

Project RISHI (Rural India Social and Health Improvement): Water Testing for Fluoride in Rajasthan, India

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WRITER'S COMMENT: *This paper is a budget proposal for a scientific research project of our choice, assigned by Dr. Karma Waltonen for her UWP 104F (Writing in the Health Sciences) class. I immediately knew that I would focus my proposal on the goals of UC Davis Project RISHI (Rural India Social and Health Improvement), a non-profit organization that I had intimately become involved in. Project RISHI prompts not only a discovery of solutions for a variety of social and health issues, but promotes the long-term sustainability of those resolutions. I truly believe that type of deeper understanding and critical thinking is the best way to approach a crisis, following the philosophy of treating the person and not just the symptoms. The UCD mission of 2013 has set goals regarding treating water in a village in Anandwan, Maharashtra, which has not had proper water testing in ten years. Aside from the humanitarian aspects of these issues, Anandwan itself has created several beautiful reconstructions to their independent society and landscape to support a spiritual and inviting space that is also self-sufficient. By helping this village further, we stand to gain a wide number of creative solutions that have already been placed in effect and proven to be successful. The evolution of one village can spread its influence to others, and my writing was solely to recruit support for an overall improvement in the quality of life of villagers. I truly enjoyed writing this piece, and my thanks go to Dr. Waltonen for all of her support and guidance, as well as turning the daunting style of budget proposals into familiar territory.*

INSTRUCTOR'S COMMENT: *Once, when my son was little, he said he was going to be a scientist because he didn't like to write. Of course, our upper-classmen who take our specialized courses in Writing in the Biological Sciences, Writing in Science, and Writing in Health have come to understand that writing will be an essential part of their careers. One of the more challenging assignments is one of the most important: grant writing. I ask my students to submit a brief grant proposal on a topic of their choice. The students must take care to write for a wide audience, as people who give money don't always*

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understand heavy scientific jargon. They must also be able to give a complete proposal for a viable project. Sadhna's excellent response to this assignment came from her passion for her topic, her attention to detail, and her ability to synthesize, analyze, and organize. (Note: the cover sheet was omitted to conform to this publication.)

—Karma Waltonen, University Writing Program

Abstract

Project RISHI (Rural India Social and Health Improvement) is a non-profit 501-3(c) status organization that will be travelling to Rajasthan, India with a group of thirty undergraduate student volunteers for two weeks in the summer to test general water conditions in sixty predetermined sites, specifically evaluating the fluoride and nitrate levels between two different water collecting systems. The organization is applying for a grant of \$6,055 to fund fluoride, nitrate, and general water testing strips necessary to conduct this project overseas.

The results will be compiled and analyzed to determine the effectiveness of each water filtration system to conclude whether borewells or rooftop rainwater harvesting tanks would be the best method for Indian villages to adopt. This will be in addition to a verbal survey that will electronically record satisfaction levels and health problems with those who use rooftop water harvesting tanks daily. There will be an emphasis on the capability of each collection system to filter fluoride, due to the high prevalence of skeletal fluorosis as a rising endemic in India.

The mission of Project RISHI is to implement long-term social and behavioral solutions to the root of major health problems in the rural villages of India. Previous trips to Rajasthan have successfully confirmed the high rates of skeletal fluorosis in the Bharatpur district (as well as six surrounding districts) through personal surveys and censuses collected directly from local hospitals. Following this conclusion, it has been a targeted goal for Project RISHI to determine which methods have been most effective in filtering water for fluoride and how to implement this change across Rajasthan. This can serve as a major exemplary model for improving the health of millions of people across India and can hopefully be carried on to neighboring states in due time as well.

The funds from the grant will be used solely for the purpose of water testing supplies – volunteers will pay travel expenses, in-country lodging

and transportation will be covered by a non-profit organization, and any translations to Hindi will be conducted by pre-approved doctors assisting in verbal surveys as well as by native speakers within the organization.

Statement of Need

Of the 32 states in India, 17 are at high risk for the pervasiveness of skeletal fluorosis, a bone disease in which excess fluoride washes away calcium from the bone matrix and the fluoride mineralizes bones to increase its density, while decreasing bone strength. It also has a detrimental impact on other organs, such as the kidney, liver, brain, and reproductive organs (Whitford 7). K.P. Singh, M. Teotia and S. P. S. Teotia, authors of “Highlights of Forty Years of Research on Endemic Skeletal Fluorosis in India,” surveyed 411,744 people who suffered from this bone disease, with at least 43% of this subset suffering from endemic skeletal fluorosis specifically (109). It is a persistent disease in India, and Raja Reddy’s “Understanding the Disease of Endemic Skeletal Fluorosis and Ways to Contain It” verifies, amongst many other studies, that this endemic places sixty million people in India at risk and has already critically affected six million (3). Reddy delves further into the issue in “Neurology of Endemic Skeletal Fluorosis,” stating that ten percent of this six million have been severe, devastating cases of this disease in which neurological function is impaired (1).

Skeletal fluorosis is generally a teeth and bones disease, but the impact that fluoride accumulation has on bones can lie dormant for several decades, while the incognizant patient who presents with very few symptoms may erroneously believe he or she suffers from arthritis. However, during this process of accumulation, the patients can still be burdened by gastrointestinal symptoms, and the worst cases of this disease can include brittle bones from deteriorating calcium compounds. This ultimately leads to mechanical compression of the spinal cord and nerve roots due to osteophytosis (a bone outgrowth that occurs near joints where there has been a greater deterioration, which may be to prevent joints from moving, as overexertion can be dangerous). According to the charts in “Highlights of Forty Years of Research on Endemic Skeletal Fluorosis in India,” those who suffer from skeletal fluorosis will face a wide array of symptoms over a period of decades. This can include an increase in bone mass, joint stiffness, constipation, symptoms similar to arthritis, pain during general movement, calcification of ligaments, and with

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more severe cases there will be symptoms of spine and joint deformities, compression of the spinal cord, and muscle wasting (Singh, Teotia, and Teotia 110). A study exclusively examines the disease's prevalence in children and shows it can even affect young children between the ages of 11 to 14, significantly disproving previous studies that claimed it was a disease that affected only adults (Kunwar, Teotia, and Teotia 687).

In India, there is a high concentration of fluoride in drinking water that is most likely increasing the incidence of this disease. Some areas have implemented a BIRD-K rooftop rainwater harvesting (RWH) tank, which serves as a collection system that directly transports rainwater from its holding center to a filter, with minimal contact with contaminated external elements. BIRD-K is the Institute for Rural Development, an NGO in Karnataka that focuses on implementing rural projects for the progression and safety of society. Other bacteria that may remain following this filtration system are eliminated by boiling the water for household use.

However, a majority of these Indian states still relies heavily on borewells as their primary source for drinking water, and this form of collected water tends to stay in contact with soil and other contaminants for extended periods of time, with a greater presence of fecal contamination. With the growing need for the storage of clean drinking water, borewells are simply expanded on by digging them deeper, which leads to the possibility of increasing fluoride levels that can be caused by exceedingly greater exposure to minerals in deeper soils. These differences in rainwater collection methods may be a major factor in the endemic nature of skeletal fluorosis, though this requires further correlating data for confirmation of the effectiveness of RWH filtration systems.

Program Description

Project RISHI will be using water-testing kits – containing general, fluoride, and nitrate strips – to collect data comparing the water parameter levels in borewells to that of BIRD-K RWH tanks. In the first two weeks of September, a group of thirty University of California, Davis student volunteers will travel to India via their own expenses and donations from the public.

These volunteers will use water testing strips, for which funding is being requested by this grant, to collect the data of fluoride and nitrate levels in 60 selected areas (out of the approximately 40,000 villages) of

Rajasthan. This state in India has been chosen because of its shockingly high rate of skeletal fluorosis across all 32 districts, as well as its scattered use of RWH tanks in select homes.

For each of the 60 sites, three results will be recorded for fluoride parameters, three results for nitrate, and two for each of the parameters included in the general water testing kits. Three Data Collection Volunteers will be assigned specifically to recording results throughout the trip on personal laptops to ensure the accuracy of the data. All volunteers – both recording and water testing – will be trained prior to the trip by the Project RISHI advisor, and all electronics will be kept in a locked safe throughout the journey when not in use. Having three volunteers specialized to a recording task also serves as a precaution for any technical issues that may occur during this extensive compilation process. In-country transportation and temporary lodging will be funded by the Maharogi Sewa Samiti non-profit organization in India.

Fluoride and nitrate tests will be conducted at three distinct height levels when testing the water in borewells: at the surface, approximately half way through, and at the bottom. The general parameters will only test the water at the surface and at deep water levels of borewells.

The 60 households that have BIRD-K RWH tanks will each be tested three times for fluoride and nitrate levels, and two times for the general parameters as well. In addition to this, an electronic survey will be conducted to collect the following information from each owner and family of a RWH tank:

- (1) How long have you used a BIRD-K Rooftop Rainwater Harvesting tank for your home?
- (2) Has your health improved noticeably over time with the use of this tank?
 - a. What was your previous medical history?
 - b. Have those health problems diminished at all?
 - c. Have you or members of your family been diagnosed for skeletal fluorosis?
 - d. Do you consistently boil the water from your tank before using it in the household?
- (3) Why do you believe your neighbors and/or others in your community have not implemented this filtration system yet?
- (4) Are there any issues with maintaining this tank system that you would like to address?

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These questions will serve as a health and satisfaction assessment for the RWH tank mode of filtration, and the data will be organized into three categories: health conditions, satisfaction with RWH tanks, and miscellaneous comments. An in-country doctor volunteering from the local hospital will accompany the Project RISHI students and assist in verbally confirming survey data to minimize human errors in translation and entice responses that are more accurate. A respected figure from the area will decrease any discrepancies or cultural misunderstandings that can occur when gathering data from villagers who may otherwise have been disgruntled by or suspicious of interrogations from strangers.

Immediately after the trip, student volunteers will return to California for a follow-up consultation conference with Project RISHI's advisor, an Environmental Engineering professor with a specialty in international water sanitation testing, for guidance on deriving results from this data. He will review all the conclusions extrapolated from the results as well as edit subsequent articles pertaining to these studies prior to submission to the *Journal of Undergraduate Research* at UC Davis.

Budget

	Number of Tests Needed	Quantity (# of boxes)	Price	Total
Sigma Aldrich Fluoride Testing Kits (30 test strips)	Borewells: 60 sites x 3 samples RWH tanks: 60 sites x 3 samples 360 strips	12	\$78.70	\$944.40
Hach Nitrate Testing Kits (25 test strips)	Borewells: 60 sites x 3 samples RWH tanks: 60 sites x 3 samples 360 strips	15	\$19.09	\$286.35
Ben Meadows General Water Testing Kits (2 test strips per parameter)	Borewells: 60 sites x 2 samples RWH tanks: 60 sites x 2 samples 240 strips	120	\$40.20	\$4,824.00
Total				\$6,054.75

Evaluation

Based on the collected data of the fluoride and nitrate levels of the water (in parts per million), the information will be analyzed with the Project RISHI advisor. After this consultation, the data can be evaluated for the effectiveness of filtration systems by comparing the fluoride and nitrate levels of BIRD-K RWH tanks in households that utilize them to the fluoride and nitrate levels of borewells. The data collected by general water testing kits for other parameters are critical for evaluation as well, such as levels of aluminum, which causes the gut to absorb fluoride easier, thus accelerating the degenerative process of skeletal fluorosis.

If the results indicate that borewells have a greater amount of fluoride in drinking water than the RWH tank does (with results that statistically show a level of fluoride over permissible values in >50% of the 60 measured sites) in the Rajasthan districts, then the tanks truly are effective at decreasing the concentration of fluoride. Results in regards to fecal contamination and excess of nitrate, aluminum, and bacterial microbe levels will also be addressed and taken into consideration when evaluating the adoption of BIRD-K RWH filters for everyday usage.

With these results, Project RISHI can apply for successive grants to adopt BIRD-K RWH tanks on a larger scale (at the very least expanding coverage of proper water sanitation throughout the state of Rajasthan). Skeletal fluorosis is a debilitating disease that is slow acting and crippling, but the impact that can be made with a single implementation of this simple technology can be effective in relieving a population of millions from this disease. With the funds for water testing kits, Project RISHI can breach the step of verification and turn the collected data into a plan of action.

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