Safe drinking water interventions for home and outside use
The LifeStraw® Concept

The Millennium Development Goals (MDGs) call for a reduction of the proportion of people without sustainable access to safe drinking water by half between 1990 and 2015. Yet, an estimated 884 million people in the world, 37% of whom live in Sub-Saharan Africa, still use unimproved sources of drinking water.

Lack of access to safe drinking water contributes to the staggering burden of diarrhoeal diseases worldwide, particularly affecting the young, the immuno-compromised and the poor. Nearly one in five child deaths – about 1.5 million each year – is due to diarrhoea. Diarrhoea kills more young children than AIDS, malaria and measles combined. Drinking contaminated water also leads to reduced personal productive time, with widespread economic effects.

Approximately 43% of the global population, especially the lower-income populace in the remote and rural parts of the developing world, is deprived of household safe piped water. Thus, there is a pressing need for effective and affordable options for obtaining safe drinking water at home. Point-of-use (POU) treatment is an alternative approach, which can accelerate the health gains associated with the provision of safe drinking water to the at-risk populations. It empowers people to control the quality of their drinking water. Treating water at the household level or other point of use also reduces the risk of waterborne disease arising from recontamination during collection, transport, and use in the home, a well-known cause of water-quality degradation. In many rural and urban areas of the developing world, household water-quality interventions can reduce diarrhoea morbidity by more than 40%. Treating water in the home offers the opportunity for significant health gains at potentially dramatic cost savings over conventional improvements in water supplies, such as piped water connections to households.

Water filters have been shown to be the most effective interventions amongst all point-of-use water treatment methods for reducing diarrhoeal diseases. The Cochrane review demonstrates that it is not enough to treat water at the point-of-source; it must also be made safe at the point-of-consumption.

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LifeStraw® and LifeStraw® Family are both point-of-use water interventions – truly unique offerings from Vestergaard Frandsen that address the concern for affordably obtaining safe drinking water at home and outside. These complementary safe water tools have the potential to accelerate progress towards the MDG target of providing access to safe drinking water, which would yield health and economic benefits; thus contributing to the achievement of other MDGs like poverty reduction, childhood survival, school attendance, gender equality and environment sustainability.

### The Link between LifeStraw® Water Filters and Millennium Development Goals

**Goal 1: Eradicate Extreme Poverty and Hunger**
LifeStraw® safe water interventions minimise the risk of waterborne disease, promoting economic gain by reducing healthcare expenses and increased productivity.

**Goal 2: Achieve Universal Primary Education**
The consumption of safe drinking water through LifeStraw® water filters prevent children from acquiring diarrhoea and other waterborne diseases, helping ensure that children wake up healthy each morning to continue their education.

**Goal 3: Promote Gender Equality and Empower Women**
LifeStraw® water filters empower women and girls by facilitating access to safe drinking water. LifeStraw® Family works on highly turbid water, which allows women to convert ‘dirty’ water collected from any nearby source into safe drinking water. Saved time, particularly for women and young girls, is a major benefit. Beneficiaries of water and sanitation projects in India reported benefits like less tension/conflict in homes and communities; community unity, self-esteem, women's empowerment (less harassment) and improved school attendance (WaterAid 2001).

**Goal 4: Reduce Child Mortality**
The consumption of contaminated water exposes children to waterborne diseases like hepatitis A and E, cholera, typhoid, poliomyelitis and other diseases that cause diarrhoea. By affecting normal consumption of food and reducing the adsorption of nutrients, diarrhoea is also an important cause of malnutrition, which can lead to impaired cognitive development and physical growth, reduced resistance to infection, and potentially, long-term gastrointestinal disorders. The use of LifeStraw® point-of-use water filters prevent morbidity and mortality resulting from diarrhoea among infants and children under five.

**Goal 5: Improve Maternal Health**
Diarrhoea is amongst the indirect medical causes that weaken pregnant women’s immune systems. Provision of clean drinking water through LifeStraw® has a positive impact on maternal health.

**Goal 6: Combat HIV/AIDS, Malaria and Other Diseases**
Globally, there are about four billion cases of diarrhoea each year. It is a leading cause of child mortality, morbidity and malnutrition. Diarrhoea is also a very common symptom of HIV/AIDS and a cause of significant morbidity and mortality amongst the HIV-infected. Safe drinking water through LifeStraw® filters ensures healthier lives for the immunocompromised, including children under five, pregnant women, the elderly and those living with HIV/AIDS.
Drinking Water Crisis

884 million*
deprived of improved sources of drinking water\(^1\)

4 billion
annual cases of diarrhoeal illness\(^11\)

1.8 million
lives lost each year due to diarrhoeal disease\(^11\)

443 million
school days lost each year from water-related illness\(^12\)

117 million
disability adjusted life years (DALYs) lost annually due to diarrhoea and intestinal worm infections\(^13\)

*Hundreds of millions more rely on “improved” water sources that are nevertheless subject to frequent and extensive microbial contamination.\(^4\)
In the year 2006, the Cochrane Collaboration published a systematic review of 38 randomised, controlled trials of various water quality interventions to prevent diarrhoea titled, “Interventions to Improve Water Quality for Preventing Diarrhoea.” These trials covered more than 53,000 subjects from 19 countries over 20 years.

The objective of this review was to assess the effectiveness of interventions to improve water quality for preventing diarrhoea. This review, which covered both point-of-source and point-of-use household-level interventions, found that household interventions were twice as effective in preventing diarrhoea as common source-based interventions (wells, boreholes and communal tap stands).

Among household interventions, filters were consistently the most effective in preventing diarrhoea, with an average 63% reduction.

<table>
<thead>
<tr>
<th>Intervention Type (no. of trials)</th>
<th>% Reduction (1-RR) in Diarrhoea</th>
<th>95% Confidence Interval of Estimate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtration (6)</td>
<td>63%</td>
<td>0.28 to 0.49</td>
</tr>
<tr>
<td>Chlorination (16)</td>
<td>37%</td>
<td>0.52 to 0.75</td>
</tr>
<tr>
<td>Solar Disinfection (2)</td>
<td>31%</td>
<td>0.63 to 0.74</td>
</tr>
<tr>
<td>Flocculation/Disinfection (7)</td>
<td>52%</td>
<td>0.20 to 1.16</td>
</tr>
<tr>
<td>Flocculation/Disinfection (ex Doocy)</td>
<td>31%</td>
<td>0.58 to 0.82</td>
</tr>
<tr>
<td>Improved storage (1)</td>
<td>21%</td>
<td>0.61 to 1.03</td>
</tr>
</tbody>
</table>

*Estimates outside this range have a likelihood of less than 5%

“Household interventions were twice as effective in preventing diarrhoea as common source-based interventions"
LifeStraw® – Product Features

Portable Water Filter

- Offers easy access to clean and safe drinking water away from home
- Filters* at least 1000L of contaminated water
- Removes minimum 99.9999% of waterborne bacteria (>LOG 6 reduction)
- Removes minimum 99.9% of waterborne protozoan parasites (>LOG 3 reduction)
- Reduces turbidity by filtering particles of approximately 0.2 microns
- Contains no chemicals
- Has a high flow rate
- Requires no electrical power, batteries or replacement parts

*Note: The quality of the filtered water is not guaranteed if the product is submitted to other conditions than the ones encountered during its normal use.

LifeStraw® – Usage

Place LifeStraw® in water and sip through the mouthpiece.

Regularly blow air through LifeStraw® after drinking to keep the filters clean and to prevent them from clogging.

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LifeStraw®, a portable water filter, is a complementary tool to LifeStraw® Family. It provides access to safe and clean drinking water away from home.

The following study indicates the need and frequency of water consumption away from home:

**Field study**

Onyango-Ouma, W. and Gerba, C.P. 2010. Away-from-home drinking water consumption practices and the microbiological quality of water consumed in rural western Kenya *(under publication)*

**Key Findings**

- 97% of the people report drinking water while away from home.
- Main sources of water are rivers (31%) and boreholes (14%).
- Volume of water consumed away-from-home is in average 260mL, which is equivalent to two glasses.
- Overall microbiological quality of water is poor and unfit for consumption, especially water from unprotected springs (protected springs are contaminated as well, to a lesser extent).

**Outcome**

There is a need for innovative approaches to address away-from-home drinking water consumption in resource-poor settings in order to complement and maximize the benefits of point-of-use water treatment at the household level. It is very clear that local populations in resource poor settings consume water outside home as dictated by the pattern of daily activities; and that the microbiological quality of this water is very poor. Population awareness of the poor away-from-home water quality has to be improved.

The first portable water filter takes its origin in the PVC pipe filters used for the eradication of Guinea Worm disease. Vestergaard Frandsen has for many years been a sole supplier for Pipe Filters used in The Carter Centers' Guinea worm eradication program. The success of the Pipe Filter triggered ideas behind the development of the LifeStraw®.

Dr. Ernesto Ruiz-Tiben, Technical Director of the Carter Center Guinea Worm Eradication Program (GWEP) quotes: *“Persons who travelled away from the household for extended period of times did not have a way of protecting themselves from the Guinea Worm Disease. In 1994, we tested (at CDC) the efficacy of PVC pipe filters in the removal of*
**LifeStraw® – Longevity and Efficacy**

**Laboratory test**
Evaluation of Vestergaard Frandsen's hollow fiber LifeStraw® for the removal of *Escherichia Coli* and Cryptosporidium according to the US Environmental Protection Agency guide standard and protocol for evaluation of microbiological water purifiers

**Partner**
Naranjo, J. and Gerba, C.P. Department of Soil, Water and Environmental Science, University of Arizona, USA (2010)

**Outcome**
**Longevity** of LifeStraw® was successfully assessed in laboratory conditions (harsher conditions than what is required by the EPA in terms of turbidity and organic matter), up to 1600L (approximately 160% of design life).

**Backwash frequency** used was once every 5L (corresponds to more or less a daily cleaning during real use).

**Flow-rates** varied as follows in average:
- 280mL/min at the beginning
- 280mL/min between 10 and 200L
- 250mL/min between 200 and 500L
- 170mL/min between 500 and 1000L
- 200 mL/min overall between 0 and 1000L

**Antimicrobial efficacy** of LifeStraw® was successfully assessed in the same laboratory conditions (EPA 1987 protocol for microbiological water purifiers testing) and showed that LifeStraw® meets the EPA requirements of LOG 6 reduction for bacteria and LOG 3 reduction for protozoan parasites:

<table>
<thead>
<tr>
<th>Micro-organism</th>
<th>LifeStraw® efficacy*</th>
<th>EPA requirements*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>&gt;7.3</td>
<td>6.0</td>
</tr>
<tr>
<td><em>Cryptosporidium oocysts</em></td>
<td>&gt;3.9</td>
<td>3.0</td>
</tr>
</tbody>
</table>

*Note: results in Log reduction values (LRV)*

**Turbidity** was removed during the challenges by 99.6% in average:
- influent challenge water turbidity: 104 NTU
- effluent challenge water turbidity: 0.4 NTU

**Laboratory test:** Various laboratory assessments of LifeStraw® in various countries

**Partners:**
- Laboratorio de Pruebas y Ensayos Tecnicos Asociados (LAPETSA, Colombia), SPLA Medical Crops IGHQs Diagnostic Center (South Sudan)

**Outcome:**
- 100% reduction in mesophile aerobic, total coliforms and E. Coli; K. aerogensa, and St. Faecalis

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### LifeStraw® – Health Impact

**Field study**  

**Study design**  
8-month randomized controlled trial among 313 households (1516 individuals) in remote, rural Ethiopia.

**Outcome**  
High health impact: 25% statistically significant reduction in diarrhoeal prevalence.

**Field study**  
Elsanousi, S. *et al.* 2009. A study of the use and impacts of LifeStraw in a settlement camp in southern Gezira, Sudan. *Journal of Water and Health*; 07.3

**Study design**  
647 people from 134 households participated. Study design included no control group, seasonal influence on diarrhoea not taken into account.

**Outcome**  
15.3% of participants reported a diarrhoeal incident (recalled for the previous 2 weeks) at 3–4 months before distribution of LifeStraw®, whereas only 2.3% reported diarrhoea (recalled for the previous 2 weeks) at the follow-up survey four months after distribution of LifeStraw®.
**Field study**  
Elsanousi, S. et al. 2009. A study of the use and impacts of LifeStraw in a settlement camp in southern Gezira, Sudan. *Journal of Water and Health; 07.3*

**Study design**  
647 people from 134 households participated. Study design included no control group, seasonal influence on diarrhoea not taken into account.

**Outcome**  
Compliance rates were good with 86.5% of people saying they always used the LifeStraw®. 9.8% saying they were occasional users and 3.7% saying they had never used it.

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**Field study**  
Dye, T.D. 2009. “You can take water any place you are:” A qualitative assessment of water-related illness beliefs, behaviors, and community acceptance of novel personal water filtration devices (*under publication*)

**Partner**  
Department of Public Health and Preventive Medicine, SUNY Upstate Medical University, New York

**Outcome**  
High product uptake: 83% current users after 2 months. 17% stopped using the product because they found it was too difficult to draw up water through it.

**study included both LifeStraw® and LifeStraw® Family**
LifeStraw® – Awards and Accolades

“Good design should have a positive effect on the user and if possible on society. LifeStraw® meets these basic criteria, truly an excellent design solution. LifeStraw® offers a simple, elegant solution to a large and complicated problem that profoundly affects many people's lives around the world. By addressing this problem the designers are opening possibilities of limiting the number of people without clean water – and thereby reducing deaths resulting from this lack, especially in the developing world.”
- Jury of INDEX: 2005 International Design Award (September 2005)

"LifeStraw® is a very simple and elegant solution to a problem that kills millions of people. Let's get it out there.”
- Saatchi & Saatchi Award for World Changing Ideas Judge Peter Gabriel (February 2008)

Awards

2008 Saatchi & Saatchi Award for World Changing Ideas

‘INDEX: 2005’
International Design Award

‘Well-Tech 2006’
Innovation Technology Award

Accolades

‘Best Invention of 2005’
Time Magazine (November 2005)

‘Europe's Best Invention’
Reader’s Digest (July 2006)

‘Innovation of the Year’
Esquire Magazine (December 2005)

‘Invention of the Century’
Gizmag (December 2005)

‘A Water Purifier for the Masses’
Popular Science Magazine (December 2005)

‘A Water Purifier That Could Save Lives’
New York Times (October 2006)

‘Gadget Produces Safe Drinking Water’
Newsweek (June 2007)

One of the ‘Ten Things That Will Change The Way We Live’
Forbes Magazine (February 2006)

‘Tools for Better Living’
Fortune Magazine (December 2006)

‘Design for the Rest of the World: LifeStraw®’
The New York Sun (May 2007)
References

2. UNICEF and WHO. 2009. Diarrhoea: Why children are still dying and what can be done
11. WHO. 2007. Combating waterborne disease at the household level