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Editorial

Role of Public Health Education in Addressing Intimate Partner Violence Against Women: A Global Crisis

Deborah A. Fortune, *North Carolina Central University*

Intimate partner violence (IPV) against women is a serious public health problem that is pervasive worldwide (World Health Organization [WHO], 2013). It is a global public health problem that affects about one third of women across the globe (WHO, 2013). Intimate partner violence includes both physical and sexual violence. The Centers for Disease Control and Prevention (CDC, 2012) defines intimate partner violence as physical, sexual, or psychological harm by a current or former spouse or partner. The WHO (2013) defines IPV as physical and/or sexual violence by an intimate partner. The intimate partner may be a formal partnership (e.g., marriage) or informal partnership (e.g., dating relationship or unmarried sexual relationship (WHO, 2013). For a working definition, WHO (2013) refers to physical violence to include any of the following: slapping, throwing objects to hurt a person, pushing/shoving, hitting a person with a fist or object, kicking, dragging, beating, choking, or purposively burning a person. Sexual violence is defined as physically forcing sexual intercourse, having sexual intercourse due to fear of partner, forcing partner to have sexual intercourse without use of condoms or other contraceptives, and forcing a person to perform a sexual act that is degrading or humiliating (WHO, 2013).

The WHO (2013) conducted the first global systematic review and synthesis of scientific literature on the prevalence of two forms of violence against women, which were intimate partner violence and non-partner sexual violence. The key findings from the study that are pertinent for this article include the following:

- 35% of women globally have experienced either physical and/or sexual IPV or nonpartner sexual violence.

Deborah A. Fortune is an associate professor, Department of Public Health Education, North Carolina Central University. Please send correspondences to dfortune@nccu.edu.

- 30% of all women have experienced physical violence and/or sexual violence by their husband or intimate partner. The rates were higher for some WHO regions, particularly low and middle income regions. The prevalence for South-East Asia was approximately 38%, Eastern Mediterranean was 37%, and Africa was 37%
- 38% of all murders of women are committed by their intimate partners.

The health effects that women suffer as a result of IPV include physical trauma; psychological/mental health trauma; and sexual health, such as unwanted pregnancy and HIV/other sexually transmitted infections. These health problems may lead to disability and/or death (WHO, 2013). A myriad of factors may put women at risk for IPV, including

- lack of or low employment of women, which makes women depend on men for subsistence, thus placing them at risk for IPV;
- social norms regarding male masculinity;
- male dominance over their wife or intimate partner;
- cultural acceptance of male dominance and control over women;
- lack of criminalization of domestic violence in some countries;
- lack of enforcement of laws against domestic violence in some countries; and
- lack of respect of women's right as a wife or intimate partner.

Translation to Health Education Practice

The CDC (2012) indicates that IPV can be prevented. Thus, a public health approach should be used to understand and prevent IPV among women around the world. A primary prevention public health approach should be emphasized. The following public health education strategies are recommended to prevent IPV against women globally.

Suggested Public Health Education Strategies

1. Increase awareness and knowledge about risk factors and ways to prevent IPV among youth. Emphasis should be placed on strategies for developing healthy relationships. Schools should include lessons on IPV in the health education curriculum as a component of violence prevention.
2. Empower women through education about IPV, helping them to develop self-efficacy and skills to protect themselves against IPV. Provide employment assistance to women. In addition, provide support for women who are victims of IPV.

3. Develop and provide treatment programs for male perpetrators of IPV. One component of treatment programs should emphasize changing concepts of masculinity as it pertains to dominance and control of women (e.g., men's wives or intimate partners).
4. Advocate for policies that support women's human rights and that discourage victimization of women by their husband or intimate partner. Also, advocacy efforts should include legal reform, particularly criminalizing domestic violence and enforcing laws against IPV.

Responsibilities II, IV, VI, and VII of the National Commission for Health Education Credentialing and Society for Public Health Education (NCHEC & SOPHE, 2015) are highlighted in the articles in this issue, but all seven roles and responsibilities for health educators are applicable for addressing IPV. Responsibility II states that health educators "plan health education/promotion" (NCHEC & SOPHE, 2015, p. 34). Subcompetency 2.4.1 for this responsibility recommends that those programs be based on proven health education theories and models. The WHO and London School of Hygiene and Tropical Medicine (2010) recommend the use of an ecological model to address IPV against women because of the complex nature and many factors associated with IPV. An ecological model would address influences for individual, relationship, community, and societal factors.

Responsibility IV states that health educators "conduct evaluation and research related to health education/promotion" (NCHEC & SOPHE, 2015, p. 43). There is a need for the development of evidence-based intervention for the prevention of IPV among adults (CDC, 2014). Results from those studies will serve as the foundation for addressing IPV across the globe.

Responsibility VI states that health educators "serve as health education/promotion resource person" (NCHEC & SOPHE, 2015, p. 55). Health educators need to disseminate information that is culturally relevant for countries across the globe with suggested strategies to prevent the occurrence of IPV against women.

Responsibility VII indicates that health educators should "communicate, promote, and advocate for health, health education/promotion, and the profession" (NCHEC & SOPHE, 2015, p. 59). Thus, health educators should create and tailor messages that are culturally relevant for countries on warning signs and symptoms of IPV, risks factors for perpetrator and victims of IPV, ways to promote women's rights, and strategies to prevent or reduce behaviors associated with IPV. Also, health educators should advocate that schools (K–12), health care settings (hospitals and physicians' offices), community settings (e.g., community-based organizations and local health departments), businesses, and colleges and universities intervene to prevent or reduce the burden of IPV against women across the globe.

In conclusion, IPV is a global public health problem that affects women across the globe. As a public health problem, public health educators have a role to play in addressing IPV against women. At the present, public health educators need to develop and conduct media campaigns to increase the awareness about IPV against women in an effort to generate resources and interventions for preventing IPV.

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Physical Activity Among Chinese School Youth 1997–2011: A Longitudinal Study

Ying Li, *Western Washington University*
Hui Bian, *East Carolina University*
Bingqing Wang, *Plastic Surgery Hospital, Beijing, China*

Abstract

Purpose: The prevalence of overweight and obesity among Chinese youth has increased alarmingly along with rapid economic development in the last decade. Inactivity is often listed as a major contributor. However, few researchers have examined longitudinal physical activity change among Chinese youth. The purpose of this study was to examine the trend of physical activity engagement among Chinese youth by analyzing secondary data collected from the China Health and Nutrition Survey (CHNS). **Method:** Chinese youth aged 6 to 18 were extracted from the CHNS longitudinal data from 1997 to 2011. Linear mixed models were applied to explore the trend and examine the factors related to physical activity level among Chinese youth. **Results:** A significant but weak increase was found in the frequency and time spent in Extracurricular Gymnastics, Dancing, and Acrobatics from 1997 to 2011. In addition, a significant but weak decrease was found for the time spent in Extracurricular Sedentary Activity and In-School Physical Activity. **Conclusion:** The overall physical activity pattern among Chinese school youth from 1997 to 2011 is not clear.

Keywords

physical activity; Chinese school youth; longitudinal study

Ying Li, PhD, CHES, is an associate professor of community health for the Department of Health and Human Development at Western Washington University. **Hui Bian, PhD, CHES,** is a statistics and research consultant for the Office for Faculty Excellence at East Carolina University. **Bingqing Wang, MD,** is at the Plastic Surgery Hospital, Beijing, China. Please send author correspondence to ying.li@wwu.edu.

China as the most populous country in the world has undergone many social and economic changes that have led to a high prevalence of behavior-related noncommunicable diseases such as obesity and diabetes. For example, Wildman et al. (2008) reported that the prevalence of overweight and obesity among males increased from 9.6% and 0.6%, respectively, in 1991 to 20.0% and 3.0%, respectively, in 1999–2000. For females, the prevalence of overweight and obesity increased from 14.5% and 1.8%, respectively, in 1991 to 26.5% and 5.2%, respectively, in 1999–2000. Not surprisingly, the overall diabetes prevalence increased as well. Yang et al. (2010) reported an overall diabetes prevalence of 9.7% among a nationally representative sample of 47,325 adults in 2008, which is a steady increase compared to the rates of 2.5% in 1994 and 5.5% in 2000–2001 (Gu et al., 2003; Pan, Yang, Li, & Liu, 1997).

Similarly, Chinese youth have also become heavier and bigger. Many researchers have reported the increased overweight and obesity prevalence among Chinese youth (Gordon-Larsen, Wang, & Popkin, 2014; Ji, 2008; Lau, 2004). Because of the differences in sample size, study quality, overweight and obesity criteria, and geographical distribution, the numerical reports varied across studies. To address those issues, Yu et al. (2012) conducted a meta-analysis after screening 1,326 papers and included 35 papers (41 studies), with the majority of medium quality. They reported that the prevalence of overweight and obesity increased from 1.8% and 0.4%, respectively, in 1981–1985 to 13.1% and 7.5%, respectively, in 2006–2010. The average annual increase was 8.3% and 12.4%, respectively. They also reported gender and location effects; specifically, boys or children from urban areas were more likely to be overweight or obese than girls or children from rural areas.

Childhood overweight and obesity are associated with many immediate and long-term health effects (Centers for Disease Control and Prevention, 2014). Specifically, children with overweight and obesity have a higher risk of experiencing social and psychological problems, heart disease, diabetes, joint problems, breathing problems, and adult obesity, which directly affect those children's mobility and mortality in the future. Therefore, it is important to examine childhood overweight and obesity contributor factors for prevention purposes.

Though many factors contribute to the rapid increase of the obesity and overweight issue among Chinese youth, inactivity is often listed as a major contributor (Gordon-Larsen et al., 2014; Wang & Zhai, 2013). However, there is a lack of research in which researchers have examined the longitudinal physical activity changes among Chinese youth over the years, which may prevent an accurate understanding of the reality and make goal setting more challenging. The purpose of this study was to understand the longitudinal trend of physical activity among Chinese school youth by analyzing China Health and Nutrition Survey (CHNS) data.

Method

CHNS data provided by the Carolina Population Center at the University of North Carolina were used in this study. CHNS is an ongoing study with a face-to-face interview approach to collect individual-level information on income, diet, health, and demography for all participants and community-level data on services and infrastructures in nine diverse provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong) of China. A multistage random cluster process was used to draw the sample surveyed in each of the provinces (Zhang, Zhai, Du, & Popkin, 2014).

The data set used in this study included six time points of unbalanced data (1997, 2000, 2004, 2006, 2009, and 2011), which means not all participants were interviewed in every study year. The participants for this study included children who were in school at the point of the data collection and aged 6 to 18 years old. The physical activities measures in this study were measured each study year.

Measures

EPA: Extracurricular physical activities (do not include weekend activities). The extracurricular physical activities per week (do not include weekend activities) included four measures: frequency of physical exercise engagement (frequency); minutes of gymnastics, dancing, and acrobatics; minutes of track and field and swimming; and minutes of other physical activities, including martial arts, soccer, basketball, volleyball, badminton, tennis, ping-pong, and Tai Chi.

ESA: Extracurricular sedentary activities. Sedentary activities per week (do not include weekends) measures included minutes of watching TV and videotapes, VCDs, and DVDs; minutes of extracurricular reading, writing, and drawing; and minutes of other sedentary activities, including video games, toy cars, puppets, and board games.

IPA: In-school physical activities. There were three measures for in-school physical activities per week. They were minutes of gymnastics, dancing, and acrobatics; minutes of track and field and swimming; and minutes of other physical activities, including martial arts, soccer, basketball, volleyball, badminton, tennis, ping-pong, and board games.

Data Analysis

Data analyses were performed using SPSS 22.0. Descriptive statistics were conducted to inspect the data for distribution. Median was used to describe the average physical activities per week. Because of the design of the survey, no information regarding physical or sedentary activities over the weekends was collected. For the rest of this paper, the terms *per week* or *a week* only refer to 5

weekdays, not the regular week of 7 days. Modified Box-Cox transformations were conducted to improve the normality of the measures. Linear mixed models were applied to the studied variables. Two-level random coefficient models include a time variable at Level 1 (Year) and a subjects variable (Individuals) at Level 2. Year serves as a repeated variable as well as a random effect. In other words, time is nested within subjects. Level 1 intercept (e.g., mean score of physical activity) and Level 1 slope (e.g., average growth rate in physical activities) were predicted as random effect. Individual-level predictors including gender and age were examined for their effects on change over time in physical activities. They were fixed effect predictors.

Results

A total of 18,399 children aged 6 to 18 years old were in the data set. Between 1997 and 2011, a typical Chinese youth engaged in EPA two to three times per week. When the EPA is broken down by type, the engagement duration for Gymnastics, Track, and Other Activities ranged from 14–27.5, 20–30, and 30–40 min/week, respectively. For ESA, a typical Chinese youth spent 60–84, 30–84, and 24–30 min/week in Watching TV, Reading, and Others between 1997 and 2011. Compared to EPA, IPA had fewer variations over the years in terms of engagement duration. Specifically, the duration for In-School Gymnastics was 60 min/week for most years, except 70 min/week for 2000. The engagement duration for In-School Track was 40 min/week for 2004, 2009, and 2011, with the exception of 45 min/week for 1997 and 2006 and 60 min/week for 2000. The engagement duration for In-School Other Activity was 60 min/week for 1997, 2004, 2009, and 2011, with the exception of 90 min/week for 2000 and 70 min/week for 2006. When the time for EPA and IPA are added together, a typical Chinese youth spend 90 min/week in physical activities.

Fixed Effects

The average growth rates per year for extracurricular physical activities were .02 points (p = .00) for frequency of physical exercise; .05 points (p = .04) for gymnastics, dancing, and acrobatics; .01 points (p = .15) for track and field and swimming; and .01 points (p = .68) for other extracurricular physical activities while controlling for gender, age, random effects, and repeated measure. The average growth rates per year for sedentary activities were −.03 points (p = .00) for watching TV and videotapes, VCDs, and DVDs; −.10 points (p = .00) for extracurricular reading, writing, and drawing; and −.03 points (p = .00) for other sedentary activities. The average growth rates per year for in-school activities were −.02 points (p = .00) for gymnastics, dancing, and acrobatics; −.01 points (p = .00) for track and field and swimming; and −.01 points (p = .01) for other in-school physical activities (see Table 1).

Table 1
Fixed Effects in Linear Mixed Models

Fixed effects	Estimate	*SE*	*p*	95% CI
Extracurricular physical activities				
1. Frequency (*n* = 2,157)				
Intercept	1.46	.05	.00	1.36, 1.56
Male vs. Female	.14	.03	.00	.08, .20
6–12 vs. 16–18 years	.03	.04	.45	−.05, .11
13–15 vs. 16–18 years	.03	.05	.45	−.06, .12
Year	.02	.003	.00	.01, .02
2. Gymnastics (*n* = 550)				
Intercept	5.08	.36	.00	4.37, 5.79
Male vs. Female	.17	.23	.46	−.28, .62
6–12 vs. 16–18 years	−.43	.32	.18	−1.05, .19
13–15 vs. 16–18 years	−.23	.36	.53	−.93, .47
Year	.05	.02	.04	.002, .09
3. Track (*n* = 1,217)				
Intercept	3.59	.12	.00	3.37, 3.82
Male vs. Female	.17	.08	.03	.02, .32
6–12 vs. 16–18 years	−.04	.10	.70	−.23, .15
13–15 vs. 16–18 years	−.10	.11	.34	−.31, .11
Year	.01	.01	.16	−.005, .03
4. Other activities (*n* = 1,999)				
Intercept	6.44	.19	.00	6.05, 6.82
Male vs. Female	.78	.13	.00	.52, 1.04
6–12 vs. 16–18 years	−.70	.16	.00	−1.01, −.39
13–15 vs. 16–18 years	−.40	.17	.02	−.72, −.07
Year	.01	.01	.65	−.02, .03
Sedentary activities				
1. Watching TV (*n* = 5,442)				
Intercept	8.35	.11	.00	8.13-8.57
Male vs. Female	.13	.07	.07	−.01, .27
6–12 vs. 16–18 years	.34	.10	.00	.14, .53
13–15 vs. 16–18 years	−.60	.11	.00	−.82, −.39
Year	−.03	.01	.00	−.05, −.02

Table 1 (cont.)

Fixed effects	Estimate	*SE*	*p*	95% CI
2. Reading (*n* = 4,695)				
Intercept	6.63	.07	.00	6.49, 6.77
Male vs. Female	−.01	.05	.76	−.10, .08
6–12 vs. 16–18 years	−.37	.07	.00	−.50, −.24
13–15 vs. 16–18 years	−.37	.07	.00	−.52, −.22
Year	−.10	.004	.00	−.11, −.09
3. Other activities (*n* = 1,946)				
Intercept	5.26	.17	.00	4.94, 5.59
Male vs. Female	.06	.10	.53	−.13, .25
6–12 vs. 16–18 years	−.28	.15	.07	−.58, .02
13–15 vs. 16–18 years	−.81	.17	.00	−1.14, −.47
Year	−.03	.01	.00	−.05, −.01
In-school activities				
1. Gymnastics (*n* = 3,550)				
Intercept	4.24	.03	.00	4.17, 4.30
Male vs. Female	−.03	.02	.19	−.06, .01
6–12 vs. 16–18 years	.00	.03	1.00	−.07, .07
13–15 vs. 16–18 years	.04	.04	.31	−.03, .11
Year	−.02	.002	.00	−.019, −.01
2. Track (*n* = 3,658)				
Intercept	3.99	.04	.00	3.92, 4.07
Male vs. Female	.03	.02	.13	−.01, .08
6–12 vs. 16–18 years	−.09	.04	.02	−.16, −.01
13–15 vs. 16–18 years	−.06	.04	.14	−.13, .02
Year	−.01	.002	.00	−.02, −.007
3. Other activities (*n* = 3,518)				
Intercept	4.35	.04	.00	4.27, 4.43
Male vs. Female	.29	.02	.00	.24, .34
6–12 vs. 16–18 years	−.19	.04	.00	−.26, −.12
13–15 vs. 16–18 years	−.06	.04	.14	−.13, .02
Year	−.01	.002	.01	−.012, −.002

Note. First-order autoregressive structure with homogeneous variances (AR(1)) for repeated measures.

The average initial scores for extracurricular physical activities were 1.46 (= 2.60 times) for frequency of physical exercise; 5.08 (= 20.89 min) for gymnastics, dancing, and acrobatics; 3.59 (= 20.49 min) for track and field and swimming; and 6.44 (= 35.08 min) for other extracurricular physical activities while controlling for gender, age, and random effects. The average growth rates per year for sedentary activities were 8.35 (= 64.41 min) for watching TV and videotapes, VCDs, and DVDs; 6.63 (= 67.08 min) for extracurricular reading, writing, and drawing; and 5.26 (= 35.38 min) for other sedentary activities. The average growth rates per year for in-school activities were 4.24 (= 68.41 min) for gymnastics, dancing, and acrobatics; 3.99 (= 53.05 min) for track and field and swimming; and 4.35 (= 76.48 min) for other in-school physical activities (see Table 1).

Male youth participated in more EPA than did female youth in frequency (b = .14, p = .00), track and field and swimming (b = .17, p = .03), and other activities (b = .78, p = .00) when other variables held constant. They also had more Other IPA than did female counterparts (b = .29, p = .00). As for age, youth in the 16–18 years group likely exercised more than youth in other age groups in other extracurricular physical activities ($b_{6–12}$ = −.70, p = .00; $b_{13–15}$ = −.40, p = .02), in-school track and field and swimming ($b_{6–12}$ = −.09, p = .02), and other in-school activities ($b_{6–12}$ = −.19, p = .00). However, they also reported more ESA than did youth in other age groups in extracurricular reading, writing, and drawing ($b_{6–12}$ = −.37, p = .00; $b_{13–15}$ = −.37, p = .00); watching TV and videotapes, VCDs, and DVDs ($b_{13–15}$ = −.60, p = .00); and other sedentary activities ($b_{13–15}$ = −.81, p = .00). Children aged 6–12 years had watched more TV and videotapes, VCDs, and DVDs (b = .34, p = .00; see Table 1).

Random Effects

The random effects of subjects and year on the initial scores and growth rates of physical activities were examined (see Table 2). The random effects were not significant (p > .05) in extracurricular physical activities of gymnastics, dancing, and acrobatics; sedentary activities of extracurricular reading, writing, and drawing; and in-school activities of track and field and swimming as well as other in-school activities. The multilevel models may not be proper. Therefore, the linear mixed models analyses were conducted again for measures with only repeated measures effects and fixed effects modeled.

Table 2

Covariance Structures in Linear Mixed Models

Random effects	Estimate	*SE*	*p*
Extracurricular activities			
1. Frequency (*n* = 2,157)[a]			
Variance of intercept	.498	.07	.00
Variance of year	.004	.001	.00
2. Gymnastics (*n* = 550)			
Variance of intercept	.00		
Variance of year	.0002	.01	.98
3. Track (*n* = 1,217)			
Variance of intercept	.49	.15	.00
Variance of year	.003	.001	.00
4. Other activities (*n* = 1,999)			
Variance of intercept	1.03	.52	.048
Variance of year	.01	.004	.00
Sedentary activities			
1. Watching TV (*n* = 5,442)[b]			
Variance of intercept	.010	.21	.96
Variance of year	.025	.002	.00
2. Reading (*n* = 4,695)[c]			
Variance of intercept	.28	.20	.15
Variance of year	.004	.02	.08
3. Other activities (*n* = 1,946)[b]			
Variance of intercept	.00		
Variance of year	.01	.002	.00
In-school activities			
1. Gymnastics (*n* = 3,550)[b]			
Variance of intercept	.00		
Variance of year	.001	.0002	.00
2. Track (*n* = 3,658)			
Variance of intercept	.00		
Variance of year	.0001	.0001	.33
3. Other activities (*n* = 3,518)[c]			
Variance of intercept	.02	.04	.51
Variance of year	−.001	.001	.31

Note. Variance components structure for random effects.
[a]Compound symmetry-heterogeneous covariance structure. [b]No intercept model. [c]Unstructured covariance structure.

The intercept effect is the effect of subjects on initial physical activities scores. This effect was not significant ($p > .05$) in sedentary activities of watching TV and videotapes, VCDs, and DVDs; other sedentary activities; and in-school activities of gymnastics, dancing, and acrobatics. However, the year effects were significant in those measures ($p < .05$). Linear mixed models with no random intercept effect were specified. The significant intercept effects ($p < .05$) were present in extracurricular physical activities of frequency of physical exercise, track and field and swimming, and other extracurricular physical activities. This significant effect means the initial scores of those physical activities vary among school children (see Table 2).

The year effect on the growth rates was also significant ($p < .05$) in the above mentioned measures including all extracurricular physical activities, all sedentary activities except reading, and in-school activities of gymnastics, dancing, and acrobatics, which implies that there is a tendency that school children experience different growth rates of those physical activities across years (see Table 2).

Discussion

To combat noncommunicable diseases (NCD), the Chinese government has been actively promoting healthy lifestyles by setting national goals and initiating campaigns such as the China National Plan of NCD Prevention and Treatment 2012–2015 (Chinese Center for Disease Control and Prevention, 2012). The efforts that specifically apply to Chinese youth include the passage of the governmental policy titled Central Opinions on Strengthening Youth Sports to Enhance Youth Physical Fitness (Xinhua News Agency, 2007). In this document, Chinese youth are recommended to have 60 min or more of physical activity each day, which is the same as the recommendation made by the U.S. Department of Health and Human Services (2008). Unfortunately, a typical Chinese youth from 1997 to 2011 who had an average of 90 min of physical activity per week failed to meet this recommendation, which was echoed in other studies. For example, Zhang et al. (2012) conducted a nationwide survey among 166,812 Han ethnicity students aged 9 to 18 years and reported that only 22.7% of the participants met the recommendation of having physical activity for 60 or more minutes each day. Zhang et al. (2012) further reported that students with higher physical activity desire, physically active parents, and better school sports atmospheres were more likely to meet the recommendation. In addition, students with heavy homework loads and long homework time were less likely to take part in physical activity.

A significant but weak increase was found in the frequency and time spent in Gymnastics, Dancing, and Acrobatics from 1997 to 2011. In addition, a significant but weak decrease was found for the time spent in ESA and IPA. Therefore, it is difficult to draw a conclusion regarding the overall physical ac-

tivity pattern from 1997 to 2011. At the same time, the decrease in time spent in ESA was interesting and surprising as many other researchers in China and the United States reported contradictory results (Zong & Li, 2014). Based on secondary data analysis, Zong and Li (2014) reported that time spent in front of a television, video, or computer increased, as did the proportion of children and adolescents who commuted to school in a motorized vehicle between 1991 and 2009. However, in all the studies mentioned above, the researchers adopted a subjective approach to quantify the time spent for sedentary activities, that is, self- or proxy-report. This left room for bias/errors, especially when these studies were conducted among youth.

Although there was a small decrease in IPA compared to EPA across years, the results reveal that Chinese school youth spend more time in in-school activities than in extracurricular activities. In China, academic success is emphasized. Chinese youth typically have a heavy load of homework and are free of home chores (Tudor-Locke, Ainsworth, Adair, Du, & Popkin, 2003), which may lead to a low amount of extracurricular physical activities. Fortunately, Chinese school children receive additional physical activities through mandatory physical education in schools. The schools provide an environment for different activities, and school staff can supervise and assure the quality of and the time spent in those activities. Given that Chinese school youth receive more physical activity time through school and that they fail to meet the recommendation of having physical activity for 60 min or more per day, the mandatory physical education seems necessary and crucial. At the same time, more effort is needed to educate parents about the importance of involving their children in more extracurricular activities.

It is common to see a gender difference in terms of the involvement in physical activities; specifically, girls tend to be less active compared to boys (X. Zhang et al., 2012). The results of this study are reiterative of the same theme in the literature. Zhang and Li (2008) reported that concern for getting sweaty and smelly, becoming tan after exposure to sun, and lack of female-oriented equipment and facilities contributed to the gender difference. Though boys tend to be more physically active (Zhang et al., 2012), they were more likely to be obese or overweight (Yu et al., 2012). This paradox again indicates that obesity and overweight is a complicated issue that requires a multifactor approach to understand the issue fully and address it successfully.

In China, children usually start elementary school, middle school, and high school at the ages of 8, 13, and 16, respectively. The results of this study indicate that high school students are more likely to engage in Other Extracurricular Activities and all ESA (including watching TV, reading, and others) compared to other age groups. At the same time, high school students are more likely to engage in some IPA, specifically Track and Other In-School Physical Activities, compared to the 6–12 age group, but not the middle school students. In this

study, the high school students group was a reference group, which means that results were based on the comparisons between all other groups and the reference group. Students in high school seem more active, but also spend more time in reading, writing, and so forth. Stronger coefficients can be seen in other extracurricular activities including team sports and other sedentary activities, such as playing video games and with toy cars. These contradictions require future quantitative studies to shed light on the reason for this phenomenon.

Significant random intercept and year effects were found in all EPA except gymnastics, dancing, and acrobatics. Those effects indicate that there were individual differences in those activities in 1997 (the baseline year) and that school children may have experienced different growth rates across years while controlling for gender and age. The results imply that individuals have more control not only on the type but also on the length of extracurricular activities. From a health educator's view, this increases the difficulty of intervention for improving out-of-school physical activities. It is surprising that there were no random year effects on individual growth rate in in-school activities except on gymnastics, dancing, and acrobatics when great changes have taken place throughout the country in all aspects. School staff have the authority to control the type and the length of in-school physical activities, which could explain the homogeneous growth rates among school children in those activities.

Limitations and Implications

Missing data are common in some longitudinal studies. This study is no exception. To address this issue, linear mixed models were adopted as they are good for unbalanced designs. Still, the representativeness may be challenged. Considering that huge social economic changes have occurred in China, more data points could be used to reveal a better picture of the physical activities among Chinese school youth.

The average growth rates of physical activities were obtained while controlling for gender, age, and random effects, which complicates the interpretation of the results. This is due to the diversity of the participants who were from different provinces. It is not uncommon that the in-school situation and the out-of-school situation are different across villages, cities, and provinces. Many factors could contribute to the physical activity patterns. To have a better understanding of physical activity patterns among Chinese school youth, nationwide studies and studies in which homogeneous groups are targeted should be initiated. The nationwide studies would help researchers have a comprehensive view of the issue, and homogeneous group studies would help remove confounders and make results less complex and more meaningful.

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Youth-Driven Innovation in Sanitation Solutions for Maasai Pastoralists in Tanzania: Conceptual Framework and Study Design

Sheri Bastien, *University of Calgary*
Erin Hetherington, *University of Calgary*
Jennifer Hatfield, *University of Calgary*
Susan Kutz, *University of Calgary*
Mange Manyama, *Catholic University of Health and Allied Sciences, Tanzania*

Abstract

Open defecation, poor sanitation, and hygiene are associated with transmission of diarrheal diseases, one of the leading causes of mortality in children under 5 in developing countries. The main objective of this study was to develop and evaluate an intervention called Project SHINE (Sanitation and Hygiene INnovation in Education), in which a school-based participatory science education, empowerment, and social entrepreneurship model of health promotion was used among Maasai pastoralists in the Ngorongoro Conservation Area, Tanzania. The aim of this approach was to improve sanitation and hygiene through engaging youth as change agents to develop and sustain locally relevant health promotion strategies. The intervention was built on formative research and workshops and consisted of school-based lessons, extracurricular activities, sanitation clubs, community outreach events, and a sanitation science fair. In this article, the background, conceptual framework, and the Intervention Mapping process used to guide the development of the study are described. The project will enhance understandings of pastoralist norms and practices related to sanitation and hygiene. The intervention and the sanitation science fair will provide a unique opportunity to build linkages between schools and the wider community and to foster youth interest in science and social entrepreneurship through innovative youth-driven projects.

Sheri Bastien is an adjunct assistant professor for the Department of Community Health Sciences at the University of Calgary. **Erin Hetherington** is a PhD candidate at the Department of Community Health Sciences at the University of Calgary. **Jennifer Hatfield** is an associate dean, Strategic Partnerships and Community Engagement at the University of Calgary. **Susan Kutz** is a professor in Ecosystem Public Health at the Faculty of Veterinary Medicine at the University of Calgary. **Mange Manyama** is the associate dean of Medicine at the Catholic University of Health and Allied Sciences, Tanzania. Please send author correspondence to sbastien@ucalgary.ca.

Keywords

hygiene; school-based intervention; youth innovation; pastoralists; Tanzania; intervention mapping; participatory action research; OneHealth; health promotion

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Background

Approximately 215 million people practice open defecation in sub-Saharan Africa (Galan, Kim, & Graham, 2013). Open defecation, poor sanitation and hygiene are associated with transmission of diarrheal disease, which is one of the leading causes of mortality in children under five in developing countries. Further studies are needed in order to understand associations with childhood stunting and cognitive delays and deficits (Spears, Ghosh & Cumming, 2013; UNICEF, 2012). At the policy level, recent debates concerning the post-2015 development agenda have drawn attention to neglected diseases and have been focused on the importance of consensus regarding WASH (water, sanitation, and hygiene) targets and indicators. This has been highlighted as particularly important considering that access to basic sanitation has been identified as one of the most off-track Millennium Development Goals (World Health Organization [WHO], 2014).

Traditional top-down approaches to changing sanitation and hygiene behaviors and messaging based on eliciting embarrassment, disgust, and shame have been called into question with respect to ethics, in addition to the effectiveness and sustainability of behavior change triggered by these cam-

paigns (Bartram, Charles, Evans, O'Hanlon, & Pedley, 2012; Lupton, 2015). Approaches in which local knowledge, capacity, and preferences are not recognized cannot be sustainable. Evidence shows that integrated interventions are effective for achieving behavior change as well as a host of other important nonhealth outcomes, such as improving school attendance and gender equity (Asaolu & Ofoezie, 2003; Freeman, Clasen, Brooker, Akoko, & Rheingans, 2013; Greene et al., 2012).

Interventions need to be built on local capacity through innovations that are relevant, affordable, and accessible. Focusing on partnerships with communities can leverage the potential of knowledge sharing and mutual learning (Bradley, 2007). The promise of "frugal innovation," which is the development of reliable low-cost medical devices specifically adapted to the needs of resource-constrained settings, is increasingly being recognized as essential to improving health equity (Crisp, 2014).

Tapping into the creativity of youth by leveraging the education and entrepreneurship nexus can help develop the human capital required to promote healthy communities and to spur innovation. Engaging youth as change agents in health promotion recognizes that their experiences and perspectives are of value and gives them voice to articulate concerns. It also allows youth to develop the skills to create sustainable and locally relevant strategies to improve the health of their community. Youth-led social entrepreneurship and microfinance are also approaches that empower young people to generate income from their innovations (DeJaeghere & Baxter, 2014). Finally, engagement of youth in health promotion has been linked to a decreased likelihood of engaging in risk behaviors, increased self-esteem, increased self-efficacy, and an improved sense of social cohesion and connectedness (Bernat & Resnick, 2006).

In this article, we describe the conceptual and theoretical development of an intervention in which schools are used as gateways to engage the community in developing youth-driven and locally relevant strategies to improve sanitation and hygiene among pastoralists in Tanzania. Results of the intervention based on the evaluation plan outlined will be presented in future papers.

Method

Study Setting

This study took place among Maasai communities in the Ngorongoro Conservation Area (NCA) in Tanzania. The Maasai are semi-nomadic pastoralists who depend primarily on livestock for their livelihoods. Extended families live in groups of semipermanent houses called bomas in close proximity with their livestock. The NCA is a unique setting in that it functions as a national park where the primary industry is tourism; however, the Maasai have been granted the right to maintain their traditional livelihoods. There are limited

schools and health centers, and improved infrastructure exists predominantly to serve the tourist industry (McCabe, Perkin, & Schofield, 1992). Our study focus stems from concerns expressed by the communities in the NCA regarding the effect of parasitic infection on child health and hospital records, which indicate that helminth infections (parasitic worms) and protozoa contribute to fecal–oral transmitted diseases, including diarrhea, typhoid, dysentary, and trichuris trichiura. This study was conducted in parallel with another study by our research team, in which we are investigating the prevalence of helminth infections in primary school children in the NCA.

The research project was developed on the basis of a collaboration among the University of Calgary, Canada; the Catholic University of Health and Allied Sciences, Tanzania; and communities of Maasai pastoralists in the NCA, Tanzania. This collaboration began in 2004 and has been focused on various community-driven health promotion projects (Allen, Hatfield, DeVetten, Ho, & Manyama, 2011; Birks et al., 2011; Fenton, Hatfield, & McIntyre, 2013). Our transdisciplinary research team consists of members with expertise in the fields of education, psychology, anthropology, global health, and veterinary medicine and who embrace a One Health approach to understanding the interrelationships among humans, animals, and the evironment (Zinsstag, Schelling, Waltner-Toews, & Tanner, 2011).

Study Overview

The purpose of Project SHINE (Sanitation and Hygiene INnovation in Education) is to use innovative and participatory approaches to science education and social entrepreneurship to create sustainable solutions to issues regarding sanitation and hygiene. Specifically, the aim of the project is to (a) improve knowledge, attitudes, and practices among students related to sanitation and hygiene as well as increase interest and motivation for science and (b) engage secondary school students and the wider community in developing and evaluating sanitation and hygiene prototypes and health promotion strategies to reduce parasitic infection.

The Project SHINE intervention and the process of using Intervention Mapping (IM) as a planning tool are described in greater detail next. Briefly, the intervention consists of a series of workshops, community events, school-based lessons, and extracurricular activities, which culminate in a sanitation science fair (see Figure 1).

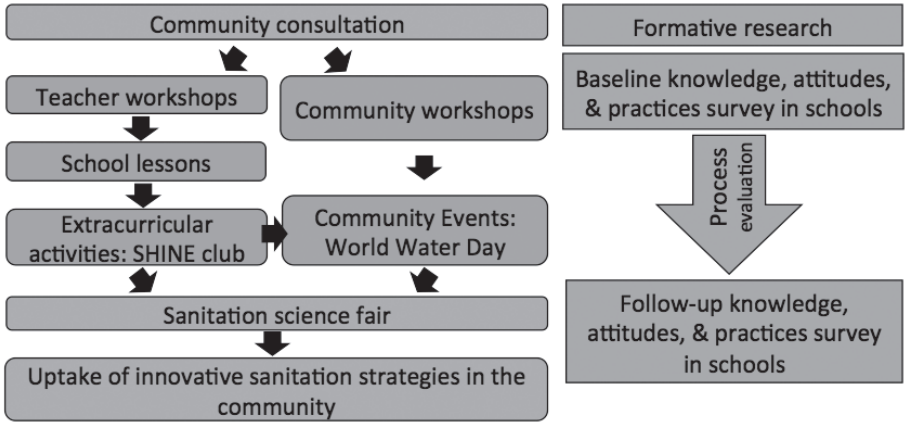

Figure 1. Project SHINE intervention overview.

Study Development

Theoretical Framework

Health promotion interventions are more likely to be effective if they are grounded in social and behavioral science theory, which may help predict or explain the pathway to a desired outcome (Glanz & Bishop, 2010). In a recent systematic review, it was found that some interventions with a focus on improving sanitation and hygiene in resource-limited settings have had positive effects on certain behavioral determinants, whereas behavioral changes in other interventions have been difficult to sustain and have tended to diminish over time (Dreibelbis et al., 2013). Strategies to increase the sustainability and effectiveness of an intervention include ensuring that interventions are multilevel and go beyond individual behavior change and that they are appropriately tailored to the context (Kreuter, Lukwago, Bucholtz, Clark, & Sanders-Thompson, 2003).

Project SHINE is situated within a social ecological framework that draws attention to the multiple overlapping factors influencing behavior at several levels of analysis (Golden & Earp, 2012), in particular the Integrated Behavioral Model for Water, Sanitation, and Hygiene (IBM-WASH) framework (Dreibelbis et al., 2013). Among a plethora of WASH models and frameworks, the IBM-WASH framework was designed based on a systematic review of other models that specify factors that influence WASH behaviors and is distinguished by its multilevel approach. The IBM-WASH framework consists of several levels, namely, societal/structural, community, interpersonal/household, individual, and habitual, and also three dimensions including contextual, psychosocial ("software"), and technological ("hardware"; Dreibelbis et al., 2013). Although

the scope of Project SHINE does not allow for engaging or addressing every level or dimension, the IBM-WASH framework was a useful tool to use in conjunction with IM to guide the specification of barriers and facilitators that may be influential in our context. An action research approach to youth and community engagement in health promotion was used in Project SHINE, and as such, theories concerning community mobilization were also particularly relevant for the conceptual design of the project (Baum, MacDougall, & Smith, 2006).

Intervention Mapping Process

The Project SHINE intervention development process was guided by an adapted IM approach, which involves six steps: (1) assessing the problem and community capacities; (2) specifying program objectives; (3) selecting theory-based intervention methods and practical applications; (4) designing and organizing the program; (5) planning, adopting, and implementing; and (6) developing an evaluation plan (Bartholomew, Parcel, & Kok, 1998). The first step, for instance, involved determining the availability of relevant prevalence data and data at the household level to develop an understanding of sanitation and hygiene within pastoralist communities. It also entailed establishing relationships with stakeholders, such as village executive officers and ward education officers, to enhance our understanding of the community context. A key aspect of applying an IM lens involves developing matrices with explicit key assumptions and elements underpinning an intervention. Two psychosocial theories in particular informed the development of the matrices: the health belief model and social cognitive theory (Bandura & McClelland, 1977; Rosenstock, Strecher, & Becker, 1988). For instance, key constructs, such as perceived severity and susceptibility, perceived benefits and barriers, and self-efficacy, as well as the role of modeling and outcome expectancies that underpin these theories guided the identification of outcomes and change objectives, in addition to the selection of theory-based methods and practical strategies to change health-related behaviors. The matrices served as important planning tools to assist in developing the intervention. The research team developed these based on literature as well as their emerging understandings of the context.

Matrices for each target population—teachers, students, and members of a local women's group—were developed for Project SHINE. An overview of the intervention matrices developed for the project is presented in Table 1. In Table 2, a truncated version of a matrix developed for students is presented, which was focused on identifying individual-, community-, and structural-level determinants related to specified characteristics and behaviors to be targeted by the intervention. IM matrices are available on the following website under Health Sciences Projects, Africa: http://www.ucalgary.ca/ghealth/projects. Performance objectives identify characteristics and behaviors intended to be

fostered in the intervention; for instance, in Project SHINE, the focus is on leadership development and empowerment, knowledge related to important sanitation and hygiene issues, and key behaviors, such as handwashing and appropriate latrine use. As key behavioral determinants, perceived benefits and barriers (pros and cons), perceived social norms, and self-efficacy are specified as key intervention targets. Finally, findings from the wider literature indicate that action plans and goal setting may be better predictors of behavior than intentions and therefore are important to specify among intervention change objectives.

Table 1

Intervention Matrix Overview

Students: Behaviors/Characteristics to promote

- Increased motivation and interest in science
- Participation/capacity/leadership to promote health (See details in Table 2)
- Increase correct and consistent handwashing
- Increased knowledge and appropriate use of latrines
- Increased knowledge of water and link to health outcomes

Teachers: Behaviors/Characteristics to promote

- Increase student motivation and interest in science
- Increase participation/capacity/leadership skills in students to engage as health promotion change agents
- Enhance knowledge and skills to teach about parasitic infection
- Promote handwashing in school setting
- Enhance knowledge about latrines and appropriate use/maintenance
- Extend knowledge of water quality and link to health outcomes

Women's Group: Behaviors/Characteristics to promote

- Participation/capacity/leadership to promote health
- Increased awareness and skills related to low-cost options to improve sanitation and hygiene
- Increase correct and consistent handwashing
- Increase knowledge and appropriate use of latrines
- Increase knowledge of water quality and link to health outcomes

Project Activities

Community Engagement

Knowledge of the project setting and context, developed through long-standing research collaboration with the communities, included interviews, group discussions, and community consultations in which we explored community concerns regarding the project. This process of community engagement was instrumental in developing the matrices and identifying, for instance, important protective behaviors and practices as well as barriers within

Table 2

Sanitation and Hygiene Intervention Planning Matrix for Students

Behavior/ characteristic to promote	Performance objectives (PO)	Pros (perceived benefits)	Cons (perceived barriers)	Perceived social norms/ influences	Self-efficacy	Action plans
Increased motivation and interest in science	PO1: Students will develop an appreciation of how engaging in science can positively affect and contribute to individual/community health. PO2: Students will develop critical thinking and leadership capacities and understand how this may positively affect employability and potential to engage in social entrepreneurship/income-generating activities. PO3: Students will participate in a range of science lessons, activities, experiments, and a sanitation science fair to develop skills and raise awareness among the wider community about the potential of science education, interest, and motivation to improve health outcomes/livelihood prospects.	1. I will increase my scientific knowledge and skills and learn about how this may lead to improved health at the individual/community level. 2. I will develop leadership and other skills that may improve my livelihood prospects. 3. I will feel that I'm making an important contribution to the wider community by drawing attention to important issues in my community.	1. Science education is not important to me/I don't like it/find it difficult. 2. The science classes at this school are boring, we do not have any equipment, and all the teacher does is talk. 3. "Western" science is limited and not relevant to my life.	1. School infrastructure influences. 2. School policy influences. 3. Teacher confidence/efficacy influences. 4. Student/school/community perceptions of importance of science.	It will be difficult to increase motivation and interest in science when: 1. I don't understand much about science or the links between science education, health, and livelihoods. 2. I don't believe science education can improve the health/livelihood prospects for youth. 3. The school does not have any lab equipment/resources/the class is too big/I cannot hear the teacher/understand the lessons. 4. Science classes are not relevant to issues to my life (textbooks and approaches based on "Western" science).	1. I will pay attention in class and learn more about how science education can positively affect health and livelihood prospects. 2. I will participate in extracurricular science activities to build my understanding of the importance of science education. 3. I will be an advocate for science education, including indigenous ways of knowing and its benefits in the school/community. 4. I will be an active participant in the sanitation science fair so that I can learn more about science education, health, and livelihoods.

Table 2 (cont.)

Behavior change strategies and methods:

1. Awareness raising and knowledge acquisition through participatory lessons, experiments, and activities related to science that are fun, are engaging, and demonstrate practical value for lives of students.
2. Skill-building sessions using role play to develop leadership skills for engaging in health promotion.
3. In-class debates about ongoing health promotion efforts in the community, which methods/strategies suit the local context and culture.
4. Debates about the relative merits of "Western" science versus traditional knowledge systems and discussion on commonalities and differences and how to value each and draw on the strengths of both.
5. Community awareness meetings and events (World Water Monitoring Day) involving parents, teachers, health workers, traditional leaders, pastoralist council, and other relevant community stakeholders to showcase student activities and project and raise the profile of students in the community.
6. Invite guest speakers (i.e., prominent Tanzanian scientists, doctors from Endulen hospital, NCA staff) to discuss the value and potential of science to affect health of communities.
7. Start a science club to encourage student inquiry and discussion about science, the nature of knowledge, and how "Western" science and local/traditional knowledge relate to each other.
8. Sanitation science fair, an opportunity for students to share their innovative ideas with parents and the wider community. Select top 3 for consideration for scale up.

Information provision
Consciousness raising
Active learning
Skill building
Role play
Planning/goal setting
Mobilization for social support/social change

Table 2 (cont.)

Behavior/ characteristic to promote	Performance objectives (PO)	Pros (perceived benefits)	Cons (perceived barriers)	Perceived social norms/ influences	Self-efficacy	Action plans
Participation/ capacity/leadership to promote health	PO1: Students will develop an awareness of how active citizen engagement and participation in health promotion at school and in the community can positively affect and contribute to individual/ community health. PO2: Students will develop specific skills, including science literacy and leadership, that will empower them to play a role in school and community health. PO3: Students will actively participate in health promotion efforts through outreach to the community via a science fair project.	1. I will increase my knowledge/skills about health and health promotion and learn about how efforts to improve health may have an effect at different levels. 2. I will develop leadership and other skills to enable active participation in community health issues. 3. I will be making an important contribution to the community by drawing attention to important health issues in my community. 4. I will get to demonstrate what I've learned about sanitation and hygiene to my parents and the wider community.	1. There are more important health issues than those related to sanitation and hygiene in the community. 2. Youth are ignored in school and in the community; we cannot make an impact. 3. I don't know enough about these issues to make a contribution. 4. Even if I come up with a good idea, we probably don't have the resources to implement it. 5. People are stubborn and will not change. 6. NCA won't support changes.	1. NCA policy influences. 2. School policy influences. 3. Community norms/preferences. 4. Cultural perceptions of youth.	It will be difficult to participate in health promotion efforts when: 1. I don't understand enough about health issues or how to engage in health promotion efforts. 2. I don't believe I can make a difference. Youth do not have the power to make changes. 3. The school/the NCA are not supportive of students getting involved in advocacy or planning health activities. 4. I am more concerned with day-to-day survival and getting enough food and water than with thinking about and finding energy for these issues.	1. I will learn more about how I can play a role in promoting healthy behaviors and practices in my community. 2. I will participate in activities at school that relate to health promotion and advocate for more student participation. 3. I will develop my leadership skills to enable me to influence health promotion efforts in my school and community. 4. I will be an active participant in the sanitation science fair to learn more about science education, health, and livelihoods and share my experience.

Table 2 (cont.)

Behavior change strategies and methods:

1. Skill-building sessions using role play to develop leadership skills for engaging in health promotion.
2. In-class debates about ongoing health promotion efforts in the community, which methods/strategies suit the local context and culture.
3. Community awareness meetings and events (World Water Monitoring Day) involving parents, teachers, health workers, traditional leaders, pastoralist council, and other relevant community stakeholders to showcase student activities and project and raise the profile of students in the community.
4. Participation in the youth advisory council/reference group for Project SHINE or the school sanitation club (opportunities for leadership development).
5. Sanitation science fair, an opportunity for students to share their innovative ideas with parents and the wider community. Select top 3 for consideration for scale up.

Information provision
Consciousness raising
Active learning
Skill building
Role play
Planning/goal setting
Mobilization for social support/social change

Table 2 (cont.)

Behavior/ characteristic to promote	Performance objectives (PO)	Pros (perceived benefits)	Cons (perceived barriers)	Perceived social norms/ influences	Self-efficacy	Action plans
Correct and consistent handwashing	PO1: Students will understand the rationale and importance of handwashing. PO2: Students will understand when it is most important to wash their hands. PO3: Students will practice correct and consistent handwashing techniques. PO4: Students will avoid potential behaviors that may increase their risk of worm infection.	1. It will improve my health in both the short and long term. 2. It makes me smell good. 3. I will feel better about myself.	1. I don't know how to wash my hands. 2. I don't have access to water or soap/ash/mud. 3. I don't believe it will have any effect or may have a negative effect on my health. 4. I don't have time to wash my hands. 5. I don't have anything to dry my hands after handwashing. 6. I find it difficult to remember to wash my hands. 7. My friends/ parents don't wash their hands.	1. Religious influences. 2. Cultural influences. 3. Peer group influences. 4. Parental/teacher monitoring and control. 5. Norms surrounding handwashing. 6. Norms related to water scarcity/use/ prioritization.	It will be difficult for me to wash my hands correctly and consistently when: 1. I am unsure how to do it properly. 2. There is no water/ soap/mud/ash available. 3. I am not convinced there will be a positive effect on my health. 4. I am in a rush to get back to class at school or go somewhere else. 5. I don't like having wet hands and nothing to dry them with. 6. I have difficulty remembering when it is most important to wash my hands. 7. I don't believe others my age are washing their hands. 8. I am unaware of the risks associated with not washing my hands. 9. I don't believe worm infections are very harmful to my health or I have other health concerns/priorities.	1. I will find out how to wash my hands properly. 2. I will learn when it is most important to wash my hands and why. 3. I will carry soap/ mud/ash with me whenever possible so that I can clean my hands. 4. I will prioritize making the time to wash my hands before and after important actions. 5. I will identify and try to avoid situations in which I may contaminate my hands when I don't have access to water/washing/drying material. 6. I will remind myself and pay attention to signs about washing hands. 7. I will talk to and convince my parents/ friends that it is a good thing to wash hands properly.

Table 2 (cont.)

Behavior change strategies and methods:

1. Use of Glo-Germ's UV light to illustrate "invisible" germs on hands.
2. Provide instructions on correct and consistent handwashing.
3. Forge links with health services. Invite health care workers to give demonstrations and practice sessions for students so they can practice and get feedback on correct and consistent handwashing.
4. Use of drama/theatre/songs to promote handwashing.
5. Reminders/cues (posters/stickers) to action to wash hands in key areas, such as in toilets and around kitchen/eating areas. Key messages to reinforce intentions.
6. Awareness raising of consequences of lack of correct and consistent handwashing to increase motivation.
7. Set behavioral goals and identify potential obstacles and strategies for overcoming barriers.
8. Stop-action role play, theatre involving community/school members.
9. Use comics to get students to reflect on and decide what they would do in various scenarios, and give feedback and tips on action plans.
10. Homework assignments that involve parents.
11. Debates about hygiene practices and norms.
12. Encouragement to support positive role modeling with peers and family members.
13. Community awareness meetings and events (Global Handwashing Day) involving parents, teachers, health workers, traditional leaders, pastoralist council, and other relevant community stakeholders to focus on the importance of handwashing and develop locally and culturally relevant efforts to promote handwashing in schools and communities.

Information provision
Intention formation
Active learning
Skill building
Role playing (if–then scenario)
Barrier identification
Planning/goal setting
Self-reevaluation/value clarification
Consciousness raising
Prompting identification as a role model
Mobilization for social change

the community to increasing uptake of handwashing, such as water scarcity. Participatory techniques, such as open defecation mapping (an exercise that involved having students draw their communities and describe human and livestock defecation practices), were used to encourage youth to think about potential contamination "hot spots" and modes of transmission of parasites. In addition, aspects of pastoralist lifestyle, including semi-nomadism and a close relationship to livestock, were discussed with study participants and stakeholders and carefully considered during all phases of intervention development. Finally, the development of theory-based behavior change strategies and methods for each priority group was an important aspect of program development and will continue to inform the project moving forward. Careful consideration of access to resources and sustainability is particularly crucial in resource-limited settings and when working with vulnerable populations. Community engagement is an integral and iterative process within the project that will deepen our understanding of pastoralist needs, norms, and practices as well as inform the development of the intervention.

School-Based Activities

Between May and September 2014, undergraduate, graduate, and faculty from the University of Calgary delivered a series of four workshops for 18 secondary school teachers that was designed to (a) enhance their knowledge of parasitism, water, sanitation, and hygiene and the link to health outcomes; (b) equip them with participatory lessons and activities that they could use in their classroom setting; and (c) prepare them to plan and implement science fairs in their schools. These interactive workshops were a unique knowledge-sharing opportunity for the Project SHINE team and the school teachers and contributed to the refinement of the project teacher manual and the intervention.

The teacher manual for secondary school biology and civics teachers was developed based on a review of the existing curriculum and was revised based on lessons learned during workshops and discussions with teachers. An overview of the topics covered in the school-based intervention is displayed in Table 3. The Project SHINE team developed lessons and adapted them from a range of other sources, including the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), Centre for Affordable Water and Sanitation Technology (CAWST), Glo Germ, and Safe Water. The lessons were designed to align closely with the objectives stated in the Secondary School Biology and Civics curriculum as mandated by the Ministry of Education in Tanzania. This was explicitly done to ensure that the lessons and activities contained within Project SHINE would serve as useful tools that would enable teachers to meet their existing teaching responsibilities, instead of increasing their teaching load. Participating teachers were provided with a teacher manual and log book so their experience with implementing project lessons could be documented.

Table 3
Overview of topics covered in the teachers' manual

Topic	Lesson objectives	Activities
Parasitism	• Discuss the symptoms, physical manifestations, and transmission of relevant sanitation-related illnesses in the area.	• Discuss the symptoms, physical manifestations, and transmission of relevant sanitation-related illnesses in the area.
Sanitation options in resource limited settings "Sanitation Spectrum"	• Describe the community's sanitation situation. • Identify options for improving sanitation. • List the steps that can be taken to improve sanitation in the household/community.	• Group work and discussions to identify sanitation issues and potential areas for change visually.
Hygiene	• Explain the importance of handwashing. • Describe the effectiveness of different methods of handwashing for removing germs.	• Glo Germ (use of Glo Germ powder/gel and UV light) used to observe microscopic germs that are invisible to the naked eye.
Water quality testing	• Understand that water quality cannot always be assessed visually. • Explain the difference between water testing techniques and the advantages and disadvantages of each.	• Conduct a variety of tests to distinguish between safe versus unsafe water, including a physical test to assess whether water looks safe to drink, a turbidity test to examine water quality, and a pH test to examine water quality.
Water treatment	• Discuss water treatment options. • Describe the advantages and disadvantages of each treatment method.	• Observe water samples under microscope and with naked eye from different sources, describe properties, and examine differences according to treatment method.

Diarrheal disease transmission	• List common ways of transmission of diarrheal diseases. • Describe a general path of bacteria from feces to mouth. • Discuss transmission routes in the community. • List problem areas and behaviors that put people at risk of infection.	• Participatory mapping exercises to examine open defecation, relationship between humans and livestock and spread of disease, flash cards, group discussion.
Use of microscopes and Foldscope	• Demonstrate how to use a microscope and Foldscope. • Demonstrate how to prepare slides.	• Hands-on exercises with microscopes and Foldscope to examine common water and sanitation-related parasites, bacteria, and viruses that are common in the area.

The school-based lessons and sanitation science fair took place in the latter phases of the intervention in November 2014 and targeted approximately 400 Form 3 students at the secondary schools. To prime the students for the science fair, the Foldscope, which is an origami-based microscope that costs less than a dollar to manufacture, was presented as an example of frugal innovation inspiration (Cybulski, Clements, & Prakash, 2014). Students were given their own Foldscope and had the opportunity to work with members of the Prakash Lab at Stanford University to assemble and experiment with using the Foldscope, in some cases as part of their science fair project. Students developed their own research projects based on needs in the community, focusing on the interactions between animal and human health.

The science fair was attended by all students enrolled and present on the day of the fair and by members of the community. In addition, students and teachers were invited to participate in the community awareness–raising events. To the best of our knowledge, this is the first sanitation science fair to be held worldwide, making this a unique opportunity in which students showcase their innovative ideas and projects designed to improve sanitation and hygiene to parents and the wider community. It is also the first One Health science fair of which we are aware, which draws attention to the need for health promotion strategies with a focus on pastoralists to be explicitly designed to address the interrelationship among man, animals, and the environment.

Evaluation Process

School-Based Data

There are two secondary schools in the NCA, and both schools agreed to participate in the study. In this study, a nonexperimental, before and after design was used to assess effectiveness of the intervention. This included a multistage consent process to ensure that the rights of children were protected and respected. After obtaining ethical permissions from Tanzanian and Canadian ethics boards, we obtained community consent from district officials and school headmasters. Given the low-risk nature of the educational intervention, which was consistent with the existing Tanzanian curriculum, a passive parental consent procedure was used whereby parents were provided with an information letter indicating the nature of the study and an option to withdraw their child. These consent methods have previously been used in Tanzania (Kajula, Sheon, De Vries, Kaaya, & Aarø, 2014; Kiragu & Warrington, 2013). We did not register any parental or student refusals for participation in the study.

Qualitative data in the form of in-depth interviews and group discussions with students, teachers, health care workers, and members of a local women's group were gathered as part of the formative research at the beginning of the study to understand perceptions of parasitism in humans and livestock as well as sanitation and hygiene practices and norms among pastoralists. An interpretive phenomenological approach was applied as an analytic framework for grasping local norms, attitudes, and practices, by accounting for verbal and nonverbal communication as documented by note takers (Fade, 2004). The findings from the formative research phase will be forthcoming.

The primary method of quantitative data collection in schools was a self-completed questionnaire. The questionnaire consisted of a set of sociodemographic questions, followed by a series of questions related to sanitation and hygiene knowledge and behaviors, sources of information and discussion about sanitation and hygiene, participation in health promotion planning and activities at the school and community level, and interest and valuation of science. Many of the scales were drawn from surveys, such as the Global School-Based Student Health Survey (GSHS), which has been validated among school children aged 13–17 years worldwide, including in Tanzania, and other validated tools (Seha, Klepp, & Ndeki, 1994; WHO, 2013). The questionnaire was pilot tested at a school in the Arusha region and revised accordingly. In April 2014, students in all grades (approximately 1,000 in total) at the two secondary schools in the NCA were invited to complete a self-administered questionnaire, with each question presented in English and Swahili to maximize comprehension. A follow-up survey was conducted at 6 months.

Upon completion of the sanitation science fair in November 2014, the evaluation team, which consisted of a wide cross-section of community representatives, and the research team reviewed the strengths, limitations, and feasibility of the projects to determine which could hold potential for scale up and youth-led social entrepreneurship. Particular emphasis was placed on low-tech solutions and suitability to local context. Discussions with the community and schools are ongoing, and details concerning the sanitation science fair and the outcomes will be presented in a forthcoming article.

To understand how the lessons were implemented and how school events, including the sanitation science fair, were carried out, a process evaluation was completed using interviews and group discussions, teacher log books, and classroom observation.

Community and Hospital-Based Data

To assess availability of sanitation facilities, we identified existing data collected as part of the Tanzania National Sanitation Campaign concerning sanitation facilities in the communities nearby participating Project SHINE secondary schools. In partnership with local authorities, we collected complementary data concerning the location, type, use, and maintenance of sanitation facilities at selected households. The data collection instrument and database were modified based on tools available from Sanitation Mapper, a free software program to map sanitation facilities using GIS funded by SHARE (Sanitation and Hygiene Applied Research for Equity). This tool has been used in low- and middle-income countries (Roma, Pearce, Brown, & Islam, 2012). In addition, monthly records from a rural hospital in the study setting dating to 6 months prior to the start of the intervention and 6 months after were included in the database to enable investigation of patterns of sanitation-related diagnoses in the community. Although we will not be able to attribute any changes to our intervention at this stage, we view this as an important first step in a process of engaging local authorities and assisting with the establishment of a monitoring and surveillance system.

In partnership with other community members, such as traditional leaders, hospital and dispensary staff, a local women's group, and policy makers, we evaluated the project on an ongoing basis to ensure that students and teachers found the project relevant and engaging and that it was having a positive effect on knowledge, attitudes, and practices; interest and valuation of science; and capacity to develop and sustain health promotion strategies.

Discussion

We believe Project SHINE is well positioned to make a unique contribution to health promotion and global health scholarship for several reasons: First, it is one of few studies in which the aim is to develop an understanding

of pastoralist knowledge and practices related to parasitic infection, sanitation, and hygiene using a One Health approach and in which a systematic development process, such as IM, is used. We also believe it is among the first to truly work in partnership with pastoralist youth and communities and within a salutogenic framework with a focus on factors that support human health rather than causes of disease. Finally, in recognition of the potential of frugal innovation, this study is also the first to test an innovative science education and social entrepreneurship model of health promotion engagement. We anticipate that if this model were found to be effective, it would have broad applicability to other settings and health issues. Support for the project has been high, with active participation and engagement in the project activities, and with students, teachers, and community members, including traditional leaders and local government officials, expressing support and enthusiasm for the study.

In Project SHINE, we attempt to deepen understandings of the context of pastoralist practices and norms related to sanitation and hygiene by situating our inquiry within a One Health framework. In addition to baseline and follow-up surveys of knowledge, attitudes, and practices of secondary school students, we collected formative research data throughout the project to explore issues such as pastoralist and livestock relationships, equity and access to resources, gender, social change effects on pastoralist sanitation and practices, seasonal variations, and sanitation and hygiene practices and norms in settings such as the school, the home, grazing pastures, and the wider community. Because of contextual constraints, such as water scarcity and lack of soap, researchers in formative research and students in the science fair projects have begun to explore the local practice of using plants for handwashing and anal cleansing. Traditional treatments for parasitism, including medicinal plants, were also explored through group discussions and interviews, as well as perceptions of hospital versus traditional treatment. We have also discussed with community members and teachers the valuation and incorporation of local knowledge in the national school curriculum, which may not always be relevant to the NCA context and which tends to privilege "Western" science and knowledge. In our setting, we see this as particularly important given that the majority of school teachers come from regions in Tanzania where cultural practices and norms are different from the NCA. It has been noted that although teachers in Tanzania may be encouraged to adapt the curriculum to the local context and culture, few make an attempt at "border crossing" or diverge from the primary material to engage with the discontinuities between a student's life world and school science or the foundational differences between Western science and indigenous knowledge systems (Semali & Mehta, 2012). Awareness and careful consideration of these tensions at all stages of the intervention are essential to ensure community buy-in and intervention effectiveness. The IM process was instrumental in encouraging systematic consideration and planning around

these key contextual features of our setting and provided added rigor to the intervention.

In this study, we used schools as settings to engage youth as change agents in the development and uptake of culturally relevant health promotion strategies to improve sanitation and hygiene among pastoralist communities. This strategy is in line with the WHO (2011) recommendations that emphasize the importance of school-based programs as effective and cost-efficient settings for health education, to reach not only school children and teachers, but also the wider community. We also used schools as gateways to the wider community in recognition that youth require support for their ideas to truly hold change-making potential. By engaging community stakeholders at multiple levels through all stages of the research process, we hope that the necessary supports and structures will be in place to increase the likelihood of uptake of promising youth ideas and strategies to improve sanitation and hygiene.

As mentioned, our model of science education and social entrepreneurship for health promotion presents a novel opportunity to foster youth-driven innovation. To that end, students participating in the project had the unique opportunity to be among the first students in the world to experiment with using the latest prototype of the Foldscope, an inspiring example of frugal innovation. The Project SHINE Sanitation Science Fair, held in November 2014, showcased student projects that may hold potential for improving sanitation and hygiene among humans and livestock in pastoralist communities or other resource-limited settings worldwide. These projects may serve as examples of successful reverse or frugal innovation, or they may simply spark an awareness, interest, and capacity among youth and communities in the NCA to continue to improve the health of their communities.

Several assumptions, limitations, and challenges associated with the Project SHINE approach merit discussion. First, a participatory action research project in which youth are engaged as agents of change assumes that youth are given voice within their communities. Given the complex nature of power structures within any community, youth participating in Project SHINE may face resistance to their ideas and strategies within the community, leading to a sense of frustration and disempowerment (Allen-Scott, Hatfield, & McIntyre, 2014). We also acknowledge that the uniqueness of the NCA context may present particular challenges to improving sanitation and hygiene practices and conditions. In addition to water scarcity, the NCA is a UNESCO World Heritage site and has land tenure rules that restrict the construction of permanent structures, including households. Furthermore, the NCA Authority has the right to prohibit and control grazing, collection of firewood, and residence, among other issues (Galvin, Thornton, Boone, & Knapp, 2008). At the same time, there is a governmental expectation that each household have a toilet, and this is reportedly enforced particularly during times of disease outbreak.

Political will at the national, regional, district, and ward levels as well as competing health priorities may present challenges to efforts to improve sanitation and hygiene. Thus, the capacity of youth and community members to exercise agency within this structure may be limited. This could be due to lack of voice within the context or to limited capacity and access to the resources required to make desired changes.

Our study will contribute toward building the evidence base for a model of participatory science education and social entrepreneurship for health promotion. We aim to test the assumption that this approach will lead to the development of effective, culturally relevant strategies to improve sanitation and hygiene among pastoralists, but we also recognize that schools are complex settings within which to work. Among the many challenges currently facing science education in Tanzania are overcrowded classrooms, shortage of textbooks, a reliance on rote learning, irrelevant curricula, poor learning outcomes, and poor linkages to the employment sector (Semali & Mehta, 2012). Teachers have multiple competing demands, and hosting a science fair requires knowledge, experience, and resources. Science fairs are not commonly held in Tanzanian schools, and none of the teachers with whom we spoke were familiar with science fairs. We hope that by partnering with our two pilot schools and by sharing resources and other teaching and learning supports with them, we can overcome some of these challenges.

Conclusion

In this article, we presented the Project SHINE design and conceptual framework that we used in an attempt to foster youth-driven innovation in sanitation and hygiene strategies for pastoralists in Tanzania. To the best of our knowledge, this is the first attempt to apply IM to a sanitation and hygiene intervention in which a pastoralist population is the priority. We have found it to be an effective planning tool that has added rigor to the study and that has fostered an iterative cycle of reflection and adaptation concerning project approaches and outcomes. It is our hope that Project SHINE will contribute to the body of evidence concerning health promotion more generally and of health promotion among pastoralist populations more specifically.

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