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A global health project: creating sustainable solutions to address anemia at Munsel-ling school in rural northern India

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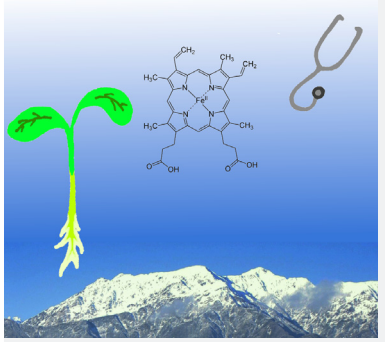

Illustration by Laura Isouthco

ABSTRACT Anemia is a major public health concern in India, especially within the rural population. Six years ago, a group of medical students from the University of British Columbia began a collaboration with a boarding school in the Spiti Valley area of Northern India. The team found a high prevalence of anemia within the school population and devised a set of sustainable projects to improve student health, including health education, greenhouses, water and sanitation, and iron supplementation. Health screens were also integrated every year to track changes in the population's health over time. To date, these interventions have significantly decreased the students' levels of anemia over the five-year period. However, the most effective intervention appears to be direct iron supplementation, yet the sustainability of this practice remains challenging.

INTRODUCTION Spiti Valley is a collection of remote villages located in the Himachal Pradesh province of India, situated at an altitude of 3,800 meters (Figure 1). For approximately seven months of the year the valley is inaccessible due to snow on the high mountain passes, which limits access to health care and basic services. In 2006, a group of University of British Columbia (UBC) medical students working with Dr. Videsh Kapoor developed UBC's first Global Health Initiative (GHI) program, the Spiti Project. This project established a partnership with the Munsel-ling Boarding School in the village of Rangrik and its affiliated local Non-Government Organization (NGO), Rinchen Zangpo Society for Spiti Development. The school is privately run and is currently responsible for the education of approximately 700 children from surrounding communities, housing three quarters of the students for the entire school year. Since its inauguration, the Spiti Project has also collaborated with the Vancouver-based Trans-Himalayan Aid Society (TRAS) and several other NGOs for funding.

In 2006, the first UBC Spiti Valley team met the local population to assess community health concerns. One pressing discovery was the high levels of anemia in the school children. Since then, teams of UBC students, mainly from the faculty of Medicine but also Dentistry, Engineering, Land and Food Systems, Journalism, and Integrated Science, along with a number of family practice residents, have designed and implemented various projects to positively impact the health and anemia of the students.

Anemia refers to a disease state in which there is a decrease in the number of, or an abnormality in, an individual's red blood cells (RBCs). It is therefore difficult for the remaining RBCs to carry enough oxygen to the tissues of the body. Severe enough anemias can be deadly; further, often the effects of anemia include cognitive and physical development abnormalities in children, fatigue, dyspnea, and a reduction in physical performance in adults[1]. The World Health Organization (WHO) classifies anemia based on varying hemoglobin (Hb) thresholds that take into account age, gender, physiological status (ie. pregnancy), and altitude[2]. The most common cause of anemia worldwide is iron deficiency; therefore, anemia levels can be an indicator of both poor nutrition and poor health[3].

According to data calculated by the WHO, India has a severely high prevalence of anemia in its population (>45%)[2]. This is considered a public health concern - especially in young children, pregnant women, and non-pregnant women of reproductive age[3].

INTERVENTIONS In order to assess levels of anemia at Munsel-ling, Hb levels of each student were measured in 2006. There were approximately 400 students, both males and females, ranging in age from 4 to 16. There are several major causes of anemia worldwide including iron deficiency (most common), folate deficiency, chronic disease, and blood

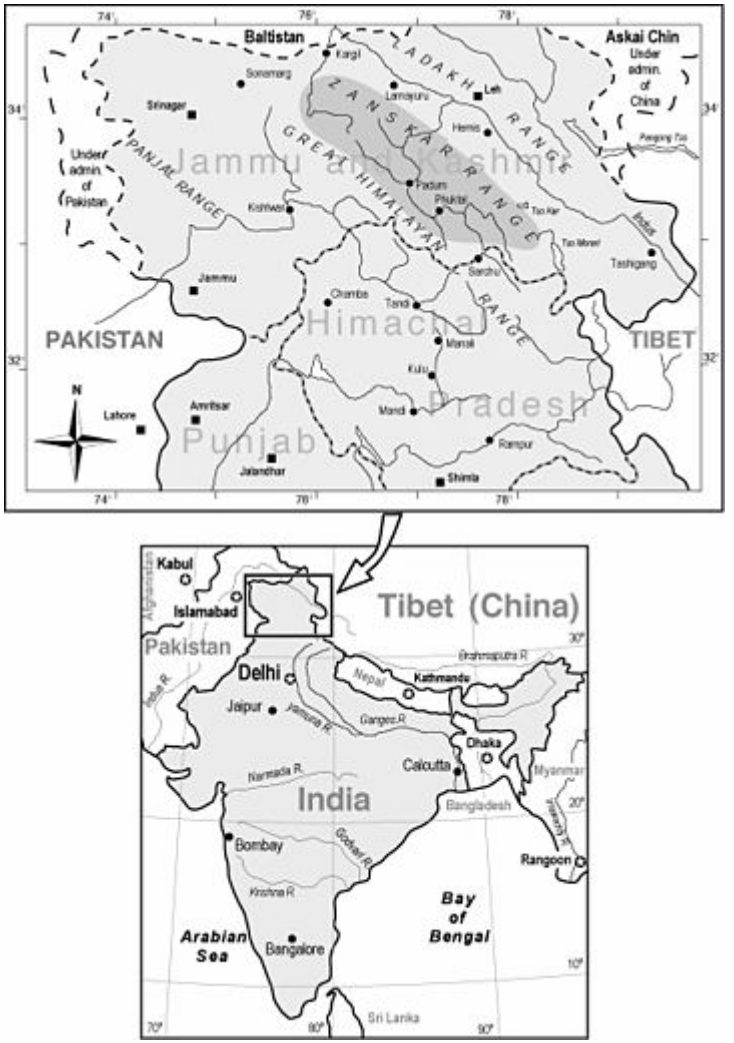

Figure 1 | Map of Spiti Valley Himachal Pradesh. Courtesy of Wikipedia. http://en.wikipedia.org/wiki/Spiti_Valley

loss. It was therefore important for the team to identify the specific etiology of Munsel-ling's anemia in order to create an intervention strategy. In 2007, the UBC team took a second set of Hb levels as well as 200 blood smears from the most severe cases. These smears were analyzed by hematologists in both New Delhi and Vancouver. The etiology of the anemia was determined to be of a mixed nutritional deficiency cause, including iron. Further diet analysis done by UBC Land and Food Systems students revealed that the mainly vegetarian diet of the students was lacking in several other nutrients including folate and vitamin B12. Discussion of these results with the local community resulted in the creation of a multi-pronged approach to target anemia and overall health in the school children. This approach included enhanced nutrition through greenhouses, water sanitation, health education, and direct iron supplementation. Also imperative to the program were annual health screens to measure the effectiveness of interventions.

Greenhouses The diet of the school children is mostly vegetarian, consisting of grain products and vegetables. Nutritional analysis based on three-day average intake of the school children revealed deficiencies in vitamin B12, iron, zinc, and vitamin A[4]. It is both difficult to transport and to grow fruits and vegetables in Spiti Valley. Road access to the area is blocked for the majority of the year due to snow and mudslides. Furthermore, due to the high altitude and landscape of Spiti Valley, it is difficult to grow crops in fields most of the year. However, there is an abundance of sunshine in Spiti Valley and greenhouses in neighbouring communities have used this natural resource to both enhance dietary intake of iron and folate and provide a valuable source of income[5].

In 2008, Munsel-ling school built its first greenhouse, following the design of a French NGO, Groupe Energies Renouvelables, Environnement et Solidarités (GERES), which has constructed similar greenhouses in surrounding areas. Future UBC teams funded an additional two greenhouses with the focus of growing iron-rich vegetables that are suited to the local Spiti diet. UBC teams also helped the school write a successful proposal to the Rinchen Zangpo Society to fund a fourth greenhouse.

In the summer of 2011, our team conducted a thorough analysis on the functioning of the greenhouses. The greenhouse staff was successfully growing spinach and mustard; however, we determined that with better agricultural practices in regards to sowing seeds, watering, fertilizing, and crop diversification, the greenhouses could become more cost effective and better enhance the diet of the students. Therefore, our future goal is to work with the greenhouse staff to teach agricultural skills regarding these areas.

Water and sanitation Clean water is imperative to prevent Gastro-Intestinal (GI) infections which can lead to anemia. At Munsel-ling the water is supplied from a government source in the mountains. Survey analysis and water testing done by UBC teams revealed that the drinking water was contaminated with both helminths (including roundworms) and the bacterium Escherichia (E.) coli. Surveys revealed that many of the students experienced diarrhea and saw worms in their stools. The 2008 UBC team wrote a water tank proposal which was successfully funded by both UBC and TRAS. In 2010, the water tank was built and a chlorine injection system for purification was implemented.

However, E. coli testing in 2011 was positive at all water sources except for a single well-based hand pump. Investigating this issue, we discovered that the chlorination instructions left by the team in 2010 were too complicated to follow in English and the effort was eventually abandoned. Thus, our 2011 team gave a

Table 1 | Number of children and percentage anemic at Munsel-ling school

	2011	2010	2009	2008	2007
No. of children	*696*	*434*	*416*	*384*	*379*
Mean age	*8.97*	*10.34*	*10.2*	*10.2*	*9.8*
Sex male, n (%)	*334 (48.5%)*	*225 (51.8%)*	*213 (51.2%)*	*199 (52%)*	*202 (53.4%)*
Mean Hb, g/L	*133.5*	*128.9*	*141.1*	*134.6*	*130.3*
Anemic, n (%)	*376 (84.1%)*	*385 (89.5%)*	*295 (71.3%)*	*299 (78.3%)*	*321 (88.4%)*

thorough demonstration of the sanitation technique to the health nurse, who was in charge of the water chlorination. We also printed and laminated the chlorination instructions in English, Hindi, and Bohti (local dialect). After the completion of water chlorination, all drinking water sources tested negative for E. coli.

Nonetheless, there are still problems with the water purification system that require future adjustments. Chlorination does not kill worms; ideally, a filtration system needs to be implanted upstream of the water source. Furthermore, water freezing in the winter damages the tanks and pipes if they are not properly emptied in time. We have advised school staff that all tanks and pipes should be emptied prior to the freeze up and water should be sourced from the hand-pump or boiled before consumption. We also need to engage the staff and students to illustrate the connection between dirty water and health problems, including worms, diarrhea, and ultimately, the exacerbation of anemia. GI infections, including worms, are known to contribute to anemia[5].

In addition to improving the water purification system, sanitation at the school needs to be enhanced. UBC-funded toilet blocks were built to prevent children from toileting outside, especially near the water source. However, a survey conducted by our 2010 team revealed that many students do not use the toilets because they are dirty and dark and younger children are afraid of falling into the hole. Now that we know these concerns, we can begin to address them. Some ideas for the future include lighting the toilet blocks and working with the students and staff to create a cleaning schedule.

Health education Of all our interventions, we have always been the most cautious with health education. The reason for this is twofold: first, we did not want to infringe on local teachers' roles; secondly, to run these health education seminars, we needed to remove students from valuable classroom time. Despite our trepidation, the teachers and principal have been very accommodating each year as we teach topics such as oral hygiene, hand washing, and sexual education.

To ensure sustainability of health education at Munsel-ling, the 2010 and 2011 Spiti teams consulted the teachers to create a Health Council composed of grade 9 and 10 students. Over the past two years, UBC students have mentored the Munsel-ling Health Council, which now teaches a health education curriculum to younger students. Each year, a new Health Council is made and the previous council teaches the new one. This ensures project sustainability and gives the students responsibility over their own health.

Iron supplementation While our other interventions are meant to contribute to anemia prevention indirectly, iron supplementation is an efficacious method of treating anemia directly[3]. Each year, a three-month supply of ferrous sulfate tablets is paid for by the UBC team, bought in New Delhi, and then transported by the team to Spiti Valley. With the aid of the school nurse and housemothers, or dormitory supervisors, 30 mg tablets are given to children under age 13 and 50 mg tablets to those over 13 each day over three months as per WHO recommendations[4]. Supplements are given to all children despite their classification as anemic or not.

Health screens In order to assess the effects of our interventions on anemia, we conducted health screens. The screening is also important for the well being of the children, as it helps to identify those that are in immediate need of further medical attention.

The health screens consist of five stations set up in the school's health clinic. The first station involves recording the height and weight of the children, which is completed by the school nurse. For the second station, a HemoCue monitor is used to sample Hb levels in the children's blood. Values used to define anemia were taken from the WHO minimal Hb levels and calibrated for altitude[4]. The third health screen station includes a basic cardiovascular and respiratory exam. The fourth station is a head and

neck exam, primarily to look for dental carries, visual anomalies, and hearing difficulty. The final station involves a dermatological screen where lice, worms, and scabies are diagnosed.

RESULTS As displayed in Table 1, anemia prevalence was found to be 88.4% in 2007. In 2008, it decreased to 78.3% and in 2009 to 71.3%. In 2010, the prevalence again increased to 89.5%. In 2011, the prevalence decreased to 84.1%. Other prevalent medical issues include head lice (76% in 2011), dental carries (73% in 2011), and worms (12% in 2011). Further details regarding these results can be found in the paper published by El-Zammar et al.[4].

CENTRAL OPINION AND DISCUSSION

Due to the multifactorial nature of the anemia at Munsel-ling, all of our interventions combat anemia from different perspectives. Greenhouses provide iron- and folate-rich nutrition, water sanitation decreases the incidence of diarrhea and worms which can contribute to anemia, and health education provides knowledge regarding hand washing which decreases the incidence of infection. Iron supplementation directly combats anemia.

Each year, we have seen a successive decline in prevalence of anemia. However, in 2009, iron was not distributed to the children due to a unique holiday event where children did not attend school. The following year, anemia prevalence returned to its original level. In 2010, iron tablets were again distributed to the children, and our 2011 team assessed that the anemia levels decreased once again, suggesting that supplementation significantly decreases anemia.

It should be noted that at the time of Hb measurement, the children are likely at their lowest levels of Hb as the greenhouse growing season has just begun, and it is the longest period since their iron supplementation ended (approximately 8-9 months). Iron supplementation is done over the summer months because this is when UBC teams go to Spiti during their holiday. Furthermore, transport to the area can only occur when the passes open, usually in May. Nonetheless, our results indicate that iron supplementation plays a significant factor in decreasing anemia prevalence in this population.

Despite the success of direct iron supplementation, it is not sustainable in its current form. UBC pays for the medication and transports the supplements to the school. However, this responsibility could be transferred to the school. A recent study illustrates that twice-weekly supplementation is more effective than daily supplementation over a course of three months[7]. This would decrease the cost of the supplements. Furthermore, the school greenhouses can be used as a source of income to buy iron supplements by selling excess crops to villagers[5].

Regardless of the success of iron supplementation; greenhouses, water and sanitation, and education programs should continue at the school. Greenhouses provide students with iron- and folate- rich food during the months they do not receive iron supplements. Sanitation should continue to be promoted to prevent further helminth infections and thus GI losses. This education can be expanded to the larger community of Rangrik so as to combat anemia in the general population. Health Council students can not only teach their younger peers, but also their families.

CONCLUSION Greenhouses, water and sanitation, health education, and iron supplementation are all programs to decrease the high prevalence of anemia at Munsel-ling school. Our results have indicated that iron supplementation is effective; however, it is not sustainable in its current form. We hope to explore the possibility of twice-weekly supplementation so that supplementation can become sustainable. Furthermore, we need to continue engaging school officials, local NGOs, and the local government to maximize the positive effects of greenhouses and water and sanitation projects. We hope that through this collaboration we can continue to amend sustainable solutions to combat anemia at Munsel-ling school so that the children can succeed in school and therefore have a chance at a better future.**H**

ABOUT THE AUTHORS

The authors are all third year medical students at UBC. They traveled to Munsel-ling school in Spiti Valley, in rural northern India, during the summer of 2011. They are part of a larger team consisting of students from various disciplines who have traveled to Munsel-ling since 2006 to create sustainable solutions to anemia. The project was started in 2006 by Dr. Videsh Kapoor in the department of Family Medicine at UBC.

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