

Social, Cultural and Behavioral Correlates of Household Water Treatment and Storage



by
Maria Elena Figueroa and
D. Lawrence Kincaid

Acknowledgements

The authors are grateful for the thoughtful and generous contributions and recommendations to this paper of Margaret Bentley from the University of North Carolina; Marco Campos from the SODIS Foundation; Valerie Curtis from the London School of Hygiene & Tropical Medicine; Chris McGahey from the Global Environment & Technology Foundation; Jennifer Mercer from the WHO Geneva; and Andrew Trevett from WHO, Bangladesh. We would also like to acknowledge the financial support of Procter & Gamble for the initial review of the literature included in this paper and funding from USAID under the Health Communication Partnership. Thanks go as well to Catherine Harbour and Bryant Robey for their editorial assistance.

Suggested citation:

Figueroa M.E., & Kincaid D.L. (2010). *Social, Cultural and Behavioral Correlates of Household Water Treatment and Storage*. Center Publication HCI 2010-1: Health Communication Insights, Baltimore: Johns Hopkins Bloomberg School of Public Health, Center for Communication Programs.

This publication may be reproduced without permission provided the material is distributed free of charge and Johns Hopkins Bloomberg School of Public Health Center for Communication Programs is acknowledged. Opinions expressed in this report are those of the authors and do not necessarily reflect the views of sponsoring agencies.

Health Communication Insights are special publications designed to disseminate the work of the Center staff and faculty on cross-cutting themes relevant to health communication programs and research.

The Center for Communication Programs is housed in the Department of Health, Behavior and Society and focuses on the central role of communication in public health programs. The Center combines the academic and research strengths of a great university with program opportunities to enhance the art and science of communication for the improvement of public health worldwide.



This report was prepared with support from the
United States Agency for International Development.



Copyright © 2010 The Johns Hopkins Bloomberg School of Public Health Center for Communication Programs. All rights reserved.

Table of Contents

Summary	
1. Introduction	3
1.1 Knowing the audience	4
1.2 Overview of this report	5
2. Theoretical background	6
2.1 Behavior change communication theories	6
2.1.1 Stage theories	7
2.1.2 Predictive theories	7
2.2 Approaches to disease and health	7
2.2.1 Microbial model	8
2.2.2 Behavioral approach	8
2.2.3 Ecological model	8
3. A communication model for water treatment and safe storage behavior	9
3.1 Communication interventions	10
3.1.1 Skills building	10
3.1.2 Promotion	11
3.1.3 Community dialogue and mobilization	11
3.1.4 Public advocacy	11
3.2 Intermediate outcomes	11
3.2.1 Individual	12
3.2.2 Household factors	12
3.2.3 Community and contextual factors	13
4. Review of the literature: What do we know?	13
4.1 Summary of findings	14
4.2 Individual-level factors	16
4.2.1 Cognitive elements	16
4.2.1.1 Knowledge of and beliefs about the causes of diarrhea	16
4.2.1.2 Beliefs about state of water	18
4.2.1.3 Beliefs related to a child's age	19
4.2.1.4 Switching from untreated to treated water	19
4.2.1.5 Attitudes –towards the practice	20
4.2.1.6 Attitudes –towards the product	20
4.2.1.7 Perceived risk and severity	21
4.2.1.8 Subjective norms	22
4.2.1.9 Self-image	23
4.2.2 Emotional factors	24
4.2.2.1 Fear of chemical side effects	24
4.2.2.2 Emotional responses to smell, taste and clarity	25
4.2.2.3 Self-efficacy	26
4.2.2.4 Empathy and trust	26
4.2.3 Social interaction	26
4.3 Household factors	28
4.3.1 Household time allocation	28
4.3.2 Support from household members and other relatives	29
4.3.3 Household resources	30
4.3.4 Household decision-making	31
4.4 Community factors	31

4.4.1	Value for water quality.....	31
4.4.2	Community leadership.....	32
4.4.3	Community action and resources	32
4.4.4	Community cohesion.....	32
4.5	Environmental and contextual factors.....	33
4.5.1	Access to products	34
4.5.2	Tradition of free goods.....	34
4.5.3	Access to water	34
4.5.4	Geographic location	35
4.6	Socio-demographic characteristics.....	35
4.6.1	Mother's education	35
4.6.2	Language and Ethnicity.....	35
4.6.3	Mother's age	35
4.7	Safe water storage.....	36
5.	Water treatment as a cluster of related behaviors and diseases	37
6.	Lessons learned	40
7.	Application of the model for communication for water treatment and safe storage to Sindh, Pakistan ...	41
8.	Implications for program design and research	45
8.1	Steps for program design.....	46
8.2	Directions for future research.....	48
9.	Conclusion	49
	References	50

SUMMARY

Lack of access to safe drinking-water and inadequate sanitation and hygiene are main contributors to the 1.8 million deaths caused by diarrheal disease each year. Providing safe and reliable water services to the 1.1 billion people who currently lack access to improved water sources is an essential long-term goal that will yield great health and economic benefits. Improved water, sanitation and hygiene will also contribute to the MDG goals for poverty reduction, nutrition, childhood survival, school attendance, gender equity and environmental sustainability (UN Millennium Project, 2005). Securing safe drinking water at the household level, however, requires more than investments in water supply infrastructure, which are expensive, require long timeframes, and do not always reach those with the greatest need. Water treatment technologies that can be used at the household level are immediate cost-effective alternatives that can improve the water quality of those in most need. To date, the use of household water treatment technologies, however, requires substantial behavior change. Interventions that promote water treatment and safe storage at the household level have not been very successful in changing consumers' perceptions and behaviors.

This report describes a predictive model of communication for water treatment and safe storage behavior that can be used to design effective water treatment interventions by changing water treatment behavior. A literature review was carried out to assess the extent to which safe water interventions and research findings support and confirm variables identified in the model. The review of the literature confirmed the usefulness of the model in identifying most of the factors that influence water treatment behavior, including non-health and health factors as well as community, household and individual-level factors. The findings show that a consumer-centred approach to water treatment is necessary to understand the range of issues properly and to find effective solutions. Surprisingly, the literature revealed that water treatment is not always perceived to have health benefits. Diarrhea is not always seen as a significant health threat and water treatment and storage are sometimes not done adequately enough to reduce the incidence of disease.

From the point of view of interventions, the literature suggests that people do not easily change and sustain new behaviors as intended. Mothers do not necessarily have sufficient decision-making power within their homes to take effective action and community resources need to be tapped by water treatment programs to facilitate the development of water treatment as a social norm. The literature indicates that no single approach to the promotion of water treatment is likely to be sufficient to sustain the practice. The review suggests that the promotion of water treatment and safe storage needs to utilize innovative, integrated and holistic approaches to be more effective in the future. The two most important challenges are to find new ways to promote water treatment that does not rely solely on a promise of reduced diarrheal disease and to address safe drinking-water as a multifactorial problem that includes strategies to change the entire cluster of behaviors related to diarrhea as well as hygiene and sanitation technology.

Box 1. Water Boiling in a Peruvian Village: Six Cases

Mrs. A, “who obeys custom,” had lived in Los Molinos for about 40 years and ran a private school in her home. Her family had a higher cash income than most families. She had sinusitis and was one of the “sickly ones” in the community. Even before Nelida, the health worker, arrived in the village, Mrs. A boiled her water in order to eliminate the “cold” quality of unboiled water. “Cooked” water was generally associated with caring for the ill in Los Molinos. So, “in obedience to custom” she boiled her drinking water because it was necessary for people who are sick, delicate, very young, very old, or pregnant.

Mrs. B, “who defies custom,” was also one of the 15 women who boiled water before Nelida arrived in the community. A 55-year old woman with a median level of income, Mrs. B and her married daughters maintained an exceptionally clean and ordered home. She boiled water daily, regardless of whether or not someone in her household was sick. Mrs. B saw herself as more refined, cleaner and superior than her neighbors. Her water boiling practice started when her brother, who lived in the capital city, asked for boiled water during his visits to the village. She saw the practice as a sign of social status. Her own practice was reinforced and her status further enhanced when Dr. U, a medical authority, visited and talked to the community about the need to boil water to kill microbes. Mrs. B was perceived in Los Molinos as a “cultural outlaw” or deviant since she boiled her water when nobody in her family was sick. She saw herself, however, as progressive.

Nelida did succeed in persuading Mrs. C to boil her water. She was a 45-year old woman who migrated from the highlands with her family to Los Molinos, a coastal community. She was afraid of the diseases prevalent on the coast and saw Nelida as someone who brought “protection against dangerous coastal diseases.” She followed most of Nelida’s health recommendations. Because she was a migrant, Mrs. C’s water boiling behavior was not condemned by others, nor did her behavior have any effect on her already marginal position in the community. Mrs. C saw Nelida as a friendly authority that provided her with personal security and she believed Nelida’s lesson that the water was contaminated.

Mrs. D, a 25-year old woman with low socio-economic status, was “persuaded by Dr. U” to boil her water. Although she had been receptive to previous health programs, Nelida’s lack of authority in the eyes of the village failed to convince her to boil her water and thus deviate from the current norm. After two years, she finally started to boil her water, but mainly because of Dr. U’s recommendation, not Nelida’s. The superior social rank given to physicians by Los Molinos society was sufficient to convince her to depart from local norms without worrying about being criticized by her neighbors.

Mrs. E, “who would but can’t,” was an unwed mother in her early thirties with a lower socio-economic status than most of her neighbors. She too was receptive to previous health department programs, knew about water contamination, and was even convinced of the benefits of boiling, but she did not do it because she “had no time.” Economic reasons as well as cultural traditions related to the attributes of water and its consumption also discouraged her from boiling. These included (1) a three-meal-a-day pattern that prevented boiling because of the scarcity of fuel, (2) the small size of her hearth that made it impossible to cook and boil water at the same time, (3) belief that water gets “cold” if left sitting overnight and therefore has to be “cooked again,” (4) the daily work pattern in which the only opportunity for boiling was right after breakfast, when she had a myriad of other responsibilities to face, and (5) the lack of another household member “to whom the chore could be delegated.”

Mrs. F, “who could but won’t,” lived in a 12-person household and was poor. Her family was culturally conservative and unresponsive to a range of health behaviors promoted in the past. She did not boil her water. She was unconvinced because she did not believe that microbes cause illness. She argued that microbes would “drown in water.” She wondered how “such minute animals, unescorted by the disease, can hurt a grown up person?” Mrs. F had the time to boil water but her adherence to traditional standards and native beliefs were at odds with the notion that boiling water was related to health.

¹ The authors heard very similar arguments as recently as 2002 in focus group research conducted among women in Guatemala (Tapia, 2003), and in 2005 in Pakistan (Figueroa & Hulme, 2007).

It is clear that improving water treatment interventions should begin with an understanding of the audience and its point of view regarding water treatment technologies and related behavior. Above all, the literature revealed the limitations of using only education about the connection between pathogens in the water and diarrhea to convince people to purify their drinking-water at home. Water treatment behavior is clearly related to many other individual beliefs and values, family relationships, social norms and ecological factors. To become effective, interventions need to identify the relevant factors operating in each specific context and then design programs that are appropriate for people who live in those circumstances.

The field of water, sanitation and hygiene lacks a theory-based approach to the design and evaluation of interventions. The proposed model fills this gap by providing practitioners with a tool to identify factors that are relevant to specific contexts where interventions are being planned. The review of the literature offers examples of such factors from actual case-studies. Using the model proposed in this report can help decision-makers to understand the underlying factors of behavior better and thus to develop more appropriate and effective program and communication strategies. It is hoped that the model proposed in this report will be used as a programmatic tool and as a research tool to guide the design and evaluation of future water treatment and hygiene programs.

1. Introduction

Simple and inexpensive technologies exist for treating drinking water in the home and storing it in safe containers. A growing body of research suggests that household water treatment and safe storage dramatically improve microbial water quality; significantly reduce the incidence of diarrhea; are highly cost-effective; and can be focused to make health improvements among the most vulnerable populations. Household water treatment (HWT) technologies typically fall in five main categories: chlorination (adding chlorine in liquid or tablet form to drinking water) flocculation/disinfection – adding powder or tablets to coagulate and flocculate sediments in water followed by a time release of disinfectant; filtration; solar disinfection -- exposing water in clear plastic bottles to sunlight for a day; and boiling. (Combating Waterborne Disease at the Household Level, WHO 2007).

Reaching the vulnerable, however, implies much more than developing affordable products and technologies for household water treatment and safe storage (HWTS). Research has shown that even when products and technologies are available to improve the quality of water sources, people do not immediately seek and use these technologies in a consistent way. Identifying and implementing successful approaches to increase uptake of water treatment products on a sustainable basis are essential for this intervention to achieve widespread and long-term success.

Research is needed to identify factors that render HWT sustainable and that can support programs at scale. A recent review concluded that the widespread promotion of household water treatment is premature given the available evidence (Schmidt & Cairncross, 2008). The evidence in this review

paper however, is represented by studies that lack the behavioral component for HWT, which is needed to make these interventions sustainable and scalable. Interventions at scale are needed, and behavioral variables need to be understood to provide useful guidance to programs.

This report examines the social, cultural and behavioral factors that need to be taken into consideration in the development of approaches to make HWT sustainable and scalable. The report also examines approaches to effective communication that water treatment interventions can use to increase the chances that those more in need get the benefits of improved water quality through sustained water treatment and safe storage practices.

The central theme that this report develops is the paramount importance of knowing the audience to achieve effective behavior change. The theoretical frameworks for communication and behavior change are first briefly introduced, with a focus on how innovations spread and become adopted and accepted. A communication model for water treatment and safe storage behavior is then proposed, derived from behavior change theories and the evidence from a variety of health communication programs. Finally, the results of a literature review, carried out to assess the extent to which safe water interventions and research findings support and confirm variables identified in the model, are given. The report ends with a series of recommendations that practitioners can follow in to design successful water treatment promotion interventions.

1.1 Knowing the Audience

“Diffusion of innovations” is a theory of how, why and at what rate new ideas and technology spread through cultures. All five editions of Everett Rogers’ classic book on this theory (Rogers, 1962, 1971, 1983, 1995, 2003) begin with a short synopsis of Wellin’s (1955) seminal ethnographic study, “Water Boiling in a Peruvian Town.” Why? It is a study of a diffusion that failed, and much can be learned from failure.

Wellin’s study examined the extent to which ecological and cultural factors affect the motivations of individuals to adopt an innovation, such as boiling water for drinking. What could be more important than this kind of lesson for the present book, which focuses on the technologies available today for water treatment?

As Wellin reports, in 1955 Nelida, the health worker for a two-year public health campaign to promote boiling water, failed to convince women in the Peruvian village of Los Molinos to incorporate water boiling into their daily activities. Nelida tried tactfully to convince the villagers to boil their drinking water by stressing that the water was contaminated and could be made safe for drinking only by boiling it. After two years of repeated visits, however, only 11 additional families accepted Nelida’s advice to boil their water, for a total of 26 out of 200 families in the village. She

was surprised to discover how few would follow her advice despite what seemed to be a convincing rational argument. What went wrong? The reasons the women gave for boiling and not boiling varied substantially (see Box 1).

The main problem with Nelida's approach is also found in many safe-water interventions today. Nelida was "innovation oriented" or "technology oriented" rather than "client oriented" or "consumer oriented." Her message was invariant and did not suit the needs or situation of individual families. "She did not begin where the villagers were; instead she talked to them about germ theory, which they could not (and probably did not need to) understand" (Rogers, 1995, p. 5). How could Nelida have gotten through to more of these villagers and changed their health behavior?

The central theme that this paper develops is the paramount importance of knowing the audience to achieve effective behavior change. Wellin's six illustrative cases of water treatment behavior (see Box 1) reveal many of the factors that determined water boiling in Los Molinos. Had Nelida understood the role of these other factors in water-boiling behavior in Los Molinos, she would not have limited her message to "killing germs" and "preventing disease." Rather, she could have devised a multi-level, multi-message strategy that dealt with prevalent norms and beliefs and that was sensitive to the variety of situations that existed in the Los Molinos households.

Nelida should have addressed the **perceived social norms** (boiling only for the ill/weak/pregnant), the role of other **hygiene** behaviors (clean/ordered house), the **social influence** of significant others (visiting brother), the role of **self-image** (seeing oneself as progressive and high status), the **empathy** of the source (the foreigner saw Nelida as friendly), the authority of the **source** (Dr. U versus Nelida), **beliefs** about hot-cold states (water gets "cold" if sitting overnight), other traditional **beliefs** about illness (microbes should drown), the village's work patterns related to boiling and water-drinking **habits** (at midday), the role of **economic resources** (fuel scarcity), and the **lack of time** due to other household chores and absence of other household members to help.

Wellin's study is still so applicable today that it could have easily been conducted in 2008 instead of 1955. He found no single quick technical solution that would change water treatment behavior and other hygiene practices. Because cultural and ecological factors generally play an important role in how people behave, "many innovations require a lengthy period, often of many years, from the time they become available to the time they are widely adopted" (Rogers, 1995, p. 1). To be effective, future interventions and research need to focus on the "adopter-side" of the equation and take into account as many individual, cultural, and ecological factors as possible.

1.2 Overview of this report

In this report we first introduce the theoretical frameworks for communication and behavior change, focused on how innovations spread and become adopted and accepted. We then propose a

communication model for water treatment and safe storage behavior, derived from behavior change theories and the evidence from a variety of health communication programs (Piotrow, et al., 1997). We use our communication model to organize a review of the literature on safe-water interventions and research conducted over the last 20 years. We then apply the model to evaluate a safe-water communication program in the province of Sindh in Pakistan. We close the chapter by discussing the programmatic and research implications of the findings and propose that future efforts use the set of intermediate factors in the model to build evidence around key social and behavioral determinants of sustained household water treatment and storage.

Our analysis discusses the issue of water treatment from a “consumer-centered” approach. Related literatures also refer to this approach as “client-centered” (e.g., family planning), or oriented towards a “receiver” or “audience” (communication theory) or simply towards a “person.” Our approach differs from previous research approaches, which have emphasized technological or mechanical fixes to improve water quality. While previous research demonstrates an orientation towards the source of such technology, the research presented here is oriented towards the appropriate match between the technology and its potential users and consumers.

Also, our focus is on sustained treatment of water to safeguard health, reflecting the need for programs to develop a consistent water treatment habit among audience members. We distinguish between *purposive* water treaters and *consistent* water treaters (Figueroa and Hulme, 2007). Purposive water treaters treat water in special situations, such as when a family member is sick or a flood or other natural disaster temporarily affects the water supply. In contrast, consistent water treaters always treat their drinking water.

2. Theoretical background

The model proposed in this chapter draws from two groups of theories: theories about behavior change communication, and approaches to disease and health.

2.1 Behavior change communication theories

Two related types of theoretical frameworks have been proposed for communication and behavior change: *stage* theories and *predictive* theories. Stage theories focus on the stages that individuals usually have to pass through over time before they change their behavior. Predictive theories identify the factors and causal pathways that determine performance or nonperformance of behavior. Both types of theories can be used to design behavior change programs. Predictive theories are more comprehensive than stage theories and are more useful for program design and evaluation, as we will describe below.

2.1.1 Stage theories

The classic example of *stage theories* is the diffusion of innovation theory (Rogers, 2003). Diffusion theory specifies two interrelated processes: (a) a spatial-temporal dissemination of an innovation within a social system (what, where, and to whom), and (b) an innovation-decision process in which individuals within the social system learn about, evaluate, and adopt an innovation (how and why). The innovation-decision process consists of five stages: knowledge, persuasion, decision, implementation, and confirmation.

Similar stage theories of behavior change have been proposed for attitude change (McGuire, 1989), health behavior (Prochaska, DiClemente, & Norcross, 1992), health communication (Kincaid, 1987, 1988; Piotrow et al., 1997), and fertility behavior (Coale & Watkins, 1986; Kincaid, 2000; Lesthaeghe & Vanderhoeft, 1998). Although the stage aspect of these theories is intuitively appealing and useful for planning interventions, behavior change is more complex with respect to time than such models are capable of representing. All of the authors of such stage theories warn that an individual does not necessarily move through each stage in the exact order as specified by the theory, and that individuals can fall back into an earlier stage after reaching a stage further along in the process.

2.1.2 Predictive theories

The second type—*predictive theories*—identify and describe social, cognitive and emotional factors as important determinants of behavior, irrespective of time. They also overcome many of the limitations of stage theories and provide a set of important determinants of behavior that stage theories omit such as emotion (Zajonc, 1984), motivation (Bandura, 1986) and other factors described later in our model. Predictive theories have been used successfully in the design and evaluation of programs about family planning (Kincaid, 2000; Babalola & Vondrasek, 2005), HIV prevention (Underwood, et al, 2006), youth reproductive health (Babalola, 2006), child immunization (Babalola & Adewuyi, 2005 press), water treatment (Figueroa & Kincaid, forthcoming) and other health areas. The implication is that these determinants or factors act jointly and simultaneously to influence behavior and that programs can be designed and implemented to affect each of these relevant factors.

2.2 Approaches to disease and health

An appropriate model for sustained water treatment and safe storage should take into account both types of theories of communication and behavior change mentioned above. The goal is to provide a comprehensive set of factors that can help develop successful interventions.

The model should also reflect approaches to disease and health. Public health scholars agree that disease and health can be explained by three related approaches: the microbial model, the behavioral

model, and the ecological model (Gostin et al., 1999). These models correspond closely to the classical epidemiologic triad of communicable diseases: the infectious agent, the host, and the environment. All three approaches apply to safe water and to hygiene promotion in general.

2.2.1 *Microbial model*

In the *microbial model*, germs are the causes of disease and interventions to maintain the health of the population consist of eliminating microbes to avoid exposure. In general, in developed countries, “many antimicrobial interventions impose minimal burdens or have been in place so long that the burdens they impose are thought of as a normal part of life” (Gostin, et al., 1999, p. 70). In less developed countries such interventions are often limited, sporadic, and short-lived. Water purification plants are an example of such model. In the developed world, where purification plants are widespread, people are used to the smell of chlorine in water. In many developing countries however, where these plants are lacking or malfunctioning, the smell of chlorine in water is a cause of concern for many people.

2.2.2 *Behavioral approach*

In the *behavioral approach* “interventions occur at the point of human conduct, whether at the individual, group or organizational level” (Gostin, et al., 1999:72), and their focus is on the promotion of healthy lifestyles or on the regulation and control of risky individual behaviors. Behavior theory has been criticized for placing the burden of responsibility for maintaining health on the individual, in effect removing risk factors from their “social and historical contexts” (Pearce, 1996, p. 679).

2.2.3 *Ecological model*

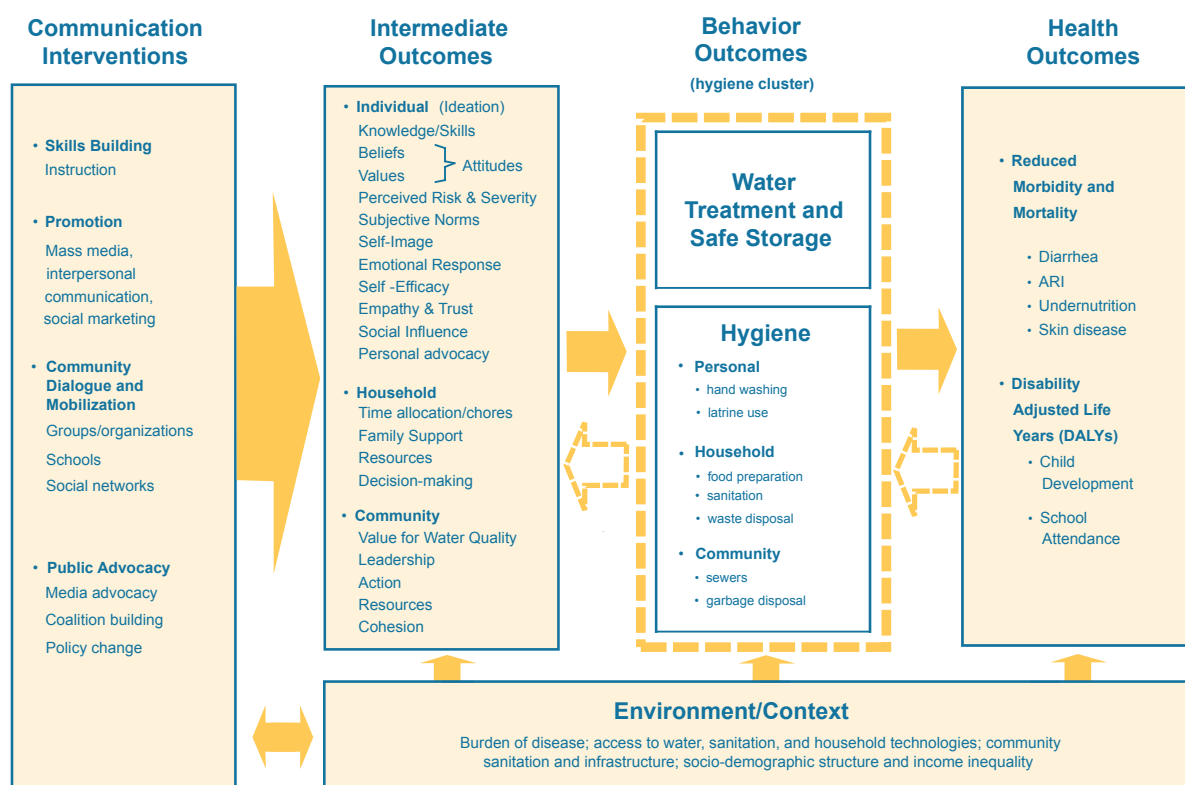
The *ecological model* emphasizes that behavior is influenced by “the conditions under which people live” (Cohen et al., 2000, p. 146). Factors such as access to safe water supply, access to services and products, good housing, availability of sanitary services, education and employment opportunities, gender differences, and the burden of disease itself are “external to the control of the individual” (Cohen, et al., 2000; Gostin, et al., 1999; Pearce, 1996; Yoder, 1997; Caldwell, 1993). In this approach interventions to improve health do not ignore the role of pathogens and individual behavior, but the context in which they coexist is given priority.

The behavioral response of a population to safe water promotion programs is expected to vary with the level of disease burden and the corresponding perception of risk, as well as with the seasonal quantity and quality of water supply. Individual differences in knowledge, beliefs, and perceived control are also important. So are community norms and social influence from relatives and neighbors, as well as the infrastructure or services needed to adopt safe water practices.

3. A communication model for water treatment and safe storage behavior

Based on the theoretical considerations described in the previous section, Figure 1 presents a predictive model of communication for water treatment and safe storage behavior that water programs can use for the design and evaluation of interventions to change these behaviors. The model shows that communication interventions (sometimes labeled promotion and education) affect water treatment and safe storage behaviors by affecting a variety of intermediate factors that directly determine these behaviors and related health outcomes. For example, a mass media campaign may lead mothers to recognize that their children are at risk of diarrhea if they regularly drink untreated water. It may also instill confidence in the audience that the water they personally treat, safely store, and properly handle, will reduce that risk. The levels of perceived risk and self-efficacy that result from the mass media campaign may then be high enough to induce some women to begin boiling their water every day.

Figure 1. A model of communication for water treatment and safe storage behavior



Copyright © 2010 The Johns Hopkins Bloomberg School of Public Health Center for Communication Programs. All rights reserved.

The first column of the model presents a variety of **communication interventions**— skills building, promotion, community dialogue and mobilization, and public advocacy. These can be designed to affect one or more of the **intermediate outcomes**, presented in the second column of the model. In turn, these affect the **behavior outcomes**, which appear in the third column—water treatment and safe storage behaviors and the cluster of related hygiene behaviors, such as hand washing and latrine use.

The fourth column depicts the **health outcomes** that can be expected. There is increasing evidence, discussed later in this chapter, that a cluster of good hygiene practices reduce the incidence of childhood illnesses. In particular, water treatment, sanitation, and hygiene have been shown to reduce morbidity and mortality from diarrhea (see for example, Fewtrell et al., 2005, Esrey et al., 1990) and Kapadia-Kundu, 1994). Research is also mounting about the effect of hand washing on acute respiratory infections (Luby, et al., 2005), and evidence also suggests a connection between household and community hygiene on other ailments such as skin diseases (Aiello & Larson, 2002). Levels of these outcomes, in turn, relate to the general development index or disability adjusted life years (DALYs) in terms of time missed from school and child development in general.

Underlying the causal process depicted in the model are a number of environmental and contextual factors (shown beneath columns two, three, and four). These include the burden of disease, access to water, household and community sanitation facilities, socio-demographic factors, and income inequality, among others.

A feedback process is identified by the broken arrows in the model. Over time, as individuals practice the cluster of healthy behaviors, their behavior is expected to reinforce the intermediate factors that initially induce the behavior. Similarly, experiencing the health outcomes shown in the model is expected to reinforce the cluster of positive water treatment and hygiene behaviors.

3.1 Communication interventions

As our literature review will describe in detail, communication for safe water and hygiene “should not be low-visibility ‘add-ons’ to water and sanitation programming. Sustained behaviors result from giving high priority and adequate resources to hygiene promotion and education” (Cairncross & Shordt, 2004, p.7). A last-minute communication effort to promote water treatment is unlikely to be sufficient to develop a sustained habit or practice of water treatment.

It is beyond the scope of this work to discuss the successes of more than two decades of health communication interventions around the world (Piotrow, et al., 1997). This experience shows, however, that multi-media interventions that are designed based on models as shown in Figure 1 are successful in accelerating the creation of new social norms and changing health behavior. Intervention studies included in this review have used a variety of efforts as presented in the model, including skills building, promotion, community dialogue and mobilization, and public advocacy. More integrated efforts with focus on intermediate outcomes (column 2) however are needed.

3.1.1 Skills building

Most of the interventions discussed in the literature review provided instructions to participants about the correct use of the water technology being promoted. Many of these interventions reinforced this message during household visits to collect data on diarrhea cases used to assess the effectiveness of the water technology.

3.1.2 Promotion

Several studies confirmed the positive effect of the different communication channels used by water treatment interventions for disseminating water treatment and hygiene messages, especially mass media (radio and television), community participation (health clubs, schools, water committees), entertainment education (local theater, videos), and interpersonal communication (motivational interviewing)¹ (Waterkeyn & Cairncross, 2005; Ahmed, 1998; Thevos et al., 2000). Other studies call attention to the importance of the content of the message, which sometimes is not clear or effective enough to change behavior (Cairncross et al., 2005).

3.1.3 Community dialogue and mobilization

Several studies point out that, for behavior to become the norm and self-sustaining (a habit), the concerted action of entire communities is required, including “organizations not normally involved in health promotion to facilitate the broad acceptance of the health message” (Nielsen, et al., 2003; p. 349). Most authors conclude that community involvement is necessary to overcome the common expectation that water and other hygiene behaviors “are not a common concern, rather they are considered private and dealt with at the household level” (Yeager, et al., 1999, p. 538).

3.1.4 Public advocacy

Some programs have used integrated approaches: mass media with community and advocacy components (Ahmed, 1998; Waterkeyn & Cairncross, 2005). There are several initiatives in the water and hygiene fields of increased use of public advocacy to raise visibility and change water and hygiene behaviors². For example, the International Network for Household Water Treatment and Safe Storage (HWTS), created in 2003, has as one of its objectives to advocate, promote, and facilitate the inclusion of HWTS in policies and practices at the national, regional and global levels. The network has raised awareness of the importance of water treatment interventions to meet safe water needs in the developing world.

3.2 Intermediate outcomes

The intermediate outcomes reflect a variety of theories of social and behavior change. Individual, household, and community approaches are all relevant for understanding health behavior. None

¹ Motivational interviewing is defined as a directive, consumer-centered counseling style for eliciting behavior change by helping consumers to explore and resolve ambivalence (Rollnick and Miller, 1995). Differently from non-directive counseling, in this technique the counselor is intentionally directive in pursuing the resolution of ambivalence.

² Examples of such initiatives include the Public Private Partnership for Handwashing with Soap (PPPHWS, <http://www.globalhandwashing.org/>), the International Network to Promote Household Water Treatment and Safe Storage (http://www.who.int/household_water/network), and the World Bank Water and Sanitation Program (<http://www.wsp.org>), to mention some.

should be treated as more important than the others. As Bandura has observed, individuals “serve as a reciprocally contributing influence to their own motivation and behavior within a system of reciprocal causation involving personal determinants, action and environmental factors” (Bandura, 1986, p. 12).

3.2.1 *Individual*

At the individual level intermediate outcomes represent ways of thinking and social interaction that some scholars have labeled as ideation (Cleland & Wilson, 1987; Kincaid, 2000; and Goldman, et al., 2001). They are also known as psychosocial factors, which include the following:

- Knowledge that results from formal learning or accumulated cognitive experiences, such as knowing about a health practice, a disease, or a product (Underhill, 2006).
- Beliefs and attitudes toward the practice or the product, such as believing that chlorine products are harmful or that clear-looking water is safe. Attitude consists of two related elements: the beliefs about an object or behavior and its expected consequences and the positive and negative values of those consequences (Fishbein & Ajzen, 1975).
- Perceived risk and severity about the harm that can be caused by a contaminated environment (Becker 1974; Janz & Becker 1984; Witte, 1992).
- Subjective norms of behavior: what an individual thinks others expect him/her to do, and Perceived norms: what an individual thinks other people are doing (Fishbein & Ajzen 1975).
- Self-image, consisting of important beliefs about oneself that are relevant for a particular behavior, such as being a caring or good mother, or a progressive person (Triandis 1972, 1980).
- Emotional response caused by a new behavior that may be either positive or negative, such as the dislike of chlorine smell and taste (Zajonc 1984);
- Self-efficacy to perform the practice, such as “feeling confident” that one can purify one’s own drinking water (Ajzen 1989; Bandura 1997).
- Empathy and trust with others, such as being responsive to the message source (Rogers, 1959; Batson, 1994) and perceiving it as credible (Slater and Rouner, 1996; Hovland et al., 1953).
- Social influence that is reflected by persuasion from others, whether positive or negative, to engage in the desired behavior, such as peer support to treat water at home (Festinger 1954; Kincaid 2004; Latane 1981; Montgomery & Casterline 1996; Moscovici 1986; Nowak, Szamrej, & Latane 1990; Rogers & Kincaid 1981; Suls 1977).
- Personal advocacy that accounts for the effect on one’s own beliefs, values, and behavior of encouraging others to adopt a new behavior (Piotrow et al. 1997).

3.2.2 *Household factors*

Individual behavior is not always the result of independent decision, particularly in developing countries where intergenerational households are common and where relatives maintain close communication. Studies of health behavior such as water treatment need to consider the role of household and family members as well as the individual. Economic theories of the household, such as the “household production of health” (Becker, 1964, 1965; Grossman, 1972; Berman, et al.,

1994), have brought household dynamics to the attention of health practitioners.

Household variables that affect behavior, according to the model of the household production of health, include *time allocation* to household chores which can substantially limit a person's available time for the practice of some behaviors (Acton 1975; Grossman 1972). *Members' beliefs, values and perceptions* have also been shown to affect a person's intention and practice of a behavior to a large extent (Grossman 1972; Figueroa 1996). *Household decision-making rules and the bargaining power of household members* can also have a strong effect on access to household resources, such as income and purchases of goods and services (Haddad & Hoddinott, 1991; Haddad, et al., 1992).

3.2.3 Community and contextual factors

Beyond the household, social-ecological models of health behavior often view individuals as part of a dynamic system in which individuals and groups interact with their cultural, socio-economic, and physical environments (Sallis & Owen, 2002, McLeroy, et al., 1988). Other theories, such as the Bounded Normative Influence theory (Kincaid, 2004), explain how a new practice can become the norm and influence household and individual behaviors.

Theories that explain how social structure and the external environment shape the health behavior of individuals and families emphasize such issues as:

- *Equitable access to resources* by all subgroups of a society, including access to education, health services, jobs, the mass media and its content, and basic infrastructure such as water and sanitation (Carnegie, et al., 2000; McKee, et al., 2000).
- *Gender roles and gender equity* in mobility and decision-making, as well as in access to resources and services (Connell RW, 1987; Underwood, 2002).
- Dimensions of *social capital* such as trust, reciprocity, and group cohesion that define and influence group behavior as a unit or that, conversely, create factions within communities (Lin, 1999).
- *Community leadership* for collective action, and *collective efficacy* that results from previous successes in collective action (Lord & Brown, 2004; Bandura, 1986; Figueroa, et al., 2002; Kincaid & Figueroa, 2008).

4. Review of the literature: What do we know?

A major purpose of our literature review is to assess the extent to which safe water interventions and research findings support and confirm variables identified in our model³. The objective was

³ Studies included in this review were identified through searches of PubMed, JAMA, EconLit, Sociological Abstracts, AGRICOLA, Social Science Citation Index and Population and Health InfoShare databases. Search terms included combinations or synonyms of water treatment, chlorination, behavior change, hygiene behavior, water behavior, water disinfectants, diarrhea prevention, diarrhea, waterborne, foodborne, fecal-oral, hand washing, belief, water quality, side-effect, water waste, water boiling, rural, point-of-use, bottled water, water-related disease, health education, clean water, KAP, household, community, empowerment, children, women, gender, and epidemic. Organization's websites searched included CARE, Environmental Health Project (EHP), World Health Organization (WHO), United Nations Children's Fund (UNICEF), Carter Center, Thrasher Research Foundation,

to identify studies that had any aspect of behavior as part of the intervention or as part of the conclusions of the study. Thus studies in this review were not selected based on their quality of approach, design, or statistical methods, as would be applied to a statistical meta-analysis.

A 20-year time period was used for the search, from 1985 to 2005, with the exception of Wellin's study in Peru in 1955. The Wellin study, together with those by Nichter in 1985 and 1988, provide a vivid picture from two distinct cultural settings (Peru and India) that illuminate the way people receive water treatment messages and are influenced by them. Because these studies view the world through the eyes of the residents themselves, they contribute valuable insights for water treatment interventions and behavioral research today, despite the fact that they were conducted many years ago.

Only publicly accessible articles were considered for our review. Therefore, it excludes research that may look at consumer-related factors but that is generally proprietary and developed to market specific consumer products.

We identified a total of 27 studies specifically related to water treatment interventions. Of these, 11 contained some information related to behavior. In addition, we identified 20 studies about other hygiene behaviors, such as handwashing and sanitation, 10 of which specifically addressed some of the intermediate outcomes in the model. In addition, 17 articles specifically related to beliefs about diarrhea were also included in the review.

4.1 Summary of findings

The findings from this review show that a **consumer-centered approach** to water treatment is necessary to understand the range of issues properly and to find effective solutions. The reviewed studies contained several particularly interesting findings about participants' perceptions of water treatment and storage:

- Water treatment is not always perceived to have health benefits.
- There are many reasons for treating water besides to remove contaminants, including to aid digestion, to give to family members after they become ill, to remove its cold properties, and as a sign of status.
- Diarrhea is not always seen as a significant health threat. Rather, it is viewed as part of growing up and may even be seen as beneficial for children, except during an epidemic such as cholera, when the need for boiling water suddenly becomes an imperative.

United States Agency for International Development (USAID), Centers for Disease Control and Prevention (CDC), International Center for Diarrhoeal Disease Research (ICDDR,B), International Food Policy Research Institute (IFPRI), Water Framework (FWR), Institute for Research on Poverty (IRP), Institute of Development Studies- Water (IDS Water) and Wateraid. Specific online journal searches included *Social Science and Medicine*, *Communication Research*, *Health Education and Behavior*, *American Journal of Public Health*, *American Journal of Physical Anthropology*, and *Journal of Diarrhoeal Diseases Research*.

- As a disease, diarrhea is perceived to be the result of many different causes, not all related to hygiene. Many of these causes are perceived to be beyond people's own control, such as children drinking untreated water outside the home.
- Water treatment is sometimes not done adequately enough or stored and handled well enough to reduce contamination to a level low enough to reduce the incidence of disease.
- If the consistency of water treatment and handling is too poor, those who try it may fail to realize and perceive any benefits to their health. This finding suggests that knowledge, skill, and persistence are as important as the water treatment itself.

From the point of view of interventions, the literature suggests the following highlights:

- People do not easily change and sustain new behavior as intended by the water treatment interventions, since the benefits are often not clear and compelling enough to convince them to continue with the new behavior.
- As care givers, mothers are important but do not necessarily have sufficient decision-making power within their homes nor have access to resources outside their homes to take effective action.
- The behavior outcome of water treatment interventions may not be sustained for a long enough period to have the desired health effect (sustained diarrhea reduction).
- Community resources need to be tapped by water treatment programs to facilitate the development of water treatment as a social norm.
- Multi-media channels and events facilitate dissemination and socialization of water treatment and hygiene messages.
- Water should not be treated in isolation from other sources of pathogens which cause gastrointestinal disease.

In addition, findings from the studies of hygiene behavior draw attention to non-health variables as motivators for behavior change. For example, studies on handwashing behavior in developing countries found that “health is low on people's list of motives, rather, hands are washed to remove dirt, to rinse food off after eating, to make hands look and smell good, and as an act of motherly caring” (Curtis, 2003, p. 73). In Bangladesh, people used soap “more for peace of mind or for physical feeling of cleanliness than for health reasons” (Hoque, 2003, p. 8). In Thailand, people washed hands when they were visibly dirty and not in relation to activities such as cooking or bathroom use (Pinfold, 1999). In Kyrgyzstan, reasons for washing one's hands included removing visible dirt, teacher's expectation that children must arrive with clean hands, before making bread (respect for bread) and to avoid microbial contamination (Biran et al., 2005). Soap was used in this same setting because of its smell and feeling of cleanliness.

The literature on safe water also confirmed the role of non-health variables on water treatment. In fact, most studies suggest that the health approach is insufficient for sustained water treatment because the health benefit (diarrhea prevention) is just one of many other possible motivators (as Wellin found in 1955), which can include anticipated convenience or improved taste.

In our review of the literature presented below, we have organized the findings according to the intermediate outcomes listed in the model in Figure 1. Thus we present findings related to individual, household, and community variables. We also discuss environmental factors outside the immediate control of individuals and households, and examine key sociodemographic variables related to point-of-use water treatment. It is worth noting that none of the articles reviewed documented the intermediate factors in a unified way. Rather, we found these intermediate factors scattered across studies. These factors were sometimes measured, but we found that most often authors mentioned them as qualitative data based on respondents' comments.

4.2 Individual-level factors

Individual factors can be classified into three subsets. *Cognitive elements* include knowledge, beliefs, attitudes, self-image, subjective norm, and perceived risk related to diarrhea or water treatment. *Emotional factors* include positive or negative emotional responses to water itself and water treatment such as taste and smell, self-efficacy, empathy and trust. *Social interaction* includes discussion of water treatment with family members and neighbors, social support or discouragement from others, and personal advocacy of water treatment. While the intermediate outcomes in the model do not reflect these subsets, primarily to avoid undue complexity, they are useful for a discussion of findings from the literature.

4.2.1 Cognitive elements

We identified several cognitive elements that are related to household water treatment behavior across a range of cultural contexts. In the literature reviewed, the *perceived benefits* of water treatment among mothers and other caretakers are lacking, except in the case of cholera. Furthermore, the *benefits of diarrhea prevention* are also weak and almost nonexistent. On the contrary, beliefs and perceptions unrelated to health per se were found to play a role in water treatment behavior.

4.2.1.1 Knowledge of and beliefs about the causes of diarrhea

Knowledge, and hence education, has always been the main factor addressed by public health interventions seeking to improve individual health. The underlying assumption is that awareness of causes of a disease and knowledge about its prevention is sufficient to induce people to make a rational decision to change their behavior. Although some level of knowledge is necessary for behavior change to occur, for many people knowledge alone has been found to be insufficient⁴.

A majority of the studies in this review, which includes studies in Latin America, Africa and Asia,

⁴ During emergency situations, however, like floods or earthquakes, people know about the risk of cholera and react to the fear caused by such disease. We discuss this later under perceived risk and fear.

have consistently found insufficient knowledge of the pathogenic causes of diarrhea among mothers and caretakers (Goldman, Pebley, & Beckett, 2001; Nichter, 1985). Some studies identified this lack of knowledge as a barrier to sustained water treatment (McLennan, 2000a; Goldman, Pebley & Beckett, 2001; Barbieri, 1993).

Among several studies a common finding is the *belief* among mothers that diarrhea is part of growing up and is due to causes unrelated to personal hygiene or unsafe drinking water. Diarrhea was commonly perceived as a sign of the body's self-cleaning of harmful wastes. Furthermore, some studies also documented mothers' belief that their babies' feces were harmless (Bukenya et al., 1990; Gorter et al., 1998; Yeager et al., 1999; Biran et al., 2005).

In Nigeria respondents often believed that diarrhea is inevitable in infants and young children and that newborns must experience early diarrhea as a sign of survival (Iyun & Oke, 2000). In Ethiopia mothers believed diarrhea helped clean the bowels and therefore was perceived as beneficial for children (Olango and Aboud, 1990). In Guatemala Quick and others (1997) found that many people regarded diarrhea as a normal occurrence of childhood. In Northern Thailand, Baclig and Patrick (1990) found that people reported three types of diarrhea, one of which—a loose bowel movement—was considered as a natural condition and an indicator of normal and progressive child development. In southern Sri Lanka Nichter (1991) discovered that only one of eleven causes of diarrhea referred to dirty water. Similar findings have been found elsewhere in Asia, where “bloody diarrhea may also be perceived as the product of an internal purification process associated with a primary illness” (Nichter, 1991, p. 269).

In their studies in Guatemala of beliefs about children's illnesses, Pebley and colleagues report that mothers identified a specific function of worms in the digestive process (Pebley, et al., 1999; Goldman, Pebley, & Beckett, 2001). Worms were believed to live in a sack in the abdomen, where they aided digestion; if they were disrupted, illness would occur. In Sri Lanka research also found the belief that worms were an important function in digestion and diarrheal episodes (Nichter, 1988).

Other causes of diarrhea identified by mothers in several of the studies reviewed included: (1) infancy teething, (2) traumatic falls, (3) inadequate care of children, (4) imbalance of hot and cold foods or states, (5) improper diet, such as too much fruit, eating sweets or overeating, (6) breastfeeding the child after s/he has been hungry for a while, (7) switching from treated drinking water to non-treated drinking water, (8) evil eye, and (9) mothers' health behavior and emotional state (Nielsen et al., 2003; Goldman, Pebley, & Beckett, 2001; Iyun & Oke, 2000; McLennan, 1998; McLennan, 2000a, Olango & Aboud, 1990; Ketsela, et al., 1991; Kaba & Ayele, 2000; Jintrawet & Harrigan, 2003; Nichter, 1988).

While these factors were perceived to be “causes” of diarrhea, a large percentage of the mothers did not know about germ theory. Even where many mothers recognized poor hygiene or “dirtiness” (such as dirty water, hands, food, or feeding bottles and flies) as being related to diarrhea, few recognized that water can be a vehicle for disease, and the association between poor hygiene and contamination was poorly understood (Goldman, Pebley, & Beckett, 2001; McLennan, 2000a; Quick, et al., 1997, Jintrawet & Harrigan, 2003; Nielsen et al., 2003).

The implication of these findings for health communication and education has been summarized by Pinfold (1999) based on analysis of different communication channels for promoting hygiene behavior in Thailand. The author observed that after the intervention few people mentioned diarrhea prevention as a motivating factor for improving hygiene behavior. Pinfold concluded that attempts to reduce childhood diarrhea through point-of-use water treatment should take into consideration the fact that diarrhea is not always viewed as an illness or as being related to water purity.

4.2.1.2 Beliefs about state of water

In Latin America and in many Asian cultures a common belief is that an imbalance of hot and cold causes illness. “Hot and cold qualities apply to foods, activities, and emotional and physical states and do not necessary refer to temperature” (Pebley, et al., 1999; p.198). In southern Punjab, Pakistan, Nielsen and colleagues (2003) found that mothers classified diarrhea both as hot and cold—whether eating too many hot foods in the summer or eating cold foods during cold weather. Bloody diarrhea was perceived to be the result of consuming hot foods; cholera, the result of consuming cold foods. Moreover, mothers thought of boiling water as a treatment for diarrhea rather than as a preventive measure.

In Peru (Wellin, 1955) and Sri Lanka (Nichter, 1985), culture-specific beliefs of hot and cold clearly defined the type of water that people consume and the time of the day they consume it. Both studies found that boiled water was primarily prepared for ill people and for those in transitional or delicate states, such as infants and pregnant women. People in the Sri Lankan community study considered “heavy” unboiled water as good for anyone in a “normal state” (normal health) and better for satisfying thirst than boiled water. Villagers viewed unboiled well water as fresh and full of life compared to boiled water, which was seen as lacking strength. Boiled water was considered to be “light” and therefore good for old people and for everybody in the evening. Piped water was thought to be “dead.”

People’s beliefs associated with water qualities can affect their water treatment behavior. In a study in rural North Eastern Brazil (Kirchhoff, et al., 1985), households discontinued water chlorination because they believed that the chlorine would interfere with the cooling process that takes place when the water is left in clay containers overnight.

4.2.1.3 Beliefs related to a child's age

In a peri-urban community in the Dominican Republic, one of the most common reasons for not purifying drinking water, among caregivers who knew about the connection between water and diarrhea, was that their children were old enough to drink untreated water. More than a third of all respondents had already stopped or planned to stop boiling water by the time their child reached two years of age (McLennan, 1998). Similarly, in a peri-urban shantytown in Peru, mothers were observed letting older children drink unboiled water more often than they let their younger children (Gilman et al., 1993).

In a subsequent study McLennan (2000b) found that water treatment, primarily by boiling, was almost universal when children were babies. After infancy, the percentage of respondents who boiled their water decreased, but chlorination increased. Among those that had stopped purification, the mean age of children at discontinuation was 14.8 months. Among those who were still treating water by any method, the mean projected age at which they planned to stop treating water was about 4.5 years. The study, however, does not provide further information about the reason that this latter group planned to wait longer to discontinue.

4.2.1.4 Switching from untreated to treated water

In the Dominican Republic, among people who knew that drinking unsafe water could cause diarrhea, the most common reason for not boiling water was that the children would drink untreated water outside the house anyway (McLennan, 1998). Caregivers also reported that switching back to treated water from untreated water was dangerous for children. In a subsequent study, McLennan (2000a) found that residents in a poor urban district did not boil their water because they believed that a child could get sick by switching back to treated water after drinking untreated water. This finding was reported again in a third study in the Dominican Republic (McLennan, 2000b).

Promoting water treatment with messages about diarrhea prevention may not be effective in cultures that do not perceive diarrhea illness as a health problem. Water treatment interventions need to consider that “bloody and acute diarrhea are not value-free conditions in many cultures” (Nichter, 1991: S270). In fact, because diarrhea in many contexts is expected and perceived as natural child development, education efforts to link water treatment and health need to consider multiple complementary communication approaches. One approach is to engage community members in a participatory process where participants openly discuss health issues and potential solutions as they see them. The advantage of this approach is that participants guided by skilled facilitators, reach conclusions within the context of their health culture and social values that facilitate sustained practices (Nichter, 1988).

4.2.1.5 Attitudes –towards the practice

An intervention with street-beverage vendors in Guatemala provides an example of the role of attitudes towards treated water. To improve the microbiologic quality of market-vended beverages in Guatemala, a water treatment system was introduced that consisted of dilute bleach for water purification, narrow-mouth containers with spigots for storage of treated water and beverages, hand washing with soap and education in using the system. Findings showed that sales increased when customers believed that the vessel and chlorine treatment made water safer to drink (Sobel et al, 1998). This *perceived benefit* by vendors and the *value for safe water* by consumers resulted in a *positive attitude* towards treated water by vendors as well as customers. This positive attitude seemed to have influenced vendors' sustained utilization of the chlorine solution and the special vessel over time during the five-month follow-up period. The authors also note that the perceived benefit of increased sales was noticed by other vendors not originally involved in the intervention who asked to acquire the system.

The value placed on water quality will also affect attitudes towards treating it. In a separate study in a peri-urban area in Guatemala, Quick and colleagues (1997) found that a chlorine and vessel intervention was not optimally utilized because of the relatively low priority the population placed on clean water relative to other needs. Conversely, in Zambia, in the evaluation of motivational interviewing to improve disinfection practices, Thevos and colleagues (2000; p.8) noted that “The study community placed a *high priority on water quality* which, combined with education about water contamination and diarrhea, could contribute to high levels of readiness or motivation to adopt the water intervention.”

4.2.1.6 Attitudes –towards the product

Perceived attributes of a product for treating water, whether positive or negative, contribute to the product's adoption and sustained use. The studies discussed below show that products that are readily accessible, perceived as easy to use, safe, affordable, and designed to fit individual, household, and community practices, as well as people's needs and preferences, have a better chance of being adopted.

In Kenya, following an intervention that introduced point-of-use water treatment, Makutsa and colleagues (2001) reported that adoption rates for chlorination were higher in the study communities, at 35%, than in urban projects in other countries, where rates ranged from 5% to 15%. The authors explain that, among other things, the interest in chemical disinfection shown by this Kenyan population may have contributed to this positive result. They observe that the higher adoption rates for chlorination found in these communities may have been due in part to *ease of access to and use of the product*. Clay pots, which were *preferred* by the population, were modified with fitted lids and spigots, thus making them *likeable*. *Perceived affordability* of the product was another factor that led to higher adoption rates, according to the authors. The treatment system,

which used clay pots and chlorine solution, was subsidized, making water treatment less costly for the population.

The study of Guatemalan street-beverage vendors by Sobel, et al. (1998) found that several attributes of the product—a narrow-mouth plastic vessel, among others—contributed to their continued use by the vendors five months after the intervention. Water vessels with a *standard volume* were reliably disinfected with a *standard amount* of fixed-concentration chlorine solution (fixed amount that fits the vessel). The vessel's narrow mouth impeded recontamination by keeping hands out and the spigot made serving *easy* and *safe* (prevent introducing hands into the vessel). During the same study, a strainer to rinse ice and a funnel were added to the vessel, the latter at the request of the vendors. Improving quality of the product (the vessel) to meet the expressed needs of its users (the vendors) facilitated adoption.

In Zambia, Quick and colleagues (2002) noted that one of the reasons for the high observed use of the water disinfectant was its substantially lower price (*perceived affordability*) and time saved (*perceived ease of use*) compared to boiling. Although the water storage vessels were available at a discounted price, those who did not purchase the vessel said that money (*affordability*) was the main barrier.

In Guatemala, having an *economical* technology, such as a clay filter produced locally in a nearby community, was recommended as a way to facilitate adoption (Barbieri, 1993). Studies of water filter use have found that *flow rate* is valued by consumers. Fewster and colleagues (2004) found that more than half of all households in a rural community of the District of Machakos, Kenya, where concrete bio-sand filters were introduced, experienced a flow rate that was *slower than convenient*. In rural Bolivia, Clasen and colleagues (2004) observed that about half of the households in the gravity water filter intervention reported that the filter was occasionally *too slow* to provide water for the family at all times, and that about a third of the filters were broken or temporarily out of service (Clasen et al., 2004, p. 656). Clasen considered this proportion a significant failure rate that could possibly be reduced through better design and instruction of the technology itself.

4.2.1.7 *Perceived risk and severity*

A person's perceived risk of contracting an illness and the perceived severity of its consequences (medical and social) are likely to trigger healthy practices (Becker, 1974). These important variables have had little if any affect on water treatment behavior, however, according to our review of the literature. Except for outbreaks of a cholera epidemic that motivate people immediately to treat their water, we found weak evidence that under normal conditions the perceived risk of diarrhea motivates water treatment or other hygiene behavior.

In fact, the perception of health risks from contaminated water is often low, and many people like their untreated sources of water and see *no need to treat*. In rural North-Eastern Brazil, for example,

one of the reasons participants gave for discontinuing water chlorination was their belief that the *water was already clean* (Kirchhoff et al., 1985). In Sri Lanka villagers boiled their water for reasons unrelated to water contamination, such as when someone was ill. “Villagers do not associate boiling with killing bacteria,” so boiling was seen as unnecessary for healthy people (Nichter, 1985). In Peru, according to Wellin (1955), people did not understand how microbes could live in water or how they could hurt a healthy adult, so they saw no need to boil their water.

Barbieri’s study in Guatemala (1993) is one of the few studies to highlight the risk and severity of diarrhea as a reason for treating water (by filtering). The president of the community development committee in La Soledad realized that the community had a very high rate of child mortality due to diarrhea, as well as frequent incapacitation of adults during the growing season. These concerns compelled him to mobilize and train community members to filter their drinking water. In contrast, in the Dominican Republic McLennan (2000b) found that a caregiver’s knowledge of a child’s risk for diarrhea was not a predictor for boiling water.

The perceived severity and fear of cholera results in immediate action to treat water. An intervention in Madagascar promoting 20-liter jerry cans and hypochlorite solution reached peak sales during the rainy (cholera) season, then declined in the dry season (Dunston et al., 2001). Researchers concluded that in this situation water treatment was perceived as a cholera prevention action, rather than as a water treatment practice per se. In Zambia, Quick (2003) reported that a major cholera epidemic in January 1999 increased the sales of the water treatment product Clorin that had been launched in October 1998. Product sales, which had been low in the first three months, increased during the threat and then receded in the dry season, as the product was used as an outbreak response measure to control the epidemic.

Water treatment may be widespread in the face of such crises, partly as a result of the efforts of governments and international assistance organizations to ensure that people treat their water to prevent cholera during an epidemic or after a natural disaster. Once the disaster is over and the messages to treat water stop, most people go back to their normal practice of not treating their drinking water. Such emergency response actions, while necessary and appropriate, may inadvertently send a message that water treatment is necessary only in “potentially fatal” occasions, not under normal conditions.

4.2.1.8 Subjective norms

Social norms influence how a person behaves. If other family members, friends, and community influentials see a behavior as positive, an individual tends to meet their expectations. Thus a positive subjective norm is developed. If a behavior is viewed as negative, then a negative subjective norm will develop. Attitudes and subjective norms are predictors of the intention to practice a behavior (Fishbein & Ajzen, 1975).

Few studies in the literature examine the influence of subjective norms on water treatment. Wellin's (1955) ethnographic study in Peru is one that does. Wellin describes how social norms in the Los Molinos community discouraged Mrs. D. from boiling drinking water, even though she was convinced by the health worker (Nelida) of the benefits. Mrs. D. finally could only boil her water without fear of being socially sanctioned in Los Molinos when a recognized authority visiting the community recommended the practice (see Box 1, p. 2).

McLennan's (2000b) study in the Dominican Republic, however, found no significant relationship between perceived community practice (the social norm) and individual. The author noted that this lack of association was unexpected and may have been due to problems in how the survey question was worded and people's unfamiliarity with this type of question. Another explanation may be that in many places water treatment behavior is unknown to many people in the community. In this case, socializing water and hygiene behaviors through communication (media and interpersonal) probably would accelerate the creation of new social norms more favorable to water treatment.

4.2.1.9 Self-image

Self-image consists of important beliefs about oneself that are relevant for a particular behavior. For example, thinking of oneself as responsible, reliable, and dependable, rather than daring, spontaneous, and thrill-seeking, would be expected to influence not only health behavior but also response to health promotion (Harrington & Donohew 1997). Studies in the water treatment literature point to some findings that are related to self image and the image of mothers—neglectfulness, perceiving oneself as poor, and the perception of being progressive.

Goldman et al. (2001) developed two measures of beliefs about the cause of diarrhea in Guatemala. One was based on responses to a hypothetical scenario about another person's child who has diarrhea. In this case 24% of respondents reported that "neglectfulness" by the caretaker was the cause of diarrhea in those children. The second measure was based on responses about the causes of diarrhea in their *own* children. In this case only 10% said that inadequate care was the cause. The authors concluded that the difference may reflect the reluctance on the part of mothers to acknowledge poor hygiene in their homes, or perhaps just a lack of mothers' awareness of the causes of their own children's diarrhea.

Either way, the study confirms that *neglectfulness* is considered one of the causes of children's diarrhea. In the Dominican Republic McLennan (2000a) found that among the most frequently mentioned barriers to diarrhea prevention, particularly handwashing, was a "lapse in caregiving," "descuido" or "forgetfulness." He argues that these barriers may be due to a lack of conviction about the effectiveness of handwashing in preventing disease or a real manifestation of neglectful childcare. This latter possibility, he adds, does not lead to "any simple or obvious approach to health education."

In Guatemala those who *believed they were poorer* (self-image) than the typical household were less likely to adopt healthy hygiene-related beliefs and behaviors (Goldman, et al., 2001). Wellin (1955) also found that the poor in Los Molinos, Peru, were more insular and tended to manifest “greater resistance to new ways and to be more prone to regard innovations as threats to established custom.” Conversely, he describes that Mrs. B’s perception of herself as *progressive* and of higher status was the main reason why she consistently boiled her drinking water. Mrs. B saw herself as *enlightened*. She boiled water as a rejection of local standards (see Box 1, p. 2).

Similar findings about the role of self-image have been documented for the Punjab area of Pakistan. Nielsen and colleagues (2003) found that hygiene practices in this area were related to the wife’s perception of *her social status* rather than as measures to prevent disease. In Bangladesh most people who have been found to continue to follow improved water and sanitation practices do so due to perceptions of well-being, convenience and social status (Hoque et al., 2004). In Burkina Faso one of the reasons mothers followed the hygiene advice provided at health education sessions may have been their wanting to be modern rather than believing in germ theory (Curtis et al., 1995).

4.2.2 Emotional factors

The literature provides compelling evidence that emotions produced by how the treated water tastes, smells, looks, and feels will affect people’s decision to continue to use it. Even when knowledge of benefits is high, emotional responses may lead people to reject treated water, if their sensory responses to it are negative. In contrast, if treated water tastes good, people may continue to use it just for the pleasure it produces.

Trust in and emotional connection with the source of the intervention’s message also play a role in water treatment behavior, according to the literature. Although self-efficacy is sometimes classified as a cognitive variable, we treat self-efficacy here as an emotional factor because it usually is measured by how confident a person feels that they can perform a given behavior. Self-efficacy is formally defined as a set of “beliefs in one’s capability to organize and execute the courses of action required to manage prospective situations” (Bandura 1997, p. 2).

The studies below provide examples of the role that emotions (appearance, taste, smell, self-efficacy, and empathy with and trust in source) play in affecting behavior:

4.2.2.1 Fear of chemical side effects

Following the intervention among street vendors in rural Guatemala to promote the use of chlorine for water treatment, Sobel et al, (1998) found that over 90% of study participants thought that chlorination was a good way to purify water. Around 15%-30% of vendors, however, expressed concern about chlorine having serious adverse health effects. Similarly, the evaluation of a point-of-use water quality intervention in rural Kenya found a widespread fear among community members

that chlorine caused infertility (Makutsa, et al., 2001). Community health workers had to convene special meetings to dispel those fears. In rural northeastern Brazil, besides the dislike of chlorine taste, households discontinued water chlorination believing that chlorine-treated water could be poisonous because it smelled like household bleach (Kirchhoff et al., 1985).

4.2.2.2 Emotional responses to smell, taste, and clarity

A consistent finding across all the water chlorination studies reviewed was the negative emotional response to the smell and taste of chlorine. About a third of participants in the intervention to increase water-treatment among street vendors in Guatemala mentioned that chlorine had a *disagreeable smell and taste*, even though more than 90% said that chlorination was an effective way to purify water—a cognitive element (Sobel et al., 1998). In the Dominican Republic, not liking the taste and smell was the second more common reason stated for not using chlorine (McLennan, 2000a), while *disagreeable taste* was the most common reason for not using chlorine among those who said that it was a good way to treat their water (McLennan, 1998). In a recent program evaluation in Zambia (Olembo, et al., 2004), the taste and smell of Clorin were among the reasons people gave for stopping its use.

In Sri Lanka people boiled water instead of chlorinating it because they disliked the medicinal smell of chlorine. However, they also *felt* that boiled water was “tasteless” (Nichter, 1985). People also said that unboiled water *satisfied thirst better* than boiled water. The author also noticed that strong and healthy people were little concerned about the water they routinely used, unless its *color, smell, or taste* changed. Villagers expressed a desire to *see* the source of their drinking water, so covered wells were not popular. Villagers actually considered it a *hardship* to drink water of unknown origin.

In Machakos district in Kenya, users of the bio-sand filter liked the filtered water because of its *clarity* and the *decrease in temperature* that resulted from evaporation (sweating) through the concrete walls of the filter (Fewster, et al., 2004). Crump et al. (2005) found that acceptability of the flocculant-disinfectant product in rural Kenya was due to its ability to *reduce water turbidity*.

Taste, smell, and the appearance of water are concerns not only in developing countries but also in other cultures. For example, in a metropolitan area of Quebec, Canada, Levallois, et al. (1999) found that 30% of survey respondents expressed dissatisfaction with the taste of their tap water, 14% were dissatisfied with the smell, and 10% disliked the appearance. The main predictor of the use of alternatives to tap water (such as bottle water and home treatment) was dissatisfaction with the taste of tap water. Those who disliked its taste were six times more likely to use an alternative source than those who did not mind its taste.

4.2.2.3 Self-efficacy

In the household water disinfection and safe storage project in Zambia, Quick, et al. (2002) concluded that one of the reasons for the “striking improvement in water treatment and storage behavior” was the study population’s sense of self-efficacy, which derived from their perceived ability to prevent diarrhea and their knowledge about how to do it (boiling or chlorination).

4.2.2.4 Empathy and trust

The way in which housewives in Los Molinos perceived the community agent, Nelida, affected their adoption of water boiling. To some women in the village, but not to all, Nelida was a friendly authority, with whom they could empathize. The higher social class housewives viewed Nelida as the educator of the poor, and they considered her as “belonging to a lower social level than theirs [and] their responses to her efforts were consistently indignant and hostile” (Wellin, 1955; pp.96). In contrast, Dr. U’s professional status and superior social rank weakened the community’s belief that boiling water was just for the ill but rather necessary.

Empathy with and trust are generally overlooked in health interventions. In fact, it was disconcerting to find that most studies reviewed did not attempt to assess the effect of the message’s source on the study populations. Trust and empathy are important factors in effective communication. “When two individuals share common meanings, beliefs and mutual understandings, communication between them is more likely to be effective”⁵ (Rogers, 1995; p.287). Interventions should seek to involve change agents and spokespersons who share community beliefs and values and can convey trust among community members. This will enhance the effectiveness of the communication and the outcomes of the health message.

4.2.3 Social interaction

Social influence and personal advocacy. Despite the relevance of these factors on behavior, we identified few studies in our review of the literature that specifically documented the role of social influence and advocacy. People learn through observing the behavior of others (social learning, or modeling) (Bandura 1986), and through interpersonal and group communication (Moscovici 1986; Nowak, Szamrej, & Latane 1990; Kincaid, 2004). Personal advocacy reinforces a person’s health behavior (Piotrow et al., 1997). The two studies below provide an example of the role of social influence on water treatment behavior.

Goldman, Pebley, and Beckett’s (2001) study in rural Guatemala of the diffusion of ideas about personal hygiene found evidence of a diffusion process through *social contacts*, primarily by way of

⁵ This is known as homophily. Nelida’s middle class status created a heterophily gap with the high class and the low class women that prevented them from paying attention to her message.

interpersonal channels (such as family and friends). Having a relative living in the capital city or abroad was one of the strongest predictors of knowledge of germ theory. Women living in larger communities or those in closer proximity to the capital—thus facilitating exposure to new ideas—were more likely to understand the concept of hygiene and water contamination. The authors found that individuals involved in community groups were significantly more likely to understand the relationship between poor hygiene and diarrhea, because they were more likely to come in contact with such ideas in the community. The authors concluded that both interpersonal and impersonal channels are important sources of information and that they influence social norms regarding hygiene and contamination.

In Peru (Wellin, 1955), the brother of Mrs. A, who lived in the capital city, brought the idea of germs and boiling water to the village and influenced Mrs. A's behavior. In Zambia “the strongest reason for starting Clorin use was [that] neighbors were using it” (Olembo, et al., 2004; p:14).

Communication interventions that use interpersonal communication, and community dialogue and mobilization as described in Figure 1 create social learning opportunities that positively affect water treatment behavior. In Madagascar, community mobilization significantly increased the community adoption of point-of use water treatment and positive storage practices (Dunston et al., 2001). Neighborhoods that were in the last stages of the community mobilization process were more likely to follow water treatment and safe storage practices (19.7%) compared to those that were in the earlier stage of the process (8.4%).

By facilitating the exchange of ideas, these types of social gatherings can help accelerate the change of social norms, but they may not be feasible in contexts where lack of social mobility limits women's access to resources outside the household and where women's decision making capacity is constrained (Halvorson, 2004). In these contexts, however, culturally appropriate groups can be created that provide similar opportunities, like the *Jiggasha* groups in Bangladesh that allowed women to join group discussions organized in the homes of opinion leaders located at central points in the village social network. The increase in modern contraceptive use was 5 times greater among women in these groups than among women who were visited by field workers at home (Kincaid, 2000b).

Waterkeyn and Cairncross (2005) reported success in creating a “culture of cleanliness” by means of community health clubs in two districts in Zimbabwe. The authors attributed the success of the health clubs to the opportunities they provided for community members to socialize, to learn while enjoying themselves in entertaining activities, to participate in issues of interest to them and to gain prestige by holding a club membership. The prestige of club membership helped new hygienic practices become the social norm. Club membership may have also provided opportunities for personal advocacy. The success of the health clubs is an example of the role of bounded normative influence (Kincaid, 2004) in social change: a new behavior among club members becomes normative within the club where it has support, members recruit new adopters and the practice gradually spreads to other members of the community until it eventually becomes the norm.

Nichter (1988, p. 49) advises that public dialogue in which community members are involved in identifying and addressing common problems is an active process of discovery that allows members to realize that individual illnesses “are in reality a community health problem.” Community dialogue however, requires a commitment from program managers and acceptance on their part that health problems cannot be compartmentalized and solved by magic bullets. It also requires some degree of flexibility to respond to community needs. According to some authors, this approach is also “the most likely way to have an observable impact on water-related health problems” (Halvorson, 2004, p. 55; Nichter, 1988). In Bangladesh, an arsenic mitigation water project was flexible enough to respond to people’s preference for a community piped water system over household-based options, which they kept for emergency situations (Hoque et al., 2004).

Talking to others about a product or a practice and the perception of other’s behavior have been shown to predict health behavior across health issues and cultures (Kincaid, et al., 1999; Storey and Schoemaker, 2006). These findings suggest that programs *would always benefit by* promoting socialization of a new behavior through interpersonal communication in community meetings and events and through the mass media (Valente, et al., 1996; Storey et al., 1999).

4.3 Household factors

Studies that focus on the household as the unit of analysis are scarce. The role that household characteristics and dynamics play in health behavior, particularly water treatment, has not been studied enough. Early adoption of water treatment reported in some of the studies mentioned below could be better understood if a richer set of ideational and household data were available.

Nonetheless, the available research suggests that programs seeking to promote preventive or treatment behaviors in the home “must deal with a domain that is not only personal or psychological but one that is also social in nature” and that interventions will be received within the “framework of the household [vis a vis the investigators’ framework]” (Berman et al., 1994; p. 211). The studies mentioned below provide evidence of how competing demands on mothers’ time, the influence of relatives in the household, levels of household income, and household decision-making patterns affect water treatment.

4.3.1 Household time allocation

Maternal fatigue, lack of time, and general inconvenience were barriers to sustained water treatment efforts cited by several authors. Wellin’s study on water boiling in Peru shows how time demands limited the capacity of Mrs. E to boil water for drinking during a typical day (Wellin, 1955) (see Box 1, p. 2). In McLennan’s studies in the Dominican Republic, “not having sufficient time”, as well as “caregiver too tired,” were common reasons cited for not boiling water (McLennan, 1998, 2000b).

The author recommended that water treatment interventions take into consideration the added responsibilities of water treatment on a mother's daily workload.

In Pakistan many mothers had heavier workloads because boys and men were migrating to urban areas to seek jobs. Farming responsibilities were added to their regular housework. Mothers often said that “there is not enough time to boil water every day” (Halvorson, 2004).

A number of studies document the difficulties that mothers face balancing the demands on their time. For example, studies of the effect of having a sick child to care for (including dealing with diarrhea) have found that mothers do not always make significant changes on the amount of time they spend on their various regular chores. Researchers recommend that, because mothers often have so many daily responsibilities that they cannot forego, household interventions need to take into account on mothers' time limitations (Bentley, et al. 1995).

4.3.2 Support from household members and other relatives

Research in Guatemala by Goldman and colleagues (2001) found that the closer household members lived to their relatives, the weaker the relationship between diarrhea and hygiene practices. The authors concluded that people who live with or near parents or in-laws and who see them frequently are less likely to adopt hygiene-related behaviors, although the relationship was not statistically significant. They reasoned that when family members live near relatives, they may have less overall authority or relative power within the family than in the absence of relatives, and thus be less able to adopt new practices on their own.

In many developing countries older relatives exert power over the entire family and function as gate keepers of traditions that family members are expected to respect and follow. While these findings could also be classified as a form of (negative) social influence, they are reported here as household factors because the source of influence is structurally related to characteristics of the household, especially the constant presence of extended family members, such as grandparents.

In contexts where women's mobility is limited, relatives also can play a significant role in providing support for household chores like water treatment. In Pakistan, the absence of husbands due to labor reasons, forced many women rely on fathers-in-law brothers-in-law, fathers, brothers or older sons to provide them with access to basic household goods such as soap and proper water storage containers (Halvorson, 2004).

In Sri Lanka Nichter (1988) found that treatment of children's diarrhea was a *family event*, with decisions about care-seeking involving not only the mother but also other family members, and in many cases other community members as well. In one of the three cases described in his study, the process started with *the family* labeling the diarrhea event as *badeillya*—copious diarrhea with vomiting— which is considered most serious. Since the mother had been with fever, *the family*

decided that she should stop breastfeeding to reduce the liquids given to the child and avoid upsetting the worms in the child's stomach. The child was given coffee to dry out the diarrhea.

On the fourth day, *the family considered* taking the child to the health center so the doctor could give oral rehydration solutions. Because the diarrhea continued, however, the *father*—suspecting a planetary cause—consulted first an astrologer and then a friend, who provided him with adult-dose tablets that had worked for his own child (Nichter, 1988, p. 45-46).

In Pakistan Halvorson (2004) also found that the management of diarrhea involved other family members and not just the mother. The author observed that the care of a child was the responsibility of mothers-in-law, sisters-in-law, and older siblings living in the house, as well as of the mother. Mothers-in-law, older mothers, and grandmothers also “strongly influenced decision-making about water management and hygiene behavior within the household environment” (Halvorson, 2004, p. 48). Similar findings were reported in Punjab, Pakistan, by Nielsen and colleagues (2003) in their study of childhood diarrhea. The authors noted that health education needs to consider the role of the grandmother and the mother-in-law within each household, as well as the husband-wife relationship.

In Kerala, India, the study of hygiene behavior by Cairncross and colleagues (2005) uncovered the effect of a supportive *household norm* on handwashing behavior. Respondents in their study were more likely to demonstrate correct hand-washing in those households where *all women* reported the practice. The authors also observed that education and communication in the study sites affected women's behavior, but not men's. Key informants confirmed that this lack of effect on men was explained by the fact that the interventions were directed to women, which gave the impression that the project was for women only.

4.3.3 Household resources

Several of the studies reviewed document the positive association between higher socioeconomic status and hygiene-related behaviors, but few if any explain the underlying mechanisms of this association. In the Dominican Republic families with more household goods (refrigerator, stove, radio, and television) were significantly more likely to purify drinking water than those who had less than four of these goods (McLennan, 2000b). In their Guatemala study Goldman et al. (2001) concluded that households with a higher socio-economic status were more likely than poorer households and other members of the community to report causes of diarrhea related to hygiene or contamination.

In a more recent study of home-based interventions for childhood diarrhea, Luby and colleagues (2004) found that some households with a refrigerator adopted the new behaviors (bleach, vessel and soap) sooner than others. The authors concluded that having a refrigerator may have contributed to a reduction of diarrhea in these households by keeping chlorine-treated water cool without adding

contaminated ice. They also noted however that refrigerator owners also benefited from receiving soap. They concluded that “refrigerator ownership identified a broader household characteristic associated with more rapid, effective use of interventions” (p.425).

In Zambia (Thevos, et al., 2000), participants reported lack of money as one of the reasons that they did not intend to purchase chlorine to purify their water. In the Dominican Republic some of the main reasons given for no longer boiling water were “cannot buy enough fuel,” “no stove,” and “no appropriate pots” (McLennan, 2000a).

4.3.4 Household decision-making

Who makes the decision about expenditures in the home is likely to affect sustained water treatment. The positive effect on health of women’s control over some of the household income has been widely documented. In Pakistan lack of control over household resources was one of the reasons that mothers mentioned as a barrier to investing in diarrhea prevention measures and treatment (Halvorson, 2004). In Kyrgyzstan there is often negotiation between spouses over what should be bought; and in households where the married couple live with the husband’s parents, the son’s mother, not his wife, had the final authority over decisions regarding household expenditures (Biran, et al., 2005).

4.4 Community factors

Communities can play a significant role in health promotion, but they may also hinder the adoption of a new behavior. Communities that participate in dialogue and collective action can produce community-level outcomes that facilitate and enhance individual behavior (Figuroa, et al., 2002; Kincaid and Figuroa, 2008). These outcomes include strong leadership, sense of ownership, favorable social norms, social cohesion, goal-setting, a value for self-improvement, and collective efficacy. The literature reviewed contains some examples of how community factors can affect household water treatment.

4.4.1 Value for water quality

In Zambia’s motivational interviewing project, Thevos and colleagues (2000) noted that the study community placed a *high priority on water quality*. Together with education about water contamination and diarrhea, this community value could have contributed to high levels of readiness or motivation to adopt the water intervention, the authors concluded.

4.4.2 Community leadership

In Guatemala Barbieri (1993) reported the positive role of *strong community leadership* in reducing diarrhea. The president of the community development committee in La Soledad, Daniel Lucas, acted as a *catalyst* to initiate a water treatment intervention in the community. After receiving training on the use of a water filter, he took the lead in motivating households in his community and in training them to filter their drinking water to prevent diarrhea.

The Wellin (1955) study in Peru showed how community leaders can have an opposite effect. Local leaders in Los Molinos were unconcerned either as officials or as men with women's household routines (p. 97). At the same time, local midwives, who exercised informal leadership among women, helped to reinforce the custom of boiling water just for the ill, rather than as a community-wide good practice.

More recent studies have advocated for the involvement of community opinion leaders to make water treatment interventions more effective (Luby, et al., 2004). In some cultures this approach would also include traditional healers from whom mothers generally seek advice and services (Halvorson, 2004).

4.4.3 Community action and resources

Social organizations such as health committees, health clubs, and mothers clubs have also proved effective in improving water treatment and hygiene practices. In Zimbabwe health clubs provided the opportunity for community members to socialize and to learn new hygiene behaviors. The health clubs attracted increased participation that contributed to the continuation of hygiene practices in the community (Waterkeyn and Cairncross 2005). In Thailand Pinfold's (1999) study of communication channels for hygiene promotion described how the participation of primary schools served as a medium for educating about hygiene practices. The study showed that schools were the only communication channel that had a significant, positive association with changes in health behavior, especially hand washing. In rural Guatemala, individuals involved in community groups were significantly more likely to understand the relationship between poor hygiene and diarrhea, presumably because they were more likely to come in contact with innovative ideas than those who were not involved (Goldman, et al., 2001).

4.4.4 Community cohesion

Social cohesion helps members of a group or community to stay together and actively contribute to the group (Figueroa, et al., 2002). In the Dominican Republic McLennan (2000b) reports that the only factor that proved significant for any method of water purification was greater *social support*, as measured by the Maternal Social Support Index (MSSI)—an 18-item scale that measured

both qualitative and quantitative aspects of mother's social support, including social networks, participation in community organizations, and help with children and household tasks. Mothers who reported receiving support from the community were more likely to treat water than those who did not receive support. The author contends that this social support helped mothers find the time and energy to comply with the extra demands of water treatment.

In Tanzania Lynch and colleagues (1994) used a participatory approach for trachoma prevention. Program managers started *where villagers were* regarding face-washing practices to prevent trachoma, and they respected the other needs of the villagers, as well. By involving representatives from all groups in the village and by allowing villagers to discuss their problems and priorities, the program gained insights about what might work best. By planning actions based on the villagers' interests and capabilities, the program was more likely to be sustainable. Sharing children's face washing with co-wives and neighbors was devised as a form of community support during this trachoma prevention program. Face washing of children increased.

This collective participatory process increased not only the villagers' *sense of ownership* of the trachoma prevention program but also their sense of *cohesion* and collective-efficacy to deal with other community problems. Increased face washing practice was also associated with household factors such as less time constraints by mothers and proximity to water sources, a significant structural factor that limited water availability in the village when its water pump broke down.

4.5 Environmental and contextual factors

The external environment, which is usually beyond the immediate control of individuals and communities, can strongly hinder or can facilitate the practice of household water treatment and safe storage. Burden of disease, especially the incidence and thus the threat of cholera, is related to knowledge and experience with water treatment technologies. Other factors such as gender, class, caste (in South Asia), and poverty or income inequality also influence access to safe water and hygiene (Roy and Crow, 2004). These factors are often neglected because they are not usually amenable to programmatic change. But water and hygiene promotion programs need to give them attention.

In the Philippines Dargent-Molina and colleagues (1994) documented the important role of contextual factors on diarrhea events. The authors studied the interaction of maternal education with contextual factors, measured as community resources (electricity, transportation and communication services), number of community mothers clubs, and household assets. The results indicate that community resources in particular played a significant role in diarrhea prevalence among children 6-12 months of age. Even maternal education, which has been shown to be protective for child health, had an insignificant effect on diarrhea events in the poorer communities.

The studies below provide examples of the role of these factors on water treatment behavior. More research is needed, however, to understand the specific role these contextual factors play in access to safe water and to design interventions that avoid perpetuating them.

4.5.1 Access to products

The long-term effects of easy access to treatment products (chlorine, vessels, fuel, wood for boiling, filters, etc.) on water treatment behavior are not well assessed in the studies reviewed. The majority of the studies that discuss availability of the product do so in the context of interventions to test the effectiveness of a water technology. They typically distribute the products to the participants in their own households for research purposes, thus making them easy to obtain.

The follow-up investigation by Quick and colleagues (1996) in Bolivia, three months after the study of an intervention (narrow-mouthed vessel and chlorine solution) was completed, found that chlorine use had declined. This decrease was attributed in part to the inconvenience in obtaining a supply of the calcium hypochlorite solution. In Madagascar Dunston and colleagues (2001) concluded that readily available *distribution channels* (which facilitated access) made it easier to satisfy the unexpected demand for the water chlorination product (Sûr'Eau) that emerged during the cholera epidemic.

4.5.2 Tradition of free goods

Dependence on external sources for free water treatment and storage technology can have a negative long-term effect if those sources suddenly disappear. In rural Kenya, for example, Makutsa et al. (2001) found that an important challenge in marketing the Safe Water System (point-of-use water treatment and safe storage) was trying to change the behavior of a population with a history of receiving free goods from non-governmental organizations, even though the price of these items was similar to commonly purchased items.

4.5.3 Access to water

As obvious as it may sound, without adequate *access to water* there is just so much a water treatment or hygiene program can achieve. Even in germ-literate communities and households, in water-scarce areas, sanitary education programs probably will not change hygiene practices (Gilman et al., 1993). In Peru, using direct observation of household hygiene practices, Gilman and colleagues found that families that *used more total water* also interrupted fecal contamination by hand washing more often. Curtis et al. (1995) found a similar result in Burkina Faso; “compounds with domestic water connections were more likely to report ‘safe’ hygiene behaviors” (p. 389). While these studies do not correspond to water treatment per se, they clearly demonstrate that access to water facilitates related hygiene practices (behavioral outcomes), as shown in Figure 1.

4.5.4 *Geographic location*

Location makes a difference. In Guatemala women living closer to the capital and closer to bus service and open roads understood the relationship between hygiene and diarrhea prevention better than women living in less accessible places (Goldman, et al., 2001). The authors concluded that, since many rural villages are geographically remote, those connected to larger towns by roads are more likely to gain access to products and information related to disease prevention.

4.6 **Socio-demographic characteristics**

4.6.1 *Mother's education*

Research has shown that, independent of a mother's knowledge of diarrhea causation, her *educational level* affects the likelihood that she will adopt preventive health behaviors (Ketsela et al., 1991; McLennan, 2000b; Cairncross & Shordt, 2004). Goldman, Pebley, and Beckett (2001; p.59) described several mechanisms in which schooling acts on health behavior: "First, schools generally emphasize neatness and order even if they do not teach hygiene explicitly. Education can also provide the means for translating new ideas into action by promoting new ways of thinking and increasing self-esteem. Furthermore, women who have been to school may identify themselves more closely with urban 'modern' culture that has norms about sanitation and biomedical explanations of disease causation."

4.6.2 *Language and Ethnicity*

Language spoken, rather than ethnicity, has been found to affect hygiene-related beliefs. In rural Guatemala Goldman et al. (2001) reported that indigenous women who only spoke Mayan were less likely than those who spoke Spanish to have hygiene-related beliefs and to accept new ideas related to hygiene and sanitation. Hence, the lack of water treatment might also be explained by lack of access to information in the appropriate language and in terms familiar to the population.

4.6.3 *Mother's age*

In the same study in Guatemala, Goldman, et al., (2001) found that older women and women with more than three children were significantly more likely to have an understanding of hygiene and contamination than younger women and those with three children or less. These findings are consistent with those from a study in rural Ethiopia that looked at diarrhea-related knowledge and practices of mothers and caregivers. Maternal age was positively correlated with adequate knowledge of causes, consequences, and treatment of diarrhea and with adequate practice of diarrhea treatment (Ketsela, Asfaw, & Belachew, 1991). Although the authors do not provide further explanation, this association may be the result of accumulated "medical knowledge" by household members through

more contact with the medical sector (Figueroa, 1996). If so, this finding suggests that water treatment and other hygiene information should be channeled through health providers.

4.7 Safe water storage

Most of the research on water treatment in the reviewed literature also included discussion of safe water storage. Few of the studies, however, discuss individual or household behaviors related to storage and other water management practices. Recently, field studies have begun to address relevant aspects of household water handling—in the broader sense of behaviors during water collection, transportation, storage, and use.

A recent study in rural Honduras by Trevett, et al (2005) that examined post-supply water quality deterioration mechanisms found a series of household behaviors that led to water contamination after collection. The authors identified five quality-deterioration factors: use of hands, dipping utensils, collection and storage containers, and bacterial growth. They conducted four contamination experiments (fingertip testing, dipping utensil experiment, collection container experiment, and ladle experiment), two coliform growth experiments, and a water use and hygiene observation study to assess the role of each of these factors on water quality deterioration.

In more than half of the observed water-drawing events (56%), there was finger contact with water, and about half of the fingertips tests (44%) tested positive for fecal contamination. Water was drawn by several family members, including children as young as two years old. The utensil-use experiment revealed that ladles did not help maintain water quality but actually made it worse. The authors speculated that ladles were being used for other purposes that might contaminate them. Households that poured water out of storage vessels had better water quality than those that used a ladle or other dipping method (p. 158). The results from their coliform growth were inconclusive. The authors concluded that water programs should give more emphasis to hygiene practices surrounding domestic water management.

Dipping a utensil in stored water is a common practice when storage containers do not have a spigot. In rural Bolivia Clasen and colleagues (2004) found that when respondents were asked to demonstrate how they would access the water, 85% dipped a cup or other utensil into the stored water (p: 653). Only 18% of households had a jerry can for water storage, and a majority of households stored water in a barrel, bucket, clay pot, or tank.

In Rwanda, Gasana et al. (2002) found that additional contamination of water occurred during transportation from the source to the home. Contamination also increased in storage containers when fresh water was added to the stored water. Homes in which storage containers were cleaned more often had less pollution of the stored water.

5. Water treatment as a cluster of related behaviors and diseases

While the focus of the literature review and the intention of this chapter are to draw attention to the social, cultural, and behavioral correlates of water treatment and safe storage, we also include a discussion about hygiene practices and the evidence of what we call a hygiene cluster.

The recent meta-analysis by Fewtrell, et al. (2005) shows that water supply interventions were effective in reducing diarrhea and other illnesses, but also water treatment, sanitation, and hygiene interventions were also found to reduce significantly the risk of diarrhea, and most had a similar degree of impact on diarrhea illness. These findings confirm that if the larger health problem is the fecal-oral transmission of pathogens, then one must recognize that this occurs through the contact of fingers with fecal matter and through food and water borne routes, all those represented in the hygiene cluster.

Particularly in highly fecal contaminated settings, the “lack of effect [of water chlorination] on diarrhea rates suggests that improvement in water quality may affect morbidity only when other variables relating to fecal-oral agent transmission are ameliorated at the same time” (Kirchhoff et al., 1985, p. 173). In fact, one of those variables may simply be the amount of water that is available.

Our model of communication for water treatment and safe storage (Figure 1), incorporates four clustered hygiene behaviors in column 3, “Behavior Outcomes” that contribute to improved health outcomes shown in column 4 of the model.

In their review of 87 studies conducted during the Water and Sanitation Decade, Esrey and others (1990; in Kapadia-Kundu, 1994) identified the following four factors as important for diarrhea morbidity:

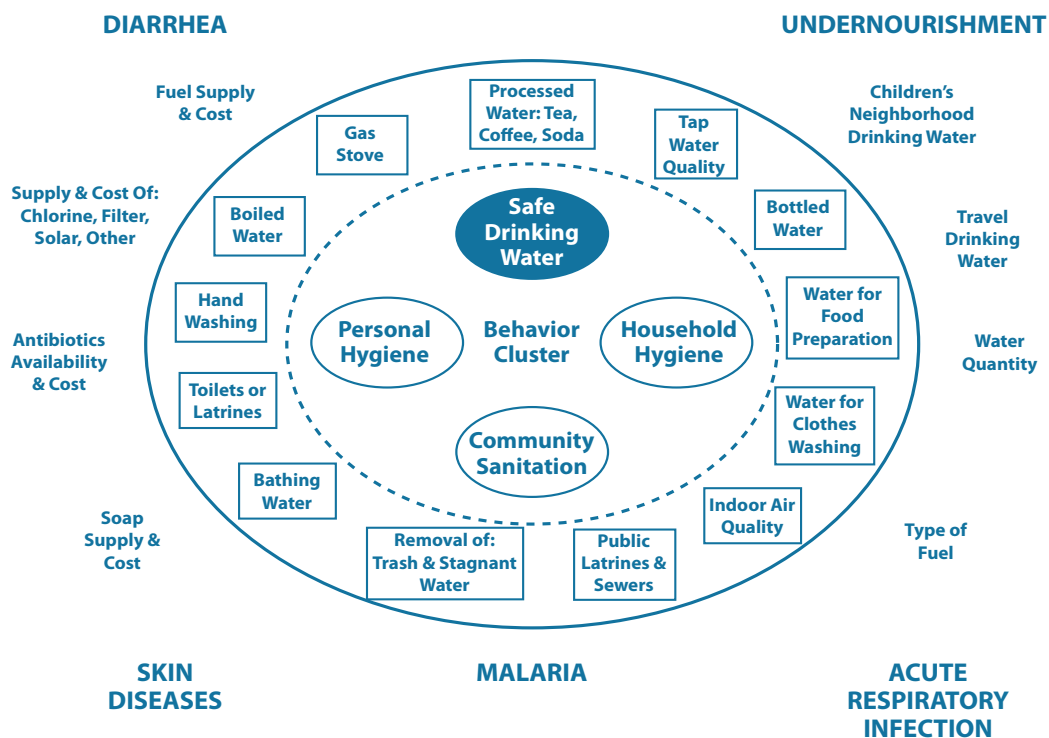
- Safe drinking water—reduction of pathogens below risk levels.
- Personal hygiene—washing hands and face, bathing, and cleaning eyes.
- Household hygiene—food preparation, utensil and container cleaning, safe disposal of human excreta via toilets and latrines, etc.
- Community sanitation—safe disposal of human excreta by means of sewers and public latrines, trash and garbage removal.

These four factors are shown in Figure 2 at the center as a cluster of related behaviors. Viewing these four behaviors as a cluster indicates that several types of behavior must be addressed if one wants to solve the diarrheal health problem. The cluster approach recognizes that variation in context and the complexity of diarrhea transmission may render any of them, when addressed alone, insufficient to reduce diarrheal disease to a level where those who adopt the desired practice can realize the health benefits and then be able to attribute those benefits to such practice. The fact that lack of personal hygiene (especially handwashing) and poor household hygiene are major sources of recontamination of treated drinking water underscores the need for safe household water storage.

Shown in the two circles around the behavior cluster are many of the uses of water that are associated with these behaviors. Most of these uses and the technologies and behaviors related to their use, such as gas stoves and hand washing, are within the control of family members. These appear in the middle ring, between the dashed line and the solid line. Those shown beyond the outer ring, such as the availability and cost of chlorine, fuel, soap, and even antibiotics, are outside of the immediate control of households themselves.

In the corners of the figure, the model shows some of the other related health problems and diseases, such as undernourishment, acute respiratory infection, malaria, and skin diseases and disorders. The greatest threat from diarrhea is for children who also suffer from poor nutrition, reduced immunity, and upper respiratory infection at the same time. These diseases are also sources of opportunistic infection for people living with HIV/AIDS, so safe water and personal hygiene are usually included as part of ARV treatment.

Figure 2. Water Treatment within a Cluster of Related Behaviors and Diseases



Copyright © 2010 The Johns Hopkins Bloomberg School of Public Health Center for Communication Programs. All rights reserved.

How does one assess the connection among these behaviors? The studies by Esrey et al. (1990) and Fewtrell et al. (2005) do not provide evidence that these multiple interventions (combining water, sanitation and hygiene) have an additive effect. Fewtrell and colleagues conclude that they were effective in reducing diarrheal disease *just as individual interventions*. The authors deduce that the lack of additive effect may be due to a lack of focus or lack of sufficient attention to each individual behavior when combining interventions.

Other studies reviewed provide evidence of a statistical association between water treatment and other hygiene behaviors and their joint effect on diarrhea. In rural Guatemala, for example, Bartlett and colleagues (1992) measured 26 indicators of hygiene behavior. Of these 26 indicators, 11 represented anti-hygienic practices. The study found that 6 of these 11 had a cumulative or dose-response effect in increasing risk of persistent diarrhea (diarrhea lasting 14 days or more) among children under three years of age. The six indicators included in this study's hygiene index were (1) toy on ground, (2) baby bottle on ground, (3) mother's hands dirty, (4) feces in yard, (5) trash on floor in household, and (6) animals loose inside the house. While only 10% of children in households with none or only one of these six indicators had an episode of persistent diarrhea, 60% of children in households with all six indicators experienced at least one episode of persistent diarrhea.

The authors concluded that inadequate hygiene exposes children "more frequently or to higher doses or multiple types of enteric pathogens [which] might result in increased risk of persistent diarrhea" (Bartlett et al., 1992, p. 71). They also reported that these hygiene behaviors "clustered," meaning that statistically they correlate with each other.

Ruel and Arimond (2002) developed a similar hygiene index based on spot-check observations for their study in Accra, Ghana. The authors measured 11 indicators and used the following 6 to create the index: mother clean, child clean, diaper/bottom clean, compound swept, no poultry feces, and no stagnant water. Households were classified as poor hygiene if they had between 0-3 good hygiene practices, those with 4-5 were categorized as average hygiene and those with all six practices were classified as good hygiene.

The results of the analysis showed that the composite index had a strong dose response relationship with diarrhea prevalence. Among households with poor hygiene, up to 40% reported having had diarrhea in the previous two weeks. This figure was 32% among average households and 25% among good hygiene households. From the regression results, the authors also reported an interaction effect between socioeconomic status and the hygiene index. "Children in the lowest socioeconomic group were approximately half as likely to have diarrhea in the previous two weeks if their household was in the good hygiene, compared to the poor hygiene group" (p. 24). Similarly, this positive effect of good hygiene was also observed among high income households. The authors noted that for average households the pattern was unclear. Nevertheless, the authors concluded that good hygiene practices could mitigate the negative effects of a poor environment on diarrhea, particularly important among poor households that tend to have higher diarrhea prevalence.

A study in Salvador, Brazil by Strina and colleagues (2003) found that households that had excreta disposal had 2.2 times more children with positive scores (hygienic behaviors) than negative scores (unhygienic behaviors). This ratio was only 1.2 for households that did not have such a facility. Moreover, 15 of 18 hygiene behaviors assessed were not directly related to sanitation, which makes

this association even more notable. The authors attributed this finding to the higher awareness of hygiene among households with a sanitary facility compared to those without one. In Bangladesh (Hoque et al., 1995) also found a positive association between water, sanitation, and hand washing behavior. Two factors, using tube-well water instead of pond water and latrine ownership, were positively associated with “good handwashing” behavior among 90 semi-rural women.

These results suggest that the cluster of hygiene behaviors should continue to be explored. Programs should develop or use field opportunities to test a more comprehensive scenario where water treatment is promoted together with other hygiene behaviors that can include not only individual hygiene but also household and community hygiene. Building the evidence about how hygiene practices affect water treatment can provide guidance to more successful programs.

6. Lessons learned

The literature indicates that no single approach to the promotion of water treatment is likely to be sufficient to sustain the practice. Furthermore, to have public health impact at the population level, safe water promotion needs to be implemented and evaluated at scale and address all of the factors—social, cultural, economic, demographic, political, and ecological—that facilitate and inhibit behavior change (Olembo et al., 2004; Blum & Feachem, 1983). A challenge is that promotion of water treatment and storage does not easily fit with conventional views of water supply agencies’ responsibilities, which tend to be more concerned with engineering. Ministries of health and Ministries of education may be logical “champions” for water treatment and storage behaviors.

Whoever the lead organizations or leading coalitions, the review suggests that the promotion of water treatment and safe storage needs to renew efforts through innovative, integrated, and holistic approaches to be more effective in the future. The two most apparent alternatives are to:

- Find a way to promote water treatment that does not rely solely on a promise of reduced diarrheal disease.
- Address the issue of safe drinking water as multi-factorial, including hygiene and sanitation issues, and design programs to change the entire cluster of behaviors related to diarrhea, as well as other related diseases.

For the first alternative, research needs to be conducted in specific cultures to determine what factors beyond immediate health benefits (reduced diarrhea) could be used to promote and increase water treatment in that culture. The literature suggests that in some developing countries water treatment can be promoted in several ways such as using a status aspiration approach to encourage treatment, or focusing on the benefits of treatment as improved taste and physical appearance, convenience, economy, and portability.

The second alternative, promoting water treatment within a cluster of related behaviors, might appear to be difficult to implement compared to one that focuses on water treatment alone. After all, how can programs designed to reduce four sources of contamination succeed when achieving success in reducing even one of them alone is difficult? The literature on handwashing promotion suggests that the approach (how a message is communicated) and the message itself promoting those behaviors make a difference in how successful an intervention can be in changing health practices. The study by Waterkeyn and Cairncross (2005, p. 1958) on sanitation and hygiene in Zimbabwe showed that health clubs were able to promote 20 hygiene practices and that club “members’ hygiene was significantly different ($p < 0.0001$) from a control group across 17 key hygiene practices ...”

More research is needed to analyze the supporting and reinforcing effect of these cluster behaviors. For example, does sustained hand washing have positive effects on water treatment? Are people who consistently use latrines and who keep them covered and clean more likely to treat their water?

These implications do not mean that water treatment should be buried within a general hygiene intervention. On the contrary, water treatment interventions need to become highly visible and be supported and promoted at four levels –the policy environment (allocating resources for promotion and water supply); service systems (including health providers and schools, distribution systems, mix of technologies); community leaders and community groups (supporting the water treatment), and; individuals and households.

7. Application of the model for communication for water treatment and safe storage to Sindh, Pakistan

In this section we present selected results of the application of the model in Figure 1 for the evaluation of a safe water communication program in the province of Sindh in Pakistan. This evaluation and the study by Olembo and colleagues (2004) are the two studies that have particularly assessed the effect of a safe water promotion program in a non-controlled experimental setting. Their results should inform future large-scale safe water interventions.

We used the model in Figure 1 to organize qualitative and quantitative water treatment research in Pakistan where a communication program was being implemented to promote water treatment⁶. The research elicited information on a range of individual, cultural, and environmental variables related to water treatment and hygiene behavior, as shown in the model.

Using a participatory qualitative approach, the research identified intermediate (ideational) and contextual factors related to sustained household water treatment. What people said about water treatment was consistent with some of the findings in this literature review and confirmed many aspects of the model.

⁶ Details of the program and research can be found in Figueroa & Hulme (2007).

Although people in the Pakistan study recognized that water could be contaminated, most did not regularly treat their water. The main reasons were the cost of fuel for boiling, lack of time to treat, uncertainty about how to use water treatment technology correctly, and because a perception that not treating water carried little risk. Some believed that “their own water” was clean enough to drink and that, when their children got sick, the cause was drinking contaminated water from somewhere else. When they did treat water, the method mentioned most often was cloth filtering. Participants did not trust chlorine-based products and disliked the smell and taste of chlorine-treated water.

They attributed diarrhea to the proliferation of flies, children putting dirty things into their mouths, germs that stick on children’s hands when they play on the ground, and their own lack of time to care for children—letting them crawl on dirty floors, walk barefoot, eat raw food, and so forth. Most participants considered diarrhea to be part of growing up and some remarked that their family’s elders have always drunk the same water and are still alive. Some participants attributed curative properties to boiled water and therefore found it useful when someone was sick at home. Participants acknowledged that in health emergencies it was necessary to treat their water.

Information derived from the qualitative research was used to develop a household survey questionnaire. The survey was conducted in Sindh province in May-June 2005. Survey respondents were 1,500 women with children 12 years and younger⁷. The interview also included direct observation of the presence of treated water in the household, water storage containers, location for hand washing and soap availability, and general household and latrine cleanliness. Household water treatment was measured by asking women when was the last time that they cleaned ⁸ their drinking water at home.

Twenty-three percent of respondents reported having treated their water within the past week—35% in urban areas and 16% in rural areas. The most commonly used method was the cloth filter (13%), followed by boiling (6%) and alum (3%). Only 39% of respondents spontaneously reported knowing about boiling water, the most common household method used worldwide. The main reason given by the majority of those who treated their water was that “it looks dirty,” followed by “to remove germs.” Only 19% said that preventing diarrhea was a reason for treating their water.

Multiple logistic regression was used to determine which variables made independent, statistically significant contributions to regular water treatment in Sindh. Table 1 presents a summary of the

⁷ The survey was fielded by the Pakistani Institute of Development Economics (PIDE) with the technical assistance of the Center for Communication Programs from the Johns Hopkins University Bloomberg School of Public Health. Financial support was provided by the United States Agency for International Development (USAID), under the Global Development Alliance Initiative, contract GPH-A-00-02-00008-00.

⁸ The word clean was the English translation of the action of treating water to make it safe to drink. It is important for household surveys to find the term that better describes household water treatment in the local context. This facilitates understanding by respondents and avoids explanations from interviewers that run the risk of being non-standard.

results, organized along the lines of the general model (Figure 1). The multiple logistic regression analysis included recall of the communication campaign and ideation (computed as an index). We categorized the independent variables as having direct and indirect effect on water treatment behavior. Because ideation directly affects water treatment, any variable that affects ideation, such as recall of a mass media campaign, has an indirect effect on water treatment, as indicated by the arrows in the model.

With data from the survey, variables derived from the model were able to explain 42% of the variance in water treatment and correctly classify 86% of the survey respondents as adopters or non-adopters of a water treatment method. The ideation index, composed of: (1) knowledge of treatment technologies, (2) beliefs and values (attitude), (3) discussion of water treatment with others, and (4) perceived social norms was the variable with the strongest relationship to water treatment, measuring 29% of the variance.⁹ (See Figueroa & Hulme, 2007 for more detail on the Pakistan study). As long as these variables and their measures fit the specific culture being studied, we expect this approach would yield similar results in other settings where water treatment programs are being planned.

⁹ To assess the cumulative effect on water treatment behavior of these four ideational factors, a single composite ideation index was computed using the four ideational factors. To develop this composite index, a factor analysis of principal components was used. The Cronbach alpha measuring the reliability of this score was 0.72 indicating a very good level of consistency. Each factor was computed through factor analysis that included all the ideational items listed in Table 1. Cronbach scores for each of the four factors ranged from 0.63 to 0.94.

Table 1. Statistically Significant and Positive Independent Determinants of Water Treatment in Sindh, Pakistan 2005 *

DIRECT EFFECTS	IDEATIONAL FACTORS
<ul style="list-style-type: none"> • Type of employment • Religion (Hinduism) • No. of women in the household <p>Environmental Factors</p> <ul style="list-style-type: none"> • Tap, river, or pond water • Scarcity of that water • Poor water quality • 2 to 5 hours to obtain water • Home storage of water • Clean latrine 	<ul style="list-style-type: none"> • Knowledge of treatment methods • Beliefs and Values <ul style="list-style-type: none"> - Untreated water can make a child sick - Treatment can prevent diarrhea - “Clear water” is not necessarily safe to drink - Tap water needs to be treated for drinking - Sweet tasting water is not necessarily safe to drink - Good health does not come from God but rather from what people do for themselves - I only trust water that I have treated • Discussion of Treatment with Others <ul style="list-style-type: none"> - Spouse, friends, and relatives - Encouragement by health workers and other - Encouraging others to treat their water • Perceived Social Norms (for water treatment) <ul style="list-style-type: none"> - Percentage friends - Percentage of community members
<p>INDIRECT EFFECTS (through Ideation)</p>	
<ul style="list-style-type: none"> • Level of campaign recall • Years of education • Soap in hand washing area • Has a regular latrine • Community group participation • Attended group meeting to talk about water treatment • TV cable ownership 	
<p>NOTE: Results from the logistic regression analysis of follow-up survey data from 1,500 women; R²=0.42 with 86% of cases correctly classified as adopters or non-adopters (74% positive & 89% negative predictive value).</p>	

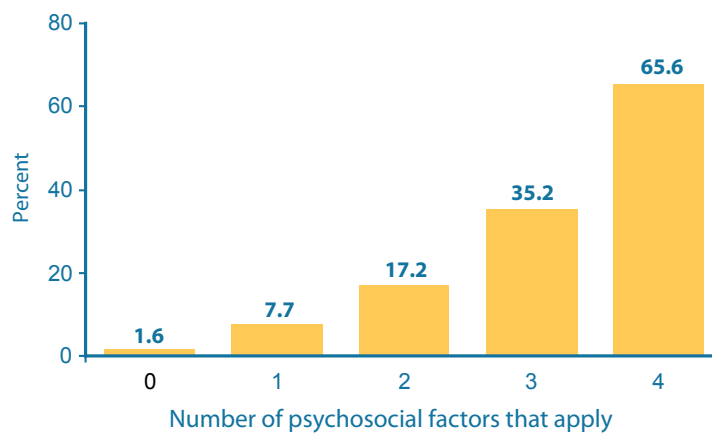
* Source: Figueroa & Hulme, 2007

The findings about ideation in this survey are encouraging for programming on household water treatment, because the socio-demographic and environmental variables¹⁰ are much more difficult to change than any of the ideational factors. Graphically, the strength of these factors on water treatment is shown on Figure 3. The greater the number of ideational factors that applied, the greater the probability that a respondent regularly treated water.¹¹

¹⁰ Significant environmental factors in this study included variables that imply contaminated water sources, or suggest a cleaner home (clean latrine and a water storage device). Religion and type of employment—having a regular job or being an employer—had positive and direct effects on water treatment, as did number of women in the household. The effect of education is indirect: women with more years of schooling have a higher level of ideation which makes it more likely that they treat their water. Cable ownership, an indicator of socio-economic status, also functions indirectly.

¹¹ For each of the four ideational factors, responses were split at the median and categorized as “low” or “high”

Figure 3. Percent water treatment by the number of psychosocial factors that apply (Pakistan Survey, 2004)



The promotional campaign and community participation measures affected the ideational factors, which in turn led to a greater likelihood of water treatment. These findings imply that behavior change programs aimed at increasing water treatment at the household level in Sindh should promote these four factors. Quantitative results showed that overall, the television campaign reached 90% of the urban population and 63% of the rural population with water treatment messages. Those exposed to the campaign were more likely to treat their water: 30% of women with a high level of recall of the water treatment messages treated water at home compared to only 18% of women with low or no recall.

The positive results of this application of the model using data from Pakistan are encouraging. They call for more consistent and comprehensive efforts to document the role of these intermediate factors on water treatment behavior in order to continue to improve the effectiveness of water treatment interventions. More large-scale applications are needed. “Taking a small effort to scale involves many changes in communication methods, “compliance-assurance” approaches, and perceived incentives” (Olembo, et al., 2004; p. 4).

8. Implications for program design and research

Improving water treatment interventions should begin with an understanding of the audience and its point of view regarding water treatment technologies and related behavior. To date, many well intentioned interventions have not involved their audiences from the beginning or conducted assessments of the factors described in the model (Figure 1) before introducing a new household water treatment and safe storage technology. Below, we offer some suggestions on the steps to take to improve program design and directions for future research.

for each of the four variables. The four variables were then summed to determine how many factors applied to each respondent.

8.1 Steps for program design

The model provides practitioners with a tool to identify factors that are relevant in the specific contexts where interventions are being planned (column 2 in the model). The review of the literature offers examples of such factors from real case-studies. Practitioners are encouraged to use this list of factors and these examples. They can use the model to help them think about their intended audiences and also help guide new qualitative research to learn more about each of their own audiences. The following are some concrete recommendations that practitioners can follow when designing a communication intervention to promote water treatment and safe storage:

1. Identify the potential audiences for the intervention. For water treatment this may include not just mothers of young children, but also fathers, the extended family and community members, and doctors and health workers. The review shows that these audiences are important because of the role they usually play to support or hinder the adoption and consistent use of water treatment practices.
2. Conduct a thorough audience research. Practitioners are encouraged to conduct or commission research to:
 - a. Explore the individual, household and community level factors listed in column 2 of the model. The review presented in this report offers a wide range of examples of some of these factors and the way in which they influence water treatment.
 - b. Identify the communication channels available to reach the intended audiences, including community organizations, local radio, local theatre groups or other local media that can be used to effectively reach the audience and which the audience trusts.
 - c. Identify relevant leaders in the community that can become supporters of the water treatment intervention and message.
3. Design the communication intervention. Once practitioners have a thorough understanding of their audience's knowledge, attitudes, perceptions, practices, family needs and home context, they can use the model to design communication interventions that will effectively change water treatment behavior. Column 1 in the model provides a list of communication approaches that practitioners can use. The literature indicates that no single approach to the promotion of water treatment is likely to be sufficient to sustain the practice, and that innovative and holistic approaches are needed to be effective in the future. Traditionally water treatment has been promoted with the promise to eliminate diarrheal disease. The review in this report suggests that other approaches should be explored in addition to health benefits:
 - a. Promote water treatment in a way that does not rely solely on a promise of reduced diarrheal disease. The literature suggests that water treatment can be promoted by using a status aspiration approach or focusing on the non-health benefits, such as improved taste and physical appearance, convenience, economy and portability.
 - b. Address the issue of safe drinking-water as multifactorial problem as described by the, cluster of related behaviors associated to diarrhea and other related diseases. This alternative might appear to be difficult to implement compared with one that focuses on water treatment alone. After all, how can programs designed to reduce four sources

of contamination succeed when achieving success in reducing even one of them alone is difficult? On the other hand, if hand washing, lack of sanitation facilities, and nonsupportive household and community hygiene norms are not addressed at the same time, then those who do adopt water treatment and safe storage may never achieve the health benefits that are promised. If they do not see them, how can we expect the new behavior to be sustained? Community approaches as listed in column 1 of the model can be used to promote multiple behaviors. The study by Waterkeyn & Cairncross (2005) on sanitation and hygiene in Zimbabwe showed that health clubs were able to promote 20 hygiene practices.

4. Use a mix of communication channels and community mobilization approaches. To achieve “synergy” and increase program effectiveness, practitioners are encouraged to use multimedia approaches rather than just a single channel. Promotion (through mass media, social marketing, local events, market days, community groups and schools, local theatre and others) can create public dialogue around water treatment and can bring out to the public what is now considered a private matter. Creating community dialogue and action about water treatment in schools, groups and organizations and through social networks will help improve skills, clarify misconceptions and keep the practice in the minds and lives of individuals and families up to the point when water treatment practices become a household habit and a new social norm.
5. Advocate for water treatment promotion at the policy level. Public advocacy as listed in column 1 of the model can increase the likelihood that water treatment is scaled up and promotion become more successful in changing and sustaining water treatment practices. Policy changes can support the availability of resources and infrastructure for water treatment and encourage water treatment. In August 2008, the Ministry of Health in Indonesia issued a National Policy on Community Based Total Sanitation that includes household water treatment as one of the 5 pillars of the policy. Interestingly, the other four pillars include, eliminating open defecation, increase hand washing with soap, and proper management of solid waste and waste water. Less than one year after the policy was issued, 3 large districts in Java have started to roll out Household Water Treatment and Safe Storage programs. This is a remarkable accomplishment if one considers that in Indonesia, only water boiling was accepted as a safe option to treat water at home for many decades.
6. Monitor progress and evaluate the intervention. The intermediate factors in column 2 of the model can be used develop indicators to monitor progress of the water treatment intervention. Using the findings from the audience research described above, practitioners can developed indicators to measure the individual, household and community level factors such as attitudes, knowledge, skills, self-efficacy, and others identified in the research. Monitoring these indicators will provide information to the intervention about which factors are improving and what others need additional effort or a refined promotion strategy to enhance program performance. This monitoring can be conducted using qualitative methods or short interviews in a selected households to track program progress. A more thorough evaluation after a year of the start of the intervention will provide more reliable information to assess accomplishments and identify factors that need to be addressed in the next phase of the intervention.

Behavior change is a process and the model provides a list of factors that need to be in place for behavior to become sustainable. Practitioners should not expect that all relevant factors will change after one single intervention. The list of factors can be used to guide monitoring progress towards the goal of sustained practice and identify which factors need to be addressed in next program stages. Through monitoring and evaluation as described above, practitioners can design interventions over 2-3 years or longer with a clear map/guide of how to track behavior change.

8.2 Directions for future research

Future research for water treatment interventions should look beyond the health outcomes such as diarrhea prevention that have been studied so thoroughly. To find a way to promote water treatment that does not rely solely on a promise of reduced diarrheal disease, research needs to be conducted in specific cultures to determine what factors, beyond immediate health benefits (reduced diarrhea), could be used to promote and increase water treatment in that culture. Future research, using qualitative and quantitative methods, should increase our knowledge of other important aspects of water treatment programs that have not yet been adequately examined. To date, research abounds about the impact of water treatment on diarrhea (column 4 of the model). This research, however, provides results about only a small part of the model. There is a significant lack of research on all of the factors in column 2 and column 3 of the model. Likewise, research is needed to assess the effect of communication interventions (column 1) on these important intervening factors (column 2) and behaviors (column 3). Had the model been available, many of the studies included in this literature review might have done more to investigate which factors were contributing to the success or failure of specific water treatment interventions. Moreover, this additional information would have been useful for improving the next series of interventions.

To improve research about the factors identified in the model, researchers need to construct valid and reliable measures of each of the intervening variables in the model. More resources should be allocated to this task. The evaluation of the intervention in Pakistan provided one example of how this can be done, but more studies are needed across a wider range of physical and cultural contexts. Through future research using this model in other contexts, a clear picture of the influence of social, cultural and behavioral factors on uptake of household water treatment and safe storage can be developed. Identifying a set of factors that are applicable across cultures and applying them in program design will optimize the use of resources in large-scale water treatment programs.

Future research should also examine the cumulative effect of exposure to communication interventions on water treatment behavior and assess their cost-effectiveness. Research from the field of family planning suggests that establishing a new social norm takes time and commitment and that communication programs designed using models such as the one proposed here make significant contributions to behavior change.

Finally, more research is needed to analyse the supporting and reinforcing effect of these cluster behaviors. For example, does sustained hand washing have positive effects on water treatment? Are people who consistently use latrines and who keep them covered and clean more likely to treat their water?

To have public health impact at the population level, safe water promotion needs to be implemented and evaluated at scale and address all of the factors—social, cultural, economic, demographic, political and ecological—that facilitate and inhibit behavior change (Blum & Feachem, 1983; Olembo et al., 2004). A challenge is that promotion of water treatment and storage does not easily fit with conventional views of water supply agencies' responsibilities, which tend to be more concerned with engineering. Ministries of health and ministries of education may be logical “champions” for water treatment and storage behaviors.

9. Conclusion

In this report, we have presented a model that not only helps structure and synthesize the research literature on water treatment, but also can be used to improve the design and effectiveness of future water treatment programs. The review of the literature confirmed the usefulness of the model in identifying most of the important factors that influence water treatment and safe storage behavior, including non-health and health factors as well as community, household and individual factors.

Above all, the literature revealed the limitations of using only education about the connection between pathogens in the water and diarrhea to convince people to purify their drinking-water at home. Water treatment behavior is clearly related to many other individual beliefs and values, family relationships, social norms and ecological factors. To become effective, interventions need to identify all of the relevant factors operating in each specific context and then design programs that are appropriate for people who live in those circumstances.

Using the model proposed in this report can help decision-makers to understand the underlying factors of behavior better and thus to develop more appropriate and effective program and communication strategies. All variables in the model have been found to influence behavior, but one should not expect that all will be significant in all cultures with all people at all times. It is hoped that the model proposed in this report will be used as a programmatic tool and as a research tool to guide the design and evaluation of future water treatment and hygiene programs.

References

- Acton, P. J. (1975). Nonmonetary factors in the demand for medical services: Some empirical evidence. *Journal of Political Economy*, 83(3), 595-614.
- Ahmed, A. (1998). *National communication campaign on sanitation of Bangladesh*. Paper presented at the 24th WEDC Conference, Islamabad, Pakistan.
- Aiello, A.E. & Larson, E.L. (2002). What is the evidence for a causal link between hygiene and infections? The LANCET Infectious Diseases Vol. 2 February 2002. <http://infection.thelancet.com>
- Ajzen, I. (1989). Attitude structure and behavior. In A. R. Pratkanis, S. J. Breckler & A. G. Greenwald (Eds.), *Attitude, Structure, and Function*. Englewood Cliffs, NJ: Prentice-Hall.
- Bacilig, P. V. & Patrick, W. K. (1990). The cultural definition of an infantile diarrhea in Tambon Korat and Koongyang, northeast Thailand: community perceptions in diarrhea control. *Asia Pac J Public Health*, 4(1), 59-64.
- Babalola, S. & Lawan U. In Press. Factors predicting BCG immunization status in northern Nigeria: A behavioral-ecological perspective. *Child Health Care*.
- Babalola, S. (2006). Gender differences in the factors influencing consistent use of condom among young people in Tanzania. *International Journal of Adolescent Medicine and Health*. 18(2): 287-298.
- Babalola, S. & Vondrasek, C. (2005). Communication, Ideation and Contraceptive Use in Burkina Faso: An Application of the propensity score matching method. *Journal of Family Planning and Reproductive Health Care*. 31(3): 207-212.
- Bandura, A. (1986). *Social foundations of thought and action : a social cognitive theory*. Englewood Cliffs, N.J.: Prentice-Hall.
- Bandura, A. (1997). *Self-efficacy : the exercise of control*. New York: W.H. Freeman.
- Barbieri, W. (1993). Participatory technology for potable water [Electronic Version]. *Inter-American Foundation Magazine*. Retrieved May 20, 2002 from <http://www.cc.ca.us/pfp/InterAm.htm>.
- Bartlett, A. V., Hurtado, E., Schroeder, D. G., & Mendez, H. (1992). Association of indicators of hygiene behavior with persistent diarrhea of young children. *Acta Paediatr Suppl*, 381, 66-71.
- Batson, C. D. (1994). Why act for the public good? Four answers. *Personality and Social Psychology Bulletin*, 20, 603-610.
- Becker, G. S. (1964). *Human capital; a theoretical and empirical analysis, with special reference to education*. New York.: National Bureau of Economic Research; distributed by Columbia University Press.
- Becker, G. S. (1965). A Theory of the Allocation of Time. *Economic Journal*, 75(299), 493-517.
- Becker, M. H. (1974). The health belief model and personal health behavior. *Health Education Monographs*, 2, 324-473.
- Bentley ME, Elder J, Fukumoto M, Stallings RY, Jacoby E, and Brown K. (1995). Acute childhood diarrhoea and maternal time allocation in the Northern Central Sierra of Peru. *Health Policy and Planning*, 10(1):60-70
- Berman, P., Kendall, C., & Bhattacharyya, K. (1994). The household production of health: integrating social science perspectives on micro-level health determinants. *Soc Sci Med*, 38(2), 205-215.
- Biran, A., Tabysheva, A., & Salmorbekova, Z. (2005). Formative research for hygiene promotion in Kyrgyzstan. *Health Policy Plan*, 20(4), 213-221.
- Blum, D., & Feachem, R. G. (1983). Measuring the impact of water supply and sanitation investments on diarrhoeal diseases: problems of methodology. *Int J Epidemiol*, 12(3), 357-365.
- Bukenya, G. B., Kaser, R., & Nwokolo, N. (1990). The relationship of mothers' perception of babies' faeces and other factors to childhood diarrhoea in an urban settlement of Papua New Guinea. *Ann Trop Paediatr*, 10(2), 185-189.
- Cairncross, S., & Shordt, K. (2004). It does last! Some findings from a multi-country study of hygiene sustainability. *Waterline*, 22(3), 4-7.
- Cairncross, S., Shordt, K., Zacharia, S., & Govindan, B. K. (2005). What causes sustainable changes in hygiene behaviour? A cross-sectional study from Kerala, India. *Soc Sci Med*, 61(10), 2212-2220.
- Caldwell, J. C. (1993). Health transition: the cultural, social and behavioural determinants of health in the Third World. *Soc Sci Med*, 36(2), 125-135.
- Carnegie, R., McKee, N., Dick, B., Reitemeier, P., Weiss, E., Yoon, C.S. (2000). Making change possible: Creating an enabling environment. In McKee N., Manoncourt, E., Yoon, C.S., & Carnegie, R. (eds). *Involving*

- People Evolving Behavior*. Southbound Penang; Malaysia.
- Clasen, T. F., Brown, J., Collin, S., Suntura, O., & Cairncross, S. (2004). Reducing diarrhea through the use of household-based ceramic water filters: a randomized, controlled trial in rural Bolivia. *Am J Trop Med Hyg*, 70(6), 651-657.
- Cleland, J., & Wilson, C. (1987). Demand theories of the fertility transition: An iconoclastic view. *Population Studies*, 41, 5-30.
- Coale, A. J., & Watkins, S. C. (1986). *The decline of fertility in Europe : the revised proceedings of a Conference on the Princeton European Fertility Project*. Princeton, N.J.: Princeton University Press.
- Cohen, D. A., Scribner, R. A., & Farley, T. A. (2000). A structural model of health behavior: a pragmatic approach to explain and influence health behaviors at the population level. *Prev Med*, 30(2), 146-154.
- Connell, R. W. (1987). *Gender and power : society, the person, and sexual politics*. Stanford, Calif.: Stanford University Press.
- Crump, J. A., Otieno, P. O., Slutsker, L., Keswick, B. H., Rosen, D. H., Hoekstra, R. M., et al. (2005). Household based treatment of drinking water with flocculant-disinfectant for preventing diarrhoea in areas with turbid source water in rural western Kenya: cluster randomised controlled trial. *Bmj*, 331(7515), 478.
- Curtis, V. (2003). Talking dirty: how to save a million lives. *Int J Environ Health Res*, 13 Suppl 1, S73-79.
- Curtis, V., Kanki, B., Mertens, T., Traoré E., Diallo, I., Tall, F., and Cousens, S. (1995). Potties, pits and pipes: explaining hygiene behaviour in Burkina Faso. *Social Science and Medicine* 41(3): 383-393.
- Dargent-Molina, P., James, S. A., Strogatz, D. S., & Savitz, D. A. (1994). Association between maternal education and infant diarrhea in different household and community environments of Cebu, Philippines. *Soc Sci Med*, 38(2), 343-350.
- Dunston, C., McAfee, D., Kaiser, R., Rakotoarison, D., Rabeloson, L., Hoang, A. T., et al. (2001). Collaboration, cholera, and cyclones: a project to improve point-of-use water quality in Madagascar. *Am J Public Health*, 91(10), 1574-1576.
- Esrey, S. A., Potash, J. B., Roberts, L., & Schiff, C. (1990). *Health benefits from improvements in water supply and sanitation: Survey and analysis of the literature on selected diseases*: Water and Sanitation Health Project.
- Festinger, L. (1954). A theory of social comparison processes. *Human Relation*, 7, 117-140.
- Fewtrell, L., Kaufmann, R.B., Kay, D., Enanoria, W., Haller, L., & Colford Jr., J.M. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect Dis* 2005; 5: 42-52
- Fewster, E., Mol, A., & Wiessent-Brandsma, C. (2004). *People centered approaches to water and environmental sanitation: The long term sustainability of household bio-sand filtration*. Paper presented at the 30th WEDC International Conference, Vientiane, Lao PDR.
- Figueroa, M. E. (1996). *The Influence of Household Traits in the Outpatient Demand for Health Care: The Case of Mexico*. Baltimore, MD: The Johns Hopkins University.
- Figueroa, M. E., Kincaid, D. L., Rani, M., & Lewis, G. (2002). *Communication for Social Change: A Model for Measuring the Processes and its Outcomes*: Rockefeller Foundation
- Figueroa, M.E. & Hulme, J. (2007). Water Treatment Promotion in Three Contexts: Lessons for Future Programs. Report of the Safe Water Drinking Alliance programs in Haiti, Pakistan and Ethiopia. USAID, CARE, PSI, P&G and Johns Hopkins Center for Communication Programs. Internal Report. Baltimore, Maryland, 2007.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior : an introduction to theory and research*. Reading, Mass.: Addison-Wesley Pub. Co.
- Gasana, J., Morin, J., Ndikuyeze, A., & Kamoso, P. (2002). Impact of water supply and sanitation on diarrheal morbidity among young children in the socioeconomic and cultural context of Rwanda (Africa). *Environ Res*, 90(2), 76-88.
- Gilman, R. H., Marquis, G. S., Ventura, G., Campos, M., Spira, W., & Diaz, F. (1993). Water cost and availability: key determinants of family hygiene in a Peruvian shantytown. *Am J Public Health*, 83(11), 1554-1558.
- Goldman, N., Pebley, A. R., & Beckett, M. (2001). Diffusion of ideas about personal hygiene and contamination in poor countries: evidence from Guatemala. *Soc Sci Med*, 52(1), 53-69.
- Gorter, A. C., Sandiford, P., Pauw, J., Morales, P., Perez, R. M., & Alberts, H. (1998). Hygiene behaviour in rural Nicaragua in relation to diarrhoea. *Int J Epidemiol*, 27(6), 1090-1100.
- Gostin, L. O., Burris, S., & Lazzarini, Z. (1999). The law and the public's health: a study of infectious disease law in the United States. *Columbia Law Rev*, 99(1), 59-128.

- Grossman, M. (1972). *The demand for health: a theoretical and empirical investigation*. New York, National Bureau of Economic Research; distributed by Columbia University Press.
- Haddad, L., & Hoddinott, J. (1991). *Household Expenditures, Child Anthropometric Status and the Intrahousehold Division of Income: Evidence From the Coite d'Ivoire*. Princeton, N.J: Woodrow Wilson School of Public and International Affairs, Princeton University.
- Haddad, L., Hoddinott, J., & Peña, C. (1992). *Intrahousehold Resource Allocation: Policy Issues and Research Methods*. Washington, D.C.: International Food Policy Research Institute.
- Halvorson, S. J. (2004). Women's management of the household health environment: responding to childhood diarrhea in the Northern Areas, Pakistan. *Health Place, 10*(1), 43-58.
- Harrington, N. G., & Donohew, L. (1997). Jump start: a targeted substance abuse prevention program. *Health Educ Behav, 24*(5), 568-586.
- Hoque, B. A. (2003). Handwashing practices and challenges in Bangladesh. *Int J Environ Health Res, 13 Suppl 1*, S81-87.
- Hoque, B. A., Mahalanabis, D., Alam, M. J., & Islam, M. S. (1995). Post-defecation handwashing in Bangladesh: practice and efficiency perspectives. *Public Health, 109*(1), 15-24.
- Hoque, B. A., Hoque, M.M., Ahmed, T., Islam, S., Azad, A.K., Ali, N., Hossain, M., & Hossain, M.S. (2004). Demand-based water options for arsenic mitigation: an experience from rural Bangladesh. *Public Health, 118*, 70-77.
- Hovland, C. I. (1953). *Communication and persuasion; psychological studies of opinion change*. New Haven, Yale University Press.
- Iyun, B. F., & Oke, E. A. (2000). Ecological and cultural barriers to treatment of childhood diarrhea in riverine areas of Ondo State, Nigeria. *Soc Sci Med, 50*(7-8), 953-964.
- Janz, N. K., & Becker, M. H. (1984). The Health Belief Model: a decade later. *Health Educ Q, 11*(1), 1-47.
- Jinrawet, U., & Harrigan, R. C. (2003). Beliefs of mothers in Asian countries and among Hmong in the United States about the causes, treatments, and outcomes of acute illnesses: an integrated review of the literature. *Issues Compr Pediatr Nurs, 26*(2), 77-88.
- Johns Hopkins Bloomberg School of Public Health Center for Communication Programs (CCP), Procter and Gamble (P&G), CARE, Population Services International (PSI) and US Agency for International Development (USAID), 2005. Global Development Alliance, Safe Drinking Water Alliance. Report of Findings Manuscript. Baltimore Maryland, December 15, 2005.
- Kaba, M., & Ayele, F. (2000). Ethnographic study of diarrhoeal disease among under-five children in Mana District, Jimma Zone, Southwest Ethiopia. *Ethiopian Journal of Health and Development, 14*(1), 77-83.
- Kapadia-Kundu, N. (1994). *An empirical test of the Sadharanikaran communication theory to defecation hygiene behavior: Evaluation of a child-to-community intervention in Maharashtra, India*. Baltimore, Maryland: Johns Hopkins University.
- Ketsela, T., Asfaw, M., & Belachew, C. (1991). Knowledge and practice of mothers/care-takers towards diarrhoea and its treatment in rural communities in Ethiopia. *Ethiop Med J, 29*(4), 213-224.
- Kincaid, D. L. (1987). The convergence theory of communication, self-organization, and cultural evolution. In D. L. Kincaid (Ed.), *Communication theory: Eastern and western perspectives* (pp. 209-221). New York: Academic Press.
- Kincaid, D. L. (1988). The convergence theory of communication: Its implications for intercultural communication. In Y. Y. Kim (Ed.), *International and intercultural annual: Theoretical perspectives on international communication* (Vol. 12, pp. 280-298). Beverly Hills: Sage.
- Kincaid, D. L., Figueroa, M. E., Underwood, C. R. and Storey, J. D. (1999). Attitude, Ideation and Contraceptive Behavior: The Relationship Observed in Five Countries. Johns Hopkins Bloomberg School of Public Health Center for Communication Programs (CCP). Technical Report, Baltimore, MD.
- Kincaid, D. L. (2000). Mass media, ideation, and contraceptive behavior: A longitudinal analysis of contraceptive change in the Phillipines. *Communication Research, 27*(6), 723-763.
- Kincaid, D. L. (2000b). Social networks, ideation, and contraceptive behavior in Bangladesh: A longitudinal analysis. *Social Science and Medicine, 50* (2): 215-231.
- Kincaid, D. L. (2004). From innovation to social norm: bounded normative influence. *J Health Commun, 9 Suppl 1*, 37-57.
- Kincaid, D. L., & Figueroa, M. E. (2008). Communication for Participatory Development: Dialogue, Collective Action, and Change. In *Handbook of Applied Communication*. Mahwah, NJ: Lawrence Erlbaum.

- Kirchhoff, L. V., McClelland, K. E., Do Carmo Pinho, M., Araujo, J. G., De Sousa, M. A., & Guerrant, R. L. (1985). Feasibility and efficacy of in-home water chlorination in rural North-eastern Brazil. *J Hyg (Lond)*, *94*(2), 173-180.
- Knowles, E.S. & Linn, J.A. (2004). *Resistance and Persuasion*. Mahwah, N.J.: Lawrence Erlbaum.
- Latane, B. (1981). The psychology of social impact. *American Psychology*, *36*, 343-365.
- Lesthaege, R., & Vanderhoeft, C. (1998). *Ready, willing, and able: A conceptualization of transitions to new behavioral forms*. Paper presented at the National Academy of Sciences meeting on the Social Dynamics of Change in Developing Countries, Washington, DC, January 29-30.
- Levallois, P., Grondin, J., & Gingras, S. (1999). Evaluation of consumer attitudes on taste and tap water alternatives in Québec. *Water Science and Technology*, *40*(6), 135-139.
- Lin, N. (1999). Building a network theory of social capital. *Connections*, *22*, 28-51.
- Lord, R. G., & Brown, D. J. (2004). *Leadership processes and follower self-identity*. Mahwah, N.J.: Lawrence Erlbaum.
- Luby SP, Agboatwalla M, Feikin DR, Painter J, Billhimer W, Altaf A, Hoekstra RM. (2005). Effect of handwashing on child health: a randomised controlled trial. *Lancet*, *366*(9481):225-33.
- Luby, S. P., Agboatwalla, M., Hoekstra, R. M., Rahbar, M. H., Billhimer, W., & Keswick, B. H. (2004). Delayed effectiveness of home-based interventions in reducing childhood diarrhea, Karachi, Pakistan. *Am J Trop Med Hyg*, *71*(4), 420-427.
- Lynch, M., West, S. K., Munoz, B., Kayongoya, A., Taylor, H. R., & Mmbaga, B. B. (1994). Testing a participatory strategy to change hygiene behaviour: face washing in central Tanzania. *Trans R Soc Trop Med Hyg*, *88*(5), 513-517.
- Makutsa, P., Nzaku, K., Ogutu, P., Barasa, P., Ombeki, S., Mwaki, A., et al. (2001). Challenges in implementing a point-of-use water quality intervention in rural Kenya. *Am J Public Health*, *91*(10), 1571-1573.
- McGuire, W. J. (1989). Theoretical foundations of campaigns. In R. R. Rice & C. K. Atkin (Eds.), *Public Communication Campaigns*. Newbury Park, CA: Sage.
- McKee N., Manoncourt, E., Yoon, C.S., & Carnegie, R. (eds). (2000). *Involving People Evolving Behavior*. Southbound Penang; Malaysia.
- McLennan, J. D. (1998). Knowledge and practices of preventing diarrhoea in malnourished children. *J Diarrhoeal Dis Res*, *16*(4), 235-240.
- McLennan, J. D. (2000a). Prevention of diarrhoea in a poor District of Santo Domingo, Dominican Republic: practices, knowledge, and barriers. *J Health Popul Nutr*, *18*(1), 15-22.
- McLennan, J. D. (2000b). To boil or not: drinking water for children in a periurban barrio. *Soc Sci Med*, *51*(8), 1211-1220.
- McLeroy, K.R., Bibeau, D., Steckler, A. & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, *15*, 351-377.
- Montgomery, M., & Casterline, J. (1996). Social learning, social influence, and new models of fertility. *Population and Development Review*, *22*(supplement), 151-175.
- Moscovici, S. (1986). Social influence and conformity. In G. Lindzey & E. Aronson (Eds.), *Handbook of Social Psychology* (Vol. 2, pp. 347-412). New York: Random House.
- Nichter, M. (1985). Drink boiled water: a cultural analysis of a health education message. *Soc Sci Med*, *21*(6), 667-669.
- Nichter, M. (1988). From aralu to ORS: Sinhalese perceptions of digestion, diarrhea, and dehydration. *Soc Sci Med*, *27*(1), 39-52.
- Nichter, M. (1991). Use of social science research to improve epidemiologic studies of and interventions for diarrhea and dysentery. *Rev Infect Dis*, *13 Suppl 4*, S265-271.
- Nielsen, M., Hoogvorst, A., Konradsen, F., Mudasser, M., & van der Hoek, W. (2003). Causes of childhood diarrhea as perceived by mothers in the Punjab, Pakistan. *Southeast Asian J Trop Med Public Health*, *34*(2), 343-351.
- Nowak, A., Szamrej, J., & Latane, B. (1990). From private attitude to public opinion: A dynamic theory of social impact. *Psychological Review*, *97*, 362-376.
- Olango, P., & Aboud, F. (1990). Determinants of mothers' treatment of diarrhea in rural Ethiopia. *Soc Sci Med*, *31*(11), 1245-1249.
- Olembo, L., Kaona, F. A. D., Tuba, M., & Burnham, G. (2004). *Safe water systems: An evaluation of the Zambia CLORIN Program (Final Report)*.

- Pearce, N. (1996). Traditional epidemiology, modern epidemiology, and public health. *Am J Public Health*, 86(5), 678-683.
- Pebley, A., Hurtado, E., & Goldman, N. (1999). Beliefs about children's illness. *J Biosoc Sci*, 31(2), 195-219.
- Pinfold, J. V. (1999). Analysis of different communication channels for promoting hygiene behaviour. *Health Educ Res*, 14(5), 629-639.
- Piotrow, P. T., Kincaid, D.L., Rimon II, J.G., Rinehart, W. (1997). *Health communication : lessons from family planning and reproductive health*. Westport, Conn.: Praeger.
- Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change. Applications to addictive behaviors. *Am Psychol*, 47(9), 1102-1114.
- Quick, R. (2003). Changing community behaviour: experience from three African countries. *Int J Environ Health Res*, 13 Suppl 1, S115-121.
- Quick, R. E., Kimura, A., Thevos, A., Tembo, M., Shamputa, I., Hutwagner, L., et al. (2002). Diarrhea prevention through household-level water disinfection and safe storage in Zambia. *Am J Trop Med Hyg*, 66(5), 584-589.
- Quick, R. E., Mintz, E. D., Sobel, J., Mead, P. S., Reiff, F. M., & Tauxe, R. V. (1997). *A New Strategy for Waterborne Disease Transmission*. Paper presented at the 23rd Water, Engineering and Development Centre Conference, Durban, South Africa.
- Quick, R. E., Venzel, L. V., Gonzalez, O., Mintz, E. D., Highsmith, A. K., Espada, A., et al. (1996). Narrow-mouthed water storage vessels and in situ chlorination in a Bolivian community: a simple method to improve drinking water quality. *Am J Trop Med Hyg*, 54(5), 511-516.
- Rogers, C. R. (1959). A Theory of Therapy, Personality, and Interpersonal Relationships as developed in the Client-Centered Framework. In S. Koch (Ed.), *Psychology: A study of a science, Volume III, Formulations of the person and the social context*. (pp. 184-256). New York: McGraw-Hill.
- Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
- Rogers, E. M., & Kincaid, D. L. (1981). *Communication networks : toward a new paradigm for research*. New York: Free Press.
- Rollnick S., & Miller, W.R. (1995). What is motivational interviewing? *Behavioural and Cognitive Psychotherapy*, 23, 325-334.
- Roy, J. and Crow, B. (2004). Gender Relations and Access to Water: What We Want to Know About Social Relations and Women's Time Allocation. *Center for Global, International and Regional Studies*. Paper CGIRS-2004-5. March 26, 2004. <http://repositories.cdlib.org/cgirs/CGIRS-2004-5>
- Ruel, M. T., & Arimond, M. (2002). Spot-check observational method for assessing hygiene practices: review of experience and implications for programmes. *J Health Popul Nutr*, 20(1), 65-76.
- Sallis, J.F. & Owen, N. (2002). Ecological models of health behavior. In K. Glantz, B.K. Rimer & F.M. Lewis (Eds.) *Health behavior and health education* (3rd ed. pp. 462-484). San Francisco, CA: Jossey-Bass.
- Schmidt W., & Cairncross, S. (2009). Household water treatment in poor populations: Is there enough evidence for scaling up now? *Environmental Sciences and Technology* 43(4), 986-992
- Slater, M. D., & Rouner, D. (1996). How message evaluation and source attributes may influence credibility assessment and belief change. *Journalism and Mass Communication Quarterly*, 73(4), 974-991.
- Sobel, J., Mahon, B., Mendoza, C. E., Passaro, D., Cano, F., Baier, K., et al. (1998). Reduction of fecal contamination of street-vended beverages in Guatemala by a simple system for water purification and storage, handwashing, and beverage storage. *Am J Trop Med Hyg*, 59(3), 380-387.
- Storey, J.D., Boulay, M., Karki, Y., Heckert, K., and Karmacharya, D.M. (1999). Impact of the integrated radio communication project in Nepal, 1994-1997. *Journal of Health Communication*, 4(4), 271-94.
- Storey, J.D., & Schoemaker, J.F. (2006). Social norms, communication and the sustainability of health behavior over time: A multilevel analysis of contraceptive use in Indonesia, 1997-2002. Manuscript for publication. Johns Hopkins Bloomberg School of Public Health Center for Communication Programs (CCP). Baltimore, MD.
- Strina, A., Cairncross, S., Barreto, M. L., Larrea, C., & Prado, M. S. (2003). Childhood diarrhea and observed hygiene behavior in Salvador, Brazil. *Am J Epidemiol*, 157(11), 1032-1038.
- Suls, J. M. (1977). Social comparison theory and research. In J. Sulz & R. Miller (Eds.), *Social Comparison Processes* (pp. 1-8). New York: John Wiley.
- Tapia, M. (2003). *Divine Nature and Human Intervention: Two Central Themes for the Adoption of Water Purification Practices in Guatemala*. Baltimore, Maryland: Johns Hopkins University, Center for

Communication Programs.

- Thevos, A. K., Quick, R. E., & Yanduli, V. (2000). Motivational Interviewing enhances the adoption of water disinfection practices in Zambia *Health Promotion International*, 15(3), 207-214.
- Trevett, A. F., Carter, R. C., & Tyrrel, S. F. (2005). Mechanisms leading to post-supply water quality deterioration in rural Honduran communities. *Int J Hyg Environ Health*, 208(3), 153-161.
- Triandis, H. C. (1972). *The analysis of subjective culture*. New York,: Wiley-Interscience.
- Triandis, H. C. (1980). Values, attitudes, and interpersonal behavior. In H. Howe & M. Page (Eds.), *Nebraska Symposium on Motivation 1979* (pp. 197-259). Lincoln: University of Nebraska Press.
- Underhill, A. F. (2006). Theories of learning and their implications for on-line assessment. *Turkish Online Journal of Distance Education*, 7(1), Article 15. Retrieved August 1, 2006, from <http://tojde.anadolu.edu.tr/tojde21/articles/anthony.htm>
- Underwood, C., Hachond, H., Serlemitsos, E. & Bharath, U. (2006). Reducing the risk of HIV transmission among adolescents in Zambia: Psychosocial and behavioral correlates of viewing a risk-reduction media campaign. *Journal of Adolescent Health*. 38(1): 55.e1-55.e13.
- Underwood, Carol. (2002). Belief and attitude change in the context of human development, in Sustainable Human Development , from *Encyclopedia of Life Support Systems (EOLSS)*, Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford ,UK, [<http://www.eolss.net>]
- Valente T.W., Poppe P.R., Merritt A.P. (1996). Mass-media-generated interpersonal communication as sources of information about family planning. *Journal of Health Communication*, 3(1), 247-65
- Waterkeyn, J., & Cairncross, S. (2005). Creating demand for sanitation and hygiene through Community Health Clubs: a cost-effective intervention in two districts in Zimbabwe. *Soc Sci Med*, 61(9), 1958-1970.
- Wellin, E. (1955). Water Boiling in a Peruvian Town. In B. Paul (Ed.), *Health, Culture and Community* (pp. 71-103). New York: Russell Sage Foundation.
- Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs*, 59(4): 329-349.
- Yeager, B. A., Huttly, S. R., Bartolini, R., Rojas, M., & Lanata, C. F. (1999). Defecation practices of young children in a Peruvian shanty town. *Soc Sci Med*, 49(4), 531-541.
- Yoder, P. S. (1997). Negotiating relevance: belief, knowledge, and practice in international health projects. *Med Anthropol Q*, 11(2), 131-146.
- Zanjonc, R. B. (1984). On the primacy of affect. *American Psychologist*, 39(2), 117-123.

