

## COMBATING INFANT MORTALITY IN RURAL INDIA: EVIDENCE FROM A FIELD STUDY OF EHEALTH KIOSK IMPLEMENTATIONS<sup>1</sup>

**Viswanath Venkatesh**

Walton College of Business, University of Arkansas,  
Fayetteville, AR 72701 U.S.A. {vvenkatesh@vvenkatesh.us}

**Arun Rai**

Robinson College of Business, Georgia State University,  
Atlanta, GA 30303 U.S.A. {arunrai@gsu.edu}

**Tracy Ann Sykes and Ruba Aljafari**

Walton College of Business, University of Arkansas,  
Fayetteville, AR 72701 U.S.A. {tracy@tracyannsykes.com} {aruba@uark.edu}

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*The United Nations' Millennium Development Goals listed high infant mortality rates as a major problem in developing countries, especially in rural areas. Given the powerful information dissemination capabilities, information and communication technologies (ICTs) have been suggested as interventions to build infant care awareness and to modify healthcare behaviors. We examine how the use of one ICT intervention—specifically, eHealth kiosks disseminating authenticated and accessible medical information—can alleviate the problem of high infant mortality in rural India. We investigate how mothers' social networks affect their use of eHealth kiosks, seeking professional medical care for their infants and, ultimately, infant mortality. Drawing on the social epidemiology and social networks literatures, we focus on advice and hindrance from both strong and weak ties as the conduit of social influence on mothers' health-related behaviors for the care of their infants. Over a period of 7 years, we studied 4,620 infants across 10 villages where the eHealth kiosks were implemented along with support resources for proxy use. The results revealed that (1) eHealth kiosk use promotes seeking professional medical care and reduces infant mortality, (2) mothers are especially vulnerable to hindrance from both strong and weak ties as they choose to maintain the status quo of traditional infant healthcare practices (e.g., reliance on untrained personnel, superstitions, fatalism) in villages, and (3) advice from both strong and weak ties offers the potential to break down misplaced beliefs about infant healthcare practices and to develop literacy on seeking professional medical care. In contrast, in a comparative group of 10 neighboring villages, the reduction in infant mortality was not as pronounced and the effect of professional medical care in reducing infant mortality was lower. Our findings suggest that an ICT intervention can effectively address one of society's most important problems (i.e., infant mortality) even in parts of the world with limited resources and deep suspicion of technology and change. Overall, we believe such an ICT intervention will complement other investments being made, including the facilitation of use (proxy use) and provision of professional medical facilities to reduce infant mortality.*

**Keywords:** Social networks, strong ties, weak ties, infant mortality, Millennium Development Goals

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## Introduction

In 2000, the United Nations set major goals toward improving the lives of the poorest people in the world and adopted eight Millennium Development Goals. A few of these interrelated goals were motivated by the unacceptably high infant (from birth through 1 year of age) mortality in less developed countries, such as India. Infant mortality rates in India at that time were more than 25 times greater, with rural India being even higher, than what they are in developed countries, such as the United States (UNICEF 2011). Especially troubling is that many infant deaths could be prevented through simple interventions that can be made available to, and applied by, those in need (Save the Children 2014). Abject poverty (Burke 2010) coupled with significant issues surrounding medical practices (for examples, see ABC News 2009; Huggler 2004) amplify infant mortality rates in India, especially in rural areas where over 70 percent of the country's population resides. For centuries in rural India, traditional medical care has been provided by personnel untrained in professional medical care<sup>2</sup> often holding superstitious and fatalistic beliefs about infant healthcare practices. Rural India continues to be characterized by poor behavioral (e.g., lack of care in drying and wrapping a newborn) and medical practices (e.g., use of non-sterilized equipment during delivery, which can lead to life-threatening infections) that adversely affect the survival of infants (see Iyengar et al. 2008; Kesterton and Cleland 2009). The trade press has carried several stories about infant healthcare problems in rural India (Bhowmick 2014; Business Standard 2014). The interested reader is also referred to video reports<sup>3</sup> related to infant mortality and the culture surrounding the problem in India (note that these videos are graphic in their depiction of difficulties faced in these contexts).

The problem of infant mortality in rural India remains persistent despite several initiatives of the central and state governments in India and international organizations, such as the United Nations (UNDP 2008). Providing professional medical resources, raising awareness of those resources, and disseminating information on best wellness practices for

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<sup>2</sup>When we refer to professional medical care, we mean care that is provided by a fully trained and licensed practitioner of any form of medicine, be it Ayurveda, homeopathy, or Western. We contrast this to traditional medical practices that are prevalent in rural India that are often rooted in superstitions, fatalism, and cultural mores, and can oppress mothers in how they care for infants. Such traditional practitioners neither possess any formal training nor do they typically possess knowledge of hygienic healthcare practices.

<sup>3</sup><http://www.youtube.com/watch?v=I78otJX1vyl>;  
<http://www.youtube.com/watch?v=-Q0GXXtyukI>;  
<http://www.youtube.com/watch?v=KoedQMjio8>.

infants are necessary, yet insufficient, actions for reducing infant mortality. Although his or her mother is an infant's primary care giver, the societal context in rural India might interfere with care decisions or actions. Thus, it becomes important to understand how the societal context might enable or constrain the perceived utility of interventions and, ultimately, their effectiveness in reducing infant mortality.

Information and communication technology (ICT) represents a key potential intervention (Heeks 2009; Zakaria 2006) due to its powerful ability to disseminate authenticated medical information that can reduce infant mortality not only by promoting better healthcare practices, but also by promoting the use of professional medical care. The question of what factors lead to ICT interventions being effective [or not] in addressing the infant mortality problem remains. We are inspired by the idea that contextualization can be an effective approach to understand a problem, developing new knowledge about how to address a problem, and making a theoretical contribution (see Alvesson and Kärreman 2007; Johns 2006). We suggest that the collectivist nature of rural Indian society is likely to render a mother's social context critical in determining her use of the ICT intervention, professional medical care, and ultimately infant mortality. This is especially true of the enablers of and constraints to a mother's use of an ICT intervention to change infant care practices deeply entrenched in society. We argue that social interactions among mothers, manifested as both positive and negative social ties influence health-related behaviors, such as using an eHealth kiosk to seek help with diagnosing and treating an infant's illness. Although prior work suggests that individuals' social network characteristics influence their adoption and use of ICT (Fang et al. 2013; Sykes et al. 2009; Venkatesh et al. 2011), little is known about how a mother's social network influences her health-related behaviors and, ultimately, infant mortality. We seek to examine elements of a mother's social network that are integral to the success or failure of the ICT intervention.

Grounded in a framework from social epidemiology on the role of social influence in affecting health-related behaviors (Berkman and Glass 2000; Berkman and Krishna 2014), we draw from social network theory (Krackhardt 1992; Monge and Contractor 2003; Umphress et al. 2003) to understand how mothers' social ties impact their use of an ICT intervention and professional medical care and ultimately infant mortality. This approach enables us to capture the complex social interactions through which mothers receive information about the ICT intervention (Sarker, Ahuja et al. 2011a; Sarker, Sarker et al. 2011b), cues to action on infant healthcare practices, and professional medical care. Complex social interactions form social ties—both strong and weak—that might enable or constrain a mother's use of an eHealth kiosk

and seeking of professional medical care. Because literacy rates—both general and especially computer (Parikh and Ghosh 2006)—are low in rural India, social ties represent a key source of information about infant healthcare practices both at home and from professional medical care providers.

Against this backdrop, we develop a model that incorporates two key ideas. First, we suggest that mothers living in rural India are subject to social influence with respect to norms and values pertaining to infant healthcare practices through their social ties and that these ties can encourage or discourage the use of the eHealth kiosk. Second, we distinguish between enabling and constraining social ties manifested as advice and hindrance respectively, and further distinguish between strong and weak ties. We examine the social influence of these varied ties on key health-related behaviors and outcomes. We studied an eHealth kiosk intervention in 10 villages in India over seven years. We focused on infant mortality, that is, mortality that might occur from the time of birth through the first year of life. After following over 6,000 women and their infants (if applicable), we found that advice from strong and weak ties, due to enabling social influence, promoted eHealth kiosk use, seeking professional medical care, and reduced infant mortality. In contrast, we found that hindrance from strong and weak ties reinforced the status quo of denial, fatalism, and the reliance upon ill-informed traditional infant healthcare practices. Hindrance from strong and weak ties circumvented the positive potential of the ICT intervention and increased infant mortality. Examining infant mortality in 10 neighboring villages (control group with no ICT intervention), we found that providing professional medical care without an associated ICT intervention was less effective in combating infant mortality. Further, analyses of direct and indirect effects of advice and hindrance from both strong and weak ties suggest partial mediating effects of health-related behaviors (i.e., eHealth kiosk use and seeking professional medical care) on the relationship between the examined ties and infant mortality. Our work demonstrates that, due to the complex societal influences surrounding the infant mortality problem, taking a technology deterministic view toward addressing the problem with ICT and professional medical care interventions is inadequate and instead requires a contextual perspective with a focus on mothers' social networks.

## **Context: Societal Problem and Our ICT Intervention**

### ***Healthcare and Infant Mortality in Rural India***

In India, the infant mortality rate is unacceptably high (Center for Reproductive Rights 2008), with rates of over 50 for every 1,000 live births, with even higher rates in rural areas. The

three leading causes of death in infants are birth asphyxia, pre-term birth complications (pre-mature birth complications, including low birth weight), and infections (sepsis) (Million Death Study Collaborators 2010; United Nations 2011). In recent years, economic growth in India has been unevenly distributed, with a general growth of over 7 percent in total GDP across sectors, with only about 3.6 percent growth in the agricultural sector (Das and Pathak 2012), in which the majority of India's workers are employed (India in Business 2015). This influences the disparity between urban and rural areas because in rural areas, agriculture provides the livelihoods of the majority of the households. Urban centers, such as Chennai, boast of professional medical services approaching or similar to those found in developed countries. However, only about a fourth of India's population lives in urban centers (Center for Reproductive Rights 2008). Further, 75 percent of the hospital beds in India are in urban areas, leaving only 25 percent of the hospital beds to serve the medical needs of about 75 percent of the population (Center for Reproductive Rights 2008). Although the Indian government has increased spending on public healthcare programs, current spending is only around 4 percent of the GDP, with only 10 percent of that spending being focused in rural areas (Das and Pathak 2012).

Although rural India has improved access to healthcare services in recent years, inequalities remain due to geographical, cultural, social, and economic factors. While some villages in India have modern facilities (e.g., Banerji 2011), such villages tend to be closer to urban areas and somewhat larger. However, more geographically remote rural villages are lacking in such advances and are often plagued by extreme levels of superstition and ill-informed traditional healthcare practices (e.g., ABC News 2009; Sinha et al. 2014). For instance, mothers in rural India often believe that they have little or no control over their infant's health and that a visit to the doctor is necessary only when a problem occurs with little or no regard for preventive care (e.g., Choudhry 1997; Sinha et al. 2014). The Indian government introduced several initiatives and programs in rural villages, such as Child Health Screening and Early Intervention Services, the Janani-Shishu Suraksha Karyakram program to improve healthcare access in rural settings for pregnant women and newborn infants, and the Janmitra integrated platform to provide health, education, and government services through community information centers (Gorla 2009). Many of these initiatives have been described as promising, yet face challenges with weak implementations (Save the Children 2014). Often, when developing countries implement programs to improve the lives of their citizens, a "build-it-and-they-will-come" approach is taken. In other words, governmental and nonprofit agencies focus on providing programs and services, assuming that provision is all that is necessary for their success (Center for Reproductive Rights 2008). Unfortunately,

this approach is riddled with problems, such as poor dissemination of information about the programs. For example, the Indian government has promised that every woman will be provided four antenatal checkups through the National Rural Health Mission (NHRM). However, less than three-quarters of women receive any antenatal examination at all (Center for Reproductive Rights 2008), a problem that is even more pronounced in rural India. Similar problems exist with seeking preventive and ongoing care for infants that in turn contribute to higher infant mortality rates in rural India.

### **ICT Intervention: eHealth Kiosk**

ICT-enabled Internet information kiosks have been used in Indian villages to provide access to various types of information through government and NGO portals. For instance, Venkatesh and Sykes (2013) studied kiosks that provided information on farming practices and agricultural information to farmers, and found that the kiosks helped to increase the average income of farmers in a short period of time. One recent example of a government initiative is a plan to implement 40 health kiosks operated by midwife nurses to identify patients with chronic diseases in poor urban areas, electronically maintain their records, and provide free medicine (Aiyappa 2014). We focus on a health information portal—hereafter, we refer to this intervention as the *eHealth kiosk*—and its use by women. These kiosks were staffed for 16 hours a day, with, at all times, at least one of the kiosk attendants being a woman. Such kiosk attendants play a key role in facilitating proxy use, which makes up the majority of use in rural India due to the low levels of general and computer literacy (see Venkatesh and Sykes 2013).

ICT interventions, such as eHealth kiosks, can facilitate the communication of complex health-related information ideas in ways that villagers, who may not be literate, can more easily understand, by using multimedia content. For instance, it has been suggested that pictures increase attention and recall of health information (Houts et al. 2006). Simple text-based health information is also provided in local languages. For example, frequently asked questions about pregnancy and delivery are presented in simple and easy to comprehend formats. Text-based information might also include links to relevant videos to reinforce health messages. Appendix A shows examples of the types of information that was available from the eHealth kiosks.

## **Theory**

Our theorizing involves two steps. First, we draw upon a key concept from social epidemiology that psychosocial mech-

anisms have the potential to influence health-related behaviors (Berkman and Glass 2000; Berkman and Krishna 2014), and conceptualize mothers' eHealth kiosk use and seeking of professional medical care as health-related behaviors that can be affected by one particular psychosocial mechanism, social influence. Second, we use social network theory to theorize how different types of social influence transmitted through different types of social ties affect health-related behaviors. We elaborate on these two steps of our theorizing and then present our hypotheses development.

### **Role of Social Influence for Health-Related Behaviors**

As the eHealth kiosk intervention is introduced in the societal context of rural India, we suggest that the interpretation and use of the eHealth kiosk by mothers is likely to be shaped by social influence. Past work has shown social influence to affect the acceptance and use of ICT by citizens in societal contexts (e.g., Hsieh et al. 2008; Venkatesh and Sykes 2013) and by employees in organizational contexts (e.g., Ibarra and Andrews 1993; Sykes 2015; Sykes et al. 2014; Venkatesh et al. 2011). Berkman and colleagues' synthesis of prior work by sociologists, anthropologists, and psychiatrists resulted in a comprehensive framework associating social relationships with health-related behaviors and outcomes (Berkman and Glass 2000; Berkman and Krishna 2014). The framework captures four main factors: social structural conditions (e.g., norms and values), social networks (e.g., centrality, frequency of contact), psychosocial mechanisms (e.g., peer pressure, social support, social influence), and pathways (e.g., coping, adherence to treatments). A key aspect of the framework is that individuals' health-related behaviors (e.g., adherence to treatments, help-seeking) are affected through psychosocial mechanisms that depend on their social networks (Berkman and Krishna 2014).

Although the framework identifies social influence as playing a key role in shaping health-related behaviors, research on social epidemiology has focused more on social support than on social influence (Berkman and Krishna 2014). We argue that social influence emanating from mothers' social networks in rural Indian villages will play a strong role in determining if they engage in seeking information from an eHealth kiosk, engaging in modern infant healthcare practices (e.g., help-seeking for diagnosing and treating infant's illness, tips on diet, hygiene conditions), and seeking professional medical care. We expect that social influence will be crucial in affecting these various behaviors given the collectivist nature of the culture, poverty, and illiteracy that characterize rural India.

## Conceptualizing Social Influence Based on Content and Strength of Ties

To better understand how social influence affects mothers' health-related help-seeking behaviors, particularly eHealth kiosk use and use of professional medical care, we turn to social network theory. We draw on social network theory to differentiate between (1) a mother's strong ties and her weak ties, both of which can be sources of social influences, and (2) advice and hindrance content (see Sykes and Venkatesh 2012), both of which can emanate from either a mother's strong ties or her weak ties.

First, we differentiate between strong ties and weak ties. Depending on the frequency of interactions, strong and weak ties emerge. Strong ties are associated with higher frequency of interactions. For instance, Krackhardt (1992) suggests that frequent interaction is a condition for a *philos* relationship—a type of strong tie. In general, strong ties tend to be affective in nature (Umphress et al. 2003) and are usually characterized by *homophily* (i.e., tendency of individuals to bond with similar others) and *easy access to resources* (Ibarra 1993; McPherson et al. 2001; Podolny and Baron 1997). In a collectivist culture, for instance, strong ties are likely to exist among family members, relatives, and friends. Weak ties, in contrast, are associated with lower frequency of interactions and tend to be less affective. Weak ties are likely to exist with acquaintances (i.e., individuals who one knows, but who are not considered particularly close). With strong ties, access to resources is granted more easily due to increased trust and shared norms and goals between individuals involved in such ties (Krackhardt 1992). However, because weak ties tend to be less affective and not based on homophily, they are likely to be less biased and to be able to transfer new information. Specifically, weak ties have the potential to bridge structural holes in social networks (Burt 1992) in the process of providing access to unique and diverse information. We argue that both types of ties will act as conduits for social influence in different ways. The transmitted social influence may shape decisions about infant healthcare practices through improved and constrained access to resources. Improved access occurs when mothers start disseminating information to others in their network about good infant healthcare practices. Constrained access occurs when mothers become sensitive to traditional infant healthcare practices that might be highly valued by the culture despite their harmful nature.

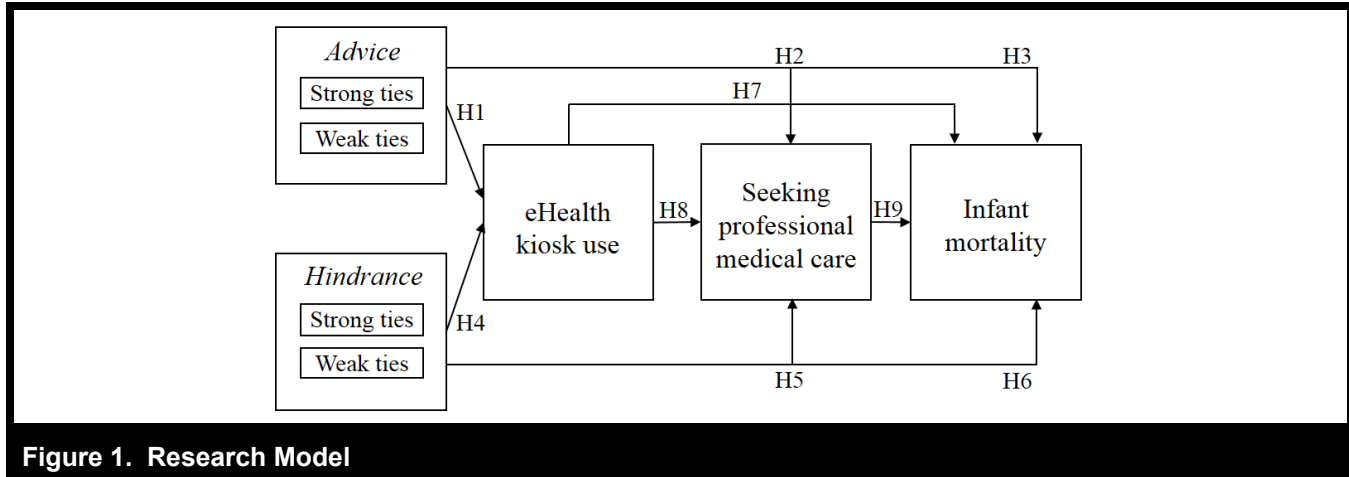
Second, we differentiate between two types of content—advice and hindrance (Sykes and Venkatesh 2012)—that can be transmitted through social networks, and suggest that both types of content can affect eHealth kiosk use by mothers. Advice, whether emerging from strong or weak ties, reflects

positive social influence that facilitates access to resources (Wellman and Wortley 1990). In rural India, mothers with advice ties, for instance, might receive information about new infant healthcare practices from other mothers who had encouraging experiences with the eHealth kiosk. Hindrance, whether emerging from strong or weak ties, in contrast, reflects negative social influence that impedes access to resources (Wellman and Wortley 1990). Mothers subject to hindrance from ties, for instance, might receive information that sways them from accessing or using other credible resources for infant healthcare practices. Based on these distinctions among social ties, we develop our hypotheses. Our research model is shown in Figure 1.

### Advice from Social Ties and eHealth Kiosk Use

The societal context of rural India provides an environment where a mother receives advice from her connections to other women. A mother may receive advice from these ties about caring for her infant, determining how to deal with health problems that her infant is experiencing, and engaging in behaviors or making decisions related to caring for her infant. The societal conditions in rural India facilitate the flow of such advice when women interact and get the chance to discuss, observe, and learn about infant healthcare practices. From a social network perspective, interactions of mothers with other women through such social events or even seasonal agricultural work increase the likelihood of observing, discussing, and learning about good infant healthcare practices.

Consistent with Monge and Contractor's (2003) view of advice from social networks as an important contributor to contagion, advice, whether emerging from strong ties or weak ties, in rural India represents enabling social influence transferred to the mother. When advice emerges from strong ties, we suggest that the social influence will facilitate access to resources due to increased trust and shared norms. For instance, a mother who gets advice from her sister or a close friend about consulting a credible source on infant healthcare practices is more likely to heed the advice due to the affective nature of the strong tie. Berkman and Krishna (2014) suggest that help-seeking behavior and adherence to medical treatments are health-related behaviors that are sensitive to social influence. Consistent with this perspective, we argue that eHealth kiosk use, seeking professional medical care, and engaging in good infant healthcare practices represent favorable health-related behaviors that a mother could pursue when her advice ties encourage her to do so. When advice comes from weak ties, we expect that enabling/encouraging social influence will be transmitted as well but in a different way. Specifically, there is a greater likelihood that the advice received from weak ties will be of greater variety (Granovetter



1973) than what is available from the mother's strong ties. In other words, with the ability to access diverse knowledge resources and perspectives, mothers can build a more heterogeneous knowledge base to make better informed decisions about eHealth kiosk use, seeking professional medical care and engaging in good infant healthcare practices. Mothers with access to these differing viewpoints that challenge the status quo are more likely to be intrigued about the eHealth kiosk and motivated to try it. Likewise, they may engage in some newer, healthy infant healthcare behaviors based on the greater diversity of information because they have likely learned the benefits of these new practices over traditional infant healthcare practices. Furthermore, as the number of weak ties for advice increases, the likelihood of a mother obtaining access to diverse infant healthcare practices is also likely to increase. Similarly, weak advice ties may promote the mother to seek professional medical care for an ailing infant. Based on our field observations, we provide illustrative scenarios pertaining to the impacts of both strong and weak advice ties on the health-related behaviors and infant mortality (Table 1). Thus, we hypothesize

H1: Advice from (a) strong ties and (b) weak ties will have a positive effect on eHealth kiosk use.

H2: Advice from (a) strong ties and (b) weak ties will have a positive effect on seeking professional medical care.

H3: Advice from (a) strong ties and (b) weak ties will have a negative effect on infant mortality.

#### Hindrance from Social Ties and eHealth Kiosk Use

The societal context of rural India can foster a dark side in that mothers' social networks might constrain their decisions

about infant healthcare practices. Hindrance, whether emerging from strong or weak ties, transfers social influence to mothers by discouraging newer, better infant healthcare behaviors or decisions. Specifically, hindrance arises when ties reinforce the status quo and obstruct newer, better infant healthcare behaviors (see Sparrowe et al. 2001); in this case, this could mean hindering eHealth kiosk use, seeking professional medical care, and/or engaging in newer infant health care practices. The power of hindrance from ties stems from two main societal conditions in rural India. First, new or modern healthcare practices are sometimes perceived as bad and are rejected because they challenge cultural traditions. For instance, family issues that pertain to reproductive behavior are not viewed as mere biological or physical processes but deeply rooted in cultural traditions (Haq 2008). In this case, any new infant healthcare practices that challenge the essence of cultural traditions can be met with strong opposition. Second, hindrance from ties comes with significant social pressure to comply with established norms or prevailing opinions (Wellman and Wortley 1990). Under such social pressure, individuals contemplating different behaviors or beliefs will feel more comfortable when their behaviors or beliefs are similar to those of others in their social network (Goode 1960). Specifically, constraining or hindering social influence of ties act in a manner similar to contagion by cohesion (Monge and Contractor 2003).

When hindrance arises from strong ties, a mother's fear of being ostracized due to challenging the status quo in infant healthcare practices will sway her away from using the eHealth kiosk, seeking professional medical care for an ailing infant, or embracing newer infant healthcare practices. Specifically, her behavior might, due to contagion, be influenced by hindrance that implicitly demands cohesion and rejection of novel ideas (Monge and Contractor 2003). Examples of traditionally shared infant healthcare practices include, but are

**Table 1. Scenarios Reflecting Favorable Impacts of Advice from Strong and Weak Ties**

Situation	Advice from Strong Ties	Advice from Weak Ties
<p><b>eHealth kiosk use:</b> Swetha has become concerned about her 9-month-old daughter Ana's diarrhea that she has been having for more than two days.</p>	<p>Three days after the symptoms began, Swetha expressed concerns to Lina, a close friend who has four children and usually accompanies Swetha to the local market. Based on her positive experience with the kiosk, Lina encouraged Swetha to consult the kiosk as it might be helpful to Ana's case. Swetha felt that she could trust Lina because she considers her as a sister and decided to consult the kiosk next morning.</p>	<p>Swetha has been following the advice of her friends and having Ana drink a mix of honey and dried ginger powder every few hours—a treatment prescribed by the local medicine man. However, the trouble is persistent. Reshma, a distant neighbor, who sometimes visits with Swetha's friend, Chitra, visits. She has used the kiosk herself and suggests that Swetha go just to see if there is more information about the diarrhea problem. Chitra and Swetha are not completely convinced but admit that maybe going to the kiosk could answer questions or give them other options to try.</p>
<p><b>Seeking professional medical care:</b> Reshma has become concerned about fluctuation in her infant's weight during the first six months since he was born.</p>	<p>Chitra, Reshma's sister, mentions that she remembers experiencing similar worries about her infant and that she consulted the medical staff at a clinic. She remembers that they were nice, treated her infant gently, and asked her to stop by the clinic every month to record her infant's weight and find out any irregular patterns. Reshma felt encouraged about her sister's experience, especially after Chitra offered to accompany her to the clinic, and decided to check her infant's weight regularly at the clinic.</p>	<p>Reshma's neighbor mentions she and her sisters-in-laws regularly check their infants' weight at a nearby clinic. She mentions that there may not be a problem as fluctuation in weight might be normal, but the only way to find out is to keep a track of it. Reshma felt encouraged about her neighbor's experience and asked her if she would be willing to accompany her to the clinic to check her infant's weight.</p>
<p><b>Adoption of newer healthcare practices:</b> Dali is excited about her first baby, Sara, but feels overwhelmed about taking care of her diet because she has no experience.</p>	<p>Dali has been surrounded by her aunts and sisters who provide her with information about the timely introduction of semi-solid meals and minimum meal frequency. Dali feels that she could trust the knowledge of her aunts and sisters about the infant's diet. She feels confident about having Sara on this diet, especially as Sara continued growing up healthy.</p>	<p>Dali brought up the diet of Sara to her neighbor, Lina, and mentioned how happy she was with the help of her aunts and sisters. Lina mentioned that she was in the same situation and got similar tips from her relatives, one of whom much like Dali's sister had obtained tips from the clinic. The advice received included slight differences in the diversity of semi-solid meals. Lina suggested that Dali maintain the feeding habits received from her relatives while including more diverse options to increase the nutritious value for Sara. Dali liked the idea and acted accordingly.</p>

not limited to, taking a “wait-and-see” stand instead of seeking health information/help from any credible source at the time an infant begins showing symptoms of serious illness. Other potentially harmful health-related behaviors involve maintaining traditions, such as delaying weighing newborns (Bhattacharya et al. 2008) that creates a gap in newborn records that are necessary to track their health status. Hence, the mother's view of infant healthcare could, due to contagion, be influenced and constrained through hindrance, especially when it comes from strong ties.

A similar pattern of social influence would occur with hindrance arising from weak ties. Specifically, weak ties can also

reinforce the status quo, withhold valuable health information, and introduce incorrect information, thereby dissuading a mother from using an eHealth kiosk, seeking professional medical care and/or engaging in newer infant healthcare practices. In our context, a mother subject to social influence from weak hindrance ties might receive irrelevant or incorrect information related to a health question that could ultimately lead to neglect, misdiagnosis, or incorrect treatment. She can also receive information on the limited value of healthy behaviors, with fatalistic views that quality of health and length of life are preordained. She can be urged even by acquaintances to respect and practice the traditions of thousands of years on infant health and not to stray away from

these traditions. The particular characteristic of weak tie hindrance may lie in the fact that a weak tie does not have a specific agenda and may thus be perceived as more objective when promoting traditional healthcare practices and undermining the value of the eHealth kiosk, professional medical care, and modern infant healthcare practices. Based on our field observations, we provide illustrative scenarios pertaining to the impacts of both strong and weak hindrance ties on the health-related behaviors and infant mortality (Table 2). Thus, we hypothesize

H4: *Hindrance from (a) strong ties and (b) weak ties will have a negative effect on eHealth kiosk use.*

H5: *Hindrance from (a) strong ties and (b) weak ties will have a negative effect on seeking professional medical care.*

H6: *Hindrance from (a) strong ties and (b) weak ties will have a positive effect on infant mortality.*

### **eHealth Kiosk Use, Seeking Professional Medical Care, and Infant Mortality**

A mother's literacy about infant healthcare (i.e., the ability to obtain, process, and understand infant healthcare practices) is crucial to engage in better infant healthcare practices and, ultimately, improve survival chances of her infant. When mothers become more literate about their infant's health, their ability to knowledgeably deal with the first signs of problematic health conditions, or to avoid those conditions entirely due to proactive wellness behaviors, increases (DeWalt et al. 2004). In that regard, ICT interventions (e.g., touch screens, kiosks, conversational agents) can be leveraged to codify and effectively communicate complex healthcare (Paasche-Orlow et al. 2006) and educate mothers on beneficial and harmful infant healthcare practices. We suggest several advantages of eHealth kiosk use. For instance, exposure to health information through an eHealth kiosk raises the mother's level of infant health literacy that in turn encourages her to seek professional medical care as well as engage in preventive behaviors (e.g., preventive checkups, timely visits for medical care). The odds of poor health outcomes are 1.5 to 3 times higher for individuals with low health literacy (DeWalt et al. 2004). Consequently, we expect that eHealth kiosk use will lead to a decrease in infant mortality as the mothers become more literate about protecting infants from illness as well as detecting symptoms that could become chronic illnesses and progress to become fatal.

Limited infant healthcare literacy, especially in rural India, is usually associated with low trust of providers and pessimism

about professional medical care of infants. There is also often a lack of knowledge on when a mother should seek care for the infant (e.g., what symptoms warrant a visit to the clinic). In general, acquiring new health practices (i.e., basic health concepts and skills) is complex because new knowledge challenges mothers to change their perspectives toward their infant healthcare practices (Freedman et al. 2013). We suggest that eHealth kiosks would assist in addressing these literacy issues through their capabilities to disseminate authenticated information on infant healthcare practices. Specifically, the anticipated impact of eHealth kiosks can be described in terms of the consciousness raising process, as the eHealth kiosk intervention will increase mothers' awareness of health behavior issues concerning infants mainly through education and informative health messages (Prochaska and DiClemente 1982). Essentially, mothers who become better informed through eHealth kiosk use about the capabilities of professional medical care will be more motivated to seek professional medical care for their infants. Thus, we hypothesize

H7: *eHealth kiosk use will have a negative effect on infant mortality.*

H8: *eHealth kiosk use will have a positive effect on seeking professional medical care by mothers for their infants.*

As key decision makers about their infant's healthcare, mothers learning about healthcare services and better infant healthcare practices will make them more inclined to seek professional medical care from appropriate sources, such as those available through clinics. Mothers are also expected to approach traditional medical care providers (e.g., folk practitioners) with more caution when they consult them about their infant's health issues and instead go to those who are professionally trained and licensed. Thus, mothers will tend to avoid traditional medical care providers who lack adequate medical knowledge or professional training on infant healthcare (Patil et al. 2002). Mothers who seek professional medical care are likely to base their health decisions on validated health information. When mothers are more informed about professional medical care, they are likely to realize that traditional medical care providers could arrive at inaccurate diagnoses or prescribe ineffective or even hazardous treatments to patients (Patil et al. 2002) that ultimately endanger their infants' lives. In this regard, acquiring valid health information (i.e., becoming more health literate through use of eHealth kiosks) offers the potential to move beyond simple comprehension of immediate health conditions to instill healthy behaviors (Ahlers-Schmidt and Chesser 2013) that are likely to improve infants' chances of survival. Finally, when more mothers seek professional medical care in clinics and hospitals, the likelihood of their infants receiving



**Table 2. Scenarios Reflecting Adverse Impacts of Hindrance from Strong and Weak Ties**

Situation	Hindrance from Strong Ties	Hindrance from Weak Ties
<p><b>eHealth kiosk use:</b> Swetha was contemplating a visit to the kiosk to see if there is any information that might help with Ana's breathing issue.</p>	<p>Many of Swetha's friends counsel against wasting time by going to the kiosk. Others accuse Swetha of being disrespectful for lacking faith in the village medicine man. Although the ribbing is friendly, it does raise doubts for Swetha and she pushes back the trip to the kiosk. Several days pass and Ana's illness worsens as she continues to have the concerning symptoms. The woman mentioned that Swetha might be better-off if she consults with a highly respected medicine man in her neighborhood and that she could give her the address.</p>	<p>Swetha communicated her intention to a group of women as she was washing Ana's clothes at the river. One woman shared that her sister-in-law observed other women taking their children to the kiosk instead of visiting the village medicine men. According to her, the children's health condition became worse because their mothers abandoned the advice of traditional medicine men. The woman mentioned that Swetha might be better off if she consults with one of the highly respected medicine man. Swetha thanked the woman and pushed back the trip to the kiosk. Several days pass and Ana's illness worsens, even after visiting the medicine man.</p>
<p><b>Seeking professional medical care:</b> Reshma thought about weighing her infant at the clinic to see whether there is a medical explanation behind fluctuation in her infant's weight.</p>	<p>Chitra warned her sister, Reshma, about exposing her infant to professional medical staff because they are strangers. Specifically, Chitra shared a story of a mother who used to weigh her infant regularly at the clinic but her infant became ill because the nurse kept admiring how beautiful the baby was, thus casting an evil eye. Reshma became afraid that her infant will become ill due to the nujur, the evil eye, and decided not to go to the clinic to weigh her infant.</p>	<p>Reshma asks if any of her acquaintances had encountered concerns with their infants' weight. Most of the women felt they had noticed such fluctuations but thought they were normal. Other women had taken their infants to village's medicine man and avoided the modern medical clinics because the clinics could be full of evil spirits. Reshma feels she may just do as the other women have done. She feels no social pressure to conform and feels that they have no reason to lie to her, but she was scared about the evil spirits.</p>
<p><b>Adoption of newer healthcare practices:</b> Swetha has become very concerned about her 9-month old daughter Ana's breathing.</p>	<p>Swetha has been following the advice of her friends and giving Ana a teaspoon of honey mixed with powdered bay leaf (<i>Cinnamomum tamala</i>) right before bed—a treatment prescribed by the local medicine man. However, the breathing trouble was persistent. Local medicine men recommended that all members of Ana's family gather every evening to pray for her. Swetha expresses concerns to her mother-in-law about not actively seeking help from other sources, especially the modern clinic. Her mother-in-law chides her for even mentioning the evil clinic and threatens to ostracize both Ana and her if she were to challenge traditional practices. Swetha could not argue further with her mother-in-law. Sadly, Ana passed away after few days.</p>	<p>Swetha communicates with her neighbors and expresses concerns about the recommendation of the medicine men to solely pray for Ana every evening, especially because the medicine men's treatments had not worked. Her neighbors are surprised that Swetha did not seem to have faith in well-respected medicine men who have been treating the children of the village for many years, especially as these men come from a family that has been in medical practice for generations. Swetha mentions that she believes in prayers but feels that additional actions need to be taken, including perhaps consulting the new medical clinic. The other women assure her that it is all about destiny and that she should have more faith and stop worrying. Swetha feels she may just continue to invite family members for prayers every evening and hope for the best as many of the villagers seem to do.</p>

timely and effective medical treatments increases. For instance, an infant's chance of survival will greatly increase when the infant receives vaccinations against a variety of diseases, such as malaria. An infant's risk of getting infected with dangerous diseases decreases with these healthy actions,

thus reducing the likelihood of mortality. Thus, we hypothesize

H9: *Seeking professional medical care will have a negative effect on infant mortality.*

## Method

In this section, we describe the study setting, participants, data collection procedure, and measurement.

### Setting

Our study was conducted in 10 villages in rural India where the local governments, in partnership with private organizations, initiated a developmental program to equip villagers, especially women, with health knowledge about infant, child, and maternal healthcare. Because we are interested in infant mortality, we focused on the communication and dissemination of health knowledge concerning prenatal and infant healthcare practices, with the former especially having a substantial effect on infant health. The villages were specifically chosen for this development program based on being in very remote parts of the country that were characterized by the societal and healthcare delivery conditions in rural India, as discussed earlier. As noted earlier, a major component of the program involved the implementation of an ICT intervention: Internet-enabled eHealth kiosks that provided access to an e-government portal to disseminate health-related knowledge. The 10 villages involved in this program represented the intervention group (i.e., locations where eHealth kiosks were being implemented). In order to isolate the effects of the eHealth kiosk, we identified 10 villages, each demographically similar and geographically proximal to one of the 10 villages in the intervention group. These adjacent villages did not have eHealth kiosks implemented during our study window and thus served as the control group.

Training was provided to villagers to aid in using the kiosks. In order to accommodate the low literacy rates in these villages, the training was mainly designed to highlight different types of health information that could be obtained from the eHealth kiosks rather than sophisticated uses of the complete e-government portal. The kiosks were staffed by individuals who served as proxy users (for a discussion on proxy use in low literacy contexts such as ours, see Parikh and Ghosh 2006; Venkatesh and Sykes 2013). Each eHealth kiosk was made available 7 days a week for 16 hours each day. The women in all of the villages, both in the intervention and control groups, had access to fairly similar small healthcare clinics that were located in nearby towns. In addition, a comparison of the demographic characteristics and the various network variables between the intervention village and corresponding control group village did not reveal any significant differences.

Given our interest in understanding the phenomenon and the impact of the intervention, it was necessary to conduct this

study over a longer period of time. Further, having an impact on infant mortality rates by overcoming deeply rooted societal problems in rural India can necessarily be expected to take time. Consequently, we examined the outcomes, namely kiosk use, seeking professional medical care and infant mortality, over a period of 7 years. During this same time, by also following the control group of neighboring villages, we were able to understand the differential effects of the eHealth kiosk intervention in conjunction with other governmental programs, such as new health clinics, mobile clinics with doctors that visit villages, vaccination education, and TV programs that educate women about infant healthcare practices over and above situations where only other governmental programs were available.

### Participants

Our study focused on infants in the chosen villages over a period of 7 years. The primary level of analysis is the infant given that mortality (yes/no) is recorded for each infant, which, as noted earlier, is defined as the first year of the newborn's life. We tracked different infants for a year. Given that infants are tied to women/mothers for several reasons, especially due to the impact of prenatal care on infant health and infant healthcare being controlled most significantly by the mother and her social ties, various variables are measured from or about the mother. To avoid the issue of non-independence of observations, we only included a mother's first infant and associated variables in those cases where a woman gave birth to more than one infant in the study window. Although data were gathered with a focus on the infant level, it was important to collect data about all women in the village for the computation of network variables because often the women who advise or hinder a mother could be older women who are past child-bearing age or did not give birth in the study window (e.g., because they had already had children and/or chose not to have an infant).

The sampling frame had a total of 4,844 first-born infants in the study window born to 8,330 women in the 10 treatment group villages and 5,920 first-born infants in the study window born to 9,220 women in the 10 control group villages.<sup>4</sup> Our final sample had 4,620 infants in the treatment group villages, which was based on the responses to other variables (e.g., ties, seeking professional medical care) from the mothers. The response rate among women in each village was greater than 80 percent overall, which exceeds the acceptable rule of thumb for social network studies (Knoke and

<sup>4</sup>Note that the first-born infant in the study window refers to the first infant born to a woman within the study window. Such an infant may not actually be the first-born infant to the woman.

Yang 2003). The average age of the women was approximately 27 years. The majority of women (83%) were married. We compared women from the control group villages to those who resided in the villages implementing the eHealth kiosks in terms of demographic characteristics (e.g., age, marital status, education level, number of children when the study was initiated) and found no statistically significant differences.

## **Procedure**

We developed a survey instrument to collect the data. Given the context of the study, surveys were gathered via personal interviews, with interviewers reading each question to each participant and noting down their responses. Surveys were written originally in English and then translated to the appropriate local Indian language that was spoken in the target village. In order to address any language barriers in collecting and analyzing the data, we recruited two translators who were proficient/fluent both in the local language and English to translate the original survey instrument from English into the local language. The second translator then translated the local language version of the survey instrument back to English. The translators discussed any disparities and reconciled them (Brislin et al. 1973).

Prior to the eHealth kiosk implementation, data about infant mortality were gathered from the villages in the intervention and control groups. This period was also important to interact with the villagers to gain their trust both for the implementation of the kiosk and the data collection. In this period, all adult women in each village were surveyed through a personal interview to obtain information pertaining to their social networks and various control variables. The preliminary data collection was followed by training sessions administered every day for a month. The training sessions targeted at women were conducted by the same two women every day, with one trainer being from the firm responsible for the kiosk implementation and the other being a government representative who was an expert on healthcare, particularly related to infants, children, and mothers. The sessions were designed to inform women about the benefits of using the kiosks, for example, different types of health information that was available to the mothers that could be leveraged to better take care of infants. The sessions were also designed to include information available related to prenatal and maternal healthcare—this is important and relevant as it has implications for subsequent infant health. Women were welcome to attend as many training sessions as they wished.

Trained professionals were recruited to interview each woman in the local language. On average, an initial interview (sur-

vey) lasted from 3 to 4 hours, which was due to the roster-based social network survey (which is described in greater detail in the “Measurement” section). Each woman was compensated at each point of data collection. The amount of the compensation was approximately 500 Indian Rupees, which was a generous amount given that the average annual household income in the village was 20,000 Indian Rupees. The interviewers followed a script for the initial set of survey questions and then used a semi-structured interview approach to gather additional information. After the training period, mortality and seeking professional medical care data were collected throughout the study period of 7 years.

One author spent a considerable amount of time during the course of the entire study, via several visits a year to the villages, observing training sessions, interacting with villagers to understand the sociocultural environment and their views of traditional and professional medical care, interacting with traditional medical care providers in villages to better understand the source of their knowledge, and visiting the various professional healthcare clinics, doctors, and nurses to understand substantive issues related to providing healthcare to infants. The visits also included control group villages to understand the impact of other programs targeted toward healthcare independent of the eHealth kiosk implementations. In the control group of villages, comparable data, except for eHealth kiosk use, which is not applicable, were collected.

## **Measurement**

### **Advice and Hindrance from Strong and Weak Ties**

Following accepted sociometric techniques (Wasserman and Faust 1994), each potential participant was provided with a fixed contact roster that listed the names of all other women in the village (see Cummings and Worley 2004; Garton et al. 1997). To measure social influence through social ties (i.e., advice and hindrance), we captured perceptions of the extent to which each focal woman received advice or was hindered by other members in the network of women. These data formed two relevant socio-matrixes: advice ties and hindrance ties.

Each woman was asked to rate how frequently she went for advice to every other woman on the contact roster (Appendix B shows the scales). For each woman name on the roster, the scale ranged from 1, which indicates many times a day, to 5, which indicates less than once a month. If there was no tie, the row was left blank. When the frequency was at least once a week, it was coded as a strong advice tie. When the frequency was either once a month or less than once a month, it was coded as a weak advice tie. A similar approach was used

to collect hindrance tie data, with each focal woman answering the frequency with which every other adult woman hindered her activities, thus resulting in a strong or weak hindrance tie. We learned that conversations were often very broad ranging and it was difficult for mothers to specifically share how frequently they went to someone for advice or hindrance for a specific topic (e.g., infant healthcare). Rather, they noted that conversations, and the related advice or hindrance, often covered a variety of topics, some broad in nature and others being personal. During the course of our interactions and observations, we found that, possibly due to the collectivist nature of the society, participants did not seem to hesitate to discuss very personal matters even with women they did not know very well (such conversations would be considered inappropriate or unlikely to occur in Western cultures except between/among close friends).

We computed the scores for strong and weak ties for both advice and hindrance content for each ego as the degree centrality from the ego-reported network matrices. The scores were measured as the number of ties an ego had with others in the networks—both receiving advice and hindrance respectively.

### **eHealth Kiosk Use**

eHealth kiosk use was measured as the total use of the eHealth kiosk by a mother during an infant's life (i.e., first year from the time of the birth). This included both direct use and proxy use when the use pertained to health. Proxy use refers to use that was aided by a kiosk attendant (see Parikh and Ghosh 2006; Venkatesh and Sykes 2013); we found that 100 percent of the use by women was proxy use. This was tracked both by the system and a physical ledger, and was later triangulated across the two sources to ensure that only use relating to infant health or health-related behaviors were included.

In our analysis, we considered two different windows of measurement of eHealth kiosk use. First, as a control variable, we used eHealth kiosk use in the year before the infant's birth. Such a measurement was important from the perspective of prenatal care that has substantial implications for infant health. Second, we used eHealth kiosk use in the first year of the infant's life as a key predictor in our model testing.

### **Seeking Professional Medical Care**

Given that we are interested in infant mortality, the number of infant visits to a professional medical care provider was captured. We focused on actual visits to local clinics, mobile

clinics, and hospitals (usually found in urban areas). Logs from the mobile clinics and hospitals were used to document patient visits. Medical care was recorded separately at the individual level to track visits each year and gathered from clinic and hospital records—these were then triangulated with survey responses gathered from mothers and other family members (especially the father) when necessary (if the mother had passed away). Indeed, some visits pertained to a combination of mother and infant. As mortality statistics for infants are documented only based on live births, failed pregnancies are beyond the scope of this research. We thus computed the number of professional medical care visits for each infant in our sample by using the multiple sources and triangulating to arrive at the most accurate possible measurement. In addition, as noted earlier, we computed the number of visits by the mother seeking professional medical care in the year before the birth of the infant that we use as a control variable as it represents important prenatal care and care that is received during pregnancy, which is known to have ramifications for an infant's health.

### **Infant Mortality**

To understand infant mortality, we examined the sample of live births and tracked an infant for a period of a year after his or her birth. These data were collected for the entire study duration of 7 years. However, given that infancy is only for the first year of a newborn's life, the mortality of each infant is recorded in that one year. If an infant died during the first year of life, mortality was coded as a 1. For the purpose of this analysis, we used an additional control variable to represent surviving mothers (yes/no); this variable was later excluded because it was only a selection criterion and found to be nonsignificant. As already mentioned, our analysis used data only about the first infant born to any woman during our seven-year study window. There is one caveat that should be noted: it was necessary for us to find that the pregnancy occurred during our study window (relevant for year 1 of the study) and the infant completed one year of age within the study window (relevant for year 7 of the study). Infants who did not fall fully into the study window were excluded.

### **Control Variables**

We controlled for variables at two levels: village and infant. At the village level, because collectivist cultures give weight to powerful individuals in general, we controlled for the attitude of the village head to kiosk use (seven-point scale) and the education of the village head (using the scale described in the next paragraph related to education of women). Other contextual control variables at the village

level were wealth of the village (average income of the village in Indian Rupees at the start of the study), distance to the nearest city (kilometers per Google Maps), and frequency of the government physicians' visits (per year).

At the infant level, we controlled for several variables. We controlled for year of infant birth that was coded as the year within the seven-year period of study when the birth occurred (i.e., from 1 to 7).<sup>5</sup> This was an important variable to control because of the potentially declining mortality rates due to other healthcare programs and positive spillover effects (from year to year) of the eHealth kiosk, information being disseminated, and the healthcare clinics. Other control variables included were mother's age, marital status (set to 1 if married in the year of infant birth), number of children the mother had at the start of the study, and education level (no school, primary school attended, primary school completed, middle school attended, middle school completed, high school attended, high school completed). Perhaps not surprisingly, given our context, in our sample, none of the mothers were educated; given the lack of variance on this variable, it was dropped. The number of infant mortalities in the participating family (we limited this to infant mortality within one year of the birth of the infant in the sample), health knowledge (tested via a simple 10-question health literacy quiz about infant health collected at the time of the initial interviews to collect social network data), and need for medical care (coded as 1 in case the participant became pregnant during the one year after the eHealth kiosk installation) were also included as control variables. As noted earlier, we also controlled for eHealth kiosk use and visits to professional medical care providers in the year of the pregnancy to account for prenatal care.<sup>6</sup> Finally, we controlled for visits to traditional medical care providers, such as the village medicine man or even someone who may be thought to be endowed with divine powers; these data were collected by asking mothers or surviving closest of kin how many times the mother and/or infant went to visit such practitioners to seek medical care during the relevant two-year window (one year prior to the birth of the infant and the year of infancy). Our conversations with mothers in the villages revealed that the perceptions of who were traditional medical care providers varied greatly and those who different mothers, even within the same village, accessed for care also

<sup>5</sup>Consistent with what we noted earlier, we only included births toward the end of year 1 so the mother could have possibly used the eHealth kiosk during the entire pregnancy. Likewise, we only included infants born through the beginning of year 7 so that the entire infancy could be tracked.

<sup>6</sup>As noted earlier, government programs in rural India aim to increase access to healthcare services through different forms of professional medical care, such as mobile clinics. We grouped all forms of professional medical care together.

varied. For instance, shamans are sometimes feared and only sought in extreme cases by some families.

## Results

We used UCINET 6.29 (Borgatti et al. 2002) to calculate the various network centralities. Given the multilevel nature of our model, with some control variables at the village level and others at the infant level, hierarchical linear modeling (HLM) was used to analyze the data. HLM takes into account the nonindependence of observations and adjusts the degrees of freedom to account for relationships of infants nested within villages (see Bryk and Raudenbush 1992; Singer and Willett 2003). We used HLM 6.0 (Bryk and Raudenbush 1992) to estimate our model. One key necessary condition to estimate HLM models is that there should be a significant variance in the outcome measure at a higher level of analysis (Hofmann 1997; Hofmann et al. 2000). In our context, this means it was necessary to examine if there was significant between-village variance in any of the infant-level variables. A NULL two-level model with no predictors of the key infant-level variables showed that significant variance was explained between infants. The statistics (i.e.,  $r_{wg}$ , ICC(1) and ICC(2)) that assess agreement among infants at a lower level are not relevant in our study because there are no measures that are based on an aggregation of measures taken at the infant level.

Table 3 shows the descriptive statistics and correlations. The pattern of correlations among the network centralities, seeking professional medical care, and infant mortality was as predicted, thus lending preliminary support to our hypotheses. Several of the control variables were also correlated with the key dependent variables. One key argument we made early in the paper was that the context of mothers in rural India would create a low base rate issue when it comes to using eHealth kiosks. We found that, in fact, in all villages over the entire duration of the study, less than 10 percent of the mothers visited the kiosks. Further, all of the use by mothers was proxy use in that the kiosk attendant facilitated it.

Given that infant mortality was our key outcome of interest, we felt it was important to understand the pattern that emerged over time. Table 4 shows a comparison of the infant mortality rates over time in the villages that we studied: control group (10 villages combined) versus intervention group (10 villages combined). It shows that there was an overall encouraging trend both in the intervention and control groups. It is clear that, as expected, there was a general declining trend in infant mortality rates, likely due to the various efforts on the part of the government and nonprofit organizations to improve healthcare access in rural India, as discussed earlier. From Table 4, it is also clear that the mor-

**Table 3. Descriptive Statistics and Correlations**

	Min.	Max.	Mean	SD	1	2	3	4	5	6	7	8
1. Wealth of the village	4,235	175,841	20,135	1,470								
2. Education of the village head	1.04	2.19	1.55	1.01	.21***							
3. Att. of the village head to kiosk use	1.32	3.58	2.90	1.10	.06	.13*						
4. Distance to nearest city	11.46	19.55	15.30	4.75	-.16**	-.07	-.10					
5. Frequency of govt. physicians' visits	14.00	18.00	15.65	2.50	-.16**	.05	.11*	.07				
6. Year of infant birth	1	7	3.41	1.40	.04	.02	.06	.03	.04			
7. Mother's age	17.6	41	26.85	12.40	.13*	.04	.03	.02	.02	.08		
8. Marital status	NA	NA	NA	NA	.03	.05	.07	.05	.08	.07	.13*	
9. # of children	0	7	3.75	1.00	-.07	.02	.10	.06	-.07	.04	.14*	.13*
10. Infant mortalities in family	0	3	0.86	0.39	-.08	.06	.15*	.19**	-.16**	.07	.12*	.14*
11. Knowledge	2	8	4.17	3.01	.10	.10	.08	-.15*	.19**	.06	.08	.18**
12. Seeking traditional medical care	0	6	2.60	1.48	-.07	-.13*	-.16**	.24***	-.13*	-.14*	-.10	.16**
13. Seeking professional medical care (prev. yr.)	0	2	0.56	.84	.11*	.14*	.14*	-.21***	.26***	.13*	.28***	.12*
14. eHealth kiosk use (prev. yr.)	0	4	1.57	4.03	.13*	.13*	.12*	-.17**	.15*	.19**	-.17**	-.12*
15. Strong ties advice centrality	44.11	286	120.68	37.15	.14*	.06	.04	.04	.02	.10	.19**	.19**
16. Weak ties advice centrality	39	295	195.40	41.44	.10	.04	.06	.08	.07	.12*	.26***	.21***
17. Strong ties hindrance centrality	35	308	86.75	19.55	-.17**	.05	.02	.06	.01	-.14*	-.21***	.24***
18. Weak ties hindrance centrality	25	664	266.55	57.80	-.20**	.06	.08	.10	.04	-.17**	-.26***	.28***
19. eHealth kiosk use	0	7	1.01	3.80	.19**	.21***	.17**	.13*	.25***	.24***	-.19**	-.15*
20. Seeking professional medical care	0	6	1.03	0.85	.14*	.22***	.23***	.11*	.27***	.21***	.31***	-.17**
21. Infant mortality	0	1	0.07	0.04	-.20**	-.14*	-.12*	-.20**	-.24***	-.25***	-.20**	-.19**

	9	10	11	12	13	14	15	16	17	18	19	20
9. # of children												
10. Infant mortalities in family	.17**											
11. Knowledge	-.13*	.07										
12. Seeking traditional medical care	.20**	.26***	-.17**									
13. Seeking professional medical care (prev. yr.)	.13*	-.14*	.16**	-.28***								
14. eHealth kiosk use (prev. yr.)	.10	-.15*	.25***	-.12*	.17**							
15. Strong ties advice centrality	.15*	-.13*	.28***	.06	.17**	.28***						
16. Weak ties advice centrality	.20**	-.22**	.34***	.08	.24***	.31***	.20**					
17. Strong ties hindrance centrality	.17**	.19**	.06	.26***	-.27***	-.24***	-.19**	-.19**				
18. Weak ties hindrance centrality	.22***	.14*	.08	.27***	-.29***	-.24***	-.20**	-.17**	.23**			
19. eHealth kiosk use	.11*	-.21***	.24***	-.13*	.23***	.44***	.30***	.31***	-.31***	-.39***		
20. Seeking professional medical care	.16**	-.25***	.35***	-.14*	.29***	.25***	.26***	.28***	-.28***	-.31***	.35***	
21. Infant mortality	.08	.30***	-.20**	.17**	-.33***	-.28***	-.33***	-.29***	.29***	.30***	-.41***	-.47***

\*p < .05; \*\*p < .01; \*\*\*p < .001.

tality rates of the intervention group were lower than the mortality rates of the control group in the post-intervention period ( $p < .05$ , Mann-Whitney U Test for the 2005-2011 period).

For each outcome variable of interest, we estimated different HLM models, one with the control variables and others with

various combinations of predictors. Table 5 shows these results. The first model explaining each of the three dependent variables (i.e., eHealth kiosk use, seeking professional medical care, and infant mortality) included the control variables at level 1 (i.e., wealth of the village, education of the village head, attitude of the village head to kiosk use, distance to

**Table 4. Infant Mortality Rates\***

Year	Control Group (10 Villages)	Intervention Group (10 Villages)
2002	73.8	73.1
2003	70.8	70.2
2004 (intervention)	68.9	68.0
2005	65.4	62.0
2006	64.0	60.0
2007	62.3	54.3
2008	59.9	53.1
2009	58.9	47.0
2010	57.8	44.3
2011	57.5	42.3

\*Coded as the number per 1,000 live births (still-born data accuracy was low, thus excluded).

nearest city, and frequency of government physicians visits) and control variables at level 0 (i.e., infant birth year, mother's age, marital status, number of children, infant mortality in the family, knowledge, seeking traditional medical, seeking professional medical care in the previous year, and eHealth kiosk use in the previous year). The variance explained in eHealth kiosk use, seeking professional medical care, and infant mortality was 35 percent, 37 percent, and 34 percent, respectively. The subsequent models incorporated various combinations of the predictors, which significantly increased the variance explained in eHealth kiosk use, seeking professional medical care, and infant mortality. The final models, including all predictors in the case of the each of the three dependent variables, explained 47 percent (eHealth kiosk use), 51 percent (seeking professional medical care), and 55 percent (infant mortality) of the variance.

H1a and H1b relate to the effects of advice from strong and weak ties respectively on eHealth kiosk use. The results revealed significant positive effects of advice from strong ties and advice from weak ties on eHealth kiosk use. Thus, H1a and H1b were supported. H2a and H2b relate to the effects of advice from strong and weak ties respectively on seeking professional medical care. The results revealed significant positive effects of advice from strong ties and advice from weak ties on seeking professional medical care. Thus, H2a and H2b were supported. H3a and H3b relate to the effects of advice from strong ties and weak ties respectively on infant mortality. The results revealed significant negative effects of advice from strong ties and advice from weak ties on infant mortality. Thus, H3a and H3b were supported. Regarding hindrance, H4a and H4b relate to the effects of hindrance from strong ties and weak ties respectively on eHealth kiosk use. The results revealed significant negative effects of hindrance from strong ties and hindrance from weak ties on

eHealth kiosk use. Thus, H4a and H4b were supported. H5a and H5b relate to the effects of hindrance from strong ties and weak ties respectively on seeking professional medical care. The results revealed significant negative effects of hindrance from strong ties and weak ties on seeking professional medical care. Thus, H5a and H5b were supported. H6a and H6b relate to the effects of hindrance from strong ties and weak ties respectively on infant mortality. The results revealed significant positive effects of hindrance from strong ties and weak ties on infant mortality. Thus, H6a and H6b were supported. In sum, all the hypotheses about the effects of social ties were supported, thus providing strong evidence for our view of the ICT intervention as a health-related behavior that is influenced by advice and hindrance from strong and weak ties.

H7 relates to the effect of eHealth kiosk use on infant mortality. The results revealed a significant negative effect of eHealth kiosk use on infant mortality. H8 relates to the effect of eHealth kiosk use on seeking professional medical care. The results revealed a significant positive effect of eHealth kiosk use on seeking professional medical care. Finally, H9 relates to the effect of seeking professional medical care on infant mortality. The results revealed a significant negative effect of seeking professional medical care on infant mortality.

In order to compare the results from the intervention group with the control group, we conducted related analyses using the data about networks and seeking professional medical care in the control group as well. These results are shown in Table 6. These analyses are necessarily different from what is reported in Table 5 because eHealth kiosks were not employed in the control group villages. These analyses provide us an understanding of the impacts of social ties and other

**Table 5. Results of Model Testing in Intervention Group Villages**

Models:	eHealth Kiosk Use		Seeking Professional Medical Care				Infant Mortality					
	1	2	1	2	3	4	1	2	3	4	5	6
R <sup>2</sup>	.35	.47	.37	.48	.38	.51	.34	.42	.42	.50	.44	.55
<b>Level-1 variables:</b>												
Wealth of the village	.08 (.055)	.05 (.065)	.06 (.072)	.04 (.083)	.05 (.103)	.03 (.112)	-1.11* (.016)	-1.10 (.031)	-1.11* (.015)	-1.10 (.033)	-1.10 (.037)	-1.07 (.044)
Education of the village head	.13* (.019)	.11* (.020)	.13* (.020)	.12* (.022)	.12* (.025)	.10 (.041)	-1.06 (.028)	-1.05 (.040)	-1.05 (.041)	-1.03 (.055)	-1.05 (.043)	-1.05 (.047)
Att. of the village head to kiosk use	.10 (.092)	.07 (.139)	.14* (.017)	.13* (.019)	.13* (.021)	.12* (.022)	-1.06 (.036)	-1.05 (.038)	-1.06 (.037)	-1.03 (.035)	-1.06 (.037)	-1.03 (.039)
Distance to nearest city	.10 (.133)	.05 (.183)	.05 (.180)	.04 (.193)	.04 (.201)	.03 (.212)	-1.12* (.012)	-1.11* (.015)	-1.12* (.013)	-1.08 (.044)	-1.12* (.021)	-1.11* (.022)
Frequency of govt. physicians' visits	.17** (.018)	.12* (.021)	.17** (.020)	.17** (.025)	.15* (.030)	.14* (.031)	-1.13* (.015)	-1.12* (.017)	-1.13* (.018)	-1.10 (.030)	-1.14* (.017)	-1.12* (.023)
<b>Level-0 variables:</b>												
Year of infant birth (1 to 7)	.13* (.022)	.11* (.023)	.13* (.019)	.13* (.021)	.12* (.022)	.11* (.025)	-1.16** (.011)	-1.15* (.019)	-1.16** (.012)	-1.12* (.020)	-1.19** (.022)	-1.14* (.025)
Mother's age	-.12* (.012)	-.11* (.015)	.20** (.018)	.17** (.024)	.16** (.026)	.12* (.031)	-1.13* (.012)	-1.12* (.014)	-1.13* (.013)	-1.11* (.016)	-1.12* (.015)	-1.11* (.019)
Marital status	.03 (.084)	.02 (.099)	-.12* (.021)	-.08 (.039)	-.10 (.033)	-.04 (.082)	-1.11* (.016)	-1.07 (.025)	-1.10 (.037)	-1.08 (.042)	-1.11* (.015)	-1.06 (.047)
# of children	.07 (.084)	.05 (.102)	.05 (.105)	.04 (.123)	.04 (.150)	.02 (.187)	.02 (.283)	.02 (.290)	.03 (.267)	.01 (.420)	.02 (.312)	.01 (.440)
Infant mortalities in family	.12* (.015)	.11* (.019)	.15* (.021)	.14* (.025)	.15* (.029)	.12* (.031)	.16** (.022)	.15* (.031)	.17** (.019)	.14* (.030)	.15* (.034)	.11* (.033)
Knowledge	.14* (.020)	.11* (.022)	.21*** (.009)	.17** (.014)	.18** (.014)	.14** (.019)	-1.19** (.031)	-1.18** (.032)	-1.19** (.030)	-1.16** (.032)	-1.18** (.027)	-1.17** (.029)
Seeking traditional medical care	-.08 (.049)	-.07 (.053)	-.10 (.190)	-.07 (.235)	-.08 (.271)	-.03 (.293)	.04 (.371)	.04 (.379)	.04 (.401)	.03 (.412)	.04 (.420)	.04 (.439)
Seeking professional medical care (prev. yr.)	.19** (.015)	.16** (.021)	.24*** (.008)	.23*** (.013)	.22*** (.015)	.17** (.025)	-1.24*** (.007)	-1.23*** (.008)	-1.24*** (.007)	-1.21*** (.009)	-1.23*** (.009)	-1.21*** (.010)
eHealth kiosk use (prev. yr.)	.34*** (.008)	.24*** (.017)	.19** (.014)	.15* (.022)	.17** (.020)	.13* (.029)	-1.20** (.020)	-1.15* (.025)	-1.15* (.026)	-1.13* (.027)	-1.18** (.020)	-1.07 (.039)
Strong ties advice centrality		.18** (.022)		.17** (.023)		.15* (.032)		-1.17** (.024)		-1.16** (.026)		-1.14* (.035)
Weak ties advice centrality		.25*** (.018)		.24*** (.012)		.22*** (.014)		-1.22*** (.010)		-1.20** (.026)		-1.17** (.029)
Strong ties hindrance centrality		-.24*** (.021)		-.22*** (.009)		-.17** (.028)		.17** (.019)		.15* (.028)		.14* (.031)
Weak ties hindrance centrality		-.19** (.024)		-.15* (.021)		-.11* (.023)		.14* (.025)		.12* (.027)		.12* (.029)
eHealth kiosk use					.25*** (.013)	.19** (.027)			-1.30*** (.008)	-1.23*** (.014)		-1.19** (.031)
Seeking professional medical care											-1.35*** (.008)	-1.23*** (.019)

Notes: Infant mortality data were analyzed using a logit function. Unstandardized coefficients are reported with standard errors in parentheses. \*p < .05; \*\*p < .01; \*\*\*p < .001.



**Table 6. Results of Model Testing in Control Group Villages**

	Seeking Professional Medical Care		Infant Mortality			
	1	2	1	2	3	4
<b>Models:</b>						
R <sup>2</sup>	.26	.42	.26	.40	.33	.46
<b>Level-1 variables:</b>						
Wealth of the village	.10 (.032)	.07 (.039)	-1.12* (.014)	-1.11* (.017)	-1.11* (.018)	-1.05 (.036)
Education of the village head	.12* (.011)	.08 (.022)	-1.03 (.122)	-1.02 (.197)	-1.02 (.241)	-1.02 (.298)
Distance to nearest city	.05 (.043)	.02 (.060)	-1.12* (.017)	-1.08 (.082)	-1.09 (.133)	-1.05 (.204)
Frequency of govt. physicians' visits	.20** (.021)	.17** (.024)	-1.14* (.021)	-1.14* (.027)	-1.13* (.029)	-1.10 (.055)
<b>Level-0 variables:</b>						
Year of infant birth (1 to 7)	.12* (.012)	.03 (.071)	-1.18** (.019)	-1.16** (.021)	-1.17** (.024)	-1.14* (.030)
Mother's age	.19** (.020)	.12* (.029)	.10 (.023)	.10 (.029)	.09 (.044)	.08 (.057)
Marital status	-.11* (.019)	-.02 (.028)	-1.13* (.022)	-1.08 (.078)	-1.07 (.122)	-1.02 (.144)
# of children	.08 (.072)	.02 (.084)	.02 (.077)	.02 (.129)	.01 (.140)	.01 (.149)
Infant mortalities in family	.14* (.013)	.11* (.021)	.17** (.021)	.14* (.032)	.13* (.037)	.11* (.039)
Knowledge	.28*** (.009)	.19** (.024)	-1.19** (.027)	-1.16** (.030)	-1.15** (.031)	-1.14* (.037)
Seeking traditional medical care	-.13* (.012)	-.03 (.030)	-1.10 (.316)	-1.05 (.398)	-1.03 (.412)	-1.03 (.442)
Seeking professional medical care providers (prev. yr.)	.21*** (.010)	.12* (.021)	-1.24*** (.009)	-1.21** (.017)	-1.20** (.022)	-1.18** (.025)
Strong ties advice centrality		.18** (.024)		-1.18** (.020)		-1.13* (.031)
Weak ties advice centrality		.25*** (.008)		-1.25*** (.008)		-1.16** (.019)
Strong ties hindrance centrality		-.21*** (.007)		.14* (.019)		.13* (.020)
Weak ties hindrance centrality		-.12* (.022)		.16** (.011)		.12* (.024)
Seeking professional medical care					-1.26*** (.013)	-1.20** (.025)

Notes: Given that there were no kiosks in the control group, eHealth kiosk-related variables are necessarily absent. Infant mortality data were analyzed using a logit function. Unstandardized coefficients are reported with standard errors in parentheses. \*p < .05; \*\*p < .01; \*\*\*p < .001.

governmental actions (e.g., improved healthcare access in rural India) on seeking professional medical care and infant mortality. As noted earlier in Table 4, there is a declining overall trend in infant mortality in the control group villages as well. Based on the results presented in Table 6, we observed some patterns and contrast them to the effects observed in Table 5. First, the control variables behaved remarkably similarly, suggesting that the control group villages are likely similar to the intervention group villages in terms of the overall sociocultural environment. Second, the year of infant birth is nonsignificant in model 2 of seeking professional medical care, thus suggesting that the declining trend is entirely captured by our explanatory variables, whereas the significant effect in Table 5 may suggest that the complex confluence of the sociocultural change over time had a positive effect on seeking professional medical care over time in the intervention group villages. Third, also from model 2 that explains seeking professional medical care, we observed that the magnitude of the effect of hindrance from strong and weak ties seemed to be stronger than the effects observed in Table 5. This could potentially be due to the strong negative influences persisting to a greater extent in the control group villages, compared to the intervention group where the eHealth kiosk may be combating this to some extent. This lends some additional credibility to our arguments regarding the sensitivity of eHealth kiosks use to the societal context. The effect of seeking professional medical care in models 3 and 4 above were also smaller in magnitude compared to the results in Table 5 (models 5 and 6). Once again, this may be due to the fact that the eHealth kiosk promoted better self-care and home-care practices that may in turn reduced infant mortality. In addition, professional medical care providers encouraged women to seek information at the eHealth kiosks for managing their infant's health and engaging in better healthcare practices. Also, the eHealth kiosk can serve as a source of clarifications where a woman, either by going to the eHealth kiosk or through her network ties, may get information to help her more effectively put into practice the healthcare practices suggested by a professional healthcare provider. Given that this opportunity was not available to women and their infants in the control group villages, the overall effectiveness of professional medical care was perhaps undermined in the control group.

Although not our focus, we followed Zhang et al. (2009) and found support for partial mediation of the influence of social ties on seeking professional healthcare and infant mortality through eHealth kiosk use. Some interesting patterns related to this partial mediation should be noted. As can be seen in Table 5, the effects of the social network variables on both seeking professional medical care and infant mortality were significant. When seeking professional medical care was dropped from the model explaining infant mortality, the social

network effects became slightly stronger; further, given that the social network variables had a strong effect on seeking professional medical care, this was consistent with partial mediation of the effects of social network variables on infant mortality. A similar pattern was observed with the effects of eHealth kiosk use on infant mortality and the effects of the social network variables on seeking professional medical care.

## Observations and Conversations

Although we did not conduct a mixed methods study (Venkatesh et al. 2013), as noted earlier, one of authors engaged extensively in the context, thus conversing a great deal with mothers throughout the duration of our study. The observations and conversations from this engagement help provide additional richness to perceptions of the intervention and its overall impact. Likewise, several people who were involved in the data collection heard several anecdotes and stories that corroborate our theory. We provide further information based on these observations of and conversations with some mothers to demonstrate the social dynamics surrounding the use of the ICT intervention and how such dynamics influenced the mothers' behaviors in taking care of their infants.

Our observations of and conversations<sup>7</sup> with mothers in rural India revealed powerful contextual factors that supported our view of the success/failure of the eHealth kiosk in tackling the infant mortality problem. We observed that the broader cultural norms dictate mothers' behaviors in general. A mother indicated:

*I always trust my friends. Many are like sisters to me. What I do with my babies will without reservation be determined by what they tell me to do.*

Hence, mothers seem to be involved in a continuous social comparison process as one mother shared:

*The entire [name] clan goes to the clinic even though only [youngest sister] goes to the kiosk. None of their babies have died even when we had the really cold winter last year.*

In general, there seemed to be more intense fear about not conforming to others in the villages as one mother said:

<sup>7</sup>Note that these conversations took place in local languages and, as such, some richness is often lost in translation. In some cases, specific myths and stories were invoked by the mothers as part of the conversation that often lent more power to the points they made; however, these were beyond the scope of translation and inclusion here given the culturally and religiously laden nature of the myths and stories.

*If my best friend sees me going to the clinic or the kiosk, she will kill me [figuratively]. She may also tell her husband who will tell my husband because they see each other often. What happens then will not be good [edited graphic and profane text].*

Another mother indicated how the feelings were, however, changing:

*There is generally more openness to the kiosk and Western doctors these days. When it all started, the sentiment toward them was very negative, like they were evil. Now, I think we can go if we want. It's a family decision. No one cares one way or another. But this has taken 5 years. If it was like this when I had my first one [baby], she may still be here....[At that time] we couldn't go to the clinic then without possibly risking even being thrown out of the village.*

Mothers also shared their views based on their experiences with the eHealth kiosk and the constraining/enabling dynamics behind their behavior as they made decisions about their infants' healthcare. As one of the mothers described her experience:

*I learned so much from the kiosk. I saw videos that helped me take care of my infant better. She sleeps so much better at night now. I am so happy I made the decision to go [to the kiosk]. I tell all my friends that they should go.*

It is clear that the mother saw the eHealth kiosk as effective in diffusing information that, at the same time, left a positive impression that made her want to encourage her friends to go to the eHealth kiosk. On the flip side were mothers who were hindered by their ties. One mother articulated this thus:

*My friends really don't like the kiosk or clinics. They say there are horror stories about children becoming deformed after going to the clinic for weeks. Some even die. They think if I go I will bring the evil to them and so they won't talk to me if I go. I am worried for my infant but what can I do?*

Another mother provided additional justification to maintain the status quo:

*How can I break with centuries of our village's traditions? Infants die and that's because of evil spirits and the wrath of God. The Western doctors cannot change that unless they change it through evil magic.*

A sad story of the impact of hindrance from a strong tie was shared by another mother who indicated

*I lost one infant already. But my sisters [referring to friends] tell me it is the will of God. They say when infants die, it is because they are here to collect a debt from a previous birth. I am pregnant now. I want to learn about this computer center by going there but I fear I will be ostracized by my sisters [friends]. I'd be lost without them.*

The favorable impact did seem to be more evident with the passage of time, as noted by one mother who could not contain her excitement about the intervention:

*My best friend's infant is so healthy. She visits the clinics regularly. Her whole family supports it. All of us in our clique are going to do that now....We have come a long way from two years ago when my best friend was dead set against the kiosk and the Western doctors.*

Beyond the social ties, the reactions of mothers who benefited enormously from the information about infant healthcare practices accessed through the eHealth kiosks and professional medical care providers was a source of encouragement for the use eHealth kiosks. One mother noted:

*There is a lot of nutritional information that I can get about what is important to feed my baby at various stages of its growth. I feel my infant is growing so much faster than others [compared to babies of relatives and friends] because I am following as much of what I learn as possible.*

Another mother talked about learning practices that help her infant sleep better at night and, on many occasions through the night:

*I learned that some of the things that we were told [by traditional medical care providers and other elders] were wrong. Seeing the videos showed me how to get the baby to sleep better.*

One mother noted how the combination of the eHealth kiosk and professional medical care helped her:

*I was worried about the high fever that my baby was experiencing for three evenings in a row. I went to the eHealth kiosk because I wanted to decide if I should make the half-a-day trip to the clinic. It turned out it could have been malaria or other*

*dangerous illnesses. When I went to the clinic, not only did the doctor help us by giving medication for the infant, but also she told me a lot of things on how can I strengthen the immunity of the baby. She also told me to come back for some vaccinations. Now that the baby healed fully, I think the doctor is a God-send. If only my friend had done this. She lost an infant two months ago after she [the infant] had high fevers in the evening for about two weeks.*

## Discussion

Our findings demonstrate that infant mortality in rural India can be effectively combatted with an ICT intervention that works in concert with other key enablers, namely advice from strong and weak ties and professional medical care, but is subject to the constraint posed by hindrance from strong and weak ties. The ICT intervention, specifically eHealth kiosks, can be used to disseminate authenticated health information about infant healthcare, positively alter infant healthcare practices, promote the utilization of professional medical care, and reduce infant mortality in rural India. Our model with all predictors included explained 55 percent of the variance in infant mortality, which was higher than any of the nested models that employed a subset of predictors (i.e., models that do not incorporate the social network variables and/or eHealth kiosk use and seeking professional medical care). The significant effects of eHealth kiosk use, advice from strong and weak ties, and hindrance from strong and weak ties corroborate our view of the ICT intervention and its impact on infant mortality. Advice from strong and weak ties increased eHealth kiosk use. In contrast, hindrance from strong and weak ties reduced eHealth kiosk use. In other words, connections to other women who disapprove of the intervention were highly influential in what a mother does. This observed pattern shows that advice and hindrance from strong and weak ties contribute to the use of the ICT intervention that ultimately impacts seeking professional medical care and infant mortality.

The comparative analyses between the control group and the intervention group revealed that both groups exhibited similar patterns in the effects of advice and hindrance from strong and weak ties on seeking professional medical care and infant mortality. However, relative to the control group, the intervention group realized better outcomes due in part to the role of the eHealth kiosk in promoting better infant healthcare practices that likely improved the well-being of infants and reduced the likelihood of life-threatening situations. A major, disturbing finding was the highly positive and significant

effect of hindrance from strong and weak ties on infant mortality in both groups. This finding indicates that mothers were especially vulnerable to the influence of hindrance from these ties and tended to shy away from pursuing desirable health-related behaviors (i.e., using eHealth kiosk and seeking professional medical care in the intervention group; only seeking professional medical care in the control group).

## Theoretical Implications

Our findings have implications for (1) the role of the societal context in understanding the societal problem and how the ICT intervention should be managed in such contexts, (2) different types of social ties that promote and hinder the effectiveness of the ICT intervention, and (3) the role of social ties and the ICT intervention to collectively develop literacy and empowerment of mothers that can change their beliefs and behaviors related to infant care and, ultimately, combat the infant mortality problem.

Our findings illuminate the critical role of the societal context in perpetuating behaviors that lead to greater infant mortality and the important role it plays in an ICT intervention inducing desired behavioral changes. Recent work has shown that an effective ICT intervention to address the digital divide problem among the socioeconomically disadvantaged involves not only providing ICT access at no cost or at an affordable cost through government or private-public partnered initiatives, but also necessarily achieving meaningful use of the ICT (Hsieh et al. 2011; Wei et al. 2011). This work has also shown that achieving meaningful use of ICT among the socioeconomically disadvantaged requires (1) developing different forms of capital—habitus, cultural, social, and economic (Hsieh et al. 2011)—and (2) recognizing that social networks affect the use of ICT and diffuse information on various practices (e.g., farming) provided by the ICT intervention (Venkatesh and Sykes 2013). Our study elaborates this understanding by showing that successfully intervening with ICT to address serious societal problems (in our case, unacceptably high infant mortality) involves breaking the *vicious cycle* of misinformation and counterproductive beliefs and behaviors in a societal context.

We better understand the impact of social influence emanating from an individual's strong and weak ties on the interpretation, use, and success of an ICT intervention to address a serious societal problem: infant mortality. Our findings reveal that advice and hindrance from strong and weak ties both represent social influence mechanisms that impact the behaviors associated with infant mortality and the effectiveness of an ICT intervention in two ways. First,

hindrance from strong and weak ties circumvents the positive potential of the intervention and increases infant mortality rates. Specifically, mothers become sensitive to hindrance from strong ties that reinforce the status quo of denial, fatalism, and relying on ill-informed traditional infant healthcare practices. Such hindrance shapes the meaning of the intervention and sways mothers from acquiring or absorbing validated infant healthcare practices. Second, through enabling social influence, advice from strong and weak ties promotes eHealth kiosk use, thereby reducing infant mortality. Advice from strong and weak ties enables or encourages the use of an eHealth kiosk, either because of a prior satisfactory usage experience or knowledge of other mothers who had a positive experience. Hence, a mother who gets advice from strong and weak ties might be encouraged to access information on validated infant healthcare practices. Further, as the number of strong and weak ties transferring advice increases, the likelihood that the mothers will get access to diverse infant healthcare practices tends to increase. In contrast to hindrance from strong and weak ties, advice from strong and weak ties offer the opportunity to alter the meaning of the intervention and professional medical care in a positive manner. This effect is consistent with the contagion model that posits that late adopters (i.e., hesitant or ill-informed mothers) are expected to adopt an intervention (i.e., consult the eHealth kiosk and implement validated infant healthcare practices) as a result of a socialization process (Burt 1987). Our view of such a process incorporates the power of advice from both weak and strong ties, which addresses the need to better understand how both types of ties provide advantages to actors (Kilduff and Brass 2010). Specifically, the power of advice from weak ties stems from its ability to provide access to novel information (Granovetter 1973) and the power of advice from strong ties stems from its ability to facilitate access to resources (Krackhardt 1992).

Our study also has implications for how ICT interventions can build a *virtuous* cycle of literacy and social support that empowers individuals to break from dysfunctional traditional beliefs and practices and the perpetuation of societal problems. It sheds light on how individuals might revise their beliefs based on new knowledge gained from their social networks (Oinas-Kukkonen et al. 2010). The socioeconomically disadvantaged mothers who received advice from their strong and weak ties were encouraged to use the eHealth kiosks, thereby driving down infant mortality. Further, using eHealth kiosks developed literacy of mothers on three fronts: (1) breaking down misplaced beliefs, superstitions, and practices pertaining to infant healthcare that were harmful to the health of infants and increased the risk of infant fatalities, (2) seeking professional medical care when infants were ill or presented symptoms that required timely corrective care, and

(3) the critical need of preventive care (e.g., vaccinations) and routine checkups to monitor infant well-being and promote early detection of health problems. These observations reflect a major transformation that the mothers went through as they developed situational awareness about infant health and health-related behaviors by accessing authenticated information from the eHealth kiosks and professional medical care providers despite the inconsistency of this information with traditional infant healthcare practices that were deeply rooted in their social context.

### **Strengths, Limitations, and Future Research Directions**

One of the key strengths of this study was the research design that helped us develop a more comprehensive understanding of the impacts of advice and hindrance from strong and weak ties on eHealth kiosk use, seeking of professional healthcare, and infant mortality. By studying this phenomenon over a 7-year period, we accumulated substantial evidence regarding the effectiveness, enablers, and constraints of an ICT intervention used to address a deeply entrenched societal problem.

There are a few limitations associated with our research design. First, healthcare access in rural India continues to progress as the central and state governments attempt to maintain active dissemination of information and set up medical clinics and hospitals throughout the country. Such progress falls outside of our control. However, this concern is alleviated to some extent in our study given that the evidence we found from adjacent villages without the ICT intervention: although the infant mortality rate dropped in these villages, the drop was not as much as in the villages with the ICT intervention. Second, we examined general advice and hindrance from strong and weak ties. In the context of our work, as we discussed earlier, we felt this was a reasonable approach given the close interactions among mothers in rural India. In addition, during our interviews, we found that mothers had a difficult time separating out various types of advice and hindrance from their strong and weak ties—and because conversations were often free-flowing and could last for hours, they had a difficult time reporting on frequency of specific advice or hindrance. To complement our work, a smaller-scale study can delve into types of advice and hindrance, and potentially confirm or extend our findings. Third, we measured advice and hindrance from strong and weak ties at the beginning of our study and it is possible that through the course of our study, these ties changed. However, the practical constraints associated with repeated measurement of networks, especially given the multiple networks studied, precluded us from pursuing this line of inquiry. Related to this, future work can focus on network change and

its impacts. Fourth, it is possible that weak ties with health-care professionals could bridge structural holes in villages and transfer information about the benefits of the eHealth kiosk. Future work could build on our findings by identifying and comparing different sources of social network ties such as those with healthcare professionals. Finally, our work was situated in rural India. As the nature of the infant mortality problem can be expected to be markedly different across sociocultural contexts, extensions of this work in other developing and developed country contexts confronting the infant mortality problem is an important avenue for research. Given the higher literacy rates and sophistication of ICT and health infrastructures in developed countries, the potential to leverage ICT to address the infant mortality problem is promising. It will be important to determine the design of ICT interventions that is effective in a developed country context and to uncover the types of social networks, including those that are digitally enabled, that promote the use of these ICT interventions as well as wellness behaviors, preventive healthcare, and the timely seeking of corrective healthcare. Such work will not only complement and extend digital divide research conducted in the United States (e.g., Hsieh et al. 2008; Kvasny 2006), but also contribute to research on broader topics, such as e-government (Srivastava 2011; Srivastava and Teo 2007, 2010) and social networks and technology diffusion, especially in healthcare (e.g., Venkatesh et al. 2011).

### **Practical Implications**

Our work offers important implications for policy makers and intervention designers, especially given the growing recognition of ICT interventions as potential remedies to healthcare issues in developing countries. A recent report about the status of healthcare access in India indicated that accessibility to public or private healthcare facilities remains a challenge in rural areas, mainly due to high costs, and that a roadmap is essential to ensure that interconnections and dependencies of healthcare resources are recognized (IMS Institute 2013). Our findings shed light on the role of social ties in rural settings as important antecedents to the accessibility and utility of health resources that may be deployed in these settings. Such antecedents might indirectly reduce the cost of healthcare by equipping mothers with health knowledge, encouraging preventive healthcare and, ultimately, reducing the need for expensive healthcare. Because eHealth kiosks represent a major infrastructure investment due to costs associated with space and computers, it becomes important to enact constructive social mechanisms (i.e., dissemination of well-informed advice) in which these kiosks can be better leveraged to improve infant health and ultimately reduce infant mortality. Specifically, it becomes important to

develop courses of actions that foster enabling social influence in the daily lives of mothers without causing strife in their personal lives. For example, policy makers might design context-sensitive programs that encourage door-to-door visits by social workers, public media (e.g., radio, television) and small organized public meetings where the dialogue on infant wellness and health issues shifts from one-to-many to many-to-many.

Policy makers might also consider designing training interventions that prepare eHealth kiosk attendants and social workers for addressing hindrance or negative social influence. Our finding that hindrance from strong and weak ties circumvents the positive potential of the intervention raises a red flag on a serious hurdle that needs to be addressed to combat infant mortality. One potential course of action might be to encourage eHealth kiosk attendants and social workers to identify women/mothers in an advantaged position in a societal context to drive initial buy-in within the local community. eHealth kiosk attendants and social workers might provide cues or insights into the content that needs to be communicated through the eHealth kiosk. Specifically, interactions of social workers or eHealth kiosk attendants with mothers enable them to identify prevalent misconceptions about preventive healthcare actions, wellness behaviors, and the seeking of medical care for infants. In addition, governments can disseminate the value of the intervention by asking mothers who have benefited from using the eHealth kiosk to share their experiences via more traditional media (e.g., radio or television) to reach out to more mothers or expectant mothers.

Finally, policy makers who are responsible for managing and evaluating these ICT interventions need to be aware that it takes time to accrue benefits due to the complexity of changing lifestyles, beliefs, and attitudes that are deeply rooted in the culture of rural villages. Our finding that advice from strong and weak ties in conjunction with an ICT intervention can be powerful to break misplaced beliefs and practices pertaining to infant healthcare provides useful guidance in combating infant mortality. Thus, policy makers need to develop strategies to tackle hindrance and promote advice during various stages of the implementation and investment in healthcare infrastructure in conjunction with macro-level implementation strategies.

### **Conclusion**

We sought to unearth contextual factors that drive the success of an ICT intervention targeted at tackling the infant mortality problem in rural India. We found interplays of social ties—hindrance and advice from both strong and weak ties—to

transmit different types of social influence that affect eHealth kiosk use. Our large-scale study makes a significant contribution to our understanding of ICT interventions and their impacts, thus furthering the scope and reach of theories related to ICT interventions as remedies to complex societal problems. From a practical standpoint, our work underscores the critical role of managing ICT interventions in the societal context in which it is embedded, as it drives how these interventions are interpreted and how they are supported or obstructed.

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## About the Authors

**Viswanath Venkatesh** is a Distinguished Professor and Billingsley Chair in Information Systems at the University of Arkansas. He received his Ph.D. from the University of Minnesota. His research focuses on understanding the diffusion of technologies in organizations and society. His work has appeared or is forthcoming in leading journals in information systems, organizational behavior, psychology, marketing, and operations management. He is widely regarded as one of the most influential scholars in business and economics (e.g., highlycited.com), with about 50,000 cites and about 13,000 times per Google Scholar and Web of Science, respectively. His papers are among the most cited papers published in the various journals, including *Information Systems Research*, *MIS Quarterly*, and *Management Science*. He has served on or is currently serving on several editorial boards, including *MIS Quarterly*. He has published a book that provides guidance on achieving academic success ([vvenkatesh.com/book](http://vvenkatesh.com/book)).

**Arun Rai** is Regents' Professor of the University System of Georgia and holds the Harkins Chair of Information Systems and the J. Mack Robinson Chair of IT-Enabled Supply Chains and Process Innovation in the Center for Process Innovation and the Department of Computer Information Systems at the Robinson College of Business, Georgia State University. His current research is focused on how firms can conceive, design, implement, and leverage digital innovations to create business value and how interventions involving digital innovations can address societal problems related to healthcare and poverty. He has served as a senior editor for *MIS Quarterly*, *Information Systems Research*, and *Journal of Strategic Information Systems*, as an associate editor for *MIS Quarterly*, *Information Systems Research*, *Management Science*, and *Journal of MIS*, and is currently Editor-in-Chief of *MIS Quarterly*. He was named Fellow of the Association for Information Systems in 2010 and Distinguished Fellow of the INFORMS Information Systems Society in 2014.

**Tracy Ann Sykes** is an assistant professor in information systems at the Walton College of Business, University of Arkansas, where she has been since 2011. She has previously held appointments at the National Science Foundation and the Australian National University. She received her BS in business from the University of Maryland and her Ph.D. in information systems from the University of Arkansas. Her research focuses on leveraging social network theory, methods, and analysis to understand technology diffusion in a variety of settings including healthcare and developing countries. Her papers have appeared in leading IS, operations management, and medical informatics journals.

**Ruba Aljafari** is a doctoral student majoring in information systems at the University of Arkansas. She earned her Master's in information systems from the University of Nebraska and another Master's in international business from Jordan University. Her research interests include use and impact of technology in the context of healthcare. From the patient's perspective, she is interested in understanding the antecedents and consequences of particular forms of technology use. She is pursuing several research projects that focus on understanding how the use of technology could become a mechanism to engage patients, whether in the context of developing or developed countries, in the creation and delivery of healthcare services.

## Appendix A

### Illustrations of the Type of Information that is Available from the Kiosk

The screenshot shows a kiosk interface for the National Health Portal (NHP) India. At the top, there are navigation options: 'English', 'Login', and 'Register'. Below these are font size controls (A A A) and text-to-speech controls (T T T T). A red star icon is followed by a message in Hindi: 'अभी केवल अंग्रेजी में बीटा संस्करण किया गया है। विकास के तहत हिन्दी और अन्य भारतीय भाषाओं में आगे की सामग्री उपलब्ध होगी।' Below this is a search box labeled 'खोज'. The main content area is titled 'Pregnancy' and lists several topics: 'What is Pregnancy?', 'What are the Stages of pregnancy?', 'What is Prenatal care or Antenatal care?', 'Counseling', 'Advantages of institutional deliveries', 'Why is abdominal pain during pregnancy?', 'What are the serious problems that can lead to abdominal pain during pregnancy?', and 'Breastfeeding'.

Figure A1. Screenshot of a List of Relevant Pregnancy Topics

**Ultrasound:** Obstetric ultrasounds are most commonly performed during the second trimester at approximately week 20. Ultrasounds are considered relatively safe and have been used for over 35 years for monitoring pregnancy. Among other things, ultrasounds are used to:

- Check for multiple fetuses
- Assess possible risks to the mother (e.g., miscarriage, blighted ovum, ectopic pregnancy, or a molar pregnancy condition)
- Check for fetal malformation (e.g., club foot, spina bifida, cleft palate, clenched fists)
- Determine if an intrauterine growth retardation condition exists
- Note the development of fetal body parts (e.g., heart, brain, liver, stomach, skull, other bones)
- Check the amniotic fluid and umbilical cord for possible problems
- Determine due date (based on measurements and relative developmental progress)

**Figure A2. Screenshot of an Explanation of Medical Examination During Pregnancy**

**As per government of India norms:** Every pregnant women makes at least four visit for ANC, including the registration or the first visit.

Suggested schedules for antenatal visits:

1st visit: Within 12 weeks or preferably as soon as pregnancy is suspected.










2nd visit: Between 14 and 26 weeks

3rd visit: Between 28 and 34 weeks

4th visit: Between 36 weeks and term.

**Figure A3. Screenshot of a suggested schedule for antenatal visits**

#### ▼ Videos Related to Pregnancy

1. 10 steps to a clean delivery 
2. How to care for a newborn 
3. How to take care of a newborn- during 1st hours 
4. Warning signs during pregnancy 
5. 10 steps to safe delivery 
6. You tube video link of mSakhi, (where 'Sakhi' means 'a friend' in Hindi):  An interactive vernacular audio/video-guided mobile application that provides support to ASHAs in conducting routine activities across the continuum of MNCH care
7. Obstetric and Neonatal Emergencies 
8. Food for life: What Pregnant Woman need to eat? 
9. Welcome birth of girls and boys 

**Figure A4. Screenshot of a list of relevant pregnancy videos**

# Appendix B

## Measures of Advice and Hindrance from Social Network Ties

	I contact this person for advice:				
	Many times a day	Once a day	Once a week	Once a month	Less than once a month
Name 1	1	2	3	4	5
Name 2	1	2	3	4	5
....					
Name n-1	1	2	3	4	5

	This person makes my life difficult:				
	Many times a day	Once a day	Once a week	Once a month	Less than once a month
Name 1	1	2	3	4	5
Name 2	1	2	3	4	5
....					
Name n-1	1	2	3	4	5

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