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Preventing dengue through mobile phones: Evidence from a field experiment in Peru☆

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ABSTRACT

Dengue is the most rapidly spreading mosquito-borne viral disease in the world (WHO, 2009). During the last two decades, the dramatic rise in the number of dengue infections has been particularly evident in Latin American and the Caribbean countries. This paper examines the experimental evidence of the effectiveness of mobile phone technology in improving households' health preventive behavior in dengue-endemic areas. The main results suggest that repeated exposure to health information encourages households' uptake of preventive measures against dengue. As a result, the Breteau Index in treatment households, an objective measure of dengue risk transmission, is 0.10 standard deviations below the mean of the control group, which shows a reduction in the number of containers per household that test positive for dengue larvae.

The estimates also show marginally significant effects of the intervention on self-reported dengue symptoms. Moreover, we use a multiple treatment framework that randomly assigns households to one of the four treatment groups in order to analyze the impacts of framing on health behavior. Different variants emphasized information on monetary and non-monetary benefits and costs. The main results show no statistical differences among treatment groups.

1. Introduction

Dengue is one of the most serious mosquito-borne viral diseases affecting humans and is a leading cause of illness in the tropics and subtropics. It is transmitted by the bite of Aedes mosquitoes infected with any of four dengue serotypes. According to the World Health Organization, dengue represents an enormous global health burden, with 2.5 billion people worldwide at risk of contracting the disease (WHO, 2009). Most alarming is the fact that, in the two last decades, humanity has experienced a global emergence of dengue as a major public health problem due to large demographic shifts, lack of effective mosquito control, inadequate water and sewer management systems, and weak public health infrastructure.

This paper presents evidence from the first large-scale, clustered, randomized control trial that evaluates the effectiveness of mobile phone technologies in enhancing households' health preventive behavior in dengue-endemic areas. In recent years, mobile phone service has become the most rapidly adopted technology in developing countries, as the costs of installing mobile phone towers are low relative to those of landlines (Jensen, 2010). Mobile phone service could facilitate the diffusion of knowledge and best practices, reduce transaction costs, and improve the delivery of public services (Aker and Mbiti, 2010; Chong, 2011).

Indeed, a small number of non-experimental microeconomic studies have investigated the role of mobile phone technologies in fostering economic development, particularly in rural agricultural markets. Studies of fishermen in India (Jensen, 2007) and of

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farmers in Niger (Aker, 2010) and Uganda (Mutu and Yamano, 2009) have shown that access to mobile phone service is associated with significant increases in arbitrage, declines in price dispersion, and increases in the number of markets over which farmers trade, all of which have led to improvements in farmers' welfare. Despite these promising results, mobile phone service has not yet been used extensively to advance preventive health care in developing countries (Blaya et al., 2010). Given that households in developing countries invest little in preventive health care, and considering that the treatment of one single case of dengue ranges from US$10 to US$25 (WHO, 2009), the provision of preventive information through text messages has the potential to be a cost-effective health care intervention.

We also contribute to the literature regarding mosquito-borne diseases, which has focused on malaria due to the significant number of lives worldwide that have been claimed by this disease. Not much has been written on dengue in the economics literature. Dengue can cause recurring and debilitating infections and without adequate treatment, it increases vulnerability to other diseases, affects educational performance of children, and reduces labor market productivity of adults (Beatty et al., 2011; Anderson et al., 2007). There is no specific antiviral medicine or vaccine against dengue; thus policy makers have turned their attention to prevention policies which can be classified into those that kill adult mosquitoes (indoor residual sprays), those that inhibit mosquito breeding (larval habitat management), and those that reduce dengue infection in humans (mosquito-treated nets).[1]

Previous research in the medical literature has shown that there are large private returns from the prevention of dengue, although the adoption of preventive measures is low (Anders and Hay, 2012). In the standard model of investments in human capital, individuals invest in health products if the expected benefits from the preventive product outweigh its costs. Low adoption of preventive products could be due to a lack of knowledge or people's underestimation of the importance of controlling the mosquito vector, since dengue may present as a mild illness episode (Elder and Lloyd, 2006). Given that the Aedes mosquito thrives in urban environments with limited water supply and ensuing shortage, it has been shown that one of the most effective ways to control dengue is to provide households with preventive information so that they can eliminate the breeding places of the mosquito through house maintenance and disposal of tires and plastics (Espinoza-Gomez et al., 2002). Thus, the goal of our intervention was to provide repetitive access to information in order to improve knowledge of preventive practices, which may lead to reductions in dengue infestation risk. In contrast to recent experimental studies on health information, where households received a one-time randomly assigned message, we sent 30 messages over a period of 3 months before the peak of the dengue season. Reminders can mitigate 'attentional failure' and thus change intertemporal allocations, and improve consumer welfare by providing associations between future opportunities and today's choices (Karlan et al., 2010).

We conducted the field experiment in 100 urban localities in the province of Talara in the department of Piura in northern Peru. Our area of study is considered an endemic dengue area because of its weather conditions, proximity to the Equatorial tropical area, and low development of water supply and sanitation facilities. In fact, the Peruvian Ministry of Health has declared the area as endemic since a dengue outbreak in 2001 infected 11,703 people with this virus in Piura. Since then, more than 20,000 people have been clinically diagnosed with the virus (Ramírez, 2011).

Following the World Health Organization guidelines on dengue prevention, we sent information regarding the mosquito's life cycle (e.g., eggs laid on the wet walls of containers of water), the conditions that allow dengue to spread, and several strategies for controlling the spread of the disease. To be effective, messages were locally relevant by customizing them based on local uses of language and local illness classifications. We measure the impact of this informational exposure on health-preventive behavior (covering of water reservoirs, the use of mosquito nets and window screenings, among others), self-reported dengue symptoms, cases of diarrhea, and the presence of dengue larvae in water containers three months later. Importantly, the presence of externalities is addressed by using GIS coordinates for all households in the sample.

Based on several prior experiments on health prevention that were done mainly in developed countries, we are also interested in analyzing whether the perspective in which the information is presented affects preventive behavior. It has been shown that the framing of messages could shape attitudes toward risk and thereby influence behavior and choices (Kahneman and Tversky, 1979). In order to analyze the impacts of message framing on health behavior, we randomly assigned localities within the treatment group to one of four treatment groups. Each framing group highlighted a piece of general information; some messages provided general information by highlighting the positive (and negative) consequences of adopting a preventive behavior while other messages emphasized the monetary cost.

Several results emerged. First, exposure to repeated health preventive information affects households' health behavior. The Breteau Index, an objective measure of dengue risk transmission, shows that households exposed to preventive information experienced a decrease in the number of water containers per household testing positive for dengue with respect to the control group. This is explained by changes in household behavior since there are statistically significant increases in the probability of covering water reservoirs, cleaning of water reservoirs, consumption of safe water, and the use of screens in windows and/or mosquito bed nets. These findings contribute to the literature on preventive behavior, the area in which most of the experimental studies that find small effects provided information during a one-time visit (Dupas, 2009). Studies that find positive effects were conducted over many months by providing repetitive information (Cairncross et al., 2005; Luby et al., 2004; Pop-Eleches et al., 2011; Lester et al., 2010).

Second, we evaluated the impact of exposure to repetitive information on different dengue indicators. The follow-up data included self-reported information on dengue incidence and illness of household members during the treatment period. The results show that behavioral changes associated with the intervention translated into a reduction in dengue symptoms (fever, headache, and eyes pain) but did not affect the number of clinical diagnosed dengue cases. Mild episodes of dengue may not lead to significant costs to households, but they affect people's perception toward the severity of the disease. We also analyzed whether the behavioral changes are big enough to have an effect on preventable water-related diseases. The results show a decline in the incidence of diarrhea in treatment households, although the null of no difference between the treatment and control areas cannot be rejected at standard levels. These indicators, however, were self-reported and thus are likely to be affected by recall error and misdiagnosis.

Third, the point estimates suggest that households exposed to non-monetary loss messages experienced a slightly higher

[1] We do not focus on indoor residual spray, since the costs of this intervention are borne by the government, which is in charge of conducting the spraying campaigns.