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ORIGINAL ARTICLE

Impact of a Group-Based Video and Interactive Group Session Addressing Diarrheal Disease, Helminthic and Schistosomiasis Infections, Hypertension and Diabetes on Short and Long-Term Improvement in Knowledge and Healthy Behaviors in Seroconcordant HIV-Negative Zambian Couples

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Abstract

Background: Non-communicable and neglected tropical diseases (NCD and NTD) contribute to high morbidity and mortality in Zambia. While the public health importance of NTD has long been recognized, prevalence of disease remains high. NCD are emerging as causes of morbidity and mortality. Knowledge of risk factors, diagnosis, management, and prevention of NCDs and NTDs in the general population is poor and as a result, low-cost commodities are insufficiently used.

Methods: Urban couples recruited in five government health centers (HC) participated in a video-based group intervention addressing hand washing, water treatment, routine deworming, and urinary schistosomiasis screening to prevent morbidity and mortality from NTD. Chlorine, soap, and deworming for the family were provided, along with schistosomiasis treatment. The intervention also promoted lifestyle changes to prevent and ameliorate hypertension and diabetes and emphasized the importance of medical management regardless of symptomatology. Blood pressure screening identified hypertensives that were given low-sodium salt and referrals. Those with glucose on urine dipstick were counseled and referred. Knowledge and observed and self-reported behaviors were measured 1-2 weeks and 6 months after the interventions. All activities took place in the HC and conducted by trained HC staff.

A comparison group recruited at five matched HC was assigned to an HIV prevention intervention and completed the same surveys as the intervention group at baseline and 6 months.

Results: One to two weeks after the intervention, reported use of chlorine treatment for drinking water increased from 24% to 96%, with knowledge of correct volume for dilution of 20 L and 5 L containers improving from 29%-35% to 96%-98%. Knowledge of household deworming increased from 62% to 99%. Observed handwashing technique improved including duration (20 seconds) and scrubbing of back, palms, wrists, between fingers and under fingernails. Knowledge that hypertension and diabetes could be asymptomatic increased from 63% to 82% and recall of potential sequelae also improved including heart disease/attack (14% to 41%), stroke (26% to 61%) and death (65%

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to 83%). Correct definition of hypertension (BP > = 140/90) increased from 6% to 54% and citing salt reduction as part of management increased from 31% to 85%. An increase in those reporting not adding salt (8% to 20%) corresponded with a decrease in those reporting > = 1/2 teaspoon (16% to 5%). Knowledge that diabetics should reduce sugar intake increased from 48% to 89% and the proportion reporting adding > = 3 tsp to their tea decreased from 42% to 26%. Taking prescribed medication and getting regular medical checks knowledge increased for both hypertension (38% to 73% and 28% to 66%, respectively) and diabetes (32% to 71% and 20% to 60%, respectively). These improvements were retained at 6-month follow-up and sharing-related household duties to prevent NTD and NCD improved. Comparison group surveys confirmed equivalency of NTD and NCD knowledge and behaviors between the two groups at baseline. Surveys at 6 months showed no improvement in the comparison group, confirming that secular trend did not play a role.

Conclusion: Video-based interventions are time and money-saving and ensure consistent messaging. Sustained improvements in knowledge and behavior were reported when low-cost commodities were provided.

Keywords

Non-communicable diseases, Neglected tropical diseases, Hygiene and sanitation, Helminthiasis, Handwashing, Healthy lifestyle, Video, Couples

Abbreviations

BP: Blood Pressure; CLTS: Community-Led Total Sanitation; CNC: Concordant HIV-negative Couples; CRT: Cluster Randomized Trial; CVCT: Couples' HIV Voluntary Counseling and Testing; ELISA: Enzyme-Linked Immunosorbent Assay; GHP: Good Health Package; HC: Health Center; NCD: Non Communicable Diseases; NTD: Neglected Tropical Diseases; SSA: Sub-Saharan Africa; WHO: World Health Organization

Introduction

Neglected tropical diseases (NTD) and non-communicable diseases (NCD) pose an important threat to health in Africa. In Zambia and many Sub-Saharan Africa (SSA) countries, the most prevalent NTDs are cholera, soil transmitted helminths and schistosomiasis. Among the leading causes of death in Zambia are lower respiratory infections (pneumonia) and diarrheal diseases at 4th and 5th respectively, with children most affected [1,2]. Various studies in SSA including Zambia have shown that handwashing can reduce prevalence of diarrheal diseases by 25% or more [3-8]. Cholera is also a frequent problem in two of the largest cities in Zambia, Lusaka and Ndola, with regular outbreaks occurring during the rainy season since the 1970s [9]. Previous cholera outbreaks have been linked to high fecal contamination of water sources and raw/prepared foods, inadequate safe water supply and sanitation, and insufficient drainage [9-15].

Hypertension and diabetes leading to heart disease and stroke are increasingly common due to urbanization, increase sedentary lifestyles and high salt and high fat diets. Stroke is now the 3rd leading cause of death having increased by almost 60% from 2009 to 2019 and ischemic and hypertensive heart disease are ranked at 7th and 10th position respectively [1]. Risk factors attributable to mortality and morbidity (disability) include water sanitation and hygiene (WaSH) in 4th position and high blood pressure (BP), high body mass index, and dietary risks at 6th-8th position respectively [1].

We previously offered basic NTD/NCD education with a flip chart and a selection of services (blood pressure screening, urine dipstick for blood (schistosomiasis) and sugar (diabetes) and commodities (hand soap, chlorine, deworming for the family, low sodium salt) to couples seeking joint HIV counseling and testing in Lusaka and Ndola, two of Zambia's largest cities [16], and these services were associated with increased follow-up for repeat HIV testing. However, health center (HC) staff reported that knowledge about NTD and NCD was poor, prompting us to develop a more intensive education program.

We present here knowledge and behaviors related to prevention, screening and treatment of common NTD and NCD in seroconcordant HIV-negative Zambian couples (CNC) who participated in a Good Health Package (GHP) comparator arm of a cluster randomized trial (CRT) described in detail elsewhere [17]. Baseline information is compared to survey responses two weeks and six months after a video-based educational session with practicums and provision of low-cost commodities. Outcomes at six months are compared with CNC in clinics randomized to a contemporaneous and unrelated HIV prevention, also described in more depth elsewhere [17]. Our findings will highlight successful couples-based prevention strategies to reduce the morbidity and mortality associated with NTD and NCD through education, practical training, low-cost commodity distribution and screening with treatment/referral.

Methods

Ethics

Approval has been granted by the OHRP-registered University of Zambia Biomedical Regulatory Ethics Committee and Emory University Institutional Review Board and retrospectively registered as NCT02744586 on ClinicalTrials.gov. Couples viewed a verbatim reading of the informed consent on a video, met with a counselor to discuss any questions or clarifications, and jointly signed consent [18-20]. A unique alphanumeric ID was implemented for all data gathering tools. Locator information was stored separately from data to maintain privacy and confidentiality.

Study design

Ten participating clinics (8 in Ndola and 2 in Lusaka) included 5 dyads with non-overlapping catchment areas matched by clinic volume and HIV prevalence. Each dyad was randomized such that one clinic was

assigned to the GHP arm and the other to the control arm. An enrollment visit was followed by receipt of the intervention several days later. The short-term impact was measured 1-2 weeks after the intervention with intervention-specific questionnaires. Long-term impact was measured at six months with the same assessments in GHP and control groups, including knowledge and behaviors related to NTDs/NCDs. The trial is ongoing (clinicaltrials.govNCT02744586) with a 60-month follow-up visit to have more detailed comparisons of HIV risk factors between both arms and to assess longer-term knowledge and implementation of strategies in GHP arm. Hypotheses of the CRT are that the GHP arm will sustain improved knowledge and behaviors related to NTD/NCD prevention and treatment than the control arm. Conversely, the control arm will have a lower incidence of HIV risk factors, such as reported outside sexual contacts, incident HIV and STI than the GHP arm.

Objective

The purpose of this manuscript is to compare changes in NTD/NCD-related knowledge and behaviors in the GHP arm at baseline (pre-intervention) and post-intervention at two weeks and six months. This study will also compare knowledge and behaviors at six months post-intervention visit between GHP and a comparison group (control) that received an HIV intervention in order to assess potential secular trend due to other NTD/NCD programs.

Study population

At Couples HIV Voluntary Counseling and Testing (CVCT) offered in government health centers in Lusaka and Ndola, two of Zambia's largest cities, couples underwent pre-test counseling, HIV rapid testing per national guidelines adapted for couples [21] and post-test counseling. According to Center for Disease Control and Prevention and World Health Organization (WHO) guidelines, couples received HIV results together and were counseled per their couple HIV status [22,23].

In 2016, couples who received CVCT services and met pre-screening eligibility (both partners HIV-negative, women aged 18-45 and men aged 18-65, cohabiting for > = 3 months, interested, willing and capable of understanding and fulfilling study procedures and providing contact information) were invited the following weekend to return for screening and enrollment.

Study reimbursement

At each visit, couples received approximately 3 USD per person-visit as study reimbursement to cover time at clinic and transport, as described in the informed consent. An additional 2 USD per person was given as a lunch allowance for more extended study visits.

Enrollment visit

After joint informed consent, the couple was separated, and a baseline questionnaire was administered to women by female counselors and men by male counselors and included socio-demographic characteristics, knowledge of and behaviors related to NTDs and NCDs. The visit lasted 2-3 hours.

Intervention visit

The "Good Health Package" (GHP) video rationale and content was developed based on previous use of health education flip chart and a choice of provision of commodities (deworming tablets, chlorine and hand soap) and health screenings (blood pressure, diabetes and schistosomiasis) related to NCDs and NTDs to improve follow-up HIV testing in couples in which at least one partner was HIV-negative [16]. All materials were translated into the vernacular (Bemba and Nyanja) and content was equivalent to or below 8th grade level. During the visit, spouses watched a one-hour video that consisted of two-30-minute parts. Part one content covered risk groups; transmission and mechanism of action; signs and symptoms; key facts and statistics; and prevention strategies. In the first part of the video, spouses were separated into men and women's groups; male counselors led the men's groups, and female counselors led the women's groups. Pauses were incorporated throughout the video in key areas; during these pauses, the counselor actively facilitated discussion points to allow for questions, answers and further discussions/clarifications if needed. Hand washing with soap to prevent respiratory and diarrheal infections and intestinal helminths was emphasized, and during breaks in the video, participants practiced under supervision. Use of drinking water treatment with chlorine to prevent cholera and other causes of diarrhea was described and again participants practiced putting the correct amount of chlorine into 5-liter (one measure of the top of the chlorine bottle cap) and 20-liter (one measure of the bottom of the chlorine bottle cap) containers. Schistosomiasis education highlighted how freshwater areas within a city could be potential sources of infection based on a recent study showing active infection in 10% of healthy adults in Lusaka [24]. (Of note, we did not include discussions of malaria as we were not able to offer bed nets due to their high cost and the focus on pregnant women for available stock).

Modifiable lifestyle changes related to salt and sugar intake, weight maintenance and physical activity were emphasized for prevention of hypertension and diabetes, and salt and sugar measurements were used to illustrate portion control. All couples came back together in part two of video which had a quiz related to topics in the video in addition to discussion on the importance of equal responsibility in terms of household health and implementing strategies at home to improve the family's health. Couples were provided with a bottle of chlorine sufficient for one year of use in an average household, hand soap, and one round of de-worming

medication sufficient for the household. Blood pressures were taken, and urine dipsticks were used for detection of urinary schistosomiasis (hematuria) and diabetes (glucosuria). All couples received low sodium salt and messaging for hypertension prevention. Participants with a blood pressure > = 140 mmHg systolic and/or > = 90 mmHg diastolic received added lifestyle and dietary counseling and were referred for medical evaluation. Participants with elevated glucose (> = 500 mg/dl (27.77 mmol/L) in urine were also referred for medical evaluation. Those with hematuria were provided with free treatment for schistosomiasis with praziquantel. The visit lasted 3-4 hours.

Follow-up visits 1-2 weeks and 6 months post-intervention visit

GHP spouses were separated and administered a questionnaire about knowledge, implementation of strategies, sharing of household roles, and behaviors related to their intervention content. At the 6-month follow-up visit, couples in both GHP and control arms responded to the same questions on hypertension, diabetes, diarrheal diseases, schistosomiasis, and helminths.

Data management and analysis

Questionnaire data is managed using Microsoft Access and Research Electronic Data Capture (REDCap) electronic data capture tools hosted at Emory University [25] with IT support from Research and Woodruff Health IT Division grant support (UL1 TR000424). Responses to questionnaires are presented as frequencies. To establish significance, differences in responses between pre-and post-intervention and between men and women are assessed with chi-square tests. Because the number of participants is large, some statistically significant differences are not meaningful, and we thus only highlight in text significant differences of > 5%. Data analysis is conducted using SAS 9.4 (SAS Institute, Cary, N.C.).

Results

Demographic characteristics

In the 570 couples, who participated in the intervention and the first follow-up visit, the average age was 32 for men and 26 for women and the average duration of union was 5.9 years. The couple reported an average of 4.6 people in the household including an average of 2.1 children under 16. Literacy in the vernacular (Bemba or Nyanja) was good with 80% of men and 63% of women reporting reading easily. Most couples earned something with 99% of men and 71% of women reporting some income. Among men, 73% reported reading or understanding English easily compared with 55% of women.

A public tap was the most common source of water (33%) with outdoor tap piped into the yard (26%), a protected well (17%), and bore hole directly (15%) also common. Only 7% reported piped water in the home. Most could access water within a < 15 min walk (82%) or a 16 to 20-minute walk (9%). Two percent of respondents reported having high blood pressure and 36% knew of family members with high blood pressure. Only two respondents reported diabetes though 19% of respondents reported had affected family members.

In the presentation of data from Table 1, Table 2, Table 3 and Table 4 below, differences are significant unless specified and only significant differences of > 5% are mentioned in text.

Knowledge and behaviors prior to and 1-2 weeks post GHP intervention (Table 1)

At baseline, 46% of respondents (49% of men and 43% of women) did not treat their drinking water, 31% boiled water, and 24% added chlorine. This increased to 96% using chlorine and 15% boiling two weeks post-intervention. Knowledge of how much chlorine to use for 5-liter and 20-liter containers rose from 29-35% to 96-98%. Most respondents knew that handwashing after using the toilet and before cooking and eating were important before the intervention. Handwashing after handling animals, dirty diapers, or rubbish were reported more often though respondents citing after sneezing or coughing into your hands or before and after caring for the sick remained suboptimal at 36-40%. The techniques used during handwashing demonstration also improved with knowledge of scrubbing back of hands, palms, between fingers, and under fingernails, all increasing to > = 70%. For length of time for hand washing (20 seconds), an increase was seen between baseline and post-intervention for self-report (23% to 66%) as well as observed (5% to 43%).

Reported ways to get intestinal worms at baseline included eating dirt/soil (46%), not properly washing raw vegetables and fruits (43%), and undercooked meat (22%), all of which increased to > = 84% after the intervention. Less frequently reported ways to get intestinal worms at baseline, such as not washing hands after touching soil, using the toilet, and before handling food increased from < = 14% to > = 40% post-intervention. Prior to the video, 62% of respondents thought that deworming should include everyone in the home, and 26% thought it involved only the children. This increased to 99% volunteering that everyone in the home should be dewormed.

The knowledge that most hypertensive and/or diabetic patients did not have symptoms increased from 63% to 82%. Knowledge also increased that hypertension could lead to heart attacks (14% to 41%), stroke (26% to 61%) and death (65% to 83%). Only 6% of respondents correctly cited what value is considered high blood pressure (> = 140/90 mmHg) before the intervention; this increased to 54% (61% of men and 48% of women).

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Table 1: Knowledge and behaviors prior to and 1-2 weeks post GHP intervention.

	Baseline pre-intervention						Two weeks post-intervention					
	Total (N = 1140)		Men (N = 570)		Women (n = 570)		Total (N = 1140)		Men (N = 570)		Women (n = 570)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
How do you treat your drinking water?												
I do not treat my drinking water	523	46%	278	49%	245	43%	17	1%	9	2%	8	1%
Boil	351	31%	162	28%	189	33%	172	15%	80	14%	92	16%
Add chlorine	275	24%	127	22%	148	26%	1095	96%	544	95%	551	97%
Strain it through a cloth/Water filter/Other/Don't know	90	8%	43	8%	47	8%	20	2%	11	2%	9	2%
How much chlorine do you need for a 20 L container?												
Top of cap	115	10%	45	8%	70	12%	13	1%	9	2%	4	1%
Bottom of cap	404	35%	219	38%	185	32%	1115	98%	555	97%	560	98%
Other	76	7%	43	8%	33	6%	7	1%	4	1%	3	1%
Don't know	545	48%	263	46%	282	49%	5	0%	2	0%	3	1%
How much chlorine do you need for a 5 L container?												
Top of cap	287	29%	147	30%	140	29%	1100	96%	549	96%	551	97%
Bottom of cap	59	6%	31	6%	28	6%	18	2%	9	2%	9	2%
Other	78	8%	43	9%	35	7%	13	1%	8	1%	5	1%
Don't know	555	57%	267	55%	288	59%	9	1%	4	1%	5	1%
When do you wash your hands?												
After using the toilet	1064	93%	527	92%	537	94%	1124	99%	565	99%	559	98%
Before cooking and eating	1018	89%	519	91%	499	88%	1104	97%	551	97%	553	97%
After handling animals, dirty diapers, or rubbish	529	46%	273	48%	256	45%	915	80%	453	79%	462	81%
Before and after caring for the sick	100	9%	44	8%	56	10%	453	40%	233	41%	220	39%
After coughing or sneezing into your hands	68	6%	31	5%	37	6%	416	36%	209	37%	207	36%
Other/Don't know	160	14%	84	15%	76	13%	101	9%	55	10%	46	8%
How much time should you spend scrubbing your hands while washing them?												
20 seconds or as long as it takes to sing or hum the 'Happy Birthday Song' twice	260	23%	132	23%	128	22%	747	66%	398	70%	349	61%
Other/Don't know	880	77%	438	77%	442	78%	390	34%	171	30%	219	39%
Can you demonstrate how to properly wash your hands?												

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Wet hands with your hands with clean water	1055	93%	535	94%	520	91%	1137	100%	569	100%	568	100%
Apply soap to lather your entire hand	941	83%	442	78%	499	88%	1113	98%	548	96%	565	99%
Scrub back of hands	607	53%	333	58%	274	48%	985	86%	475	83%	510	89%
Scrub palms	587	51%	331	58%	256	45%	971	85%	475	83%	496	87%
Scrub between fingers	406	36%	231	41%	175	31%	982	86%	486	85%	496	87%
Scrub underneath fingernails	123	11%	71	12%	52	9%	799	70%	367	64%	432	76%
Scrub wrists	220	19%	123	22%	97	17%	774	68%	377	66%	397	70%
Rinse your hands with clean water and air dry	782	69%	386	68%	396	69%	935	82%	449	79%	486	85%
Scrub hands for 20 seconds or as long as it takes to sing or hum the Happy Birthday song twice	59	5%	42	7%	17	3%	493	43%	250	44%	243	43%
Did not demonstrate any of the steps	24	2%	7	1%	17	3%	0	0%	0	0%	0	0%
How can someone get worms?												
Eating dirt/soil	525	46%	202	35%	323	57%	963	84%	480	84%	483	85%
Not properly washed raw vegetables and fruits	486	43%	244	43%	242	42%	1035	91%	523	92%	512	90%
Undercooked meat	255	22%	148	26%	107	19%	1030	90%	522	92%	508	89%
Not washing your hands after touching soil	163	14%	82	14%	81	14%	574	50%	300	53%	274	48%
Not washing hands with soap after using toilet	54	5%	31	5%	23	4%	571	50%	311	55%	260	46%
Not washing hands before handling food	65	6%	42	7%	23	4%	460	40%	246	43%	214	38%
Other/Don't know	369	32%	217	38%	152	27%	37	3%	33	6%	4	1%
Who in your household should get dewormed?												
Myself	50	4%	9	2%	41	7%	0	0%	0	0%	0	0%
My spouse	37	3%	22	4%	15	3%	0	0%	0	0%	0	0%
My children	299	26%	145	25%	154	27%	12	1%	6	1%	6	1%
Everyone	708	62%	346	61%	362	64%	1126	99%	562	99%	564	99%
Other/Don't know	95	8%	58	10%	37	6%	1	0%	1	0%	0	0%
Do most people with high blood pressure (BP) or diabetes (sugar) have symptoms?												
Yes, people with one and/or both diseases usually have symptoms	418	37%	222	39%	196	34%	205	18%	94	17%	111	19%
No, most people with high BP and/or diabetes do not have symptoms	721	63%	347	61%	374	66%	934	82%	475	83%	459	81%
High blood pressure (BP) can lead to…?												
Heart disease or heart attack	157	14%	95	17%	62	11%	468	41%	232	41%	236	41%

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Stroke	302	26%	141	25%	161	28%	698	61%	363	64%	335	59%
Death	737	65%	350	61%	387	68%	942	83%	496	87%	446	78%
Other/Don't know	265	23%	142	25%	123	22%	147	13%	77	14%	70	12%
What blood pressure is considered high?												
Greater than or equal to 140/90 mmHg	74	6%	33	6%	41	7%	617	54%	345	61%	272	48%
Other	76	7%	46	8%	30	5%	138	12%	56	10%	82	14%
Don’t know	989	87%	491	86%	498	87%	384	34%	168	29%	216	38%
What should someone do if they have high BP?												
Reduce their salt intake	352	31%	182	32%	170	30%	969	85%	506	89%	463	81%
Take medicine prescribed by doctor	437	38%	216	38%	221	39%	828	73%	424	74%	404	71%
Get their BP checked regularly	319	28%	144	25%	175	31%	755	66%	383	67%	372	65%
Exercise	73	6%	43	8%	30	5%	483	42%	270	47%	213	37%
Lose weight if they are overweight	47	4%	17	3%	30	5%	375	33%	184	32%	191	34%
Get checked for diabetes (sugar)	44	4%	17	3%	27	5%	270	24%	132	23%	138	24%
Stop smoking	26	2%	14	2%	12	2%	250	22%	156	27%	94	16%
Other/Don't know	584	51%	294	52%	290	51%	244	21%	116	20%	128	22%
What should someone do if they have diabetes?												
Reduce their sugar intake	551	48%	290	51%	261	46%	1017	89%	529	93%	488	86%
Take medicine prescribed by doctor	363	32%	184	32%	179	31%	807	71%	399	70%	408	72%
Get their sugar checked regularly	228	20%	92	16%	136	24%	685	60%	336	59%	349	61%
Lose weight if they are overweight	41	4%	17	3%	24	4%	345	30%	157	28%	188	33%
Exercise	49	4%	29	5%	20	4%	411	36%	229	40%	182	32%
Get their BP checked	40	4%	16	3%	24	4%	280	25%	145	25%	135	24%
Other/Don't know	518	45%	251	44%	267	47%	170	15%	80	14%	90	16%
On average, how much salt do you add to your evening meal at the table?												
NONE	93	8%	35	6%	58	10%	232	20%	89	16%	143	25%
PINCH	728	64%	394	69%	334	59%	753	66%	397	70%	356	62%
¼ TSP	139	12%	80	14%	59	10%	101	9%	64	11%	37	6%
½ TSP	94	8%	34	6%	60	11%	42	4%	19	3%	23	4%
> = ¾ TSP	86	8%	27	5%	59	10%	12	1%	1	0%	11	2%
On average, how much sugar do you add to your cup of tea or coffee?												
NONE	9	1%	6	1%	3	1%	11	1%	9	2%	2	0%

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< 1 TSP	14	1%	10	2%	4	1%	23	2%	15	3%	8	1%
1 TSP	75	7%	33	6%	42	7%	109	10%	57	10%	52	9%
2 TSP	563	49%	274	48%	289	51%	697	61%	349	61%	348	61%
3 TSP	260	23%	144	25%	116	20%	185	16%	106	19%	79	14%
> = 4 TSP	219	19%	103	18%	116	20%	115	10%	34	6%	81	14%

Table 2: Adoption and maintenance of behavior change two weeks and six months post GHP intervention.

	Two weeks Total (N = 1140)		**6 months Total (N = 961)**	
	n/mean	**%/SD**	**n/mean**	**%/SD**
What strategies did you and your spouse began implementing?				
Chlorine for drinking water	1103	97%	933	97%
Soap (handwashing)	1085	95%	922	96%
Deworming the entire family	955	84%	779	81%
Reduce salt in cooking (use “Low Salt”)	862	76%	725	76%
Limiting exposure to areas with Bilharzia	525	46%	437	46%
Avoid eating foods with lots of salt (breads, crisps, processed meats such as polony, bacon, sausage)	559	49%	451	47%
Avoid adding a lot of sugar to drinks such as tea, coffee	468	41%	148	15%
Agree on food preparation together	448	39%	333	35%
Avoid or limit the number of drinks with a lot of sugar (soft drinks and alcohol)	435	38%	213	22%
Maintain healthy weight	337	30%	204	21%
Avoid stress	351	31%	192	20%
Eat plenty of fruits and vegetables, including greens	315	28%	110	11%
Increase physical activity (exercise)	309	27%	200	21%
Avoid/limit tobacco products like cigarettes	256	22%	119	12%
Limit alcohol intake	252	22%	76	8%
Drink at least 2 liters of clean water per day	223	20%	48	5%

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Table 3: Impact of the GHP intervention on sharing household duties.

	Baseline						6 months Post-Intervention					
	Total (N = 1140)		Men (N = 570)		Women (n = 570)		Total (N = 961)		Men (N = 481)		Women (n = 480)	
	N	%	N	%	N	%	N	%	N	%	N	%
In terms of your day to day activities in the household, who is primarily responsible for												
Collecting drinking water												
Myself	482	42%	31	5%	451	79%	354	37%	17	4%	337	71%
My spouse	407	36%	387	68%	20	4%	286	30%	277	58%	9	2%
Both of us	169	15%	116	20%	53	9%	284	30%	168	35%	116	24%
Other	75	7%	31	5%	44	8%	33	3%	17	4%	16	3%
NA	7	1%	5	1%	2	0%	1	0%	1	0%	0	0%
Treating drinking water with chlorine												
Myself	211	19%	27	5%	184	32%	280	29%	19	4%	261	54%
My spouse	121	11%	114	20%	7	1%	216	23%	209	44%	7	1%
Both of us	48	4%	35	6%	13	2%	450	47%	245	51%	205	43%
Other	7	1%	5	1%	2	0%	2	0%	1	0%	1	0%
NA	753	66%	389	68%	364	64%	11	1%	6	1%	5	1%
Purchasing food for the house												
Myself	323	28%	212	37%	111	19%	106	11%	61	13%	45	9%
My spouse	260	23%	81	14%	179	31%	99	10%	36	7%	63	13%
Both of us	551	48%	275	48%	276	48%	753	79%	384	80%	369	77%
Other	6	1%	2	0%	4	1%	1	0%	0	0%	1	0%
Preparing the food/ cooking												
Myself	540	47%	24	4%	516	91%	394	41%	14	3%	380	80%
My spouse	482	42%	470	82%	12	2%	375	39%	365	76%	10	2%
Both of us	101	9%	68	12%	33	6%	181	19%	98	20%	83	17%
Other	17	1%	8	1%	9	2%	8	1%	4	1%	4	1%
Taking care of sick persons in household												
Myself	206	18%	29	5%	177	20%	28	3%	3	1%	25	5%
My spouse	87	8%	80	14%	7	1%	21	2%	18	4%	3	1%
Both of us	832	73%	457	80%	375	78%	910	95%	459	95%	451	94%
NA	11	1%	3	1%	8	1%	1	0%	1	0%	0	0%

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Changing baby's nappy												
Myself	408	36%	17	3%	391	69%	364	38%	13	3%	351	73%
My spouse	380	33%	375	66%	5	1%	342	36%	335	70%	7	1%
Both of us	73	6%	51	9%	22	4%	95	10%	62	13%	33	7%
NA	278	24%	127	22%	151	26%	159	17%	71	15%	88	18%
Washing the dishes												
Myself	494	43%	21	4%	473	83%	420	44%	13	3%	407	85%
My spouse	444	39%	438	77%	6	1%	390	41%	383	80%	7	1%
Both of us	98	9%	68	12%	30	5%	96	10%	62	13%	34	7%
Other	103	9%	42	7%	61	11%	53	6%	23	5%	30	6%

NA: Not Applicable

Table 4: Comparison of knowledge uptake in GHP group with the control group that received a different intervention to assess potential contribution of secular trend due to other programs.

	GHP 6 months follow-up						SOV 6 months follow-up					
	Total (N = 961)		Men (N = 481)		Women (n = 480)		Total (N = 986)		Men (N = 493)		Women (n = 493)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
How do you treat your drinking water?												
Add chlorine	932	97%	463	96%	469	98%	347	35%	162	33%	185	38%
Boil	368	38%	181	38%	187	39%	294	30%	155	32%	139	28%
Strain it through a cloth	1	0%	1	0%	0	0%	6	1%	2	0%	4	1%
Use a water filter	13	1%	7	1%	6	1%	10	1%	4	1%	6	1%
Solar disinfection	2	0%	0	0%	2	0%	4	0%	2	0%	2	0%
I do not treat my drinking water	1	0%	1	0%	0	0%	396	40%	214	44%	182	37%
Other	2	0%	2	0%	0	0%	2	0%	2	0%	0	0%
Don't know	0	0%	0	0%	0	0%	9	1%	6	1%	3	1%
How much chlorine do you need for a 20 L container?												
Top of cap	18	2%	13	3%	5	1%	178	18%	76	15%	102	21%
Bottom of cap	931	97%	462	96%	469	98%	434	44%	223	45%	211	43%
Other	5	1%	3	1%	2	0%	22	2%	10	2%	12	2%
Don't know	6	1%	3	1%	3	1%	348	35%	182	37%	166	34%
How much chlorine do you need for a 5 L container?												
Top of cap	925	96%	463	96%	462	96%	361	37%	196	40%	165	34%
Bottom of cap	21	2%	12	2%	9	2%	116	12%	52	11%	64	13%

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Other	8	1%	4	1%	4	1%	54	5%	26	5%	28	6%
Don't know	6	1%	2	0%	4	1%	452	46%	217	44%	235	48%
When do you wash your hands?												
After using the toilet	949	99%	473	98%	476	99%	936	95%	471	96%	465	95%
Before cooking and eating	928	97%	460	96%	468	98%	883	90%	443	90%	440	89%
After handling animals, dirty diapers, or rubbish	785	82%	377	78%	408	85%	638	65%	293	60%	345	70%
Before and after caring for the sick	332	35%	179	37%	153	32%	213	22%	112	23%	101	21%
After coughing or sneezing into your hands	278	29%	115	24%	163	34%	154	16%	66	13%	88	18%
Other/Don't know	34	4%	18	4%	16	3%	46	5%	15	3%	31	6%
How much time should you spend scrubbing your hands while washing them?												
20 seconds or as long as it takes to sing or hum the 'Happy Birthday Song' twice	670	70%	330	69%	340	71%	483	49%	220	45%	263	54%
Other	257	27%	141	29%	116	24%	283	29%	170	35%	113	23%
Don't know	33	3%	10	2%	23	5%	213	22%	99	20%	114	23%
Can you demonstrate how to properly wash your hands?												
Wet hands with your hands with clean water	946	99%	474	99%	472	99%	898	91%	442	90%	456	93%
Apply soap to lather your entire hand	926	96%	462	96%	464	97%	868	88%	420	86%	448	91%
Scrub between fingers	808	84%	400	83%	408	85%	524	53%	285	58%	239	49%
Scrub back of hands	836	87%	401	83%	435	91%	618	63%	349	71%	269	55%
Scrub palms	815	85%	404	84%	411	86%	579	59%	326	66%	253	51%
Scrub underneath fingernails	625	65%	265	55%	360	75%	146	15%	70	14%	76	15%
Scrub wrists	659	69%	335	70%	324	68%	312	32%	148	30%	164	33%
Rinse your hands with clean water and allow to air dry	835	87%	393	82%	442	92%	781	79%	388	79%	393	80%
Scrub hands for 20 seconds or as long as it takes to sing or hum the Happy Birthday song twice!	310	32%	161	33%	149	31%	25	3%	11	2%	14	3%
How can someone get worms?												
Undercooked meat	877	91%	437	91%	440	92%	347	35%	215	44%	132	27%
Not properly washed raw vegetables and fruits	872	91%	433	90%	439	92%	466	47%	261	53%	205	42%
Eating dirt/soil	810	84%	392	81%	418	87%	731	74%	343	70%	388	79%
Not washing your hands after touching soil	417	43%	200	42%	217	45%	137	14%	65	13%	72	15%
Not washing hands with soap after using toilet	360	38%	197	41%	163	34%	106	11%	62	13%	44	9%

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Not washing hands before handling food	232	24%	116	24%	116	24%	84	9%	52	11%	32	7%
Other/Don't know	32	3%	23	5%	9	2%	133	14%	76	15%	57	12%
Who in your household should get dewormed?												
Myself	0	0%	0	0%	0	0%	18	2%	8	2%	10	2%
My spouse	0	0%	0	0%	0	0%	20	2%	14	3%	6	1%
My children	12	1%	8	2%	4	1%	231	23%	120	24%	111	23%
Everyone	944	98%	471	98%	473	99%	722	73%	350	71%	372	76%
Other/Don't know	0	0%	0	0%	0	0%	29	3%	5	1%	6	1%
Bilharzia only affects children in rural areas												
True	10	1%	6	1%	4	1%	52	5%	23	5%	29	6%
False	949	99%	475	99%	474	99%	907	92%	450	92%	457	93%
Don't know	0	0%	0	0%	0	0%	23	2%	18	4%	5	1%
People in my household can get bilharzia from bathing, washing and playing in contaminated water where snails are present												
True	946	99%	475	99%	471	99%	922	94%	457	93%	465	95%
False	12	1%	6	1%	6	1%	35	4%	15	3%	20	4%
Don't know	1	0%	0	0%	1	0%	26	3%	19	4%	7	1%
Hypertension/Diabetes												
On average, how much salt do you add to your evening meal at the table?												
NONE	202	21%	82	17%	120	25%	125	13%	70	14%	55	11%
PINCH	570	59%	313	65%	257	54%	700	71%	346	70%	354	72%
¼ TSP	110	11%	65	14%	45	9%	84	9%	41	8%	43	9%
½ TSP	41	4%	10	2%	31	6%	62	6%	24	5%	38	8%
¾ TSP	0	0%	0	0%	0	0%	3	0%	2	0%	1	0%
> = 1 TSP	37	4%	11	2%	26	5%	9	1%	8	2%	1	0%
On average, how much sugar do you add to your cup of tea or coffee?												
NONE	14	1%	6	1%	8	2%	7	1%	4	1%	3	1%
< 1 TSP	6	1%	3	1%	3	1%	8	1%	6	1%	2	0%
1 TSP	78	8%	45	9%	33	7%	41	4%	21	4%	20	4%
2 TSP	652	68%	314	65%	338	71%	500	51%	215	44%	285	58%
3 TSP	155	16%	92	19%	63	13%	343	35%	205	42%	138	28%
> = 4 TSP	55	6%	21	4%	34	7%	82	8%	39	8%	43	9%
How many softies (Coca Cola, etc) do you drink per week? (mean)	2.8	3.2	3.3	3.7	2.3	2.5	2.7	2.7	3.3	3.2	2.1	2.0

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Do most people with high blood pressure (BP) or diabetes (sugar) have symptoms?												
Yes, people with both diseases usually have symptoms	194	20%	83	17%	111	23%	356	37%	197	41%	159	32%
People with either high BP or diabetes usually have symptoms	22	2%	12	3%	10	2%	56	6%	31	6%	25	5%
No, most people with high BP and/or diabetes do not have symptoms	743	77%	385	80%	358	75%	561	58%	254	53%	307	63%
High blood pressure (BP) can lead to…?												
Heart disease or heart attack	308	32%	174	36%	134	28%	146	15%	89	18%	57	12%
Stroke	570	59%	308	64%	262	55%	377	38%	193	39%	184	37%
Death	875	91%	442	92%	433	90%	793	81%	391	80%	402	82%
Other/Don't know	66	7%	36	7%	30	6%	72	7%	42	9%	30	6%
What blood pressure is considered high?												
Greater than or equal to 140/90 mmHg	508	53%	266	55%	242	51%	103	10%	46	9%	57	12%
Other	98	10%	48	10%	50	10%	27	3%	15	3%	12	2%
Don’t know	354	37%	167	35%	187	39%	853	87%	430	88%	423	86%
What should someone do if they have high BP?												
Reduce their salt intake	850	89%	437	91%	413	86%	426	43%	187	38%	239	49%
Take medicine prescribed by doctor	708	74%	349	73%	359	75%	614	62%	313	64%	301	61%
Get their BP checked regularly	623	65%	294	61%	329	69%	444	45%	198	40%	246	50%
Exercise	436	45%	240	50%	196	41%	72	7%	48	10%	24	5%
Lose weight if they are overweight	280	29%	150	31%	130	27%	113	11%	46	9%	67	14%
Get checked for diabetes (sugar)	205	21%	98	20%	107	22%	59	6%	29	6%	30	6%
Stop smoking	179	19%	109	23%	70	15%	23	2%	15	3%	8	2%
Other/Don't know	198	21%	108	22%	90	19%	185	19%	85	17%	100	20%
What should someone do if they have diabetes?												
Reduce their sugar intake	862	90%	440	91%	422	88%	540	55%	275	56%	265	54%
Take medicine prescribed by doctor	707	74%	333	69%	374	78%	557	57%	296	60%	261	53%
Get their sugar checked regularly	516	54%	242	50%	274	57%	381	39%	176	36%	205	42%
Lose weight if they are overweight	281	29%	158	33%	123	26%	110	11%	52	11%	58	12%
Exercise	373	39%	198	41%	175	37%	41	4%	32	7%	9	2%
Get their BP checked	195	20%	101	21%	94	20%	52	5%	27	5%	25	5%
Other/Don't know	130	14%	68	14%	62	13%	167	17%	73	15%	94	19%

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Knowledge of lifestyle and dietary changes that people with hypertension should adopt improved for reducing salt intake (31% to 85%), taking prescribed medication (38% to 73%), and getting regular BP checks (28% to 66%). Interestingly, while knowledge of the importance of losing weight if overweight and exercising did improve, fewer than half of respondents mentioned those recommendations even after the intervention. Similar findings were noted with diabetes with reducing sugar intake (48% to 89%), taking prescribed medicine (32% to 71%), and getting sugar levels checked improving substantially (20% to 60%) but far less recall of diet and exercise recommendations.

Respondents did report behavior change after receiving GHP. Participants reporting adding none (or no salt) to their evening meal increased from 8% to 20% after the intervention visit. The percent increase in reporting no salt corresponded to a decrease in those reporting adding a ¼ tsp or more to their evening meal. Similarly, sugar added to a cup of tea of coffee shifted down with those reporting > = 3 tsp dropping from 42% to 26%.

Follow-up, retention and the comparison group (control)

Of the GHP 570 couples who completed baseline, the intervention and the two-week follow-up, 480 completed the 6-month follow-up. The control arm, interviewed at 6 months for comparison, included 489 couples.

Adoption and maintenance of behavior change two weeks and six months post GHP intervention

Table 2 presents strategies ordered by frequency mentioned two weeks post-intervention and compares analogous responses at 6 months. Implemented strategies mentioned at two weeks that were maintained at 6 months included chlorinating drinking water (97%), handwashing with soap (96%), deworming the family (81%) and reducing salt in cooking or using low sodium salt (76%). Some other behaviors adopted with lower frequency were also maintained, including avoiding areas with bilharzia (46%), avoiding salty foods (47% including 50% of men and 44% of women, not shown), and agreeing on food preparation together (35% including 39% of women and 31% of men, not shown).

Other reported health maintenance behaviors were less likely to be maintained over time including limiting sugary drinks, maintaining a healthy weight, avoiding stress, eating plenty of fruits and vegetables, exercising, avoiding tobacco products, limiting alcohol intake and drinking 2 liters of clean water/day.

Impact of the GHP intervention on sharing household duties (Table 3)

While men and women agreed that women usually collected water, the proportion reporting both partners collecting water increased from 15% before the intervention visit to 30% at 6 months, with men more likely to report sharing this duty (35% compared with 24% of women). Similarly, prior to the intervention visit, women assumed most of the responsibility for water chlorination in the 24% of households that used chlorine. After the intervention visit, sharing this responsibility increased to 47% in the 90% of households using chlorine, with the proportion of men reporting sharing 8-9% higher than their wives. Close to half (48%) of respondents at baseline reported sharing food purchasing duties, while a third reported the man took charge of this duty. Sharing food purchasing increased to 65% at two weeks and 79% at 6 months with similar reports from men and women. Food preparation was almost exclusively the woman's responsibility with a modest increase in shared responsibility (from 9% to 22% at two weeks) after the intervention visit. The proportion of couples sharing responsibility for taking care of sick persons in the household increased from 73% prior to the intervention visit to 95% at 6 months. Changing baby's nappy and doing dishes remained primarily a woman's job. Only 20% of households had animals, and handling animals was a shared duty before and after the intervention visit (not shown).

Comparison of knowledge uptake in GHP with the control group that received a different intervention to assess potential contribution of secular trend due to other programs (Table 4)

The control group that received an unrelated HIV intervention was interviewed at 6 months, contemporaneously with participants described in preceding tables, to assess the potential contribution of secular trend due to other water and sanitation, NTD and NCD programs. Knowledge of chlorine for water treatment (97% of GHP group vs. 35% of controls), and how to prepare potable water (96-97% vs. 37%-44%) were higher in the GHP group. When, how long, and the steps involved in hand washing including responses to questions and practical demonstrations were substantially better in the GHP group as was knowledge of how one could get worms and who in the house should be dewormed. The control group respondents reported adding more salt to food and sugar to tea/coffee. The control group was also less likely to know that hypertension and diabetes are usually asymptomatic and can result in heart attack or stroke. Lastly, knowledge of what blood pressure levels are considered high and actions to take if one has high blood pressure or diabetes were uniformly better in the GHP group.

Discussion

Neglected tropical diseases (NTDs) and non-communicable diseases (NCDs) are prominent causes of morbidity and mortality in Zambia. This study confirms

the urgent need for information and practical training in basic hygiene and sanitation, deworming and dietary and lifestyle changes to prevent respiratory and diarrheal disease, helminthic infection, hypertension and diabetes. Video-based group discussions with practical training in preparation of chlorinated potable water and proper hand washing, combined with provision of chlorine and hand soap, prompted substantial improvements in knowledge and reported behavior. Education about transmission, prevention and treatment of helminths, along with distribution of mebendazole or albendazole for household de-worming, reinforced the importance of chlorine and handwashing. Screening with free treatment for schistosomiasis further heightened awareness of this prevalent but often asymptomatic NTD. Misconceptions about the clinical symptoms, sequelae, and management of hypertension and diabetes were reduced, and participants reported adding less salt to their food and sugar to their tea/coffee. These benefits were sustained over time, and a contemporaneous comparison with a group who received an unrelated HIV intervention confirmed that other health promotion programs had not resulted in a secular trend that might confound the interpretation of our findings.

Urban sanitation in Zambia is a challenge due to high population density, unplanned growth, and limited resources for conventional sanitation [26]. In Lusaka and Ndola, pit-latrines combined with leaking sewerage discharge untreated human sewage directly into the aquifers which residents rely on for drinking water [27-31]. Cholera outbreaks occur when potable water is unavailable and basic hygiene is poor. In total, 34,950 cases of cholera were reported in Zambia between 2008 and 2017, and the country is considered endemic for cholera with crowded urban areas at highest risk [13,32,33]. Respiratory and diarrheal diseases, among the leading causes of death in Zambia, particularly in children, along with common parasitic infections of the gut [34], can be prevented with handwashing, water chlorination, and periodic household anti-helminthic treatment [35-43]. WHO and UNICEF Joint Monitoring Programme indicators for Water Supply, Sanitation and Hygiene Models using Demographic and Health Surveys and other studies have predicted safely managed drinking water also reduces stunting and diarrhea in children [44,45], thus averting negative health outcomes which may increase risk of NCD later in life [46-49].

Zambia has attempted to address these problems through community-led total sanitation (CLTS), which has emerged as the most widely implemented policy intervention for improving rural sanitation in low-income countries [50]. The Sanitation and Hygiene Applied Research for Equity Programme funded by the UK Department for International Development has also sponsored human resource strengthening in research capacity in Zambia [51]. In November 2011, CTLS was featured as part of the Zambia Sanitation and Hygiene Program (ZSHP) in order to increase the use of improved sanitation facilities and adopt positive hygiene practices [52]. In a pre- and post-assessment of national-scale CLTS programming in Zambia conducted from 2013 to 2016, the authors measured a 16% increase in access to improved sanitation facilities and modest increases in hand washing behavior and dedicated hand hygiene spaces [50]. Our GHP intervention focused on improving knowledge and skills combined with provision of chlorine, hand soap, and deworming medication. As several CLTS survey areas overlapped with our study area [52], we compared our GHP group with our comparison (control) group that received an HIV intervention to assess the role of secular trend in hygiene and sanitation knowledge and behaviors. Our findings confirm that knowledge and use of chlorine remained poor in our comparison group (35% use compared with 97% in the GHP group), as did knowledge of when and how to effectively hand wash and prepare food to reduce transmission and who in the household should be regularly dewormed. These findings reinforce the importance of ongoing and repeated education and commodity provision efforts.

We have recently shown that schistosomiasis is associated with HIV-1 transmission and death in Lusaka, possibly related to enhanced inflammatory responses caused by egg deposition in the lower genital tract [24,53]. A recent assessment based on literature review estimates nationwide prevalence of schistosome infection exceeding 30% with an adult prevalence of 54% [54]. While our program used urine dipstick to assess prevalence of microhematuria suggestive of *Schistosoma haematobium*, hepatosplenic schistosomiasis due to *Schistosoma mansoni* is also a neglected problem in Zambia. On questioning, 68% (75/110) of Zambian patients with portal hypertension (88% of whom were ELISA positive for schistosoma antibodies) knew nothing about schistosomiasis transmission [55]. Although this NTD is generally considered to be concentrated in rural areas or near bodies of water [56], our previous work has shown that 59% of Lusaka residents had positive ELISA titers [24]. Further work is needed to improve knowledge, prevention, screening and treatment for schistosomiasis.

While NTDs, hygiene, and sanitation have long been a focus of concern in Africa, hypertension and diabetes have recently been identified as emerging public health problems. Several studies in Zambia have shown a high prevalence of hypertension in both urban and rural areas [57,58]. In Lusaka, 1,928 individuals participated in the survey, of which 33% were males. 21% of males and 49% of females were overweight or obese. The prevalence for hypertension was 35% (38% of men and 33% of women). Risk factors have been similar to those identified in western countries: older age, male sex, high body mass index, increased alcohol consumption,

sedentary lifestyle, higher education and smoking [59-61]. One study showed mean total weight of salt added to food was nearly double the WHO recommendation, with women adding significantly more salt to food than men [62]. As in other studies in Africa, lack of and limited knowledge is a barrier to effective prevention, diagnosis, and management of NCDs in the region [63-68]. Most individuals do not know that they have high BP and others do not take any medication [57]. In focus groups, participants cited westernized diets, lack of physical activity, stress, psychological factors and urbanization as causative factors for hypertension. Participants lacked understanding of BP medications, healthy lifestyles, adherence to treatment and ongoing monitoring [62]. Our study confirmed poor knowledge of the manifestations, sequelae, prevention and management of NCD and demonstrated sustained improvement in this knowledge after the intervention. Reported salt intake declined after the GHP intervention, with the proportion no longer adding salt rising from 8% to 20% and the proportion adding > = 1/2 tsp declining from 16% to 5%. We provided low sodium salt (half potassium and half sodium chloride) which is available in Zambian stores and should be more closely studied. Future efforts to improve hypertension control should focus on population preventive care and primary healthcare provider education on individual management [69].

Surveys including measures in blood sugar have found a 15% prevalence of diabetes mellitus in Ndola bank employees [70]. In a household survey in Lusaka adults, the prevalence for impaired glucose level or diabetes was 4% [71]. As in the west, risk factors included obesity, physical inactivity, older age and mild hypertension. The authors conclude that interventions targeting the younger 25-34 age group should be put in place now to curtail the development of diabetes. Our survey confirmed the need for more education: The knowledge that diabetics should reduce sugar intake was only 48% before the intervention visit, rising to 89% afterwards, with corresponding increases in respondents citing taking prescribed medication and getting sugar levels tested regularly. This knowledge translated into reported behaviors with the proportion of respondents adding > = 3 tsp to their cup of tea or coffee decreased from 42% before to 26% after receiving GHP.

In one qualitative study in Zambia, knowledge of cardiovascular disease risk factors was good but "risk factors were difficult to avoid due to ingrained taste preferences for high salt and sugar, increasingly busy lives that force them to use cooking oil to reduce preparation time, cultural preference for big body size or fatness, especially for women, stigmatized body image attached to HIV, stressful life or life events related to poverty, and financial barriers to affording quality foods and healthcare services" [72]. We make a similar observation in our study: While use of salt and sugar declined and knowledge of manifestations and management increased, a minority of participants cited increasing physical activity, maintaining a healthy weight or eating plenty of vegetables and fruit as important strategies. Government clinic nurses who received training in delivering our intervention underwent screening. A number were found to be hypertensive, which was not surprising as they were generally women aged 40-50 age, and many were overweight by international standards. Their views echoed those mentioned above and reinforce the need to include perceptions of health care providers to better inform NCD policy [73].

Other studies have highlighted male involvement in traditionally women-oriented household roles in the context of maternal and child health [74-78]. We have worked extensively with Zambian couples on HIV and unplanned pregnancy prevention, and collaboration between spouses is strongly associated with success in those domains [18,79,80]. We noted an increase in shared household responsibilities relating to collecting and treating water, food purchasing and preparation and taking care of sick persons. This highlights opportunities to engage men in traditionally women-oriented household roles for the betterment of their family's health. This not only can improve family health but also gender equity within the couple.

Limitations

Our study was not without limitations. We acknowledge that a limitation was measuring the impact of knowledge uptake on disease outcomes. Given the increased burden of NTD and NCD in SSA, more studies linking biological markers with knowledge uptake are needed. Additionally, there were limitations in our methods of testing and treatment: our schistosomiasis screening did not include detection of *S. mansoni* as we used urine dipsticks; urine dipstick screening for glucose is less expensive but also less sensitive for diabetes screening than glucometers or HbA1c testing [81-83]; and though we provided albendazole and mebendazole for deworming we understand that this may not adequately treat other helminth infections such as Taenia and protozoa including cryptosporidium, giardia and amoeba [34].

Conclusion

This study shows the feasibility of delivering multiple health education topics without compromising areas. Our study highlights that a video-based intervention focusing on NCDs and NTDs can lead to substantial and sustained knowledge uptake in Zambian couples. As we utilized a simplified flipchart-only version of this tool integrated with CVCT, we would propose expansion of this with CVCT and family planning which is shown to be effective.

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Statement of Equal Authors' Contribution: Author Contributions

T.S. contributed to Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Validation; Visualization; Roles/ Writing - original draft; Writing - review & editing. K.W. contributed to Formal analysis; Methodology; Writing - review & editing. Ra. P. contributed to Formal analysis; Methodology; Writing - review & editing. W.K contributed to Conceptualization; Supervision. M.I. contributed to Conceptualization; Supervision. A.T. contributed to Formal analysis; Methodology. K.M. contributed to Data curation; Supervision; Validation; Writing-review & editing. C.K. contributed to Writing - review & editing; N.A. contributed to Writing - review & editing; R.B. contributed to Writing - review & editing; Ro. P. contributed to Supervision; Writing - review & editing; S.A. contributed to Conceptualization; Funding acquisition; Writing - review & editing.

Trial Registration

Retrospectively registered on ClinicalTrials.gov #: NCT02744586.

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