta_1 T1_{it} + \beta_2 T2_{it} + \gamma \bar{y}_i + \delta_t + \delta_s + \varepsilon_{it} \tag{1}$$

where for vendor i at time t, y_{it} is the outcome variable, $T1_{it}$ is equal to 1 if the vendor is in the T1 treatment group (that just receives the infrastructure only) and had received the infrastructure at time t and 0 otherwise, $T2_{it}$ is equal to 1 if the vendor is in the T2 treatment group (that receives both the infrastructure and the training) and had received the infrastructure at time t, $\bar{y}_i$ is the mean of the pre-treatment outcome for vendor i, δ_t is a time fixed effect, and δ_s is a strata-specific fixed effect. Identification comes from the randomly assigned treatment status. Using pre-treatment controls and outcomes, we observe no significant difference in observables between the treatment groups across a variety of different methodologies: 1) Kolmogorov-Smirnov (KS) test of identical distributions, 2) Univariate balance tests, 3) Joint orthogonality test. In particular, we focused on the size of the differences rather than their statistical significance (Imbens and Rubin, 2015), and find that

the normalized differences are always below 0.25.

4.2 Hypotheses

Using our main equation, we can test the following:

Test 1: Compare T1 to C to identify supply side effects purely due to having the infrastructure.

Test 2: Compare T2 to T1 to identify supply side effects purely due to capacity building after the infrastructure are provided.

In other words, if β_1 and/or β_2 are positive and significant, then the infrastructure provided has had an effect on the outcome variable; if β_2 if larger than β_1, then the capacity training has increased the total effect.

This project aims to quantify whether or not vendors use the infrastructure provided, and additionally understand and identify mechanisms underlying vendors' decision-making regarding the infrastructure. For the remainder of this section, we present a series of hypotheses that we are interested in testing. We frame this discussion as a decision-tree, where we begin with the question of whether or not vendors use the infrastructure. If they are observed using it, then this leads to a follow-up set of hypotheses aimed at understanding further this result. If we observe a null result, then a separate set of hypotheses will be tested.

4.2.1 Do vendors use the infrastructure?

Our starting point is understanding whether vendors are using the infrastructure provided to them and if we observe better health and safety behaviour during normal kiosk operations.

Hypothesis 0: Vendors in the treatment groups are more likely to engage in better health and safety practices, including the use of infrastructure provided, during normal kiosk operations.

Given that we provided a range of infrastructure, such that there are numerous dimensions that we can observe, to aggregate information effectively, we create several indices. Each of the variables used in the indices is a binary variable, and we take the simple mean of all variables (where variables with missing values are treated as missing and not included in the calculation of the average). As such, a higher value indicates better (safer) outcomes.

Using equation (1), we aim to estimate the effect of T1 and T2 on the following set of outcome variables related to health and safety behaviours:

- *Index 0: Treatment infrastructure.* This index consists of whether or not the vendor has a handwashing facility; whether the vendor's handwashing facility has soap visible; whether the vendor is wearing disposable gloves; is wearing a hair cover; whether there is a garbage bin visible for vendor use; whether there is a garbage bin for customers; whether there is a drinking water facility for customers; whether there is a handwashing facility for customers; and whether there is soap visible at the customer facility.

- *Index 1: Kiosk facilities.* This index consists of whether or not the vendor has a hand-washing facility; whether this facility has soap visible; whether the water used for dishes is clean; whether there is soap visible in or next to the water; whether the vendor has a clean towel; a clean apron; is wearing disposable gloves; is wearing a hair cover; whether there is a garbage bin visible; and if the garbage bin is clean and tidy.

- *Index 2: Food handling.* This index consists of whether cooked food is kept separate from raw food; whether cooked food is covered; whether raw food is covered; whether the vendor uses tongs to serve food; whether the vendor uses spoons to serve food; whether the vendor is observed washing his or her hands before serving or touching food; whether the counter where food is prepared is clean.

- *Index 3: Customer facilities.* This index consists of whether food is served on disposable plates; whether there is a garbage bin for customers; whether this garbage bin is clean and tidy; whether there is a drinking water facility for customers; whether drinking water is distributed from a clean and tidy facility; whether there is a handwashing facility for customers; whether this facility is clean and tidy; and whether there is soap visible at this facility.

- *Index 4: Overall.* This index is the average of Index 1-4 all of the above index components.

- *Chlorine levels.* We also create an indicator variable equal to one if water collected from the vendor's primary water storage container contains chlorine levels above 0.2ppm; zero otherwise.

If vendors in the treatment groups do use the infrastructure provided (Index 0) and this generates relatively better health and safety behaviours (Index 1-4) more generally as compared to the control group, then β_1 and/or β_2 should be positive and significant. If capacity training amplifies this effect, then β_2 should be relatively larger than β_1.

4.2.2 If vendors use the infrastructure, then why?

In this section, we present a set of hypotheses that will follow if we reject the null for Hypothesis 0 and conclude that vendors do use the infrastructure provided to them, and are more likely to display positive health and safety behaviours during regular kiosk activities. Here, we aim to understanding further the impacts of the infrastructure.

We firstly consider whether the usage of the infrastructure (and improved health and safety behaviours more broadly) impacts business operations more broadly, such as labour supply, profits, and prices.

Hypothesis 1a: Use of infrastructure yields a positive change in business practices, either in the present or in expectations for the future.

The outcomes we are interested here are as follows:

- *Business practices:* Variables here include whether vendors are open days per week; spend more time per day preparing food, selling food or cleaning the kiosk; have a greater number of customers per day;

and have greater daily sales and profits. We collect information on business practices on a bi-weekly basis, in addition to the baseline and endline surveys.

- *Business expectations:* Here, we are interested in whether vendors plan to be open relatively more days per week in the future, and whether they expect to have higher profits. We collect information on business expectations on a bi-weekly basis, in addition to the baseline and endline surveys.

- *Prices:* Here our outcome of interest is the price of menu items relative to baseline prices. We collect information on prices on a bi-weekly basis, in addition to the baseline and endline surveys.

- *Business assets:* We construct an index of business assets, which include the following items: gas cylinders, gas ovens or stoves, frying pans, tubs, bowls, ladles, pressure cookers, trays, serving spoons, drums (large and small), plates and small bowls, tables and chairs, and baskets. We collect this information in the baseline and endline surveys.

- *Business financing:* Here we consider how kiosk owners finance their business operations. Specifically, whether or not they have a bank account; if vendors purchase inputs on credit, and if so, what proportion; applications for loans from banks, microfinance institutions, or other courses; loans received from banks, microfinance institutions, family or friends, or other courses; the conditions of any loans received, such as interest rates and monthly repayments. We collect this information in the baseline and endline surveys.

- *Business savings:* Here our outcomes are whether kiosk owners have any savings; if so, how often to they save and how much each time. We collect this information in the baseline and endline surveys.

- *Business challenges:* Here our outcomes are any problems that vendors face in doing business; whether they receive any kind of assistance; and coping strategies for specific events such as unexpected price rises, loss of customers, or necessary compliance with food industry regulations.

Using equation (1), we aim to estimate the effect of T1 and T2 on the above set of outcomes. If the infrastructure provided has additional effects on the above business practices, then β_1 and/or β_2 should be positive and significant. If capacity training amplifies this effect, then β_2 should be larger than β_1. We may expect to see some effects here as the infrastructure provided is a relatively large transfer, and may allow vendors to improve their businesses. If customers value the infrastructure or improvements in health and safety more generally (discussed below), then they may be more likely to frequent vendors in the treatment groups relative to the control. This then would have impacts on customer numbers, sales, and profits.

We next consider whether changes observed in vendor behaviour are durable; that is, vendors continue to use the infrastructure and demonstrate better health and safety food practices after the treatment period has ended. This is particularly interesting for the smaller infrastructure, where to continue using the products following the end of the study, the vendors will have have to purchase them (on the other hand, the larger infrastructure should be durable).

Hypothesis 1b: Vendors continue to use both the small and large infrastructure and demonstrate better

health and safety food practices after the treatment period has ended.

To answer this hypothesis, we plan to use information collected from both the short- and long-term monitoring surveys.[9] We will use the following equation:

$$y_{it} = \alpha + \beta_1 T1_{it} + \beta_2 T2_{it} + \beta_3 T1_{it} * P_t + \beta_4 T2_{it} * P_t + \gamma \bar{y}_i + \delta_t + \delta_s + \varepsilon_{it} \tag{2}$$

where P_t is an indicator equal to zero for time periods during which infrastructure was provided, and equal to one for time periods following the end of the infrastructure provision period. All other variables are defined as in equation (1).

The outcomes that we are interested here will be the same as those in Hypothesis 0: Indices 0-4, and the chlorine levels observed in the vendor's primary water source. If this hypothesis is true, and we reject the null, then β_3 and/or β_4 will not be significantly different from zero (here, we are under the assumption that β_1 and/or β_2 are positive and significant).

This hypothesis is important to understand how persistent change in behaviour is in this context. If we find that vendors in the treatment group do continue to exhibit better health and safety behaviours after the treatment period has ended, then this suggests that willingess-to-pay is greater than the cost of the infrastructure and changing habits regarding food practices. In this case, it is likely that a long-term equilibrium where vendors habitually practice safe food practices will hold. Conversely, if vendors do not continue to use the infrastructure or purchase small infrastructure, and health and safety practices return to their baseline levels, this may suggest one of the following:

- Vendors do not believe that the infrastructure or the improved health and safety practices are valuable; e.g., there is no increase in customers or profits.
- Vendors find the infrastructure too expensive, such that purchasing these items and using them regularly is problematic.

Finally, we are interested to see whether improved health and safety behaviours that vendors in the treatment group exhibit spillover to vendors in the control group.

Hypothesis 1c: There is evidence of spillover effects, whereby vendors we observe in the control group adopt better food safety practices.

Understanding the role of spillover effects is important not just for understanding how vendors who are not part of the treatment group are affected, but also for correctly estimating the true treatment effect.[10] Here, we expect that control clusters that are geographically closer to treated clusters will be relatively more likely to exhibit spillover effects.

[9] Recall, the short-term monitoring refers to the monitoring data collected during the intervention, while long-term monitoring refers to data collected in the months following the end of the intervention.

[10] In the presence of spillover effects, the SUTVA assumption; that is, the treatment assignment is uncorrelated with potential outcomes of other groups (Angelucci and Di Maro, 2016).

We know where vendors' kiosks are located on the street. We can therefore compute density informations for each cluster of vendors in a close or distant neighborhood. We define "close neighborhood" as a collection of vendors between 0 and 400 meters apart (up to 5 minutes walk) and a "distant neighborhood" as a collection of vendors between 400 and 800 meters apart (between 5 and 10 minutes walk).

For close neighborhood, we define the share of treated vendors in a close neighborhood as:

$$N^T_{0-4it} = \frac{\text{Number of vendors of a treated cluster working in a close neighborhood}}{\text{Number of vendors working in a close neighborhood}}$$

Similarly, for a distant neighborhood:

$$N^T_{4-8it} = \frac{\text{Number of vendors of a treated cluster working in a distant neighborhood}}{\text{Number of vendors working in a distant neighborhood}}$$

The strategy is therefore to examine whether outcome variables are impacted by the density of vendors of treated clusters once accounting for the overall density of vendors in the neighborhood.

As such, the extended model is:

$$y_{it} = \alpha + \beta_1 T1_{it} + \beta_2 T2_{it} + \gamma_{0-4} N^T_{0-4it} + \gamma_{4-8} N^T_{4-8it} + \phi_{0-4} N_{0-4it} + \phi_{4-8} N_{4-8it} + \gamma \bar{y}_i + \delta_t + \delta_s + \varepsilon_{it} \quad (3)$$

where N_{0-4it} and N_{4-8it} control for the overall density of vendors in the neighborhood. The parameters of interest are γ_{0-4} and γ_{4-8}, which are the between externality coefficients. The identification of these parameters is facilitated by the variation in clusters' sizes across the sample (which we use as a stratification variable).

4.2.3 If vendors do not use the infrastructure, then why not?

Suppose now that we do not find evidence that vendors in the treatment groups are significantly more likely to use the infrastructure provided or exhibit better health and safety behaviours more generally, or using them in an incomplete way (for example, vendors may be using the small infrastructure infrequently or not at all, but partially using the large infrastructure, such as the water container). In other words, we retain the null in Hypothesis 0. This yields a set of hypotheses aimed at understanding why this may be the case.

Hypothesis 2a: Vendors have a lack of understanding of how to use the infrastructure

The outcomes that we are interested here will be the same as those in Hypothesis 0: Indices 0-4, and the chlorine levels observed in the vendor's primary water source. We are also interested in vendor knowledge regarding health and safety practices more generally. We collect the following variables every other week in the monitoring surveys:

- What is used to clean hands and when do vendors think it is necessary to clean their hands during the normal business operations?
- Is the water in the primary storage container treated, and if so, with what?

- How frequently is water used to wash dishes and utensils changed?
- How frequently is the main garbage bin emptied?

To test this hypothesis, we assume that the information constraint is relaxed somewhat for vendors in T2, who receive the weekly capacity training on safe food practices and receive additional support on how to use the infrastructure (this may be particularly useful for the smaller infrastructure such as the chlorine tablets and soap).[11] As such, if there is an information constraint, we should observe that β_2 should be larger than β_1 in equation (1) with the aforementioned outcome variables.

Hypothesis 2b: The perceived benefits of using the infrastructure are less than the cost of using the infrastructure.

This hypothesis is related to Hypothesis 1b, where the issue of willingness-to-pay is relevant. Here, if the weekly trainings improve vendors' perceptions of benefits from use, then we will see a difference between T1 and T2, similar to Hypothesis 2a). To investigate this channel, we will use endline data on vendors' habits and value that they attach to the infrastructure provided. We will have the following set of questions:

- How difficult is it for you to i) have clean drinking water available daily, ii) empty the garbage bin, iii) wash hands before preparing food, iv) cover cooked food, v) change water for washing dishes, vi) provide food on disposable plates?
- What are the biggest challenges for i) complying with food safety regulations, ii) preparing food safely, iii) keeping the kiosk clean, iv) washing hands before preparing food, v) treating water in the primary storage container
- When you think about your regular clients, what are the most important factors in their decision to consume street food? On a scale of 1-10, where 10 is very highly, how much do you think your customers value i) a clean kiosk, ii) drinking water and handwashing facilities, iii) lower prices for menu items
- (For treatment group): Did the infrastructure provided i) allow you to raise prices, ii) increase profits, iii) reduce time spent cleaning, iv) improve the quality of the food sold

If vendors' perceived benefits are low, then we should see relatively low means for the above variables. Using equation (1), we can test the difference between treatment and control groups for any significant differences, as well as any differences between the two treatment arms. Here, if the training increases the perceived benefits, then we should see that β_2 is relatively larger than β_1.

4.2.4 Do consumers prefer safer street food?

In order to provide direct evidence regarding the demand side of the market, we conduct a survey on 3,000 street food consumers across each cluster in the sample. The purpose of the survey is twofold. First, we gather extensive information on their street food habits, thereby giving us both a holistic picture of their stated preferences and beliefs, as well as a means of analyzing such preferences as a function of the street vendor's

[11] As additional qualitative evidence, we will be able to draw from the trainers' notes, which will document how each training session with the vendors went.

or stall's characteristics. Second, we administer a comprehensive series of choice scenarios, in the spirit of a discrete choice experiment (DCE) (World Health Organization, 2012). This allows us to obtain quantitative information on the relative importance of different attributes that influence their choice of street food, as well as the trade-offs between price and vendor characteristics and the probability of take-up of pricier but "better" options.

Hypothesis 3a: Consumers have a positive willingness-to-pay (WTP) for safer food.

We focus specifically on consumer willingness-to-pay (WTP), which we can ascertain from standard DCE setups. We model consumers' preferences with conditional logit models, which allow for multiple observations being obtained from the same individuals. The underlying consumers' utility function is assumed to be the following:

$$U_i = \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \varepsilon_i \tag{4}$$

where U_i is the utility of individual i, x_{mi} is the attribute m of the food item being tested ($m \in \{1,2,3,4\}$), $\beta_1 - \beta_4$ are the parameters to estimate, and ε_i is an individual exogenous shock. In our DCE, we have 4 attributes: 1) Vendor's personal hygiene, 2) Kiosk's hygienic condition, 3) Location of the vendor, and 4) Price of the food item. Attribute 1) and 2) have two levels: high and low. Attribute 3) has two levels: close and far. Attribute 4) has 5 levels. The dependent variable is a dummy equaling 1 for the choice that yields the highest utility within each pair of alternatives. Using the coefficients estimated from a conditional logit model, we will be able to determine which attributes are statistically significant and, if so, in which direction, as well as their relative importance.

Using this data, we plan to test the following set of hypotheses.

Hypothesis 3b: Consumers have a larger WTP for a more hygienic kiosk than for a more hygienic vendor.

The WTP for a more hygienic vendor, or for a more hygienic kiosk, is given by the ratio of the hygiene coefficients (β_1 or β_2) to the negative of the price (β_4), which measures how much consumers would be willing to pay to switch to a more hygienic option. The expected sign of the coefficients are intuitive: the hygiene coefficients are expected to be positive and significant, whereas the coefficient on price is expected to be negative and significant. Our hypothesis is that $-\frac{\beta_2}{\beta_4} > -\frac{\beta_1}{\beta_4}$, that is, a larger WTP for a more hygienic kiosk than for a more hygienic vendor.

Hypothesis 3c: Consumers have a positive but smaller WTP for closer vendors.

Finally, the coefficient on β_3 is expected to be positive and significant. This is expected to yield similar findings, that is, a higher willingness to pay for closer vendors. However, our hypothesis is that $-\frac{\beta_2}{\beta_4} > -\frac{\beta_1}{\beta_4} > -\frac{\beta_3}{\beta_4}$, that is, distance plays a smaller role in the purchasing decisions of consumers.

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