To Promote Adoption of Household Health Technologies, Think Beyond Health

Health risks from poor malaria control, unsafe water, and indoor air pollution are responsible for an important share of the global disease burden—and they can be addressed by efficacious household health technologies that have existed for decades. However, coverage rates of these products among populations at risk remain disappointingly low.

We conducted a review of the medical and public health literatures and found that health considerations alone are rarely sufficient motivation for households to adopt and use these technologies.

In light of these findings, we argue that health education and persuasion campaigns by themselves are unlikely to be adequate. Instead, health policymakers and professionals must understand what users value beyond health and possibly reengineer health technologies with these concerns in mind. (*Am J Public Health.* 2013;103:1736–1740. doi:10.2105/AJPH.2013.301367)

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HEALTH RISKS FROM POOR malaria control, unsafe water, and indoor air pollution are responsible for an important share of the global disease burden.[1–3] These risks can be mitigated by efficacious household health technologies that have existed for decades. Insecticide-treated nets (ITNs) control malaria by protecting individuals sleeping under them from the bite of mosquitoes that carry the parasitic disease and by killing these mosquitoes directly.[4,5] Water treatment processes, including boiling, solar disinfection, chemical disinfection (sometimes preceded by flocculation), and filtration, eliminate the microbial agents that cause diarrheal disease.[6,7] Reengineered biomass cookstoves burn more efficiently and cleanly than traditional stoves, reducing concentrations of indoor air pollutants that cause cancers and respiratory infections.[8,9]

However, these technologies have fallen short of their potential to improve health in developing countries, primarily because of low rates of adoption and use. Of the three, ITNs have seen relatively more progress in adoption and continued use among at-risk populations. The *World Malaria Report 2011* of the World Health Organization (WHO) estimates that 50% of households in sub-Saharan Africa have at least one ITN (with about 96% of these currently in use), a substantial increase over the 3% household coverage estimated in 2000.[4] The picture is more grim for water treatment and cooking technologies. Rosa and Clasen estimate that less than 30% of households in countries where unsafe drinking water can be a problem adequately treat their water at home (mainly through boiling), with significantly lower rates among African and rural households despite their being at higher risk of waterborne disease.[10] A report sponsored by the United Nations Development Programme (UNDP) and WHO estimates that 27% of households that cook with solid fuels do so with some form of "improved" cookstove.[11] A common problem, especially for improved cookstoves, is that usage rates also often decline after initial adoption.[12]

HOUSEHOLD TECHNOLOGIES AND GLOBAL HEALTH POLICY

Some of the observed differences in rates of adoption and use among these three technologies stem from differences in the priority accorded to each by global health policy initiatives and recommendations. ITNs have been core to policy recommendations for malaria control since the 1998 launch of the Roll Back Malaria partnership by WHO, UNICEF, the UNDP, and the World Bank.[13] Household water treatment technologies have received relatively less attention. According to a report commissioned by WHO, policy initiatives focused on water have historically emphasized community infrastructure, whereas household-oriented programs often target sanitation and hygiene.[6] Improved cookstoves have been variously promoted by government, nongovernmental organizations, and private sector actors since the 1980s,[14–17] with possibly the most significant impact coming from the Chinese government's distribution of more than 100 million improved stoves during the 1980s and 1990s.[14,15] The Global Alliance for Clean Cookstoves was launched in 2010 to coordinate among different actors and bring more sustained focus to the development and dissemination of advanced stoves.[18]

If low rates of adoption and use were explained by insufficient supply alone, then international campaigns like the Global Alliance for Clean Cookstoves could play an important role simply by mobilizing resources. On the other hand, if a critical problem is also that users do not value the technologies offered to them, it is essential to better understand why this is the case. A deep exploration of user preferences, including what is valued beyond health, could provide important insights potentially leading to the redesign of current technologies into new forms that users will want, not just need.

WHY HOUSEHOLDS ADOPT NEW TECHNOLOGIES

Inadequate information about health benefits is one possible explanation for the low rates of adoption of health-improving products. However, studies are accumulating in a variety of contexts that show a surprisingly weak

effect of health education, especially on its own.[19–21] One possible reason is the expense of adoption in the absence of effective credit or savings instruments.[19,22] An equally critical but arguably less-recognized issue may be the importance of nonhealth motives in decisions to adopt household health technologies.

Relative to medical care, household technologies such as ITNs, water treatments, and improved stoves are deeply integrated into daily life. Substantial and ongoing user engagement is required to reap the health benefits of these technologies.[6,23] Nonhealth considerations like time required for use, taste, comfort, and convenience may therefore be highly salient to users. Even small objective or subjective "costs" like these, multiplied many times over by daily use, may lead consumers to reject health technologies.

To assess the relative role of nonhealth factors, we examined the medical and public health literature published between 1985 and 2010 on the adoption of ITNs, household water treatments, and improved cookstoves. Our PubMed search yielded 1105 candidate articles, of which 210 met our inclusion criteria (for complete details on methods, including search terms and inclusion criteria, see supplementary materials, available as a supplement to the online version of this article at http://www.ajph.org). We then coded the motivations for adoption reported in each article. Our objective was not a rigorous systematic review (because we do not believe that the peer-reviewed literature on these issues is focused enough to warrant one), but rather a less formal assessment of the relative importance of different factors—focusing in particular on the balance between health and nonhealth considerations.

We grouped factors reported as related to adoption into four categories that are not mutually exclusive: health, comfort, convenience, and sociocultural factors. (Cost is another factor that can affect adoption, but it is not an intrinsic motivation for use—even an affordable technology will not be put into use unless it serves some valued function.) Two of the authors (C. W. and L. P.) independently applied the detailed criteria provided in the supplementary materials to count how many articles cited each factor as important for adoption. These authors reconciled conflicting codings, and a third author (M. C. T.) reviewed and finalized the codings.

In short, we coded "health" if an article suggested that users adopted a technology because of its health benefits—such as reduction of probability of malaria, diarrhea, or respiratory disease—or failed to adopt because of health concerns associated with its use. "Comfort" signified that adoption was motivated by a technology's physical comfort, taste, or aesthetics. "Convenience" factors were those related to ease of use, compatibility with existing habits, and time requirements. "Sociocultural" factors revolved around belief systems or social norms. Table 1 shows examples of factors coded under each category, with references to sample articles in which they were cited as having positive or negative influence on adoption.

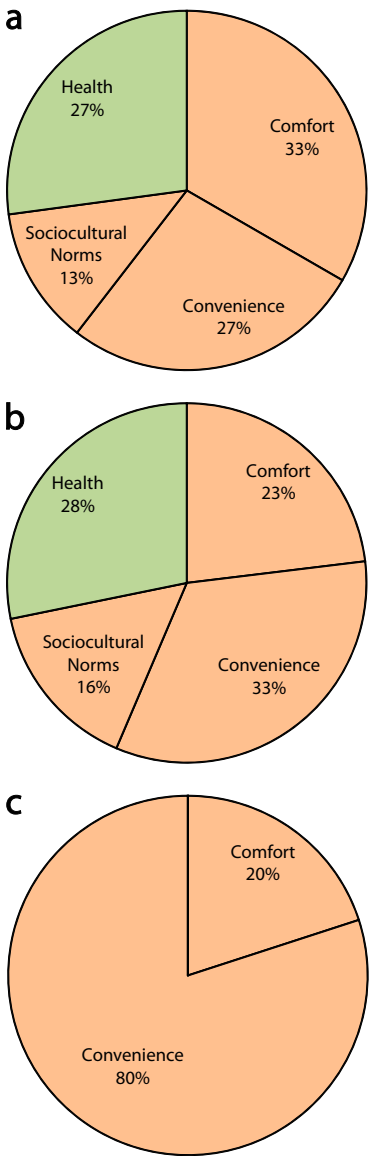
HOW HEALTH AND NONHEALTH FACTORS INFLUENCE ADOPTION

As shown in Figure 1, health was not the most frequently cited influence on adoption for any of the three technologies. Interestingly, even when it was cited as important, the influence of health-related motivations was not always positive. For example, articles documented users being concerned about the health effects of ITNs because the insecticide on the bed net was seen to kill mosquitoes; others described users being concerned about water treatments because the smell of treated water was

TABLE 1—Sample Health and Nonhealth Factors Cited in Reviewed Articles as Affecting Adoption of Household Health Technologies

Technology	Factor			
	Health	Comfort	Convenience	Sociocultural
Insecticide-treated net (ITN)	Reduces malaria risk[24] Insecticide might damage human health[25]	Reduces mosquito nuisance[26] Makes house interior more/less attractive[27] Too hot to sleep under[28]	Difficult to hang[29] Takes up needed space[29] Needs to be cleaned[30]	Tradition of ITN use[31] Belief that severe malaria not caused by mosquitoes[26] Belief that women in first pregnancies and adolescent girls at low risk[32]
Household water treatment	Reduces diarrheal disease[33] Bleach smell means product is poisonous[34]	Improves/degrades water taste[35] Removes dirt, improves water appearance[36]	Provides needed additional container[37] Water treatment takes too long[38]	Tradition of boiling water[10] Habit of consuming water heated in pots with rice residue[39] Belief that guinea worms come from within body[38]
Improved biomass cookstove	(None in reviewed articles)	Reduces irritation from smoke[40]	Easy/hard to use[9,40] Cooks faster/slower than traditional methods[9,40]	(None in reviewed articles)

Note. We conducted a review of the medical and public health literatures (between 1985 and 2010) regarding adoption of household health technologies. A representative article from this review is cited for each factor.



Note. Data are manually coded from the results of a PubMed query on adoption behavior. The search yielded 1105 articles (from the years 1985 to 2010), of which 175 were ultimately found to be relevant to adoption of insecticide-treated bed nets, 28 to adoption of household water treatments, and 7 to adoption of improved biomass stoves. (Relative to the other two technologies, it is only relatively recently that improved cookstoves have been rigorously evaluated as a health intervention, explaining the significantly smaller sample of articles.) Additional materials available as a supplement to the online version of this article at http://www.ajph.org

FIGURE 1—Relative frequency (percentage of all reasons given) with which different factors are cited in reviewed articles as influencing adoption of (a) insecticide treated nets, (b) point-of-use water treatments, and (c) improved biomass cookstoves.

reminiscent of bleach, a known poison (Table 1).

An important finding is that many studies we reviewed reported that even consumers who understood the health benefits of a technology did not prioritize them relative to other needs. For example, a study assessing adoption of a purifier system for removing arsenic from water in Bangladesh concluded that understanding arsenic's toxicity and knowing someone suffering from it were not associated with use of the system.[41] A company selling improved stoves in India found that measuring the lung function of prospective customers to demonstrate the damage from traditional biomass cooking did not boost stove sales.[42]

Rather, nonhealth motivations seemed to dominate adoption and use decisions in our sample. ITNs were valued more for combating the nuisance of mosquito bites (comfort) than for reducing the probability of contracting malaria. The relative inconvenience of water disinfection technologies dominated health considerations, with the time-consuming requirements of boiling, carrying, or filtering water creating an important barrier to their adoption. Water treatments that actively improved the taste and appearance of treated water were more likely to be valued. Strikingly, for improved cookstoves, none of our reviewed studies cited health considerations as playing an important role. The most important consideration was convenience of cooking, which is a time-consuming daily household activity.

A key implication of our findings is that the technologies with the best prospects for widespread population health impact may be those that actively provide cobenefits alongside health improvement. The fact that ITNs address the nightly nuisance of mosquito bites as well as the health threat of malaria may at least partly explain why their adoption has been more widespread than water disinfection technologies or improved cookstoves. At the same time, the primacy of nonhealth motivations calls for careful attention to how closely such cobenefits are aligned with health improvement. Several studies noted lower rates of bed net use during seasons or in locations in which mosquitoes were perceived to be less bothersome, even while malaria transmission remained a substantial risk.[24,43,44] Analogously, if people are attracted to water treatments for their ability to reduce turbidity and improve the appearance of drinking water, there is a risk they will fail to treat water that appears clear but is microbiologically unsafe.[6,36,45,46]

Even where a technology does not provide cobenefits as an inherent part of fulfilling its health function, innovative product designers can uncover and appeal to nonhealth motivations for use. For example, in one sanitation intervention, a closed-valve container method for treating water proved popular simply because households in the region desperately needed containers.[37] (Unfortunately, this particular intervention proved not to be biomedically efficacious, highlighting the importance of ensuring that nonhealth motivations for use align with targeted health outcomes.)

RECOMMENDATIONS

Our review's findings emphasize the need to closely assess

and understand underlying user preferences and hidden costs beyond health in the design and delivery of household health technologies. Unlike traditional pillars of global health that require only limited engagement or behavior change on the part of beneficiaries (such as micronutrient fortification of staples or even vaccination programs), the technical efficacy of household technologies is a necessary but far from sufficient condition for real-world population health impact. People must actually want to use the household product they are being sold (or given) on an ongoing basis, and health motives alone may often be insufficient to drive adoption and sustained use. We therefore offer two broad recommendations for expanding the use of household health technologies in developing countries.

First, it is critical to investigate user preferences more systematically from the earliest stages of developing a new technology. "Human-centered" design has shown some success on this front[47]—for example, in defining what users actually want in a cookstove.[48] Identifying overlapping areas of health and desired nonhealth benefits, and designing accordingly, may substantially increase the use of health-improving products. (Taking this observation to heart, the Bill and Melinda Gates Foundation recently solicited proposals for a "next generation condom that significantly preserves or enhances pleasure."[49]) Just as importantly, a deeper understanding of user preferences—and their degree of alignment with health objectives—may forestall unintended consequences down the road. Many global health practitioners presumably agree that nonhealth motivations affect the adoption of health-improving products, but we nonetheless highlight that the implications of this view are not well reflected in prominent global health policies and programs (which frequently emphasize the promotion of health technologies in their current form simply because they are good for health).

Second, suppliers of health technologies should actively seek out and incorporate user feedback to refine their products as they learn about user preferences over time (much the way that markets for other goods and services function). Put differently, iterative product prototyping and testing with users is not only important at the design stage,[47] but such feedback is also critical as products diffuse and user experience with them grows. This is true whether products are sold commercially or distributed free of charge as part of a public health campaign. Commercial distribution has a degree of built-in feedback through traditional market mechanisms. Free or highly subsidized distribution through the public and not-for-profit sectors may be justifiable on traditional grounds (such as the existence of large positive externalities),[50] but these modes of distribution require more dedicated effort to gather equivalent user feedback. Tracking ongoing usage is inherently costly and difficult, and monitoring and evaluation metrics are often inadequate or inappropriate (such as the excessive focus on distribution targets in India's national cookstove program[14,16]). Innovations in program or product design that facilitate appropriate measurement of use over time are sorely needed.

Both of our recommendations aim to encourage suppliers of household health technologies to better understand what users actually value rather than simply telling them or trying to persuade them of what they should do in the interest of their health. ■

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Contributors

M. C. Thurber, A. Slaski, and G. Miller conceptualized the study and developed initial coding rules. M. C. Thurber reviewed and finalized the article codings and wrote the initial draft. C. Warner and L. Platt performed the literature search and coded the results. R. Gupta and G. Miller contributed significant research insights and made important revisions.

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Protocol approval was not needed because no human participants were involved.

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