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Original Article

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An integrated community-based hypertension improvement program improves hypertension awareness in Ghana

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ABSTRACT

Background: We evaluated the impact of an integrated community-based hypertension intervention on hypertension awareness (defined as prior diagnosis of hypertension among persons with elevated blood pressure), prevalence of hypertension, and behavioural risk factors for hypertension.
Methods: The community-based hypertension improvement program implements an integrated package of interventions in one health district in Ghana. The project is evaluated using a quasi-experimental design consisting of population-based cross-sectional surveys (the focus of this paper) in an intervention and a comparison districts, plus a cohort study in the intervention district-only. The cohort study determined hypertension control.
Results: At baseline, we interviewed 2,400 respondents (1,200 each from the Lower Manya Krobo (intervention district) and Akuapim South (comparison district) and interviewed 2,533 adults aged 30 years or older from same districts at endline – 1,306 from the Lower Manya Krobo and 1,227 from Akuapim South districts. Hypertension awareness significantly increased in the intervention district from 47.7%; 95% confidence interval (CI) (42.0–53.7) at baseline to 59.2%; 95% CI (53.8–64.6) at endline, while in the comparison district, there was a small, non-significant decrease from 44.7%; 95% CI (38.8–50.8) to 36.6%; 95% CI (31.3–42.2). There is strong evidence of difference between these two districts OR ($P = 0.005$). There were no significant differences in changes of hypertension prevalence or treatment from baseline to endline between the two districts The proportion of people that know more than 2 risk factors increased in the control groups (odds ratio [OR], 1.770; 95% CI, 1.242–2.5142) while this does not change significantly in the intervention group (OR, 0.865; 95% CI, 0.61–1.210).
Conclusion: This integrated community-based program improved hypertension awareness, and some behavioural risk factors, but not hypertension prevalence at the community level.

Keywords: Hypertension; Hypertension awareness; Hypertension prevalence; Hypertension control; Biological risk factors; Integrated community-based intervention

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Conflict of Interest
The co-authors PL, AKL, PP, AJA, and DP-M worked on the ComHIP Program for which their institutions (LSHTM and UGSPH) have received grants from the Novartis Foundation. The co-authors RD, RMMD, and DM are staff of the FHI 360, which provided technical direction to ComHIP implementation.

Author Contributions
Conceptualization: Perel P, Lamptey P; Data curation: Laar A, Adler AJ, Prieto-Merino D; Formal analysis: Prieto-Merino D; Funding acquisition: Dirks R, Perel P, Lamptey P; Investigation: Laar A, Adler AJ, Der RM, Mangortey D, Dirks R, Lamptey P; Methodology: Laar A, Adler AJ, Prieto-Merino D, Dirks R, Perel P, Lamptey P; Project administration: Laar A, Der RM, Mangortey D, Perel P; Supervision: Der RM, Mangortey D; Visualization: Prieto-Merino D; Writing - original draft: Laar A, Adler AJ; Writing - review & editing: Laar A, Adler AJ, Prieto-Merino D, Der RM, Mangortey D, Dirks R, Perel P, Lamptey P.

INTRODUCTION

Raised blood pressure is a leading cause of cardiovascular disease (CVD), premature death, and disability globally, accounting for 57 million disability adjusted life years, and causing up to 7.5 million deaths, - about 12.8% of all deaths [1]. Generally defined as a systolic blood pressure of ≥ 140 mmHg, and diastolic blood pressure of ≥ 90 mmHg, the prevalence of hypertension in adults aged 35–70 years was estimated to be 40.7% in high income countries, and 39.9% in low- and middle-income countries (LMICs) [2]. Among a variable ages (ranging from 15–100 years), there is evidence that prevalence is increasing in LMICs [3-5]. Ghana-specific data on hypertension among similarly variable age groups shows prevalence ranging from 20% to 32% [6-9]. Despite the high prevalence of hypertension, studies preceding ours showed that the majority of individuals with hypertension are unaware of their status (herein defined as hypertension awareness); fewer are on treatment, and only a small proportion of those on treatment have their blood pressure under control [2,3]. Hypertension awareness in Ghana - prior diagnosis of hypertension among persons with elevated blood pressure - is estimated to range from 16.4% to 54.1%, with only between 1.7% and 12.7% of individuals with their hypertension under control [6-8,10,11].

Up-to-date papers on hypertension such as those from the landmark RODAM study [12], the study by Sanuade et al. [13]; and that by Awuah et al. [14] all report a high and rising prevalence of hypertension, low awareness, treatment, and control. The rising prevalence of hypertension and other non-communicable diseases (NCDs) creates challenges for the Ghana health system. In recognition of the increasing burden of NCDs, Ghana published the National Policy for the Prevention and Control of Chronic NCDs [15], and accompanying Strategy [16]. Following this, the Ghana Health Service (GHS) developed various guidelines for NCDs where hypertension is prioritized. The guidelines recommend that all patients with hypertension be referred for further assessment. However, the capacity of the GHS workforce to diagnose and manage hypertension is limited. Many calls exist for innovative approaches to address these challenges.

In 2015, FHI360 in collaboration with GHS and the Novartis Foundation launched the community-based hypertension improvement program (ComHIP) in one health district in Ghana. This innovative project consists of two main parts: program implementation, and evaluation. The intervention comprised a package of evidence-based actions implemented at both community and facility levels. Designed as implementation research, ComHIP comprised implementation and evaluation components. Key components of the intervention, we have been detailed elsewhere [17] are hereby summarised:

- Community-based education on CVD risk factors and healthy lifestyles using knowledge creation activities including local radio stations and traditional community sensitisation activities such as community durbars (form of organised community meeting with all key community stakeholders) and beating the gong gong (a traditional instrument used by community announcers to deliver important messages from chiefs, their elders, and government and non-governmental agencies to residents).
- Community-based screening and monitoring of blood pressure by Licensed Chemical Sellers (LCS) trained by FHI360.
- Management of hypertensive individuals by CVD nurses for confirmation of hypertension diagnosis, management, and follow-up. CVD nurses are nurses who carry out primary care whilst posted in communities, and who have been trained by FHI360.

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- Telemedicine consultation by CVD nurses or ComHIP trained physicians and referral of high risk (defined as grade three hypertension, or grade two hypertension with target organ damage or two or more risk factors) patients to specialists.
- Information and communication technology-facilitated messages for healthy lifestyles, treatment adherence and refill reminders that were routinely sent to enrolled patients.
- A cloud-based health records system linked to short message service messaging (CommCare).

Of note, the original intervention design intended for dispensation of anti-hypertensive by community pharmacists and LCS, however due to local regulations the LCS could not dispense the medications. Community pharmacists, and pharmacists located within health facilities dispensed the medications.

ComHIP was independently evaluated by the London School of Hygiene & Tropical Medicine and University of Ghana School of Public Health through a series of quantitative and qualitative studies. These studies included repeat cross-sectional surveys within the intervention and comparison districts to track overall awareness and prevalence of hypertension -see Lamptey et al. [6]; a cohort of hypertensive persons included in ComHIP to assess hypertension treatment and control [17], a cost-effectiveness evaluation; a study to assess the level of patient-centeredness within the program; an assessment of barriers and facilitators to the implementation of the ComHIP program [18] and a qualitative assessment of the perspectives of various ComHIP stakeholders [19]. This paper presents the combined results of the baseline survey (implemented in 2015) and endline survey (implemented in 2017) – focusing on evaluating change on hypertension awareness, prevalence, treatment, and behavioural risk factors for hypertension.

METHODS

Evaluation design

To evaluate the ComHIP project, a quasi-experimental study consisting of population-based cross-sectional surveys, and a cohort study were employed. The cross-sectional surveys, the focus of this paper, constitute a before-after evaluations implemented in the intervention and comparison districts. The surveys aimed to assess hypertension awareness, hypertension prevalence at the community level, and population level behavioural and biological risk factors for CVDs. As outlined above, implemented in the intervention district-only was a cohort study comprising hypertensive patients enrolled in the ComHIP study; a series of patient centeredness surveys were conducted among hypertensive patients enrolled in the cohort. Qualitative interviews were done of district level and national level ComHIP stakeholders.

Settings

The profiles of the intervention, and comparison districts, as well as details of the ComHIP intervention are detailed elsewhere [6]. Briefly, the community selected for the intervention was Lower Manya-Krobo District in the Eastern Region of Ghana. This district was selected due to a great unmet need of hypertension care and the existing relationship of FHI 360 with the district health authorities. The district has a population of 89,246 of whom 84% live in urban areas. The population is served by two public hospitals, the Atua Government Hospital and Akuse Hospital, as well as a mission hospital in Agormanya, St. Martin's. There are five health centers, serving as primary contact points for health care, referring patients to hospitals. The district includes six sub-districts, 32 community-based health planning and services zones (seven of which have compounds), and approximately 75 LCS in the district.

The comparison district is Akuapim South Municipality, selected based on similar socio-demographic characteristics (income, employment, education); infrastructure (roads, clinics, hospitals, distance from metropolitan area); baseline health profile (disease prevalence, incidence, morbidity and mortality); development activity (private investment, NGO activity, state demonstrations projects); and level of support from the local health authority. According to the 2010 Population and Housing Census, Akwapim South Municipality has an estimated population of 123,501, representing 4.7% of the total population of the Eastern Region.

The comparison received the standard GHS health delivery services. The district was visited by the ComHIP Evaluation Team twice – at baseline and at endline for purpose of implemented the population-based surveys.

Sample size computation, participants, and sampling procedure

The sample sizes for the before and after survey portion were estimated using evidence from a local study [10] that showed 23% of hypertensive adults in Ghana were aware of their hypertension status. The expected outcome was an increase in the rate of awareness of hypertension at the population level. Our sample size was estimated for an increase in awareness from 23% to 45% in intervention district, and from 23% to 30% in the comparison district. To achieve an 80% statistical power of accepting an alpha error of 0.05 we would need 284 hypertensive individuals in each group (using a simple random sample with no study design effect). When we assumed prevalence of hypertension to be 36% [20], we needed to screen 789 individuals per arm to obtain 284 hypertensive patients in each arm (284 = 0.36 * 789). A sample size of 1,200 per arm would allow for a design effect of 1.267. This design effect is equivalent to assuming an intraclass correlation coefficient (ICC) = 0.017 of the households within the EAs if an average of 17 households per EA are selected. Details of the sample size and power calculations for reduction in hypertension under different assumptions of baseline prevalence, intervention effect and sample size (per arm per survey) are provided in Lamptey et al. [6].

Sampling

Within both study districts, a random sample of households was conducted using a multiple-step sampling procedure. First, a purposive sampling technique was used to select the intervention and comparison districts; the second stage entailed a systematic selection of census enumeration areas (EAs) from those two districts. That selection was done by the Ghana Statistical Service (GSS). The third entailed a simple random selection of households and fourth, selection of adults aged 30 years or older in the selected households. Field staff randomly selected households for inclusion. Only households with one or more members aged 30 years or above and had lived in the district during the last 12 months were eligible for inclusion. The study protocol stipulated that in the event of a refusal, or if a selected household had no eligible adult the household would be replaced with the next. Multiple adults from the same household were included if they were aged 30 years or older, and consented to be interviewed. All such adults in a selected household were interviewed. There were 30 EAs each in the intervention and comparison districts. While the same EAs were used in the pre- and post- surveys, households and therefore individuals within the EAs included in the surveys were selected independently – without regard to prior participation in the baseline survey or cohort arm of the ComHIP sub-studies.

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Survey outcomes

Each outcome is codified as a binary variable (No/Yes) and the proportion of "Yes" in each district in each cross-sectional survey is estimated. We calculate the change of this proportion over time within each district using odds ratios (ORs): OR_I for the intervention and OR_C for the comparison district. The intervention is effective if these two OR are significantly different: $OR_I \neq OR_C$. This was analysed for each outcome separately:

Primary outcome

- Difference between the two groups in the change of hypertension awareness.

Secondary outcomes

- Difference in hypertension prevalence.
- Difference in hypertension treatment.
- Difference in proportion of people that know more than 2 risk factors for CVDs.

Summary of field procedures

Surveys were conducted using a paperless data collection app - the Open Data Kit software on mobile devices. With this technology, data were collected at the household level. Data collected included demographics, lifestyle factors, knowledge of risk factors and physical measurements as detailed in Lamptey et al. [6].

Measurements

Some of the key variables measured in both surveys (including demographic variables of age, sex, marital status, level of education and ethnic group) are delineated below.

Blood pressure measurement

Blood pressure was measured a minimum of three times by survey interviewers, using as fully automated, digital devices, the OMRON digital sphygmomanometer. The average of all three measures was used. Interviewers were trained to use the device according to the manufacturer's recommended protocol, using recommended methods and categories from standard guidelines (WHO, 1999).

Hypertension definitions

Hypertension is defined as high blood pressure (systolic blood pressure [SBP] ≥ 140 mmHg or diastolic blood pressure [DBP] ≥ 90 mmHg) or receiving blood pressure (BP)-lowering treatment. High BP was further defined as:

- Stage-1: $140 \leq SBP < 160$ mmHg, or $90 \leq DBP < 100$ mmHg
- Stage-2: $160 \leq SBP < 180$ mmHg, or $100 \leq DBP < 110$ mmHg
- Stage-3: $SBP \geq 180$ mmHg or $DBP \geq 110$ mmHg

Hypertension awareness

Hypertension awareness is defined as prior diagnosis of hypertension among persons with elevated blood pressure. That is an individual found to have hypertension and self-reporting a previous diagnosis of hypertension.

Hypertension treatment

Hypertension treatment is defined as an individual found to have hypertension and self-reporting being on treatment.

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Knowledge risk factors for CVDs

The number of risk factors that each respondent was able to correctly identify through their own recall (without having it read to them) was recorded. The participants were asked whether they knew about the following risk factors for CVDs: Excessive alcohol, smoking, lack of exercise, low fruit intake, low vegetable intake, excess of salt, diabetes, high blood pressure, high cholesterol, overweight.

Anthropometric measurements

The anthropometric measurements of weight, height, mid-upper arm circumference, waist and hip circumference were measured according to standard procedures [21].

Statistical analysis

Summaries of variables

Each variable in the sections of the survey mentioned above (demographic data, knowledge of hypertension, risk factors and anthropometric data) was summarised in the two groups at both surveys. Categorical variables were summarised with counts and proportions over number of valid responses and continuous variables with means and standard deviations. Standard errors for the summaries were inflated to account for the sampling design according to the observed ICC of each variable in the data. Within each district the change of the variable over time was estimated with differences of the summaries (means or proportions). Finally, the changes in the two groups were compared with a test of difference in differences and a *P*-value was produced.

Summaries of hypertension-related outcomes

We estimate the prevalence of hypertension, hypertension awareness, treatment and control in each district and each survey, along with the confidence interval. We also estimate the distribution of hypertension stages.

Comparison between districts

To compare the changes of prevalence from baseline to endline between the two districts we have modelled each outcome with a separate logistic regression that included a random effect term for the EA to account for the cluster sampling design. In the models we included the variables district and survey as binaries (0/1) and their interaction. With the coefficient of survey, we can estimate the odds ratio over time in the control group (OR_C) and intervention (OR_I) districts, and with the interaction coefficient we can compare these OR. All models were estimated three times with different levels of adjustment: a) with no adjustment, b) with minimal adjustment (sex and age), and c) fully adjusted: age, sex, ethnicity, education, ever smoked, drink alcohol, exercise, add salt at table, cook with salt, height and weight, for HTA related outcomes and only age, sex, ethnicity and education for risk factors.

Ethics approval and consent to participate

The evaluation protocol was reviewed and approved by the Institutional Review Boards (IRBs) of LSHTM (LSHTM Ethics Ref: 10152), the GHS (ID NO. GHS-

ERC 04/01/15), and the University of Ghana at Noguchi Memorial Institute for Medical Research (Ethics clearance # IRB00001276). All protocols are subject to annual review by the IRBs. Written informed consent was obtained from all participants. Prior to data collection, appropriate community entry procedures were followed. Key stakeholders and institutions were notified using introductory letters. Community volunteers were recruited to facilitate fieldwork in the intervention and comparison districts. All participants whose SBP was ≥ 140 mmHg or DBP ≥ 90 mmHg, were verbally referred to the nearest health facility for confirmation of diagnosis and management.

RESULTS

Participants' background attributes, and risk factors for hypertension

At baseline, we interviewed 1,200 respondents each from the comparison and intervention districts. Other than ethnicity, baseline characteristics were similar between districts. Participants were overwhelmingly Christian (96.0%), had a mean age of 49 years; 66.0% being between 30 and 54 years. Only 10.0% had never been married, and 25.0% had no formal education. At endline, we interviewed 2,533 adults aged 30 years or older – 1,306 from the Lower Manya Krobo (intervention district) and 1,227 from Akuapim South (comparison district). The average age of participants in the intervention and comparison districts were similar both at baseline and endline. Both surveys combined provide a sample size of nearly 5,000 individuals (2,400 at baseline and 2,533 at endline). The demographic information of both samples, including participant demographics by study district, knowledge of hypertension, risk factors for hypertension, and anthropometrics can be found in **Table 1**.

Also included are the changes from the baseline survey (percentage or mean difference in each district). The last column shows a *P*-value for a comparison between the two groups of the changes in each item separately (unadjusted for other items). Knowledge or risk factors was low in the both districts at baseline, but more so in the comparison district. The differences of changes of risk factors between baseline and endline in the intervention and comparison districts are significant (at the 5% level) in six of the items that assessed knowledge of risk factors (**Table 1**). Finally, respondents from both study districts were comparable in terms of the anthropometrics and their changes.

Table 2 shows the summary of blood pressure and hypertension variables including the primary outcome of the survey – hypertension awareness. In the intervention district over 59% of individuals were aware of their hypertension status in the endline survey - a significant increase from the baseline level of 47.7%. In the comparison district the situation was reversed with a reduction from 44.7% at baseline to 36.6% in endline survey. About a third of people in both the intervention and comparison districts had hypertension and there were minimal differences in hypertension prevalence between the baseline and endline surveys in both districts. The percent of people with Stage 1, Stage 2 and Stage 3 of high blood pressure were also similar between districts (**Table 2**). Treatment was extremely low in both districts in both surveys, and there was a non-significant reduction in treatment in both districts.

Estimates of difference in differences

Table 3 shows the OR of change between surveys in each district and the *P*-value comparing these ORs all fully adjusted as explained above. The models with minimum or no adjusted produced similar results and are not presented here. In the intervention district, there was a significant increase in the level of awareness (OR, 1.45; 95% CI, 1.06–1.99). There was a decrease in the level of awareness in the comparison district (OR, 0.76; 95% CI, 0.54–1.07, there is strong statistical evidence of difference between these two OR ($P = 0.005$). There were no significant differences in changes from baseline to endline between the comparison and intervention districts in prevalence, or treatment of hypertension (**Table 3**).

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Table 1. Summary of variables in each district and survey Endline − Baseline differences in control district (1) and intervention district (2) of % or mean difference

Demographics	Control district		Intervention district		Endline − Baseline		*P*-value
	Baseline	Endline	Baseline	Endline	(1)	(2)	(3)
Male	415 (35.5)	514 (41.9)	426 (36.5)	484 (37.1)	+6.4%	+0.6%	0.082187
Age group							
30–44	508 (43.4)	609 (49.6)	518 (44.4)	555 (42.5)	+6.2%	−1.9%	0.01964
45–54	264 (22.6)	257 (20.9)	239 (20.5)	279 (21.4)	−1.6%	+0.9%	0.30011
55–64	186 (15.9)	175 (14.3)	193 (16.5)	217 (16.6)	−1.6%	+0.1%	0.44475
65+	212 (18.1)	186 (15.2)	217 (18.6)	255 (19.5)	−3.0%	+0.9%	0.12753
Marital status							
Divorced/Separated	181 (15.5)	164 (13.4)	123 (10.5)	136 (10.4)	−2.1%	−0.1%	0.33947
Living together	59 (5.0)	79 (6.4)	72 (6.2)	109 (8.3)	+1.4%	+2.2%	0.67041
Married	647 (55.3)	684 (55.7)	641 (54.9)	644 (49.3)	+0.4%	−5.6%	0.07767
Never married	117 (10.0)	147 (12.0)	152 (13.0)	173 (13.2)	+2.0%	+0.2%	0.42183
Widowed	166 (14.2)	153 (12.5)	179 ((15.3)	244 (18.7)	−1.7%	+3.3%	0.02694
Ethnicity							
Akan	945 (80.8)	903 (73.6)	47 (4.0)	35 (2.7)	−7.2%	−1.3%	0.08994
Ewe	113 (9.7)	120 (9.8)	218 (18.7)	180 (13.8)	+0.1%	−4.9%	0.40823
Krobo/Ga/Dangbe	78 (6.7)	50 (4.1)	882 (75.6)	1,023 (78.3)	−2.6%	+2.8%	0.38782
Other	34 (2.9)	154 (12.6)	20 (1.7)	68 (5.2)	+9.6%	+3.5%	0.00042
Education							
No formal	285 (24.4)	177 (14.4)	314 (26.9)	333 (25.5)	−10.0%	−1.4%	0.01375
Primary initiated	202 (17.3)	221 (18.0)	182 (15.6)	276 (21.1)	+0.7%	+5.6%	0.06399
Primary completed	210 (18.0)	257 (20.9)	196 (16.8)	306 (23.4)	+3.0%	+6.7%	0.14695
Secondary initiated	315 (27.0)	313 (25.5)	283 (24.3)	134 (10.3)	−1.5%	−14.0%	0.00002
Secondary completed	105 (9.0)	145 (11.8)	117 (10.0)	183 (14.0)	+2.8%	+4.0%	0.60063
Tertiary	51 (4.4)	114 (9.3)	75 (6.4)	73 (5.6)	+4.9%	−0.8%	0.00194
Knowledge of HT							
> 2 risk factors	51 (4.4)	114 (9.3)	75[a] (6.4)	73 (5.6)	+4.9%	−0.8%	0.00194
Excessive alcohol	53 (5.7)	131 (10.7)	71[a] (8.7)	90 (6.9)	+4.9%	−1.8%	0.00045
Tobacco	146 (15.8)	243 (23.5)	154[a] (18.8)	166 (14.6)	+7.7%	−4.2%	0.00004
Lack of exercise	95 (10.3)	181 (17.5)	107[a] (13.0)	132 (11.6)	+7.2%	−1.4%	0.00152
Low fruit intake	34 (3.7)	82 (7.9)	45[a] (5.5)	46 (4.0)	+4.2%	−1.4%	0.00073
Low vegetable intake	8 (0.9)	56 (5.4)	14[a] (1.7)	30 (2.6)	+4.5%	+0.9%	0.00135
Excess of salt	95 (10.3)	87 (8.4)	101[a] (12.3)	133 (11.7)	−1.9%	−0.6%	0.64563
Diabetes	9 (1.0)	34 (3.3)	10[a] (1.2)	29 (2.6)	+2.3%	+1.3%	0.28671
High BP	63 (6.8)	137 (13.2)	93[a] (11.3)	161 (14.2)	+6.4%	+2.8%	0.15176
High cholesterol	103 (11.1)	153 (14.8)	89[a] (10.9)	142 (12.5)	+3.6%	+1.6%	0.44468
Overweight	29 (3.1)	48 (4.6)	26[a] (3.2)	40 (3.5)	+1.5%	+0.4%	0.42607
Anthropometrics							
Height	161.16 ± 8.70	162.42 ± 9.67	161.63 ± 8.80	161.55 ± 9.01	+1.26	−0.08	0.05303
Weight	65.97 ± 14.93	68.04 ± 14.54	66.38 ± 15.23	67.31 ± 15.36	+2.07	+0.93	0.42577
BMI	25.45 ± 5.62	26.05 ± 8.56	25.53 ± 6.27	26.02 ± 8.95	+0.60	+0.48	0.84007
MUAC	30.66 ± 4.61	31.36 ± 4.55	30.78 ± 4.84	31.75 ± 5.12	+0.70	+0.97	0.53718
Waist	87.83 ± 13.54	89.28 ± 13.51	87.92 ± 13.82	90.55 ± 13.35	+1.45	+2.63	0.26940
Hip	99.83 ± 13.91	99.69 ± 12.83	99.68 ± 12.91	100.75 ± 13.16	−0.14	+1.07	0.30285
Waist/Hip	0.88 ± 0.10	0.89 ± 0.08	0.88 ± 0.09	0.90 ± 0.07	+0.01	+0.02	0.28225

Values are presented as number (%) or mean ± SD. *P*-value: Unadjusted comparison of Endline − Baseline differences between groups.
HT = hypertension; BP = blood pressure; BMU = body mass index; MUAC = mid-upper arm circumference.
[a]Odds ratio.

The proportion of people that know more than 2 risk factors increased in the control groups (OR, 1.77; 95% CI, 1.24–2.51) while this does not change significantly in the intervention group (OR, 0.86; 95% CI, 0.61–1.21). There is a significant difference in these estimates between the districts ($P = 0.004$) (**Table 3**).

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Table 2. Hypertension prevalence, awareness, treatment and control in the intervention and comparison districts: (1) % over examined individuals, (2) % over hypertensive individuals

Variables	Comparison district				Intervention district			
	Baseline		Endline		Baseline		Endline	
	No. (%)	95% CI	No. (%)	95% CI	No. (%)	95% CI	No. (%)	95% CI
Examined	1,170 (100.0)		1,227 (100.0)		1,167 (100.0)		1,306 (100.0)	
BP – Normal (1)	805 (68.8)	65.6–71.9	820 (66.8)	63.6–69.9	785 (67.3)	63.9–70.3	871 (66.7)	63.6–69.7
BP – Stage 1 (1)	232 (19.8)	17.5–22.4	233 (19.0)	16.8–21.5	210 (18.0)	15.8–20.5	234 (17.9)	15.8–20.2
BP – Stage 2 (1)	86 (7.4)	5.9–9.1	119 (9.7)	8.1–11.7	105 (9.0)	7.4–10.9	114 (8.7)	7.2–10.5
BP – Stage 3 (1)	47 (4.0)	2.9–5.6	55 (4.5)	3.3–6.0	67 (5.7)	4.4–7.4	87 (6.7)	5.3–8.4
Hypertensive (1)	367 (31.4)	28.3–34.6	415 (33.8)	30.8–37.1	390 (33.4)	30.2–36.7	439 (33.6)	30.6–36.7
Aware (2)	164 (44.7)	38.8–50.8	152 (36.6)	31.3–42.2	186 (47.7)	42.0–53.7	260 (59.2)	53.8–64.6
Treated (2)	14 (3.8)	2.1–6.4	12 (2.9)	1.6–5.3	17 (4.4)	2.5–7.0	11 (2.5)	1.4–4.7
% of aware	14 (8.5)	4.3–15.2	12 (7.9)	4.0–15.2	17 (9.1)	4.8–15.2	11 (4.2)	2.0–8.4
Controlled (2)	2 (0.5)	0.1–2.3	8 (1.9)	0.9–4.1	8 (2.1)	1.0–4.3	4 (0.9)	0.3–2.6
% of treated	2 (14.3)	1.3–78.1	8 (66.7)	12.5–98.2	8 (47.1)	15.0–85.0	4 (36.4)	1.8–87.5

CI = confidence interval; BP = blood pressure.

Table 3. Comparison between district of changes over time (1) OR are adjusted by: age, sex, ethnicity, education, ever smoked, drink alcohol, exercise, add salt at table, cook with salt, height and weight (2) OR are adjusted by age, sex, ethnicity and education

Variables	Comparison district: Endline/Baseline		Intervention district: Endline/Baseline		Difference between groups
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	*P*-value
Awareness	0.76 (0.54–1.07)	0.11277	1.45 (1.06–1.99)	0.02173	0.00516
Hypertensive	1.14 (0.94–1.40)	0.18136	1.04 (0.86–1.26)	0.65745	0.50062
Treatment	0.86 (0.36–2.09)	0.74605	0.40 (0.18–0.91)	0.02936	0.19782
BMI > 25	1.26 (1.03–1.54)	0.02236	1.05 (0.87–1.27)	0.60816	0.19094
BMI > 30	1.12 (0.88–1.43)	0.36730	1.22 (0.98–1.53)	0.07880	0.59970
Know > 2 risk factors	1.77 (1.24–2.51)	0.00157	0.86 (0.61–1.21)	0.38720	0.00389

OR = odds ratio; CI = confidence interval; BMI = body mass index.

DISCUSSION

This endline survey assessed and compared hypertension awareness in two Ghanaian districts - before and after an implementation of a community-based intervention. Similarly, it compares hypertension prevalence, and risk factors among inhabitants of these two districts. As in the baseline, the most important demographic difference between the comparison and intervention sites was ethnicity. The majority in the comparison district belong to the Akan ethnic group, and of the majority in the intervention group, the Krobo/Ga-Dangbe ethnicity. Although belonging to two distinct ethnic groups, both are located within the same ecological zone and do not differ significantly in their health seeking behaviour or practices [22,23].

We estimated that only between 42.6%–50% of the study participants with hypertension were aware of prior diagnosis of hypertension, and about 60% at endline. The PURE study, which included participants aged 30–70 years from low and high income countries, reported an overall awareness of 46.5% (49.0% for HICs, 52.5% for upper middle income countries [UMICs], 43.6% for LMICs, and 40.8% for lower income countries [LICs]) [2]. However, compared to previous studies in Ghana, the level of awareness in our study – at baseline or endline were higher. Disparity in age, as well as setting peculiarity may explain the observed differences. For instance, whilst the PURE study, with comparable age group 35-70 years presented similar prevalence [2], several other local/Ghanaian studies [7,8,10,11] involving men and women with varying ages (range: 25–102 years) reporting varying prevalences. The 2014 Ghana Demographic and Health Survey (DHS), a nationally representative survey, assessed hypertension awareness, prevalence, and treatment [7]. Although this survey involved individuals aged 15–49 years, their age band of 30–49 years permits comparisons with our study. The level of awareness was very low - more than 6 in 10 women (63%) and 8 in 10 men (86%) having high blood pressure, reported to be unaware of their condition [7].

As to the prevailing burden of hypertension as measured by prevalence, the current data compare with those of existing surveys. The PURE study referred to above [2] reported an overall prevalence of 40.8% (40.7% for HICs, 49.7% for UMICs, 39.9% for LMICs, and 32.2% for LICs), while hypertension prevalence from local studies [7,8,10,11] involving men and women in similar age groups were comparable with our findings. Our prevalence estimates are substantially higher than the most recent DHS (2014) survey and lower than those found by Lloyd-Sherlock [10]. This is, however, not surprising given that the DHS survey included individuals for 15–49 and the Lloyd-Sherlock [10] only included adults over 50. Our estimated prevalence of hypertension is consistent with reported prevalence in other parts of Africa [4,24].

We proceed to discuss the impact of the ComHIP intervention on the survey's primary outcome – hypertension awareness, and secondary outcomes (hypertension prevalence). The data show a significant increase in hypertension awareness in the intervention district but not in the comparison district. In the intervention district, nearly 60% of individuals were aware of their hypertension status. Several studies present data on the poor patient knowledge of hypertension and low rates of awareness of hypertension diagnosis. These studies discuss key barriers to hypertension control in sub-Saharan Africa including low functional literacy, low health literacy, and health system level challenges [8,25,26]. The reasonably high leap in hypertension awareness between baseline and endline may be attributed to the ComHIP intervention. ComHIP's community mobilization initiatives, mass education, and mass screening of individuals (over 18,000 individuals were screened in the intervention district of a total population of 89,246) may have contributed to this increase. There is evidence that such interventions improve health literacy, patients' awareness of their hypertension diagnosis [27,28].

Unlike awareness, change in hypertension prevalence (baseline-endline) was largely non-significant and treatment rates remained very low in both districts. Several factors may explain our findings. An earlier review of several local studies reported similarly high prevalence of hypertension but low rates of detection, treatment and control [8]. This and other studies identified patient-level barriers (high out-of-pocket costs to pay for facility visits, laboratory tests, and medications), scarce resources, lack of patient education, and systems-level barriers (poor access to care and shortage of healthcare providers) to hypertension control [8,25,26]. While ComHIP sought to mitigate these patient-level barriers, the intervention itself could not completely eliminate their effects at the population level. The lack of impact at the population level is an indication of persistence of those known barriers at some levels, or existence of yet to be identified barriers. For instance, existing data indicate that patronage of alternative or traditional systems of care to be common throughout Ghana [29,30] which could contribute to a low treatment rate. It is however reported that even in healthcare systems with generous resources, control of blood pressure is often unsatisfactory [31]. Of note, van de Vijver et al. [32] reported on their effort and evaluating the impact of a community-based intervention for prevention of CVDs in the slums of Nairobi. Similarly designed as ComHIP, van de Vijver et al. [32] found significant declines in SBP over time in both intervention and control groups, but found no additional effect of a community-based intervention involving awareness campaigns, screening, referral, and treatment. To clarify, the arm of the ComHIP study (reported elsewhere; see Adler et al. [17] that compares with van de Vijver et al.'s work [32] determined similar impacts on systolic blood pressure. Of 1339 enrolled hypertensive patients, there were significant reductions in SBP (12.2 mmHg reduction 95% CI −14.4, −10.1) and DBP (7.5 mmHg 95% CI 9.9–6.1) after one year of follow up [17]. Regarding knowledge of risk factors for CVDs, our observation that the outcome changed in the comparison district (OR, 1.770; 95% CI, 1.242–2.5142) but not in the intervention group (OR, 0.865; 95% CI, 0.61–1.210) may not be a real change. As discussed above of hypertension prevalence and control, a real and durable change in this statistic takes time. Although random samples were taken during each survey, this observation is probably due to sample incomparability, or misappreciation of survey questions by the surveyed.

One of the strengths of our study lies in its community-based nature with a sample size of nearly 5,000 individuals (2,400 at baseline and 2,533 at endline), one of the largest studies of its kind in the region. Second, although cross-sectional surveys lack causal inferencing rigor, they were part of a larger, mixed-methods evaluation of the ComHIP intervention. ComHIP is one of few comprehensive studies which deploy a multilevel combination prevention-treatment-control intervention that engaged (patients, community, and the healthcare personnel), educated (patients and family), and used supportive tools to increase hypertension literacy, service access, service uptake, and linkage to care. Of note, as with surveys of this nature, the limitations of the data collected need to be acknowledged. First, recall bias could have resulted in under- or over-estimation of the self-reported outcomes. Second, although the field enumerators were trained to handle courtesy bias on the part of all respondents, we are not able to wholly rule it out.

Our data shows the promise of this integrated community-based hypertension improvement program at impacting hypertension awareness, but not hypertension prevalence, and treatment at the community level. The low uptake of hypertension treatment has implications on hypertension control and late presentation at health facilities with complications.

ComHIP's multilevel combination prevention-treatment-control actions that engages multiple stakeholders (patients, community, and the healthcare personnel), and its use of supportive tools has not only brought hypertension prevention services to the doorstep of community members but has also increased hypertension awareness and literacy.

Earlier local studies identified patient-level, and systems-level barriers to hypertension control, the effects which, ComHIP attempted to, but could not eliminate at the population level. The lack of impact on hypertension treatment at the population level may be an indication of persistence of those known barriers, or other yet to be identified barriers. If investigated by future studies, effective ways to adapt programs to improve hypertension treatment within the community may be found.

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REFERENCES

1. WHO. *World Health Organization Global Health Observatory (GHO) Data. Raised Blood Pressure*. Geneva: World Health Organization; 2018.
2. Chow CK, Teo KK, Rangarajan S, Islam S, Gupta R, Avezum A, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. *JAMA* 2013;310(9):959-68.
   PUBMED | CROSSREF
3. W Tobe S, Attaran A, de Villiers A, Featherstone A, Forrest J, Kalyesubula R, et al. The global alliance for chronic diseases supports 15 major studies in hypertension prevention and control in low- and middle-income countries. *J Clin Hypertens (Greenwich)* 2016;18(7):600-5.
   PUBMED | CROSSREF
4. Addo J, Smeeth L, Leon DA. Hypertension in sub-saharan Africa: a systematic review. *Hypertension* 2007;50(6):1012-8.
   PUBMED | CROSSREF
5. Vorster HH. The emergence of cardiovascular disease during urbanisation of Africans. *Public Health Nutr* 2002;5(1A):239-43.
   PUBMED | CROSSREF
6. Lamptey P, Laar A, Adler AJ, Dirks R, Caldwell A, Prieto-Merino D, et al. Evaluation of a community-based hypertension improvement program (ComHIP) in Ghana: data from a baseline survey. *BMC Public Health* 2017;17(1):368.
   PUBMED | CROSSREF
7. GSS, GHS, ICFI. *Ghana Demographic and Health Survey 2014*. Rockville, MD: GSS, GHS, ICF International; 2015.
8. Addo J, Agyemang C, Smeeth L, de-Graft Aikins A, Edusei AK, Ogedegbe O. A review of population-based studies on hypertension in Ghana. *Ghana Med J* 2012;46(2 Suppl):4-11.
   PUBMED
9. Amoah AG. Sociodemographic variations in obesity among Ghanaian adults. *Public Health Nutr* 2003;6(8):751-7.
   PUBMED | CROSSREF
10. Lloyd-Sherlock P, Beard J, Minicuci N, Ebrahim S, Chatterji S. Hypertension among older adults in low- and middle-income countries: prevalence, awareness and control. *Int J Epidemiol* 2014;43(1):116-28.
    PUBMED | CROSSREF
11. Cappuccio FP, Micah FB, Emmett L, Kerry SM, Antwi S, Martin-Peprah R, et al. Prevalence, detection, management, and control of hypertension in Ashanti, West Africa. *Hypertension* 2004;43(5):1017-22.
    PUBMED | CROSSREF
12. Agyemang C, Nyaaba G, Beune E, Meeks K, Owusu-Dabo E, Addo J. Variations in hypertension awareness, treatment, and control among Ghanaian migrants living in Amsterdam, Berlin, London, and nonmigrant Ghanaians living in rural and urban Ghana–the RODAM study. *J Hypertens* 2018;36(1):169-77.
    PUBMED | CROSSREF
13. Sanuade OA, Awuah RB, Kushitor M. Hypertension awareness, treatment and control in Ghana: a cross-sectional study. *Ethn Health* 2020;25(5):702-16.
    PUBMED | CROSSREF
14. Awuah RB, Anarfi JK, Agyemang C, Ogedegbe G, Aikins A. Prevalence, awareness, treatment and control of hypertension in urban poor communities in Accra, Ghana. *J Hypertens* 2014;32(6):1203-10.
    PUBMED | CROSSREF
15. Ministry of Health (GH). *National Policy for the Prevention and Control of NCDs in Ghana, Accra, Ghana*. Accra: Ministry of Health; 2012.
16. Ministry of Health (GH). *Strategy for the Management, Prevention and Control of Chronic Non-Communicable Diseases in Ghana 2012–2016*. Accra: Ministry of Health; 2012.
17. Adler AJ, Laar A, Prieto-Merino D, Der RM, Mangortey D, Dirks R, et al. Can a nurse-led community-based model of hypertension care improve hypertension control in Ghana? Results from the ComHIP cohort study. *BMJ Open* 2019;9(4):e026799.
    PUBMED | CROSSREF
18. Adler AJ, Laar AK, Kotoh AM, Legido-Quigley H, Perel P, Lamptey P, et al. Barriers and facilitators to the implementation of a community-based hypertension improvement project in Ghana: a qualitative study of ComHIP. *BMC Health Serv Res* 2020;20(1):67.
    PUBMED | CROSSREF

19. Laar AK, Adler AJ, Kotoh AM, Legido-Quigley H, Lange IL, Perel P, et al. Health system challenges to hypertension and related non-communicable diseases prevention and treatment: perspectives from Ghanaian stakeholders. *BMC Health Serv Res* 2019;19(1):693.
PUBMED | CROSSREF
20. WHO. *Global Status Report on Noncommunicable Diseases 2010*. Geneva: World Health Organization; 2011.
21. Jelliffe DB. The assessment of the nutritional status of the community (with special reference to field surveys in developing regions of the world). *Monogr Ser World Health Organ* 1966;53:3-271.
PUBMED
22. Van Der Geest S, Krause K. Introduction: studying health and health care in Ghana. *Ghana Stud* 2014;15:7-39.
23. Yarney L, Mba C, Asampong E. Qualitative study on the socio-cultural determinants of care of children orphaned by AIDS in the Ashanti and Eastern regions of Ghana. *BMC Public Health* 2015;15(1):6.
PUBMED | CROSSREF
24. Adedoyin RA, Mbada CE, Balogun MO, Martins T, Adebayo RA, Akintomide A, et al. Prevalence and pattern of hypertension in a semiurban community in Nigeria. *Eur J Cardiovasc Prev Rehabil* 2008;15(6):683-7.
PUBMED | CROSSREF
25. Iwelunmor J, Plange-Rhule J, Airhihenbuwa CO, Ezepue C, Ogedegbe O. A narrative synthesis of the health systems factors influencing optimal hypertension control in sub-Saharan Africa. *PLoS One* 2015;10(7):e0130193.
PUBMED | CROSSREF
26. Kayima J, Wanyenze RK, Katamba A, Leontsini E, Nuwaha F. Hypertension awareness, treatment and control in Africa: a systematic review. *BMC Cardiovasc Disord* 2013;13(1):54.
PUBMED | CROSSREF
27. Wentzel-Viljoen E, Steyn K, Lombard C, De Villiers A, Charlton K, Frielinghaus S, et al. Evaluation of a mass-media campaign to increase the awareness of the need to reduce discretionary salt use in the South African population. *Nutrients* 2017;9(11):1238.
PUBMED | CROSSREF
28. Wakefield MA, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. *Lancet* 2010;376(9748):1261-71.
PUBMED | CROSSREF
29. Minicuci N, Biritwum RB, Mensah G, Yawson AE, Naidoo N, Chatterji S, et al. Sociodemographic and socioeconomic patterns of chronic non-communicable disease among the older adult population in Ghana. *Glob Health Action* 2014;7(1):21292.
PUBMED | CROSSREF
30. de-Graft Aikins A, Kushitor M, Koram K, Gyamfi S, Ogedegbe G. Chronic non-communicable diseases and the challenge of universal health coverage: insights from community-based cardiovascular disease research in urban poor communities in Accra, Ghana. *BMC Public Health* 2014;14(Suppl 2):S3.
PUBMED | CROSSREF
31. Okano GJ, Rascati KL, Wilson JP, Remund DD, Grabenstein JD, Brixner DI. Patterns of antihypertensive use among patients in the US Department of Defense database initially prescribed an angiotensin-converting enzyme inhibitor or calcium channel blocker. *Clin Ther* 1997;19(6):1433-45.
PUBMED | CROSSREF
32. van de Vijver S, Oti SO, Gomez GB, Agyemang C, Egondi T, Moll van Charante E, et al. Impact evaluation of a community-based intervention for prevention of cardiovascular diseases in the slums of Nairobi: the SCALE-UP study. *Glob Health Action* 2016;9(1):30922.
PUBMED | CROSSREF