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Linkage to primary care after home-based blood pressure screening in rural Kwazulu-Natal: A population-based cohort study

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Complete List of Authors:	Siedner, Mark; Massachusetts General Hospital, Medicine; Harvard Medical School, Baisley, Kathy; London School of Hygiene and Tropical Medicine, Epidemiology and Population Health Orne-Gliemann, Joanna; University of Bordeaux Pillay, Deenan; Africa Health Research Institute; University of College London Koole, Olivier; Africa Health Research Institute Wong, Emily; Massachusetts General Hospital Matthews, Philippa; Africa Health Research Institute Tanser, Frank; School of Nursing and Public Health, University of KwaZulu- Natal ; Africa Health Research Institute Herbst, Kobus; Africa Health Research Institute Barnighausen, Till; Africa Health Research Institute Bachmann, Max; UEA, Population Health and Primary Care
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Linkage to primary care after home-based blood pressure screening in rural Kwazulu-Natal: A populationbased cohort study

Authors: Mark J. Siedner*^{1,2,3} Kathy Baisley^{3,4} Joanna Orne-Gliemann⁵ Deenan Pillay^{3,6} Olivier Koole^{3,4} Emily Wong^{1,2,3} Philippa Matthews³ Frank Tanser³ Kobus Herbst³ Till Barnighausen^{3,6,7,8} Max Bachmann⁹ *Corresponding Author for Inquiries: Mark J. Siedner Massachusetts General Hospital Global Health 125 Nashua Street Boston, MA 02114 USA T: +1-617-726-4686; F: +1-617-724-1637 msiedner@mgh.harvard.edu **Affiliations:** ¹Massachusetts General Hospital, Boston, USA ²Harvard Medical School, Boston, USA ³Africa Health Research Institute, KwaZulu-Natal, SA ⁴London School of Tropical Medicine and Hygiene, London, UK ⁵University of Bordeaux, ISPED, INSERM, Bordeaux Population Health Research Center, UMR 1219, Bordeaux, France ⁶University College London, London, UK ⁷University of Heidelberg, Germany ⁸Harvard School of Public Health, Boston, USA ⁹University of East Anglia, Norwich, UK Funding: The Africa Health Research Institute receives funding from the United Kingdom Wellcome Trust grant 082384/Z/07/Z. MJS receives funding from the National Institutes of Health (K23 MH099916, P30 30AI060354) Conflicts of Interest: All authors report no conflicts of interest

ABSTRACT

Objectives: The expanding burden of non-communicable diseases (NCDs) globally will require novel public health strategies. Community-based screening has been promoted to augment efficiency of diagnostic services, but few data are available on the downstream impact of such programs. We sought to assess the impact of a home-based blood pressure screening program on linkage to hypertension care in rural South Africa.

Setting: We conducted home-based blood pressure screening in a population cohort in rural KwaZulu-Natal, using the WHO STEPS protocol.

Participants: Individuals meeting criteria for raised blood pressure (>140 systolic or >90 diastolic averaged over two readings) were referred to local health clinics, and included in this analysis. We defined linkage to care based on self-report of presentation to clinic for hypertension during the next two years of cohort observation. We estimated the population proportion of successful linkage to care with inverse probability sampling weights, and fit multivariable logistic regression models to identify predictors of linkage following a positive hypertension screen.

Results: Of 11,694 individuals screened, 15% (n=1,706) were newly diagnosed with elevated pressure. 26.9% (95%CI 24.5-29.4%) of those sought hypertension care in the following two years, and 38.1% (95%CI 35.6-40.7%) did so within five years. Women (aOR 2.41, 95%CI 1.68–3.45), those of older age (aOR 11.49, 95%CI 5.87–22.46, for 45-59 years versus <30), and those unemployed (aOR 1.71, 95%CI 1.10–2.65) were more likely to have linked to care.

Conclusions: Linkage to care after home-based identification of elevated blood pressure was rare in rural South Africa, particularly among younger individuals, men, and the employed. Improved understanding of barriers and facilitators to NCD care is needed to improve the effectiveness of blood pressure screening in the region.

Key Words:

Non-communicable diseases, community health, hypertension, South Africa, linkage to care

Strengths and Limitations of this Study

- Applies a longitudinal population cohort study design with a large sample size to assess linkage to hypertension care after a home-based screening for elevated blood pressure
- Assesses an under-studied population in rural sub-Saharan Africa who are known to have high prevalence of hypertension and low rates of engagement in hypertension care
- Identifies low rates of linkage to care after home-based blood pressure screening in this population, and key factors associated with poor linkage including male sex, younger age, and being employed
- Limitations include low rates of participation in the home-based screening program and incomplete follow-up, as well as self-reported linkage to care as an outcome definition

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What is already known on this subject?

Hypertension is the risk factor responsible for the greatest number of deaths globally. Yet, awareness and treatment of the disease remains low, particularly in resource limited settings. Home and communitybased hypertension screenings have gained major traction as a means to improve penetration of disease diagnosis and prevention. Yet, few studies have assessed their downstream effects on linkage to hypertension care.

What this study adds?

We found that less than 3 in 10 people newly notified of elevated blood pressure during a home-based screening in rural KwaZulu-Natal presented to a clinic for hypertension care within the next two years. Linkage rates were particularly low in younger people, men and the employed. Consequently, community and home-based blood pressure screening in similar settings will likely require additional features to result in their desired effect of improving access to effective hypertensive care.

<text>

BACKGROUND

Over two in three deaths worldwide are attributed to non-communicable diseases (NCDs).¹ Although precise measurement of cause-specific mortality in much of the developing world remains a challenge, some estimates suggest that the majority of NCD deaths now occur in low and middle-income countries.² In South Africa, for example, the World Health Organization estimates that half of deaths are due to NCDs, and approximately 25% of the population will suffer a premature death due to them.³ Consequently, responding to the NCD epidemic in low and middle-income countries is both a major challenge and stated priority of the public health community.⁴ NCD morbidity and mortality can be substantially reduced through effective primary and secondary prevention measures targeting risk factors such as smoking, high blood pressure, diabetes, diet and physical activity.⁵ Hypertension, which can be controlled through cost-effective lifestyle and pharmacotherapy interventions, is estimated to account for over 50% of the population attributable fraction of stroke in the African region.⁶ Yet, in South Africa, national population surveys have estimated that over one quarter of South Africans adults have raised blood pressure, but only approximately one in three of them has received treatment.⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus.⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals for multiple co-morbidities.^{9 10} Whether such endeavors lead to successful linking of individuals to appropriate NCD care is not well established, and is an important question for the field. In 2010, we conducted a home-based assessment of blood pressure in approximately 12,000 people in a demographic health surveillance (DHS) site in KwaZulu Natal. We referred individuals with raised blood

1	27	pressure and not already receiving hypertension treatment to local government clinics for repeat
2 3	28	measurement and ongoing hypertension care. We assessed linkage to care during future years of the
4 5	29	home-based DHS survey. Our primary aims were to determine the probability of clinical engagement
6 7 8	30	within two years after home-based screening and referral, and to identify predictors of failure to link to
9 10	31	care. Our over-arching aim was to inform public health programmers on the feasibility of community-
11 12	32	based blood pressure screening as an entry point into NCD care in this setting.
13 14 15	33	
16 17	34	METHODS
18 19	35	Study design, setting, and participants
20 21 22	36	The African Health Research Institute (AHRI) (formerly the Africa Centre for Health and Population Studies)
22 23 24	37	is a Wellcome Trust funded research institute in South Africa. Since 2000, they have conducted a
25 26	38	population cohort study of all adults in a catchment area of 438 km ² in rural uMkanyakude District,
27 28 20	39	northern KwaZulu-Natal, covering a total population of approximately 100,000 individuals. ¹¹ Households
29 30 31	40	are surveyed 2–3 times per year, to collect information on birth, deaths and migration patterns for all
32 33	41	household members, including non-residents. Since 2003, resident household members ≥15 years have
34 35 26	42	been invited to participate in an annual home-based individual survey, which collects data on
36 37 38	43	sociodemographics and general health information.
39 40	44	
41 42	45	Blood pressure screening and referral methods
43 44 45	46	In 2010, all individuals who participated in the home-based survey were also offered a physical
46 47	47	examination to determine weight, height and blood pressure, using the WHO STEPS protocol. ¹² Blood
48 49	48	pressure was measured using Omron automated blood pressure monitors (Omron Global, Kyoto Japan).
50 51 52	49	Blood pressure was measured after 15 minutes of resting in a seated position. We collected three
53 54	50	measurements, each five minutes apart, with the mean of the last two measurements used to identify
55 56	51	those with elevated blood pressure. A positive hypertension screen was defined as a mean systolic blood
57 58 50	52	pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg. ¹³ Individuals with a positive screen and
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1	53	not already receiving treatment were referred to their preferred local public health clinic with their
2 3	54	screening results.
4 5 6	55	
7 8	56	Outcome assessment
9 10	57	For our primary outcome of interest, we defined successful linkage to care for hypertension as self-
11 12 13	58	reported linkage within two years of a positive home-based hypertension screen. To assess this outcome,
14 15	59	we used data from the two subsequent, annual home-based health surveys in 2011 and 2012. In each
16 17	60	annual health survey, respondents were asked if: 1) they have been diagnosed with hypertension in the
18 19 20	61	past 12 months; 2) if they have ever received hypertension treatment; and 3) if they are currently being
20 21 22	62	treated for hypertension. We defined successful linkage to care by a positive response to any of these
23 24	63	three questions in either 2011 or 2012. As secondary outcomes of interest, we also examined 1) linkage to
25 26	64	hypertension care within five years (as opposed to two), defined as a positive response to any of the same
27 28 20	65	three questions in the annual health surveys during 2011-2015 and 2) confirmation of hypertension care
29 30 31	66	seven years after the screening, as evidenced by clinical records from all public health clinics in the
32 33	67	catchment area in 2017, the first year linked clinical data was linked to the population cohort database.
34 35	68	
36 37 38	69	Statistical methods
39 40	70	We included in this analysis individuals who had a positive hypertension screen in the home-based 2010
41 42	71	survey, and who reported no previous diagnosis of hypertension or hypertension treatment. We first
43 44 45	72	summarized sociodemographic characteristics of eligible adults who had blood pressure measurements in
46 47	73	the 2010 survey. We then estimated population-level prevalence of linkage to hypertension care in the
48 49	74	two years after the screening program, both overall and stratified by sex and age, with the use of inverse
50 51	75	probability weights (IPWs) of the probability of participating in the hypertension screening. We used IPWs
52 53 54	76	to make the results generalizable to the entire 2010 sample. To calculate the weights, we fit a logistic
55 56 57	77	regression model with completion of blood pressure screening in 2010 as the outcome of interest and
58 59		

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1	78	included age strata, sex, education level and place of residence (urban, peri-urban, or rural) as predictors,
2 3	79	based on information routinely collected in the household-level survey.
4 5	80	
6 7 9	81	We then fit logistic regression models to estimate odds ratios (OR) and 95% confidence intervals (CI) for
8 9 10	82	factors independently associated with linkage to hypertension care within two years of a positive home-
11 12	83	based hypertension screen. Potential determinants of linkage were examined at three levels:
13 14 15	84	sociodemographic factors (age, sex, educational attainment, employment status and socioeconomic
15 16 17	85	status); geographical factors (distance from clinic, urban versus rural residency); and clinical factors (body
18 19	86	mass index, elevated blood pressure severity [defined using hypertension stages as a) stage I: systolic 140-
20 21	87	160 and diastolic 80-100; b) stage II: systolic 160-<180 or diastolic 100-<120; or c) hypertensive urgency:
22 23 24	88	systolic >180 or diastolic >120], self-report of diabetes, self-report of tuberculosis) ¹⁴ . Sociodemographic
24 25 26	89	and clinical factors whose age- and sex-adjusted association with linkage was significant at p<0.10 were
27 28	90	included in a final adjusted multivariable model. Distance from the nearest clinic was analyzed as a
29 30 21	91	continuous covariate. In order to allow for non-linear relationships between distance and linkage to care,
31 32 33	92	we used fractional polynomial functions. ¹⁵
34 35 36	93	

We tested the robustness of our findings using several sensitivity analyses. First, we changed our outcome from self-reported linkage to care in 2011 or 2012 to 1) self-reported linkage to care at any time between 2011-2015, and 2) confirmation of a clinic appointment for hypertension in 2017 among those who remained a resident in the catchment area. Next, we compared characteristics of eligible individuals who did and did not complete blood pressure screening in 2010. Next, we compared characteristics of those who participated in a subsequent health survey and those who did not, either because of refusal, out-migration, or death. Finally, we conducted sensitivity analyses in which we: 1) used IPWs of screening in the models; and 2) added a covariate to indicate the number of individual health surveys participated in during 2011-2015. Data were entered and verified in an SQL database, and were analyzed using Stata 14 (StataCorp, College Station, TX).

1			
2 3	105	Human Studies Considerations	
4 5	106	Ethical approval for the demographic surveillance study and analyses of these data was granted by the	
6 7 0	107	Biomedical Research Ethics Committee of the University of KwaZulu-Natal, South Africa. Separate	
8 9 10	108	informed consent was given for the demographics survey, the blood pressure screening, and the clinic	
11 12	109	records abstraction.	
13 14	110		
15 16 17	111	Patient and Public Involvement	
18 19	112	Patients were not involved in the design of this study. This analysis was designed by study investigators at	
20 21	113	the Africa Health Research Institute intent on leveraging prior home-based screening protocols to inform	
22 23 24	114	and optimize future community-based research, and particularly to improve the public health impact of	
25 26	115	such activities. The results of this study were presented to the South African Department of Health Non-	
27 28	116	Communicable Diseases Unit and will be disseminated to the community during the monthly scheduled	
29 30 31	117	Africa Health Research Institute community road shows.	
32 33	118		
34 35	119		
36 37 38	120	RESULTS	
39 40	121	Survey participants	
41 42	122	A total of 37,693 potentially eligible adults were in the sampling frame. Of these, approximately one	
43 44 45	123	quarter (8,589, 23%) were not available due to out-migration, death or inability to consent and another	
46 47	124	2,920 (8%) could not be contacted (Figure 1). Of the remaining 26,184 individuals who were contacted and	
48 49	125	eligible for the home-based DHS survey in 2010, 11,814 (45%) consented to participate in the general	
50 51 52	126	health survey and 11,694 (45%) had valid blood pressure measurements. Women, older individuals, and	
53 54	127	those of lower socioeconomic position and education were more likely to participate in the survey	
55 56	128	(Supplementary Table 1).	
57 58 50	129		
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1	130	The majority of participants with a blood pressure measurement were women (n=8,241, 71%, Table 1).
2 3	131	Median age was 25 years (interquartile range [IQR] 18–47 years) for men and 38 years (IQR 23–55 years)
4 5	132	for women. The majority of participants (n=7,464, 64%) resided in a rural setting, and less than one quarter
6 7 8	133	(n=2,642, 23%) lived within 1.5 kilometers of the nearest clinic. Few participants (n=1,779, 15%) were
9 10	134	currently employed.
11 12	135	
13 14 15	136	Screening for hypertension
16 17	137	Approximately one quarter (n=3,074, 26.2%) of participants were found to have elevated pressure during
18 19	138	the home-based blood pressure screening, of whom 1,368 (44.5%) reported having been previously
20 21 22	139	diagnosed or currently on treatment. Of those who had been previously diagnosed or in hypertension care,
23 24	140	1,169 (85.5%) were currently on hypertension treatment. Participants who were not previously aware of
25 26	141	their condition were significantly younger, and more likely to be men, married, employed, have a higher
27 28	142	level of education, and be living in peri-urban areas than those who had been previously diagnosed or on
29 30 31	143	treatment (Table 1). However, there was no evidence of a difference between the two groups in the
32 33	144	distance from their nearest clinic.
34 35	145	
30 37 38	146	Analytic Sample
39 40	147	A total of 1,199 individuals (70.3%) who were not previously aware of having elevated blood pressure
41 42	148	participated in a second general health survey within two years of being screened (that is, in 2011 or
43 44 45	149	2012), and were included in the primary analysis of factors associated with linkage to hypertension care.
46 47	150	Compared with the 507 individuals who did not participate in 2011 or 2012, those who participated in
48 49	151	2011 or 2012 were older (median (IQR) age = 50 (38–66) years, vs 43 (29–58) years), more likely to be
50 51	152	women, unmarried, have lower levels of education, be unemployed, and have a higher BMI
52 53 54	153	(Supplementary Table 2). There was no difference in participation rates by distance from the nearest clinic.
55 56	154	When we expanded the observation period to include surveys from 2011-2015, a total of 1,421 (83.3%)
57 58	155	participated in at least one home-based annual general health survey. Of the 285 (16.7%) individuals who
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1	156	did not participate in any health survey after 2010, 81 out-migrated and 36 died before the 2011 survey
2 3	157	(Figure 1). The remaining 168 were eligible for at least one subsequent survey but refused participation.
4 5	158	
6 7 8	159	Linkage to subsequent hypertension care
9 10	160	Using IPWs to estimate population level linkage to care, we estimate a population level prevalence of
11 12	161	linkage to care within two years of the blood pressure screen of 26.9% (95%CI=24.5-29.4%). Women were
13 14 15	162	more likely than men to link to care, and older individuals were more likely than younger individuals
16 17	163	(Figure 2), such that we estimate that 44.9% (95%CI=39.4-50.5%) of women ≥60 years presented to care
18 19	164	for hypertension in the next two years, versus only 3.0% (95%Cl=1.1-7.7%) of men under 45. When we
20 21	165	extended our surveillance period out to 2015, we estimate that 38.1% (95%CI=35.6-40.7%) of individuals
22 23 24	166	reported linking to hypertension care within 5 years. Finally, we found that only 16.6% (95%CI=14.6-18.9%)
25 26	167	of individuals who remained a resident in 2016 and who screened positive for elevated blood pressure in
27 28	168	2010 completed a clinic appointment for hypertension at one of the public health clinics in the catchment
29 30 31	169	area in 2016.
32 33	170	
34 35	171	Factors associated with presentation to hypertension care within two years
36 37	172	We found strong evidence that women (OR=2.76, 95%CI=1.97 – 3.88, p<0.001) and those of older age
39 40	173	(OR=12.89, 95%C 6.62 – 25.11, p<0.0001, comparing those 45-59 years versus those <30) were more likely
41 42	174	to present to hypertension care within two years of home-based diagnosis (Table 2). In adjusted analysis,
43 44	175	the association with age and sex remained statistically significant, and there was no evidence that the
45 46 47	176	effect of age on linkage to care differed between men and women (p-value for interaction=0.20, Figure 2).
48 49	177	There was evidence that those who were unemployed were more likely to link to care (adjusted (a)OR
50 51	178	2.09, 95%CI 1.39 – 3.14). There was an association between distance from clinic and linkage to
52 53 54	179	hypertension care such that odds of presentation increased as distance to the clinic increased (aOR for
55 56	180	linear trend in linkage with each 1 km increase in distance = 1.12, 95%CI=1.05–1.20, p<0.001). The results
57 58	181	of the fractional polynomial models suggested that the linear model adequately described the relationship
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1	182	between presentation to care and distance. After adjusting for sociodemographic and location factors, we
2 3	183	also found strong evidence that individuals with the equivalent of Stage II hypertension (aOR=2.20,
4 5 6	184	95%CI=1.63 – 2.97), and those meeting criteria for hypertensive urgency (aOR=3.07, CI=2.01 – 4.67) had
7 8	185	higher odds of linking to care than those with the equivalent of Stage I hypertension. We found similar
9 10	186	correlates of presentation to hypertension care (age, sex, distance from clinic, and employment) in
11 12	187	sensitivity analyses with weighted models, and in models with a covariate for the number of follow-up
13 14 15	188	surveys completed during 2011-2015 (Supplementary Tables 3-5).
16 17	189	
18 19	190	DISCUSSION
20 21 22	191	We found very low rates of presentation to care after home-based identification of elevated blood
23 24	192	pressure in rural KwaZulu Natal. Overall, less than one third of individuals newly identified with elevated
25 26	193	blood pressure reported being diagnosed with hypertension or receiving treatment for elevated blood
27 28 20	194	pressure from a clinic within two years, and less than one in five had evidence of visiting a clinic for
29 30 31	195	hypertension care during a 12-month period seven years after the screen. Linkage rates were particularly
32 33	196	low for men and young people. Notably, those employed and those closest to clinics also had poorer rates
34 35 36	197	of linkage. These results highlight the important need to consider the determinants of healthcare access
37 38	198	for NCDs in rural South Africa, and multi-faceted approaches to improve linkage to care after community-
39 40	199	based NCD screening programs.
41 42	200	
43 44 45	201	Linkage with clinical programs after community- and home-based disease screening for chronic disease in
46 47	202	sub-Saharan Africa have demonstrated mixed results. Most evidence has come from the HIV field, in which
48 49	203	linkage after home-based testing in pilot studies has been highly successful, ¹⁶ although lower rates are
50 51 52	204	reported in community settings. ⁹¹⁷ Studies reporting clinic attendance after hypertension screening have
52 53 54	205	generally shown low rates of linkage to care. For example, in a large (n=6,000) health fair-based screening
55 56	206	program in Uganda, 41% of participants with a new positive screen for elevated blood pressure linked to
57 58 59	207	care. ⁹ A smaller pilot study in Kenya yielded higher linkage rates (74%, n=120) after community group-

1	208	initiated blood pressure screening. ¹⁸ Interpreting these contrasting results must be done with attention to
2 3	209	the selection criteria of each. Whereas our procedures were home-based, the larger study from Uganda
4 5 6	210	included self-referring individuals who had attended a health fair, and the Kenyan study operated through
0 7 8	211	a peer microfinance program, in which NCD screening services were paired with agribusiness advice within
9 10	212	pre-organized community groups. In the prior report most similar to ours, a large program in Malawi
11 12 13	213	(n=27,305) that provided clinical referrals after home-based testing reported a 59% linkage rate within two
14 15	214	weeks of a diagnosis of hypertension, although 30% of participants were already on treatment at the time
16 17	215	of referral. ¹⁹ Moreover, approximately 50% dropped out of care within 6 months of linkage.
18 19	216	
20 21 22	217	Predictors of presentation to care in our study reinforce much of the literature on health care access and
22 23 24	218	engagement among vulnerable populations in sub-Saharan Africa. Lower engagement by younger
25 26	219	individuals and men are well-established phenomena; and a public health challenge for the region. ²⁰²¹
27 28 20	220	Although it did not reach statistical significance, we also found evidence that those with greater social
30 31	221	support, as evidenced by having a cohabitating partner, tended to be more likely to present to care. An
32 33	222	unexpected finding was that those who were unemployed and those further from clinic were more likely
34 35	223	to link to care. This finding contrasts with much of the data from the region on how distance from health
30 37 38	224	services impacts linkage to and retention in care. ²²⁻²⁴ We hypothesize that these results illustrate
39 40	225	competing demands between obligations to work and to access healthcare. Notably, a similar
41 42	226	phenomenon was found in the Malawi home-based NCD screening study, in which rural participants had
43 44 45	227	more than twice the odds of linkage to NCD care than their urban counterparts, and the most common
46 47	228	reason stated for failure to link to care in urban areas was being too busy to attend clinic; reported in 34%
48 49	229	of those not linked to care. ¹⁹ Employment is higher in male than in female South African blacks ²⁵ , and so
50 51 52	230	may also contribute to the gender difference in linkage.
52 53 54	231	
55 56	232	Our data do offer multiple potential strategies to improve linkage to care after home-based NCD screening.
57 58	233	For example, a notable distinction between many community-based HIV and NCD diagnostic programs is
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1	234	the degree of counseling and referral services provided after diagnosis. Hypertension referral services in
2 3	235	our program and many others in the region are often limited to distribution of results and referral forms.
4 5	236	In contrast, decades of standardizing in-depth HIV counseling services, and additional facilitated linkage
6 7 8	237	strategies have significantly improved rates of linkage after a new HIV diagnosis. ²⁶ Pilot studies of
9 10	238	enhanced referral after community based NCD diagnoses have also shown promise in vulnerable
11 12	239	populations in the United States, ^{27 28} and warrant investigation on a larger scale elsewhere. Similarly, our
13 14 15	240	finding and that of others that hypertension linkage was less common in those employed presents a
15 16 17	241	potential opportunity to consider expanded clinic service hours and/or community based management to
18 19	242	improve NCD care in the region. Endeavors, such as the Centralised Chronic Medication Dispensing and
20 21	243	Distribution recently launched by the KwaZulu Natal Department of Health, seek to overcome such barriers
22 23 24	244	by delivering medicines to peoples' homes and workplaces, or setting up community-based medicine
25 26	245	pickup points. Evaluations of the efficacy and sustainability of such programs will be of high importance to
27 28	246	the field.
29 30	247	
31 32 33	248	Our study is strengthened by a large sample size and the use of a home-based testing paradigm. The
34 35	249	primary limitation to our analysis is the relatively low response rate in the initial hypertension screen and
36 37	250	participation in subsequent surveys. We accounted for this limitation by comparing characteristics
38 39 40	251	between participants and non-participants, and by using inverse probability weighting techniques to make
40 41 42	252	population level inferences. Our study is also limited by a use of self-report to detect linkage to clinical care
43 44	253	over the first two years of observation, which likely results in incomplete estimation of outcomes. Use of
45 46	254	clinical records to assess long-term care seven years after the initial screen might also under-estimate
47 48 49	255	appropriate maintenance in care for individuals who normalized their blood pressure in the interim.
50 51	256	Finally, our results should be considered in the context of the low-resource, rural sub-Saharan Africa study
52 53	257	stetting, but are unlikely to generalize more broadly to urban or higher resource regions.
54 55 56	258	
57 58		
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1	259	In summary, we found very low rates of linkage to care after a population-level, home-based hypertension
2 3	260	screen in rural KwaZulu Natal. Strategies focused on increased demand generation, particularly for
4 5	261	younger individuals and men, augmented referral and linkage programs, and efforts to enhance the
6 7 8	262	convenience of service delivery, particularly to employed people, should be evaluated to improve NCD
9 10	263	care access after community based testing in the region.
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1	265 266	Author Contributions:
2 3	267	MIS: Consolved of the project wrote the first draft, and contributed to the data analysis
4 5	207	wiss. Conceived of the project, wrote the first draft, and contributed to the data analysis.
6 7	268	KB: Led the data analysis, contributed to manuscript production.
8 9	269	JOB: Helped conceive of the project and contributed to manuscript production.
10 11	270	DP: Contributed to data collection, project conception, and contributed to manuscript production.
12 13 14	271	OK: Contributed to data collection, project conception, and contributed to manuscript production.
15 16	272	EW: Contributed to data collection and project conception.
17 18	273	PM: Contributed to data collection, project conception, and contributed to manuscript production.
19 20 21	274	FT: Contributed to data collection and project conception.
22 23	275	KH: Contributed to data collection and project conception.
24 25	276	TB: Contributed to data collection, project conception, and contributed to manuscript production.
20 27	277	MB: Contributed to project conception, data analysis, and contributed to manuscript production.
20 29 30	278	All authors reviewed the manuscript for editorial contributions and approved of the final version.
31 32	279	
33 34	280	Data Sharing:
35 36 37	281	Data for this analysis is available by emailing Mark Siedner (<u>msiedner@mgh.harvard.edu)</u> and Kobus
38 39	282	Herbst (<u>kherbst@ahri.org</u>)
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Table 1. Participants with blood pressure measured in in 2010 survey, those with hypertension¹ and stratified by whether or not previously diagnosed or on treatment

	All participants	N with hypertension ¹	Previously diagnosed ²	Not previously diagnosed ³
	N=11,694	N=3074 (26.2%)	N=1368 (44.5%)	N=1706 (55.5%)
Median (IQR) age (years)	34 (21–53)	55 (43–68)	60 (51–71)	49 (35–63)
Age group				P<0.001 ⁴
<30	5107 (43.7%)	354 (11.5%)	21 (1.5 %)	333 (19.5%)
35-44	2191 (18.7%)	484 (15.7%)	118 (8.6 %)	366 (21.5%)
45-59	2265 (19.4%)	992 (32.3%)	507 (37.1%)	485 (28.4%)
60+	2131 (18.2%)	1244 (40.5%)	722 (52.8%)	522 (30.6%)
Sex				P<0.001
Male	3453 (29.5%)	720 (23.4%)	178 (13.0%)	542 (31.8%)
Female	8241 (70.5%)	2354 (76.6%)	1190 (87.0%)	1164 (68.2%)
Education				P<0.001
None	2389 (20.5%)	1032 (33.6%)	550 (40.2%)	482 (28.3%)
Less than complete secondary	6244 (53.5%)	1463 (47.6%)	662 (48.4%)	801 (47.0%)
Complete secondary/above	3040 (26.0%)	576 (18.8%)	155 (11.3%)	421 (24.7%)
Missing	21	3	1	2
Marital status				P<0.001
Single (never married)	3462 (29.8%)	518 (16.9%)	174 (12.7%)	344 (20.2%)
Married/informal union	6556 (56.3%)	1696 (55.2%)	688 (50.3%)	1008 (59.2%)
Widowed/separated/divorced	1618 (13.9%)	857 (27.9%)	506 (37.0%)	351 (20.6%)
Missing	58	3	0	3
Employed				P<0.001
Yes	1779 (15.3%)	437 (14.2%)	140 (10.2%)	297 (17.4%)
No	9828 (84.7%)	2634 (85.8%)	1228 (89.8%)	1406 (82.6%)
Missing	87	3	0	3
Residence				P<0.001
Urban	617 (5.3 %)	119 (3.9 %)	55 (4.0 %)	64 (3.8 %)
Peri-urban	3604 (30.8%)	904 (29.4%)	347 (25.4%)	557 (32.7%)
Rural	7464 (63.9%)	2050 (66.7%)	966 (70.6%)	1084 (63.6%)
Missing	9	1	0	1
SES tertile				P=0.67
Low	4193 (36.4%)	1173 (38.6%) 🧹	525 (38.7%)	648 (38.5%)
Middle	3818 (33.1%)	947 (31.2%)	412 (30.4%)	535 (31.8%)
High	3522 (30.5%)	918 (30.2%)	418 (30.8%)	500 (29.7%)
Missing	161	36	13	23
Self-report of diabetes ⁵				P<0.001
No	11300 (96.6%)	2867 (93.3%)	1176 (86.0%)	1691 (99.1%)
Yes	394 (3.4 %)	207 (6.7 %)	192 (14.0%)	15 (0.9 %)
Nearest clinic (km) ⁶				P=0.84
0- <1.5	2642 (22.6%)	676 (22.0%)	292 (21.3%)	384 (22.5%)
1.5-2.5	2879 (24.6%)	710 (23.1%)	314 (23.0%)	396 (23.2%)
>2.5-3.9	2975 (25.5%)	809 (26.3%)	368 (26.9%)	441 (25.9%)
>3.9	3189 (27.3%)	878 (28.6%)	394 (28.8%)	484 (28.4%)
Missing	9	1	0	1

¹Hypertension defined as systolic BP \geq 140mmHg or diastolic BP \geq 90 mmHg, in an average of 2 readings. ²Report having been previously diagnosed or on treatment for hypertension in 2010 survey. ³Report no previous diagnosis or treatment for hypertension in 2010 survey. ⁴P-value from Chi-squared test comparing characteristics of those previously diagnosed/treatment and those with no previous diagnosis/treatment. ⁵Report having been diagnosed with or on treatment for diabetes in 2010 survey. ⁶Quartiles based on distribution in all individuals who were eligible for 2010 survey.

Table 2 . Factors ¹ associated with linkage to hypertension care within 2 years after home-
based diagnosis of hypertension ² in 2010, among individuals who were previously
undiagnosed and participated in 2011 or 2012 (N=1199) (unweighted analysis)

	Linked to care/N (%)	Crude OR (95% CI)	Age- & sex-adjusted OR (95% CI)	Adjusted OR (95% CI) ³
Sociodemographic factors			· · ·	
Age group		P<0.001	P<0.001	P<0.001
<30	10 / 193 (5.2 %)	1	1	1
35-44	40 / 242 (16.5%)	3.62 (1.76 -7.45)	3.08 (1.49 -6.36)	3.32 (1.60 -6.89)
45-59	126 / 360 (35.0%)	9.85 (5.03 - 19.30)	8.39 (4.26 - 16.51)	9.01 (4.57 - 17.79)
60+	167 / 404 (41.3%)	12.89 (6.62 -25.11)	11.61 (5.94 -22.69)	11.49 (5.87 -22.46)
Sex		P<0.001	P<0.001	P<0.001
Male	47 / 308 (15.3%)	1	1	1
Female	296 / 891 (33.2%)	2.76 (1.97 -3.88)	2.50 (1.75 -3.57)	2.41 (1.68 -3.45)
Marital status		P<0.001	P=0.15	P=0.14
Single (never married)	55 / 250 (22.0%)	1	1	1
Married/informal union	178 / 666 (26.7%)	1.29 (0.92 -1.83)	1.33 (0.91 -1.95)	1.35 (0.92 -1.98)
Widow/sep/divorced	110 / 283 (38.9%)	2.25 (1.54 - 3.31)	0.98 (0.64 -1.50)	0.99 (0.65 -1.51)
Education		P<0.001	P=0.83	P=0.77
None	132 / 363 (36.4%)	1	1	1
Less than complete secondary	160 / 581 (27.5%)	0.67 (0.50 -0.88)	1.10 (0.81 -1.49)	1.09 (0.80 -1.49)
Complete	51 / 255 (20.0%)	0.44 (0.30 -0.64)	1.09 (0.71 -1.67)	1.15 (0.75 -1.78)
secondary/above			,	
Employed		P<0.001	P=0.02	P=0.02
Yes	31 / 178 (17.4%)	1	1	1
No	312 / 1021 (30.6%)	2.09 (1.39 - 3.14)	1.71 (1.10 -2.65)	1.71 (1.10 -2.65)
SES tertile		P=0.307	P=0.31	P=0.21
Low	125 / 459 (27.2%)	1	1	1
Middle	99 / 364 (27.2%)	1.00 (0.73 -1.36)	1.09 (0.79 -1.52)	1.12 (0.81 -1.56)
High	115 / 364 (31.6%)	1.23 (0.91 -1.67)	1.28 (0.93 -1.77)	1.34 (0.97 -1.85)
Location factors				
Residence		P=0.04	P=0.35	P=0.55
Urban	10 / 36 (27.8%)	1	1	1
Peri-urban	95 / 398 (23.9%)	0.82 (0.38 -1.75)	0.75 (0.33 -1.69)	0.67 (0.29 -1.53)
Rural	238 / 765 (31.1%)	1.17 (0.56 - 2.47)	0.92 (0.41 -2.05)	0.63 (0.27 -1.45)
Nearest clinic (km) ⁴	, ,	. ,		. ,
0- <1.5	56 / 263 (21.3%)			
1.5-2.5	71 / 269 (26.4%)	P<0.001	P=0.001	P=0.001
>2.5-3.9	93 / 310 (30.0%)	1.15 (1.08 -1.23) ⁵	1.13 (1.05 -1.21) ⁵	1.12 (1.05 -1.20) ⁵
>3.9	123 / 357 (34.5%)	. ,		
Clinical factors				
BMI category		P<0.001	P=0.07	P=0.13
<25 kg/m ²	70 / 344 (20.3%)	1	1	1
$25 - <30 \text{ kg/m}^2$	62 / 229 (27.1%)	1.45 (0.98 -2.15)	1.08 (0.71 -1.64)	1.17 (0.76 -1.81)
≥30 kg/m ²	110 / 301 (36.5%)	2.25 (1.59 - 3.21)	1.52 (1.03 -2.24)	1.51 (1.00 -2.26)
Hypertension stage ⁶	, ()	P<0.001	P<0.001	P<0.001
Stage I	142 / 730 (19.5%)	1	1	1
Stage II	134 / 342 (39.2%)	2.67 (2.01 -3.54)	2.22 (1.65 -2.99)	2.20 (1.63 -2.97)
Hypertension urgency	67 / 127 (52.8%)	4.62 (3.12 -6.85)	3.12 (2.06 - 4.74)	3.07 (2.01 -4.67)
Self-report of diabetes ⁷		P=0.19	P=0.44	P=0.47
No	220 / 1101 /29 50/)	1	1	1
NO	222 / 1121 (20.2/0)	1	1	1

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Self-report of TB ⁷		P=0.66	P=0.96	P=0.72
No	332 / 1156 (28.7%)	1	1	1
Yes	11 / 43 (25.6%)	0.85 (0.43 -1.71)	1.02 (0.49 -2.13)	1.15 (0.54 -2.46)

¹All characteristics are based on 2010 survey. ²Hypertension defined as systolic BP \geq 140mmHg or diastolic BP \geq 90 mmHg, in an average of 2 readings. ³Sociodemographic factors adjusted for age group, sex, and employment. Location factors adjusted for age group, sex, employment, and distance from nearest clinic as continuous covariate. Clinical factors adjusted for age group, sex, employment, distance from nearest clinic and hypertension stage. ⁴Quartiles based on distribution in all individuals who were eligible for 2010 survey. Fit as continuous covariate; n (%) linked in each distance quartile shown for information only. ⁵OR for linear trend in linkage with each 1 km increase in distance. ⁶Stage I: Systolic BP 140–159 or diastolic BP 90–99; Stage II: Systolic BP 160–179 or diastolic BP 100–119; Hypertension urgency: Systolic BP \geq 180 or diastolic BP \geq 120. ⁷Reports being diagnosed in the past 12m or currently on treatment

1 2 3	Figure 1 Flow diagram of eligible and included participants in a baseline community-based
4	hypertension screen in 2010 and follow-up observation during 2011/2012
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Figure 2. Proportion of individuals linked to hypertensive care two years after a new notification of elevated blood pressure (weighted estimates)

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Figure 1. Flow diagram of eligible and included participants in a baseline community-based hypertension screen in 2010 and follow-up observation during 2011/2012

1057x793mm (72 x 72 DPI)



Male Female



Figure 2. Proportion of individuals linked to hypertensive care two years after a new notification of elevated blood pressure (weighted estimates)

1057x595mm (72 x 72 DPI)

Supplementary Table 1. Comparison of characteristics between those for whom a blood pressure measurement was taken in the 2010 survey, and those with no blood pressure measurements

	Eligible for survey ¹	BP measurements	No BP measurement ²
	N=26,184	N=11,694	N=14,490
Median (IQR) age (years)	32 (20–50)	34 (21–53)	30 (20–47)
Age group			P<0.001 ³
<30	12,164 (46.5%)	5106 (43.7%)	7058 (48.7%)
35-44	5523 (21.1%)	2194 (18.8%)	3329 (23.0%)
45-59	4584 (17.5%)	2251 (19.2%)	2333 (16.1%)
60+	3913 (14.9%)	2143 (18.3%)	1770 (12.2%)
Sex			P<0.001
Male	9959 (38.0%)	3453 (29.5%)	6506 (44.9%)
Female	16,225 (62.0%)	8241 (70.5%)	7984 (55.1%)
Marital status			P<0.001
Single (never married)	8113 (31.2%)	3462 (29.8%)	4651 (32.4%)
Married/informal union	14,959 (57.6%)	6556 (56.3%)	8403 (58.6%)
Widow/sep/divorced	2910 (11.2%)	1618 (13.9%)	1292 (9.0 %)
Missing	202	58	144
Education			P<0.001
None	4558 (17.5%)	2389 (20.5%)	2169 (15.1%)
Less than complete	13,466 (51.6%)	6244 (53.5%)	7222 (50.1%)
secondary			
Complete secondary/above	8051 (30.9%)	3040 (26.0%)	5011 (34.8%)
Missing	109	21	88
Employed			P<0.001
Yes	5860 (22.7%)	1779 (15.3%)	4081 (28.6%)
No	19,997 (77.3%)	9828 (84.7%)	10,169 (71.4%)
Missing	327	87	240
Residence			P<0.001
Urban	1953 (7.5 %)	617 (5.3 %)	1336 (9.2 %)
Peri-urban	8084 (30.9%)	3604 (30.8%)	4480 (31.0%)
Rural	16,092 (61.6%)	7464 (63.9%)	8628 (59.7%)
Missing	55	9	46
SES tertile			P<0.001
Low	8566 (33.6%)	4193 (<mark>36.4%)</mark>	4373 (31.4%)
Middle	8330 (32.7%)	3818 (33.1%)	4512 (32.4%)
High	8569 (33.7%)	3522 (30.5%)	5047 (36.2%)
Missing	719	161	558

¹Individuals who were on the eligibility list for the 2010 survey (aged ≥15 years as of Dec 2009 and resident in the DSS), were successfully contacted (92% of all on the list) and still eligible at the time of contact (75% of those contacted). ²Includes 14,370 individuals who refused consent, and 120 individuals who consented but for whom blood pressure measurements were not available. ³P-value from Chi-squared test comparing those with blood pressure measurements and those without.

Supplementary Table 2. Comparison of characteristics between those who participated in the general health survey in 2011 or 2012 and those who did not, among 1706 individuals with undiagnosed hypertension in 2010

	Participated in	Did not participate	Participated in	No participation in
	2011/2012	in 2011/2012	2011-2016	later survey
	N=1199 (70.3%)	N=507 (29.7%)	N=1421 (83.3%)	N=285 (16.7%)
Median (IQR) age (years)	50 (38–66)	43 (29–58)	50 (37–65)	41 (28–57)
Age group		P<0.001 ¹		P<0.001 ²
<30	193 (16.1%)	140 (27.6%)	248 (17.5%)	85 (29.8%)
35-44	242 (20.2%)	124 (24.5%)	284 (20.0%)	82 (28.8%)
45-59	360 (30.0%)	125 (24.7%)	430 (30.3%)	55 (19.3%)
60+	404 (33.7%)	118 (23.3%)	459 (32.3%)	63 (22.1%)
Sex		P<0.001		P<0.001
Male	308 (25.7%)	234 (46.2%)	394 (27.7%)	148 (51.9%)
Female	891 (74.3%)	273 (53.8%)	1027 (72.3%)	137 (48.1%)
Marital status		P<0.001		P<0.001
Single (never married)	250 (20.9%)	94 (18.7%)	287 (20.2%)	57 (20.2%)
Married/informal union	666 (55.5%)	342 (67.9%)	817 (57.5%)	191 (67.7%)
Widow/sep/divorced	283 (23.6%)	68 (13.5%)	317 (22.3%)	34 (12.1%)
Education		P<0.001		P<0.001
None	363 (30.3%)	119 (23.6%)	424 (29.8%)	58 (20.5%)
Less than complete	581 (48.5%)	220 (43.6%)	678 (47.7%)	123 (43.5%)
secondary				
Complete secondary/above	255 (21.3%)	166 (32.9%)	319 (22.4%)	102 (36.0%)
Employed		P<0.001		P<0.001
Yes	178 (14.8%)	119 (23.6%)	220 (15.5%)	77 (27.3%)
No	1021 (85.2%)	385 (76.4%)	1201 (84.5%)	205 (72.7%)
Residence		P=0.04		P=0.16
Urban	36 (3.0 %)	28 (5.5 %)	48 (3.4 %)	16 (5.6 %)
Peri-urban	398 (33.2%)	159 (31.4%)	470 (33.1%)	87 (30.6%)
Rural	765 (63.8%)	319 (63.0%)	903 (63.5%)	181 (63.7%)
SES tertile		P=0.24		P=0.05
Low	459 (38.7%)	189 (38.1%)	544 (38.7%)	104 (37.5%)
Middle	364 (30.7%)	171 (34.5%)	431 (30.7%)	104 (37.5%)
High	364 (30.7%)	136 (27.4%)	431 (30.7%)	69 (24.9%)
BMI category		P=0.008		P<0.001
Underweight	50 (5.7 %)	25 (7.2 %)	58 (5.6 %)	17 (9.0 %)
Normal weight	294 (33.6%)	146 (42.3%)	351 (34.0%)	89 (47.3%)
Overweight	229 (26.2%)	84 (24.3%)	269 (26.1%)	44 (23.4%)
Obese	301 (34.4%)	90 (26.1%)	353 (34.2%)	38 (20.2%)
Distance to nearest clinic (km)		P=0.22		P=0.50
0- <1.5	263 (21.9%)	121 (23.9%)	320 (22.5%)	64 (22.5%)
1.5-2.5	269 (22.4%)	127 (25.1%)	323 (22.7%)	73 (25.7%)
>2.5-3.9	310 (25.9%)	131 (25.9%)	365 (25.7%)	76 (26.8%)
>3.9	357 (29.8%)	127 (25.1%)	413 (29.1%)	71 (25.0%)

¹P-value from Chi-squared test comparing individuals who participated in 2011-2012 (N=1199) with those who did not (N=507). ²P-value from Chi-squared test comparing individuals who participated in 2011-2015 (N=1421) with those who did not (N=285).

Supplementary Table 3. Factors¹ associated with linkage to hypertension care within 2 years after home-based diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in 2011 or 2012 (N=1199), using inverse probability weighting to account for non-participation in the blood pressure screen

	Linked to care/N	Crude OR (95% CI) ³	Age- & sex-adjusted	Adjusted OR (95%
	(%)		OR (95% CI) ³	CI) ^{3,4}
Sociodemographic factors				
Age group		P<0.001	P<0.001	P<0.001
<30	10 / 193 (5.2 %)	1	1	1
35-44	40 / 242 (16.5%)	3.82 (1.85 -7.87)	3.20 (1.55 -6.62)	3.26 (1.54 -6.90)
45-59	126 / 360 (35.0%)	10.35 (5.28 -20.32)	8.64 (4.39 -16.99)	9.35 (4.73 -18.46)
60+	167 / 404 (41.3%)	13.75 (7.05 -26.81)	12.27 (6.29 -23.91)	13.48 (6.82 -26.61)
Sex		P<0.001	P<0.001	P<0.001
Male	47 / 308 (15.3%)	1	1	1
Female	296 / 891 (33.2%)	2.86 (2.03 -4.03)	2.57 (1.81 -3.66)	2.77 (1.91 -4.00)
Marital status		P<0.001	P=0.09	P=0.09
Single (never married)	55 / 250 (22.0%)	1	1	1
Married/informal union	178 / 666 (26.7%)	1.35 (0.95 -1.91)	1.35 (0.91 -1.99)	1.36 (0.92 -2.01)
Widow/sep/divorced	110 / 283 (38.9%)	2.40 (1.63 -3.54)	0.94 (0.61 -1.44)	0.95 (0.61 -1.45)
Education		P<0.001	P=0.86	P=0.89
None	132 / 363 (36.4%)	1	1	1
Less than complete	160 / 581 (27.5%)	0.64 (0.48 -0.84)	1.09 (0.80 -1.49)	1.07 (0.78 -1.46)
secondary				
Complete	51 / 255 (20.0%)	0.42 (0.29 -0.61)	1.06 (0.69 -1.63)	1.10 (0.71 -1.70)
secondary/above				
Employed		P<0.001	P=0.01	P=0.01
Yes	31 / 178 (17.4%)	1	1	1
No	312 / 1021 (30.6%)	2.21 (1.46 -3.34)	1.74 (1.13 -2.69)	1.76 (1.14 -2.72)
SES tertile		P=0.36	P=0.32	P=0.26
Low	125 / 459 (27.2%)	1	1	1
Middle	99 / 364 (27.2%)	1.01 (0.74 -1.38)	1.11 (0.79 -1.55)	1.12 (0.81 -1.57)
High	115 / 364 (31.6%)	1.23 (0.90 -1.66)	1.28 (0.93 -1.77)	1.31 (0.95 -1.82)
Location factors				
Residence		P=0.03	P=0.40	P=0.68
Urban	10 / 36 (27.8%)	1	1	1
Peri-urban	95 / 398 (23.9%)	0.91 (0.42 -1.96)	0.84 (0.37 -1.89)	0.73 (0.32 -1.67)
Rural	238 / 765 (31.1%)	1.32 (0.62 -2.79)	1.03 (0.47 -2.27)	0.69 (0.30 -1.59)
Nearest clinic (km) ⁵				
0- <1.5	56 / 263 (21.3%)			
1.5-2.5	71 / 269 (26.4%)	P<0.001	P=0.001	P=0.002
>2.5-3.9	93 / 310 (30.0%)	1.15 (1.08 -1.23) 6	1.13 (1.05 -1.21) 6	1.12 (1.04 -1.20) ⁶
>3.9	123 / 357 (34.5%)			
Clinical factors				
BMI category		P<0.001	P=0.06	P=0.14
<25 kg/m ²	70 / 344 (20.3%)	1	1	1
$25 - <30 \text{ kg/m}^2$	62 / 229 (27.1%)	1.56 (1.05 -2.33)	1.13 (0.73 -1.74)	1.19 (0.77 -1.84)
≥30 kg/m ²	110 / 301 (36.5%)	2.42 (1.69 -3.45)	1.57 (1.05 -2.34)	1.51 (1.00 -2.28)
Hypertension stage ⁷		P<0.001	P<0.001	P<0.001
Stage I	142 / 730 (19.5%)	1	1	1
Stage II	134 / 342 (39.2%)	2.72 (2.04 -3.63)	2.20 (1.62 -2.99)	2.15 (1.58 - 2.93)
Hypertension urgency	67 / 127 (52.8%)	4.79 (3.22 -7.13)	3.14 (2.06 - 4.78)	3.10 (2.04 - 4.71)
Self-report of diabetes ⁸	,	P=0.28	P=0.50	P=0.56
No	339 / 1191 (28.5%)	1	1	1
Yes	4 / 8 (50.0%)	2.16 (0.53 -8.83)	1.56 (0.43 -5.65)	1.48 (0.40 -5.52)

Self-report of TB ⁸		P=0.81	P=0.77	P=0.48
No	332 / 1156 (28.7%)	1	1	1
Yes	11 / 43 (25.6%)	0.92 (0.45 -1.86)	1.12 (0.51 - 2.49)	1.34 (0.59 - 3.04
mmHg, in an a survey particip ⁴ Sociodemogr for age group, factors adjuste stage. ⁵ Quarti covariate; n (% each 1 km incu or diastolic BP the past 12m of	sites are based on 2010 solvey verage of 2 readings. ³ Weight bation, in strata defined by age aphic factors adjusted for age g sex, marital status, employme ed for age group, sex, marital s les based on distribution in all 6) linked in each distance quart rease in distance. ⁷ Stage I: Sys 100–119; Hypertension urgen for currently on treatment.	ed for non-response; w group, sex, education group, sex, marital stati nt, and distance from r tatus, employment, dis individuals who were e tile shown for informati tolic BP 140–159 or dia cy: Systolic BP ≥180 or	reights calculated as the in level and place of residen us and employment. Loca hearest clinic as continuou tance from nearest clinic, digible for 2010 survey. F fon only. ⁶ OR for linear trees stolic BP 90–99; Stage II: diastolic BP ≥120. ⁸ Report	nverse probability ce. ation factors adjust us covariate. Clinic , and hypertension it as continuous end in linkage with Systolic BP 160–17 ts being diagnosed

Supplementary Table 4. Factors¹ associated with linkage to hypertension care within 5 years (2011 to 2015) after home-based diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in a subsequent survey (N=1421) using inverse probability weighting to account for non-participation in the blood pressure screen

	Linked to care/N	Crude OR (95% CI) ³	Age- & sex-adjusted	Adjusted OR (95%
	(%)		OR (95% CI) ²	CI) ^{-, -}
Sociodemographic factors		D (0.001	D 40 001	D -0.001
Age group	25 / 240 /40 40/)	P<0.001	P<0.001	P<0.001
<30	25 / 248 (10.1%)	1	1	1
35-44	/5 / 284 (26.4%)	3.22 (1.97 -5.29)	2.69 (1.64 - 4.43)	2.93 (1.77-4.87)
45-59	211 / 430 (49.1%)	8.67 (5.48 - 13.70)	7.50 (4.73-11.89)	8.05 (5.05 - 12.84)
60+	265 / 459 (57.7%)	12.37 (7.84 - 19.53)	11.65 (7.35 - 18.47)	11.49 (7.25 - 18.22)
Sex		P<0.001	P<0.001	P<0.001
Male	92 / 394 (23.4%)	1	1	1
Female	484 / 1027 (47.1%)	3.06 (2.35 - 3.99)	2.98 (2.25 - 3.94)	2.85 (2.15 - 3.79)
Marital status		P<0.001	P=0.66	P=0.64
Single (never married)	98 / 287 (34.1%)	1	1	1
Married/informal union	298 / 817 (36.5%)	1.16 (0.88 -1.55)	1.04 (0.76 - 1.44)	1.07 (0.77 -1.48)
Widow/sep/divorced	180 / 317 (56.8%)	2.78 (1.99 - 3.87)	0.90 (0.61 -1.32)	0.92 (0.62 -1.35)
Education		P<0.001	P=0.55	P=0.66
None	217 / 424 (51.2%)	1	1	1
Less than complete secondary	269 / 678 (39.7%)	0.60 (0.47 -0.76)	1.13 (0.85 -1.50)	1.13 (0.86 -1.50)
Complete secondary/above	90 / 319 (28.2%)	0.36 (0.26 -0.49)	0.98 (0.68 -1.41)	1.05 (0.73 -1.53)
Employed		P<0.001	P=0.007	P=0.007
Yes	61 / 220 (27 7%)	1	1	1
No	515 / 1201 (42 9%)	2 04 (1 48 - 2 81)	<u>-</u> 1 62 (1 14 -2 29)	<u>-</u> 1 62 (1 14 -2 29)
SFS tertile	5157 1201 (42.570)	P=0.49	P=0 71	P=0.58
	224 / 544 (41 2%)	1	1	1 -0.50
Middle	163 / 131 (37 8%)			
High	103 / 431 (37.8%) 183 / 431 (42.5%)	1.04 (0.80 - 1.35)	1.08(0.91-1.12)	(0.75 - 1.50)
Location factors	105 / 451 (42.570)	1.04 (0.00 -1.00)	1.00 (0.01 -1.45)	1.15 (0.85 -1.50)
Residence		P=0.07	P=0.89	P=0.61
Urban	18 / 48 (37 5%)	1	1	1
Peri-urban	173 / 470 (36.8%)	1 03 (0 56 -1 92)	0.95(0.50-1.79)	0.84 (0.44 -1.62)
Rural	385 / 903 (12.6%)	1.03(0.301.32) 1.34(0.73.246)	1.01(0.54 - 1.88)	0.75 (0.39 -1.46)
Nearest clinic (km) ⁵	5657 565 (42.676)	1.54 (0.75 -2.40)	1.01 (0.54 -1.88)	0.75 (0.55 -1.40)
0- <1.5	111 / 320 (34.7%)			
1.5-2.5	128 / 323 (39.6%)	P=0.001	P=0.03	P=0.05
>2.5-3.9	147 / 365 (40.3%)	1.10 (1.04 -1.17) ⁶	$1.08 (1.01 - 1.15)^6$	$1.07 (1.00 - 1.14)^{6}$
>3.9	190 / 413 (46.0%)	· · · · ·	· · ·	· · ·
BMI category		P<0.001	P=0.004	P=0.008
<25 kg/m ²	133 / 409 (32.5%)	1	1	1
25 – <30 kg/m²	99 / 269 (36.8%)	1.28 (0.92 -1.77)	0.88 (0.61 -1.26)	0.90 (0.62 -1.31)
≥30 kg/m²	186 / 353 (52.7%)	2.44 (1.81 -3.29)	1.55 (1.10 -2.18)	1.53 (1.08 -2.17)
Hypertension stage $'$		P<0.001	P<0.001	P<0.001
Stage I	264 / 863 (30.6%)	1	1	1
Stage II	215 / 415 (51.8%)	2.49 (1.95 -3.17)	2.01 (1.54 - 2.62)	2.12 (1.55 -2.89)
Hypertension urgency	97 / 143 (67.8%)	5.02 (3.42 -7.37)	3.18 (2.10 - 4.82)	3.29 (2.01 -5.39)
Self-report of diabetes ⁸		P=0.05	P=0.08	P=0.32
No	568 / 1410 (40.3%)	1	1	1
Yes	8 / 11 (72.7%)	3.84 (0.98 -15.03)	3.09 (0.88 -10.81)	5.18 (0.21 -128.15)

Self-report of TB ⁸		P=0.73	P=0.86	P=0.30
No	560 / 1376 (40.7%)	1	1	1
Yes	16 / 45 (35.6%)	0.89 (0.48 - 1.68)	1.07 (0.49 -2.33)	1.57 (0.67-3.7)
All characteria mmHg, in an a survey particip ⁴ Sociodemogra sex, employme individuals wh shown for info BP 140–159 or Systolic BP ≥18	stics are based on 2010 survey verage of 2 readings. ³ Weight bation, in strata defined by age aphic factors adjusted for age g ent, and distance from nearest clini o were eligible for 2010 survey irmation only. ⁶ OR for linear tra- diastolic BP 90–99; Stage II: St 30 or diastolic BP ≥120. ⁸ Repor	. "Hypertension defined ed for non-response; w group, sex, education l group, sex, and employ c clinic as continuous co ic, hypertension stage, /. Fit as continuous cov end in linkage with eacl ystolic BP 160–179 or d ts being diagnosed in th	as systolic BP ≥ 140mm eights calculated as the i evel and place of resider ment. Location factors a variate. Clinical factors a and BMI. ⁵ Quartiles base ariate; n (%) linked in each 1 km increase in distant iastolic BP 100–119; Hyp he past 12m or currently	Hg or diastolic BP ≥ nverse probability ince. djusted for age gro ed on distribution in ch distance quartile ce. ⁷ Stage I: Systol ertension urgency: on treatment.

Supplementary Table 5. Factors¹ associated with linkage to hypertension care within 5 years (2011 to 2015) after home-based diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in a subsequent survey (N=1421)

	Linked to care/N (%)	Crude OR (95% Cl) ³	Adjusted OR (95% Cl) ^{3,4}	Adjusted OR (95% Cl) ^{3,5}
Sociodemographic factors	•••		· · · · · · · · · · · · · · · · · · ·	•
Age group		P<0.001	P<0.001	P<0.001
<30	25 / 248 (10.1%)	1	1	1
35-44	75 / 284 (26.4%)	3.22 (1.97 -5.29)	2.43 (1.47 -4.01)	2.61 (1.56 -4.34)
45-59	211 / 430 (49.1%)	8.67 (5.48 - 13.70)	6.58 (4.13 - 10.47)	6.96 (4.35 -11.14)
60+	265 / 459 (57.7%)	12.37 (7.84 -19.53)	10.23 (6.44 -16.25)	10.11 (6.37 -16.06)
Sex		P<0.001	P<0.001	P<0.001
Male	92 / 394 (23.4%)	1	1	1
Female	484 / 1027 (47.1%)	3.06 (2.35 -3.99)	2.54 (1.91 -3.39)	2.46 (1.84 -3.30)
Times participated				
Once	61 / 321 (19.0%)			
Twice	119 / 335 (35.5%)	P<0.001	P<0.001	P<0.001
3 times	160 / 327 (48.9%)	$1.57 (1.44 - 1.71)^{6}$	1.40 (1.27 -1.53) ⁶	1.39 (1.26 -1.52) ⁶
4 times	147 / 287 (51.2%)			
5 times	89 / 151 (58.9%)			
Marital status		P<0.001	P=0.60	P=0.55
Single (never married)	98 / 287 (34,1%)	1	1	1
Married/informal union	298 / 817 (36.5%)	1.16 (0.88 -1.55)	1.14 (0.82 -1.60)	1.16 (0.83 -1.63)
Widow/sep/divorced	180 / 317 (56.8%)	2.78 (1.99 - 3.87)	1.00 (0.67 -1.48)	1.01 (0.68 -1.50)
Education		P<0.001	P=0.74	P=0.67
None	217 / 424 (51,2%)	1	1	1
Less than complete	269 / 678 (39.7%)	0.60 (0.47 -0.76)	-	- 1.12 (0.84 -1.50)
secondary			(0.0)	(0.01000)
Complete	90 / 319 (28 2%)	0.36 (0.26 -0.49)	1 09 (0 75 -1 59)	1 16 (0 79 -1 69)
secondary/above	507 515 (20.270)	0.50 (0.20 0.45)	1.05 (0.75 1.55)	1.10 (0.75 1.05)
Employed		P<0.001	P=0.03	P=0.03
Yes	61 / 220 (27 7%)	1	1	1
No	515 / 1201 (42 9%)	2 04 (1 48 -2 81)	<u> </u>	1 48 (1 04 -2 10)
SFS tertile	5157 1201 (42.570)	P=0.49	P=0.68	P=0.56
Low	224 / 544 (41 2%)	1	1	1
Middle	163 / 431 (37.8%)	0.89 (0.68 -1.15)	0.98 (0.73 -1.32)	1 00 (0 74 -1 35)
High	183 / 431 (42 5%)	1.04 (0.80 -1.35)	1 11 (0 83 -1 48)	1.00 (0.74 1.00)
Location factors	1057 451 (42.570)	1.04 (0.00 -1.00)	1.11 (0.05 -1.40)	1.15 (0.80 -1.54)
Residence		P-0.07	P-0.63	P-0.61
Urban	18 / 18 (27 5%)	1 -0.07	1 -0.05	1 -0.01
Deri-urban	172 / 470 (26.8%)	1 03 (0 56 -1 92)	(0.82)(0.43, 1.57)	
Pural	285 / 902 (12 6%)	1.03(0.30-1.32) 1.34(0.73-2.46)	0.02(0.43 - 1.37)	0.70(0.40-1.40)
Nearest clinic $(km)^7$	3857 905 (42.0%)	1.54 (0.75-2.40)	0.93 (0.49 -1.74)	0.85 (0.45 -1.01)
0_{-} < 1 5	111 / 320 (34 7%)			
1 5 2 5	111 / 520 (54.7 %)	D-0.001	B-0.06	P-0 10
1.5-2.5	120/323(39.0%)	P=0.001	P=0.00	P=0.10
>2.5-3.9	147 / 365 (40.3%)	1.10 (1.04 -1.17)	1.07 (1.00 -1.14)	1.06 (0.99 -1.13)
>3.9	190 / 413 (46.0%)			
PMI estagen/		D<0.001	D=0.002	D-0.007
rategoly	122 / 400 /22 50/)	FNU.UU1 1	г-0.003 1	r-0.007 1
25 kg/m^2	100 / 403 (32.3%)	בד 1 100 (000 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
$20 - 50 \text{ kg/m}^2$	33 / 203 (30.8%) 196 / 252 (52.7%)	1.20 (U.92 -1.77)	U.OO (U.UI-I.ZŎ)	U.03 (U.D-1.3U)
≥30 Kg/III	100 / 333 (52.7%)	2.44 (1.81-3.29)	1.30 (1.11-2.25)	1.54 (1.U/ -2.22)
stage	264 / 962 /20 60/)	۲<0.001 1	۲<0.001 1	۲<0.001
Stage I	204 / 803 (30.0%)			
Stage II	215 / 415 (51.8%)	2.49 (1.95 - 3.17)	2.19 (1.67 - 2.88)	2.36 (1./1 - 3.26)
Hypertension urgency	97/143(67.8%)	5.02 (3.42-7.37)	3.44 (2.25 -5.25)	3.74 (2.25 -6.20)

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Self-report of diabetes ¹⁰		P=0.05	P=0.03	P=0.28
No	568 / 1410 (40.3%)	1	1	1
Yes	8 / 11 (72.7%)	3.84 (0.98 -15.03)	3.67 (1.14 -11.80)	5.64 (0.25 -126.50)
Self-report of TB ¹⁰		P=0.73	P=0.91	P=0.56
No	560 / 1376 (40.7%)	1	1	1
Yes	16 / 45 (35.6%)	0.89 (0.48 -1.68)	0.96 (0.43 -2.13)	1.31 (0.52 -3.27)

¹All characteristics are based on 2010 survey. ²Hypertension defined as systolic BP \geq 140mmHg or diastolic BP \geq 90 mmHg, in an average of 2 readings. ³Weighted for non-response; weights calculated as the inverse probability of survey participation, in strata defined by age group, sex, education level and place of residence. ⁴Adjusted for age, sex and number of times participated in subsequent surveys as a continuous covariate. ⁵Sociodemographic factors adjusted for age group, sex, number of times in subsequent surveys, and employment. Location factors adjusted for age group, sex, number of times in subsequent surveys, and employment. Clinical factors adjusted for age group, sex, number of times in subsequent surveys, employment, hypertension stage, and BMI. ⁶OR for linear trend in reported linkage with each unit increase in survey participation. ⁷Quartiles based on distribution in all individuals who were eligible for 2010 survey. Fit as continuous covariate; n (%) linked in each distance quartile shown for information only. ⁸OR for linear trend in linkage with each 1 km increase in distance. ⁹Stage I: Systolic BP 140–159 or diastolic BP 90–99; Stage II: Systolic BP 160–179 or diastolic BP 100–119; Hypertension urgency: Systolic BP \geq 180 or diastolic BP \geq 120. ¹⁰Reports being diagnosed in the past 12m or currently on treatment. To beet terien only

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	No	Recommendation	Page	Comments
Title and abstract	1	(a) Indicate the study's design with a commonly	1	
		used term in the title or the abstract		
		(<i>b</i>) Provide in the abstract an informative and	2	
		balanced summary of what was done and what		
		was found		
Introduction				
Background/rationale	2	Explain the scientific background and rationale	4	Lines 2-23
		for the investigation being reported		
Objectives	3	State specific objectives, including any	4-5	Lines 25-32
		prespecified hypotheses		
Methods				
Study design	4	Present key elements of study design early in	5	Lines 36-43
, C		the paper		
Setting	5	Describe the setting, locations, and relevant	5	Lines 36-43
c		dates, including periods of recruitment.		
		exposure, follow-up, and data collection		
Participants	6	(a) Give the eligibility criteria, and the sources	6	Lines 70-79
1		and methods of selection of participants.		
		Describe methods of follow-up		
		(b) For matched studies, give matching criteria	N/A	
		and number of exposed and unexposed		
Variables	7	Clearly define all outcomes, exposures,	5-6	Lines 45-67
		predictors, potential confounders, and effect		
		modifiers. Give diagnostic criteria, if applicable		
Data sources/	8*	For each variable of interest, give sources of	5-6	Lines 45-67
measurement		data and details of methods of assessment		
		(measurement). Describe comparability of		
		assessment methods if there is more than one		
		group		
Bias	9	Describe any efforts to address potential sources	7	Lines 94 - 103
		of bias		
Study size	10	Explain how the study size was arrived at	9	Lines 129 - 141
Quantitative	11	Explain how quantitative variables were		Lines 69 - 79
variables		handled in the analyses. If applicable, describe	6	
		which groupings were chosen and why		
Statistical methods	12	(a) Describe all statistical methods, including	6-7	Lines 69 - 103
		those used to control for confounding		
		(b) Describe any methods used to examine	6	Lines 73 – 76
		subgroups and interactions		
		(c) Explain how missing data were addressed	7	Lines 94 - 103
		(<i>d</i>) If applicable, explain how loss to follow-up	N/A	
		was addressed		
		(<u>e</u>) Describe any sensitivity analyses	7	Lines 94 - 103
Results				
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D : /: 1/	1 4 %	(c) Consider use of a flow diagram	0	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information	9	Lines 139 - 149
		on exposures and potential confounders		
		(b) Indicate number of participants with missing data for each variable of interest	N/A	No data was missing f participants who comp
		(c) Summarise follow-up time (eg, average and total amount)	9	Lines 138 - 149
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-10	Lines 151 - 161
Main results	16	(<i>a</i>) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10	Lines 163 - 180
		(b) Report category boundaries when continuous variables were categorized		Table 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-10	Lines 151 – 161 (we realised absolute prevalence of linkage prior to our multivariable model estimations)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10	Lines 177 – 180, Supplementary Tables
Discussion				
Key results	18	Summarise key results with reference to study objectives	11	Lines 183-191
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13	Lines 240-248
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13	Lines 150-254
Generalisability	21	Discuss the generalisability (external validity)	13	Lines 248-249
Generalisability		of the study results		
Generalisability		of the study results		

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article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Linkage to primary care after home-based blood pressure screening in rural Kwazulu-Natal, South Africa: A population-based cohort study

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	1	Linkage to primary care after home-based blood pressure screening in rural Kwazulu-Natal, South Africa: A
1	2	population-based cohort study
2	3	
3	4	Authors:
4	5	Mark L Siedner* ^{1,2,3}
5	6	Kathy Baisley ^{3,4}
0 7	7	loonna Orna Cliamann ⁵
, 8	/ 0	Deenen Billeu ^{3,6}
9	ð	Oli tan Karla ^{3,4}
10	9	
11	10	Emily B. Wong ^{-/-/3}
12	11	Philippa Matthews
13	12	Frank Tanser ^a
14	13	Kobus Herbst ³
15	14	Till Barnighausen ^{3,6,7,8}
16	15	Max Bachmann ⁹
17	16	
18	17	*Corresponding Author for Inquiries:
19	18	Mark J. Siedner
20 21	19	Massachusetts General Hospital Global Health
21	20	125 Nashua Street
22	20	Roston MA 02114 USA
24	21	DOSION, WA 02114 03A
25	22	1. +1-01/-/20-4080; F. +1-01/-/24-103/
26	23	<u>msiedner@mgn.narvard.edu</u>
27	24	
28	25	
29	26	Affiliations:
30	27	¹ Massachusetts General Hospital, Boston, USA
31	28	² Harvard Medical School, Boston, USA
32	29	³ Africa Health Research Institute, KwaZulu-Natal, SA
33 24	30	⁴ London School of Tropical Medicine and Hygiene, London, UK
24 25	31	⁵ University of Bordeaux, ISPED, INSERM, Bordeaux Population Health Research Center, UMR 1219,
36	32	Bordeaux, France
37	33	⁶ University College London, London, UK
38	34	⁷ University of Heidelberg Germany
39	25	⁸ Harvard School of Public Health Boston LISA
40	36	⁹ University of East Anglia, Norwich, UK
41	20	Oniversity of East Anglia, Norwich, OK
42	37	
43	38	
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51	45	
52	46	Conflicts of Interest: All authors report no conflicts of interest
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60		r or peer review only - http://binjopen.binj.com/site/about/guidelines.xittm

48 ABSTRACT

- **Objectives**: The expanding burden of non-communicable diseases (NCDs) globally will require novel public
- 7 54 8 55

Setting: We conducted home-based blood pressure screening in a population cohort in rural KwaZulu Natal, using the WHO STEPS protocol.

Participants: Individuals meeting criteria for raised blood pressure (≥140 systolic or ≥90 diastolic averaged over two readings) were referred to local health clinics, and included in this analysis. We defined linkage to care based on self-report of presentation to clinic for hypertension during the next two years of cohort observation. We estimated the population proportion of successful linkage to care with inverse probability sampling weights, and fit multivariable logistic regression models to identify predictors of linkage following a positive hypertension screen.

Results: Of 11,694 individuals screened, 14.6% (n=1,706) were newly diagnosed with elevated pressure.
26.9% (95%CI 24.5-29.4%) of those sought hypertension care in the following two years, and 38.1% (95%CI
35.6-40.7%) did so within five years. Women (aOR 2.41, 95%CI 1.68–3.45), those of older age (aOR 11.49,
95%CI 5.87–22.46, for 45-59 years versus <30), and those unemployed (aOR 1.71, 95%CI 1.10–2.65) were
more likely to have linked to care.

Conclusions: Linkage to care after home-based identification of elevated blood pressure was rare in rural South Africa, particularly among younger individuals, men, and the employed. Improved understanding of barriers and facilitators to NCD care is needed to improve the effectiveness of blood pressure screening in the region.

78 Key Words:

Non-communicable diseases, community health, hypertension, South Africa, linkage to care

- 81 Strengths and Limitations of this Study
 - Applies a longitudinal population cohort study design with a large sample size to assess linkage to hypertension care after a home-based screening for elevated blood pressure
 - Assesses a population in rural sub-Saharan Africa who are noted to have high prevalence of hypertension but with little corresponding data about linkage to care after diagnosis
 - Identifies low rates of linkage to care after home-based blood pressure screening in this population, and key factors associated with poor linkage including male sex, younger age, and being employed

• Limitations include low rates of participation in the home-based screening program and incomplete follow-up, as well as self-reported linkage to care as an outcome definition

BACKGROUND

1		
2 3	92	Over two in three deaths worldwide are attributed to non-communicable diseases (NCDs). ¹ Although
4 5	93	precise measurement of cause-specific mortality in much of the developing world remains a challenge,
6 7 8	94	some estimates suggest that the majority of NCD deaths now occur in low and middle-income countries. ²
9 10	95	In South Africa, for example, the World Health Organization estimates that half of deaths are due to NCDs,
11 12	96	and approximately 25% of the population will suffer a premature death due to them. ³
13 14 15	97	
15 16 17	98	Consequently, responding to the NCD epidemic in low and middle-income countries is both a major
18 19	99	challenge and stated priority of the public health community. 4 NCD morbidity and mortality can be
20 21	100	substantially reduced through effective primary and secondary prevention measures targeting risk factors
22 23 24	101	such as smoking, high blood pressure, diabetes, diet and physical activity. ⁵ Hypertension, which can be
25 26	102	controlled through cost-effective lifestyle and pharmacotherapy interventions, is estimated to account for
27 28	103	over 50% of the population attributable fraction of stroke in the African region. ⁶ Yet, in South Africa,
29 30 31	104	national population surveys have estimated that over one quarter of South Africans adults have raised
•••		
32 33	105	blood pressure, but only approximately one in three of them has received treatment. ⁷
32 33 34 35	105 106	blood pressure, but only approximately one in three of them has received treatment. ⁷
32 33 34 35 36 37 38	105 106 107	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for
32 33 34 35 36 37 38 39 40	105 106 107 108	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes
32 33 34 35 36 37 38 39 40 41 42	105 106 107 108 109	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the
32 33 34 35 36 37 38 39 40 41 42 43 44 45	105 106 107 108 109 110	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	105 106 107 108 109 110 111	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	105 106 107 108 109 110 111 112	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals for multiple co-morbidities. ^{9 10} Whether such endeavors lead to successful linking of individuals to
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51	105 106 107 108 109 110 111 112 112	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals for multiple co-morbidities. ^{9 10} Whether such endeavors lead to successful linking of individuals to appropriate NCD care is not well established, and is an important question for the field.
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54	105 106 107 108 109 110 111 112 113 114	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals for multiple co-morbidities. ^{9 10} Whether such endeavors lead to successful linking of individuals to appropriate NCD care is not well established, and is an important question for the field.
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56	105 106 107 108 109 110 111 112 113 114 115	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals for multiple co-morbidities. ^{9 10} Whether such endeavors lead to successful linking of individuals to appropriate NCD care is not well established, and is an important question for the field.
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58	105 106 107 108 109 110 111 112 113 114 115 116	blood pressure, but only approximately one in three of them has received treatment. ⁷ The South African Department of Health has outlined strategic NCD goals, which highlight the role for prevention of NCDs and the importance of a community-based focus. ⁸ One specific strategy includes integrating HIV and NCD screening programs and broadening access to diagnostic and treatment in the community and rural areas. Community-based NCD screening through health fairs and use of community health workers has gained traction recently as a means to efficiently screen large populations of individuals for multiple co-morbidities. ^{9 10} Whether such endeavors lead to successful linking of individuals to appropriate NCD care is not well established, and is an important question for the field.

pressure and not already receiving hypertension treatment to local government clinics for repeat measurement and ongoing hypertension care. We assessed linkage to care during future years of the home-based DHS survey. Our primary aims were to determine the probability of clinical engagement within two years after home-based screening and referral, and to identify predictors of failure to link to care. Our over-arching aim was to inform public health programmers on the feasibility of community-based blood pressure screening as an entry point into NCD care in this setting. **METHODS**

Study design, setting, and participants

The African Health Research Institute (AHRI) (formerly the Africa Centre for Health and Population Studies) is a Wellcome Trust funded research institute in South Africa. Since 2000, they have conducted a population cohort study of all adults in a catchment area of 438 km² in rural uMkanyakude District, northern KwaZulu-Natal, covering a total population of approximately 100,000 individuals.¹¹ Households are surveyed 2–3 times per year, to collect information on birth, deaths and migration patterns for all household members, including non-residents. Since 2003, resident household members ≥15 years have been invited to participate in an annual home-based individual survey, which collects data on sociodemographics and general health information.

Blood pressure screening and referral methods

In 2010, all individuals who participated in the home-based survey were also offered a physical examination to determine weight, height and blood pressure, using the WHO STEPS protocol.¹² Blood pressure was measured using Omron automated blood pressure monitors (Omron Global, Kyoto Japan). Blood pressure was measured after 15 minutes of resting in a seated position. We collected three measurements, each five minutes apart, with the mean of the last two measurements used to identify those with elevated blood pressure. A positive hypertension screen was defined as a mean systolic blood pressure \geq 140 mmHg and/or diastolic blood pressure \geq 90 mmHg.¹³ All individuals were given a copy of

1	143	their blood pressure results, along with body mass index, on a health results card. Those with elevated
2 3	144	blood pressure were counselled by study staff to seek care at their preferred local public health clinic with
4 5	145	a copy of their screening results.

Outcome assessment

For our primary outcome of interest, we defined successful linkage to care for hypertension as self-reported linkage within two years of a positive home-based hypertension screen. To assess this outcome, we used data from the two subsequent, annual home-based health surveys in 2011 and 2012. All participants who took part in the initial blood pressure screening survey were members of the demographic health and surveillance site study population, and are seen annually at home for data collection. In each annual health survey, respondents were asked if: 1) they have been diagnosed with hypertension in the past 12 months; 2) if they have ever received hypertension treatment; and 3) if they are currently being treated for hypertension. We defined successful linkage to care by a positive response to any of these three questions in either 2011 or 2012. As secondary outcomes of interest, we also examined 1) linkage to hypertension care within five years (as opposed to two), defined as a positive response to any of the same three questions in the annual health surveys during 2011-2015 and 2) confirmation of hypertension care seven years after the screening, as evidenced by clinical records from all public health clinics in the catchment area in 2017, the first year linked clinical data was linked to the population cohort database.

Statistical methods

We included in this analysis individuals who had a positive hypertension screen in the home-based 2010 survey, and who reported no previous diagnosis of hypertension or hypertension treatment. We first summarized sociodemographic characteristics of eligible adults who had blood pressure measurements in the 2010 survey. We then estimated population-level prevalence of linkage to hypertension care in the two years after the screening program, both overall and stratified by sex and age, with the use of inverse

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probability weights (IPWs) of the probability of participating in the hypertension screening. We used IPWs to make the results generalizable to the entire 2010 sample. To calculate the weights, we fit a logistic regression model with completion of blood pressure screening in 2010 as the outcome of interest and included age strata, sex, education level and place of residence (urban, peri-urban, or rural) as predictors, based on information routinely collected in the household-level survey. We then fit logistic regression models to estimate odds ratios (OR) and 95% confidence intervals (CI) for factors independently associated with linkage to hypertension care within two years of a positive home-based hypertension screen. Potential determinants of linkage were examined at three levels: sociodemographic factors (age, sex, educational attainment, employment status and socioeconomic status, which was estimated using principal components analysis of household asset ownership following the method of Filmer and Pritchett¹⁴); geographical factors (distance from clinic, urban versus rural residency); and clinical factors (body mass index, elevated blood pressure severity [defined using hypertension stages as a) stage I: systolic 140-160 and diastolic 80-100; b) stage II: systolic 160-<180 or diastolic 100-<120; or c) hypertensive urgency: systolic \geq 180 or diastolic \geq 120], self-report of diabetes, self-report of tuberculosis)¹⁵. Self-reported data on HIV diagnosis was not collected in the survey, so could not be included in the analysis. Sociodemographic and clinical factors whose age- and sex-adjusted association with linkage was significant at p<0.10 were included in a final adjusted multivariable model. Distance from the nearest clinic was analyzed as a continuous covariate. In order to allow for non-linear relationships between distance and linkage to care, we used fractional polynomial functions.¹⁶ We tested the robustness of our findings using several sensitivity analyses. First, we changed our outcome from self-reported linkage to care in 2011 or 2012 to 1) self-reported linkage to care at any time between 2011-2015, and 2) confirmation of a clinic appointment for hypertension in 2017 at any of the 11 local public sector clinics, among those who remained a resident in the catchment area. Next, we compared characteristics of eligible individuals who did and did not complete blood pressure screening in 2010. Next, For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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1	195	we compared characteristics of those who participated in a subsequent health survey and those who did
2 3	196	not, either because of refusal, out-migration, or death. Finally, we conducted sensitivity analyses in which
4 5	197	we: 1) used IPWs of screening in the models; and 2) added a covariate to indicate the number of individual
6 7 8	198	health surveys participated in during 2011-2015. Data were entered and verified in an SQL database, and
9 10	199	were analyzed using Stata 14 (StataCorp, College Station, TX).
11 12	200	
13 14 15	201	Human Studies Considerations
16 17	202	Ethical approval for the demographic surveillance study and analyses of these data was granted by the
18 19	203	Biomedical Research Ethics Committee of the University of KwaZulu-Natal, South Africa. Separate
20 21	204	informed consent was given for the demographics survey, the blood pressure screening, and the clinic
22 23 24	205	records abstraction.
25 26	206	
27 28	207	Patient and Public Involvement
29 30 31	208	Patients were not involved in the design of this study. This analysis was designed by study investigators at
32 33	209	the Africa Health Research Institute intent on leveraging prior home-based screening protocols to inform
34 35	210	and optimize future community-based research, and particularly to improve the public health impact of
36 37 38	211	such activities. The results of this study were presented to the South African Department of Health Non-
39 40	212	Communicable Diseases Unit and will be disseminated to the community during the monthly scheduled
41 42	213	Africa Health Research Institute community road shows.
43 44 45	214	
45 46 47	215	RESULTS
48 49	216	Survey participants
50 51	217	A total of 37,693 potentially eligible adults were in the sampling frame. Of these, approximately one
52 53 54	218	quarter (8,589, 22.8%) were not available due to out-migration, death or inability to consent and another
55 56	219	2,920 (7.7%) could not be contacted (Figure 1). Of the remaining 26,184 individuals who were contacted
57 58	220	and eligible for the home-based DHS survey in 2010, 11,814 (45.1%) consented to participate in the
59 60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 7

1	221	general health survey and 11,694 (44.7%) had valid blood pressure measurements. Women, older	
2 3	222	individuals, and those of lower socioeconomic position and education were more likely to participate in	
4 5 6	223	the survey (Supplementary Table 1).	
7 8	224		
9 10	225	The majority of participants with a blood pressure measurement were women (n=8,241, 70.5%, Table 1).	
11 12 13	226	Median age was 25 years (interquartile range [IQR] 18–47 years) for men and 38 years (IQR 23–55 years)	
14 15	227	for women. The majority of participants (n=7,464, 63.8%) resided in a rural setting, and less than one	
16 17	228	quarter (n=2,642, 22.6%) lived within 1.5 kilometers of the nearest clinic. Few participants (n=1,779,	
18 19 20	229	15.2%) were currently employed.	
21 22	230		
23 24	231	Screening for hypertension	
25 26	232	Approximately one quarter (n=3,074, 26.2%) of participants were found to have elevated pressure during	
27 28 29	233	the home-based blood pressure screening, of whom 1,368 (44.5%) reported having been previously	
30 31	234	diagnosed or currently on treatment. Of those who had been previously diagnosed or in hypertension care	э,
32 33	235	1,169 (85.5%) were currently on hypertension treatment. Participants who were not previously aware of	
34 35 36	236	their condition were significantly younger, and more likely to be men, married, employed, have a higher	
37 38	237	level of education, and be living in peri-urban areas than those who had been previously diagnosed or on	
39 40	238	treatment (Table 1). However, there was no evidence of a difference between the two groups in the	
41 42	239	distance from their nearest clinic.	
43 44 45	240		
46 47	241	Analytic Sample	
48 49	242	A total of 1,199 individuals (70.3%) who were not previously aware of having elevated blood pressure	
50 51 52	243	participated in a second general health survey within two years of being screened (that is, in 2011 or	
53 54	244	2012), and were included in the primary analysis of factors associated with linkage to hypertension care.	
55 56	245	Compared with the 507 individuals who did not participate in 2011 or 2012, those who participated in	
57 58	246	2011 or 2012 were older (median (IQR) age = 50 (38–66) years, vs 43 (29–58) years), more likely to be	
59 60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	8

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1	247	women, unmarried, have lower levels of education, be unemployed, and have a higher BMI
2 3	248	(Supplementary Table 2). There was no difference in participation rates by distance from the nearest clinic.
4 5 6	249	When we expanded the observation period to include surveys from 2011-2015, a total of 1,421 (83.3%)
6 7 8	250	participated in at least one home-based annual general health survey. Of the 285 (16.7%) individuals who
9 10	251	did not participate in any health survey after 2010, 81 out-migrated and 36 died before the 2011 survey
11 12 13	252	(Figure 1). The remaining 168 were eligible for at least one subsequent survey but refused participation.
14	253	
15 16 17	254	Linkage to subsequent hypertension care
18 19	255	The crude and, IPW-adjusted population prevalence of linkage to hypertension care within two years of
20 21 22	256	the blood pressure screen was 28.6% (95%CI=26.1-31.2%), and 26.9% (95%CI=24.5-29.4%), respectively. Of
23 24	257	the 343 total new linkages reported, 218 (64%) and 135 (36%) were reported in 2011 and 2012,
25 26	258	respectively. Of the 218 linkages reported in 2011, the majority (191, 88%) reported initiating anti-
27 28 29	259	hypertensive therapy. Using IPW-adjusted estimates, we found that women were more likely than men to
30 31	260	link to care, and older individuals were more likely than younger individuals (Figure 2), such that we
32 33	261	estimate that 44.9% (95%CI=39.4-50.5%) of women ≥60 years presented to care for hypertension in the
34 35 36	262	next two years, versus only 3.0% (95%CI=1.1-7.7%) of men under 45. When we extended our surveillance
37 38	263	period out to 2015, we estimate that 38.1% (95%CI=35.6-40.7%) of individuals reported linking to
39 40	264	hypertension care within 5 years. Finally, we found that only 16.6% (95%CI=14.6-18.9%) of individuals who
41 42	265	remained a resident in 2016 and who screened positive for elevated blood pressure in 2010 completed a
43 44 45	266	clinic appointment for hypertension at one of the public health clinics in the catchment area in 2016.
46 47	267	
48 49	268	Factors associated with presentation to hypertension care within two years
50 51 52	269	In models adjusted for socioeconomic, geographic, and clinical factors, we found strong evidence that
52 53 54	270	women (OR=2.76, 95%CI=1.97 – 3.88, p<0.001) and those of older age (OR=12.89, 95%CI 6.62 – 25.11,
55 56	271	p<0.0001, comparing those 45-59 years versus those <30) were more likely to present to hypertension care
57 58	272	within two years of home-based diagnosis (Table 2). In adjusted analysis, the association with age and sex
59 60		9 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1	273	remained statistically significant, and there was no evidence that the effect of age on linkage to care
2 3	274	differed between men and women (p-value for interaction=0.20, Figure 2). There was evidence that those
4 5	275	who were unemployed were more likely to link to care (adjusted (a)OR 2.09, 95%CI 1.39 – 3.14). There was
6 7 8	276	an association between distance from clinic and linkage to hypertension care such that odds of
9 10	277	presentation increased as distance to the clinic increased (aOR for linear trend in linkage with each 1 km
11 12	278	increase in distance = 1.12, 95%CI=1.05–1.20, p<0.001). The results of the fractional polynomial models
13 14 15	279	suggested that the linear model adequately described the relationship between presentation to care and
16 17	280	distance. After adjusting for sociodemographic and location factors, we also found strong evidence that
18 19	281	individuals with the equivalent of Stage II hypertension (aOR=2.20, 95%CI=1.63 – 2.97), and those meeting
20 21 22	282	criteria for hypertensive urgency (aOR=3.07, 95%CI=2.01 – 4.67) had higher odds of linking to care than
23 24	283	those with the equivalent of Stage I hypertension. We found similar correlates of presentation to
25 26	284	hypertension care (age, sex, distance from clinic, and employment) in sensitivity analyses with weighted
27 28 20	285	models, and in models with a covariate for the number of follow-up surveys completed during 2011-2015
30 31	286	(Supplementary Tables 3-5).
32 33	287	
34 35	288	DISCUSSION
30 37 38	289	We found very low rates of presentation to care after home-based identification of elevated blood
39 40	290	pressure in rural KwaZulu Natal. Overall, less than one third of individuals newly identified with elevated
41 42	291	blood pressure reported being diagnosed with hypertension or receiving treatment for elevated blood
43 44 45	292	pressure from a clinic within two years, and less than one in five had evidence of visiting a clinic for
46 47	293	hypertension care during a 12-month period seven years after the screen. Linkage rates were particularly
48 49	294	low for men and young people. Notably, those employed and those closest to clinics also had poorer rates
50 51 52	295	of linkage. These results highlight the important need to consider the determinants of healthcare access
53 54	296	for NCDs in rural South Africa, and multi-faceted approaches to improve linkage to care after community-
55 56	297	based NCD screening programs.
57		

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Linkage with clinical programs after community- and home-based disease screening for chronic disease in sub-Saharan Africa have demonstrated mixed results. Most evidence has come from the HIV field, in which linkage after home-based testing in pilot studies has been highly successful,¹⁷ although lower rates are reported in community settings.⁹¹⁸ Studies reporting clinic attendance after hypertension screening have generally shown low rates of linkage to care. For example, in a large (n=6,000) health fair-based screening program in Uganda, 41% of participants with a new positive screen for elevated blood pressure linked to care.⁹ A pilot study in Kenya that compared a home-based (n=236) with a community-based healthfair booth approach (n=346) for hypertension and diabetes screening, found equally low rates of linkage to care (30%) with both strategies¹⁹. A smaller study in Kenya yielded higher linkage rates (74%, n=120) after community group-initiated blood pressure screening.²⁰ Interpreting these contrasting results must be done with attention to the selection criteria of each. Whereas our procedures were home-based, the larger study from Uganda included self-referring individuals who had attended a health fair, and the Kenyan study operated through a peer microfinance program, in which NCD screening services were paired with agribusiness advice within pre-organized community groups. In the prior report most similar to ours, a large program in Malawi (n=27,305) that provided clinical referrals after home-based testing reported a 59% linkage rate within two weeks of a diagnosis of hypertension, although 30% of participants were already on treatment at the time of referral.²¹ Moreover, approximately 50% dropped out of care within 6 months of linkage. Predictors of presentation to care in our study reinforce much of the literature on health care access and engagement among vulnerable populations in sub-Saharan Africa. Lower engagement by younger individuals and men are well-established phenomena; and a public health challenge for the region.^{22 23} Although it did not reach statistical significance, we also found evidence that those with greater social support, as evidenced by having a cohabitating partner, had a 35% increased odds of presenting to care. An unexpected finding was that those who were unemployed and those further from clinic were more likely to link to care. This finding contrasts with much of the data from the region on how distance from

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health services impacts linkage to and retention in care.²⁴⁻²⁶ We hypothesize that these results illustrate

competing demands between obligations to work and to access healthcare. Notably, a similar phenomenon was found in the Malawi home-based NCD screening study, in which rural participants had more than twice the odds of linkage to NCD care than their urban counterparts, and the most common reason stated for failure to link to care in urban areas was being too busy to attend clinic; reported in 34% of those not linked to care.²¹ Employment is higher in male than in female South African blacks ²⁷, and so may also contribute to the gender difference in linkage. Our data do offer multiple potential strategies to improve linkage to care after home-based NCD screening. For example, a notable distinction between many community-based HIV and NCD diagnostic programs is the degree of counseling and referral services provided after diagnosis. Hypertension referral services in our program and many others in the region are often limited to distribution of results and referral forms. The potential beneficial effects of more comprehensive health and lifestyle counseling on the success of linkage after an elevated blood pressure screen should be actively explored in future work. For example, decades of standardizing in-depth HIV counseling services, and additional facilitated linkage strategies have significantly improved rates of linkage after a new HIV diagnosis.²⁸ Pilot studies of enhanced referral after community based NCD diagnoses have also shown promise in vulnerable populations in the United States,^{29 30} and warrant investigation on a larger scale elsewhere. Similarly, our finding and that of others that hypertension linkage was less common in those employed presents a potential opportunity to consider expanded clinic service hours and/or community based management to improve NCD care in the region. Endeavors, such as the Centralised Chronic Medication Dispensing and Distribution recently launched by the KwaZulu Natal Department of Health, seek to overcome such barriers by delivering medicines to peoples' homes and workplaces, or setting up community-based medicine pickup points. Evaluations of the efficacy and sustainability of such programs will be of high importance to the field. Finally, our results, and particularly the high prevalence of elevated blood pressure and low rates of care sinking after notification of such, highlight the critical importance of risk factor modification as part of

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1	351	public health strategies. Such programs, including smoking cessation, healthy diet, and exercise promotion,
2 3	352	which are recommended by South African Department of Health hypertension control policies, have
4 5	353	potential to significantly impact health, and must also remain a cornerstone of population hypertension
6 7	354	control rograms. ^{31 32}
8 9 10	355	
11 12	356	Our study is strengthened by a large sample size and the use of a home-based testing paradigm. The
13 14	357	primary limitation to our analysis is the relatively low response rate in the initial hypertension screen and
15 16 17	358	participation in subsequent surveys. We accounted for this limitation by comparing characteristics
18 19	359	between participants and non-participants, and by using inverse probability weighting techniques to make
20 21	360	population level inferences. We hypothesize that the low participation in this instance was due to the
22 23 24	361	placement of the screening activity within a routine annual survey, as opposed to a stand-alone health
25 26	362	promotion. Nonetheless, it should be noted that a similar response rate for health interventions would
27 28	363	also pose a challenge to their use for population-wide screening programs. Our study is also limited by a
29 30 31	364	use of self-report to detect linkage to clinical care over the first two years of observation and clinic records
32 33	365	seven years later, which may lead to misestimation of outcomes. For example, participants who presented
34 35	366	to clinic and had a normal blood pressure might not be detected by self-report of a new diagnosis of
36 37 38	367	hypertension or with use of clinical records to seven years after the initial screen. Our study also did not
39 40	368	investigate if and how supply-side considerations, such as staffing, wait times, and drug availability might
41 42	369	have contributed to the low rates of linkage. Although hypertension care and treatment is provided free of
43 44 45	370	charge in South Africa in health clinics in the public sector, these factors have been demonstrated to affect
46 47	371	engagement in care elsewhere in the country. ^{33 34} Finally, our results should be considered in the context
48 49	372	of the low-resource, rural sub-Saharan Africa study stetting, but are unlikely to generalize more broadly to
50 51 52	373	urban or higher resource regions.
53 54	374	
55 56	375	In summary, we found very low rates of linkage to care after a population-level, home-based hypertension
57	270	

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screen in rural KwaZulu Natal. Strategies focused on increased demand generation, particularly for

1	377	younger individuals and men, augmented referral and linkage programs, and efforts to enhance the
2 3	378	convenience of service delivery, particularly to employed people, should be evaluated to improve NCD
4 5	379	care access after community based testing in the region.
$\begin{array}{c} 6\\ 7\\ 8\\ 9\\ 10\\ 11\\ 12\\ 13\\ 14\\ 15\\ 16\\ 17\\ 18\\ 19\\ 20\\ 21\\ 22\\ 23\\ 24\\ 25\\ 26\\ 27\\ 28\\ 29\\ 30\\ 31\\ 32\\ 33\\ 34\\ 35\\ 36\\ 37\\ 38\\ 39\\ 40\\ 41\\ 42\\ 43\\ 44\\ 56\\ 57\\ 58\\ 59\\ 56\\ 56\\ 57\\ 58\\ 56\\ 56\\ 57\\ 58\\ 56\\ 56\\ 57\\ 58\\ 58\\ 56\\ 56\\ 56\\ 56\\ 56\\ 56\\ 56\\ 56\\ 56\\ 56$	380	
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1	381	Author Contributions
2	382	Author Contributions:
3 4 5	383	MJS: Conceived of the project, wrote the first draft, and contributed to the data analysis.
5 6 7	384	KB: Led the data analysis, contributed to manuscript production.
, 8 9	385	JOB: Helped conceive of the project and contributed to manuscript production.
10 11	386	DP: Contributed to data collection, project conception, and contributed to manuscript production.
12 13	387	OK: Contributed to data collection, project conception, and contributed to manuscript production.
14 15 16	388	EW: Contributed to data collection and project conception.
17 18	389	PM: Contributed to data collection, project conception, and contributed to manuscript production.
19 20	390	FT: Contributed to data collection and project conception.
21 22 23	391	KH: Contributed to data collection and project conception.
24 25	392	TB: Contributed to data collection, project conception, and contributed to manuscript production.
26 27	393	MB: Contributed to project conception, data analysis, and contributed to manuscript production.
28 29 30	394	All authors reviewed the manuscript for editorial contributions and approved of the final version.
31 32	395	
33 34	396	Data Sharing:
35 36 27	397	Data for this analysis is available by emailing Mark Siedner (<u>msiedner@mgh.harvard.edu)</u> and Kobus
37 38 39	398	Herbst (<u>kherbst@ahri.org</u>)
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Table 1. Participants with blood pressure measured in in 2010 survey, those with hypertension¹ and stratified by whether or not previously diagnosed or on treatment

		NI	Duranta contra	Nat www.tauah.
	All participants	hypertension ¹	diagnosed ²	diagnosed ³
	N=11,694	N=3,074 (26.3%)	N=1,368 (44.5%)	N=1,706 (55.5%)
Median (IQR) age (years)	34 (21–53)	55 (43–68)	60 (51–71)	49 (35–63)
Age group				P<0.001 ⁴
<30	5,107 (43.7%)	354 (11.5%)	21 (1.5 %)	333 (19.5%)
35-44	2,191 (18.7%)	484 (15.7%)	118 (8.6 %)	366 (21.5%)
45-59	2,265 (19.4%)	992 (32.3%)	507 (37.1%)	485 (28.4%)
60+	2,131 (18.2%)	1,244 (40.5%)	722 (52.8%)	522 (30.6%)
Sex				P<0.001
Male	3,453 (29.5%)	720 (23.4%)	178 (13.0%)	542 (31.8%)
Female	8,241 (70.5%)	2,354 (76.6%)	1190 (87.0%)	1164 (68.2%)
Education				P<0.001
None	2,389 (20.5%)	1,032 (33.6%)	550 (40.2%)	482 (28.3%)
Less than complete secondary	6,244 (53.5%)	1,463 (47.6%)	662 (48.4%)	801 (47.0%)
Complete secondary/above	3,040 (26.0%)	576 (18.8%)	155 (11.3%)	421 (24.7%)
Missing	21	3	1	2
Marital status				P<0.001
Single (never married)	3,462 (29.8%)	518 (16.9%)	174 (12.7%)	344 (20.2%)
Married/informal union	6,556 (56.3%)	1,696 (55.2%)	688 (50.3%)	1008 (59.2%)
Widowed/separated/divorced	1,618 (13.9%)	857 (27.9%)	506 (37.0%)	351 (20.6%)
Missing	58	3	0	3
Employed				P<0.001
Yes	1,779 (15.3%)	437 (14.2%)	140 (10.2%)	297 (17.4%)
No	9,828 (84.7%)	2,634 (85.8%)	1,228 (89.8%)	1406 (82.6%)
Missing	87	3	0	3
Residence				P<0.001
Urban	617 (5.3 %)	119 (3.9 %)	55 (4.0 %)	64 (3.8 %)
Peri-urban	3,604 (30.8%)	904 (29.4%) 💿	347 (25.4%)	557 (32.7%)
Rural	7,464 (63.9%)	2,050 (66.7%)	966 (70.6%)	1084 (63.6%)
Missing	9	1	0	1
SES tertile				P=0.67
Low	4193 (36.4%)	1173 (38.6%) 🧹	525 (38.7%)	648 (38.5%)
Middle	3818 (33.1%)	947 (31.2%)	412 (30.4%)	535 (31.8%)
High	3522 (30.5%)	918 (30.2%)	418 (30.8%)	500 (29.7%)
Missing	161	36	13	23
Self-report of diabetes ⁵				P<0.001
No	11300 (96.6%)	2867 (93.3%)	1176 (86.0%)	🔺 1691 (99.1%)
Yes	394 (3.4 %)	207 (6.7 %)	192 (14.0%)	15 (0.9 %)
Nearest clinic (km) ⁶				P=0.84
0- <1.5	2642 (22.6%)	676 (22.0%)	292 (21.3%)	384 (22.5%)
1.5-2.5	2879 (24.6%)	710 (23.1%)	314 (23.0%)	396 (23.2%)
>2.5-3.9	2975 (25.5%)	809 (26.3%)	368 (26.9%)	441 (25.9%)
>3.9	3189 (27.3%)	878 (28.6%)	394 (28.8%)	484 (28.4%)
Missing	9	1	0	1

¹Hypertension defined as systolic BP \geq 140mmHg or diastolic BP \geq 90 mmHg, in an average of 2 readings. ²Report having been previously diagnosed or on treatment for hypertension in 2010 survey. ³Report no previous diagnosis or treatment for hypertension in 2010 survey. ⁴P-value from Chi-squared test comparing characteristics of those previously diagnosed/treatment and those with no previous diagnosis/treatment. ⁵Report having been diagnosed with or on treatment for diabetes in 2010 survey. ⁶Quartiles based on distribution in all individuals who were eligible for 2010 survey.

Table 2. Factors¹ associated with linkage to hypertension care within 2 years after homebased diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in 2011 or 2012 (N=1199) (unweighted analysis)

	Linked to care/N (%)	Crude OR (95% CI)	Age- & sex-adjusted OR (95% CI)	Adjusted OR (95% $\overline{\text{CI}}$) ³
Sociodemographic factors				
Age group		P<0.001	P<0.001	P<0.001
<30	10 / 193 (5.2 %)	1	1	1
35-44	40 / 242 (16.5%)	3.62 (1.76 -7.45)	3.08 (1.49 -6.36)	3.32 (1.60 -6.89)
45-59	126 / 360 (35.0%)	9.85 (5.03 -19.30)	8.39 (4.26 -16.51)	9.01 (4.57 -17.79)
60+	167 / 404 (41.3%)	12.89 (6.62 -25.11)	11.61 (5.94 -22.69)	11.49 (5.87 -22.46)
Sex		P<0.001	P<0.001	P<0.001
Male	47 / 308 (15.3%)	1	1	1
Female	296 / 891 (33.2%)	2.76 (1.97 -3.88)	2.50 (1.75 -3.57)	2.41 (1.68 -3.45)
Marital status		P<0.001	P=0.15	P=0.14
Single (never married)	55 / 250 (22.0%)	1	1	1
Married/informal union	178 / 666 (26.7%)	1.29 (0.92 -1.83)	1.33 (0.91 -1.95)	1.35 (0.92 -1.98)
Widow/sep/divorced	110 / 283 (38.9%)	2.25 (1.54 -3.31)	0.98 (0.64 -1.50)	0.99 (0.65 -1.51)
Education		P<0.001	P=0.83	P=0.77
None	132 / 363 (36.4%)	1	1	1
Less than complete	160 / 581 (27.5%)	0.67 (0.50 -0.88)	1.10 (0.81 -1.49)	1.09 (0.80 -1.49)
Complete	51 / 255 (20.0%)	0 44 (0 30 -0 64)	1 09 (0 71 -1 67)	1 15 (0 75 -1 78)
secondary/above	517 255 (20.070)	0.44 (0.50 0.04)	1.05 (0.71 1.07)	1.15 (0.75 1.70)
Employed		P<0.001	P=0.02	P=0.02
Ves	31 / 178 (17 4%)	1	1	1
No	312 / 1021 (30.6%)	2 00 (1 30 -3 14)	1 71 (1 10 -2 65)	1 71 (1 10 -2 65)
SES tortilo	512 / 1021 (50.070)	2.05 (1.55 -5.14) P=0 307	D=0.31	D-0 21
	125 / 159 (27.2%)	1	1 -0.51	1
Middlo	125 / 455 (27.2%)	1 00 (0 72 1 26)		1 12 (0 81 1 56)
High	115 / 364 (27.2%)	1.00 (0.73 -1.30)	1.09(0.79 - 1.32) 1.28(0.93 - 1.77)	1.12 (0.81 -1.30)
Location factors	115 / 504 (51.070)	1.25 (0.51 -1.07)	1.28 (0.55 -1.77)	1.54 (0.57 -1.85)
Residence		P-0.04	P-0.35	P-0 55
Urban	10 / 26 (27 8%)	1	1	1
Beri-urban	10 / 30 (27.8%) 05 / 308 (23.0%)	0.82 (0.38 -1.75)	0.75 (0.33 -1.69)	0.67 (0.29 -1.53)
Pural	228 / 765 (23.5%)	0.02(0.56-1.75)	0.75(0.33 - 1.05)	0.67 (0.23 - 1.33)
Noarost clinis ⁴	256 / 705 (51.1%)	1.17 (0.50 - 2.47)	0.92 (0.41 - 2.05)	0.03 (0.27 - 1.43)
Der each km of distance		۲۸۵.001 1 15 (1 00 1 22 ۱ ⁵	$1 13 (105 1 21)^5$	r-0.001 1 12 (1 05 1 20 ¹⁵
	56 / 762 /71 20/1	1.15 (1.0-1.25)	1.15 (1.05-1.21)	1.12 (1.05 -1.20)
U- NI.J 1 E D E	JU / ZUJ (ZI.3%)			
1.3-2.3	11/203(20.4%)			
~2.J-J.J \2.0	33 / 310 (30.0%)			
23.3 Clinical factors	123 / 337 (34.5%)			
		D <0.001	D_0.07	D_0 13
Divil category	70 / 244 (20 20/)	P<0.001	P=0.07	P=0.13
<25 kg/m	/0 / 344 (20.3%)			
25 - 50 kg/m	02 / 229 (27.1%)	1.45 (0.98 -2.15)	1.08 (0.71-1.64)	1.1/ (U./b-1.81)
≥30 kg/m	110 / 301 (36.5%)	2.25 (1.59-3.21)	1.52 (1.03 - 2.24)	1.51 (1.00 - 2.26)
nypertension stage	442 / 720 /40 500	P<0.001	P<0.001	P<0.001
Stage I	142 / 730 (19.5%)			
Stage II	134 / 342 (39.2%)	2.67 (2.01 - 3.54)	2.22 (1.65 - 2.99)	2.20 (1.63 - 2.97)
Hypertension urgency	67 / 127 (52.8%)	4.62 (3.12 -6.85)	3.12 (2.06 -4.74)	3.07 (2.01 -4.67)
Self-report of diabetes	220 / 4404 (20 50)	P=0.19	P=0.44	P=0.47
NO	339 / 1191 (28.5%)			
Yes	4 / 8 (50.0%)	2.51 (0.62 -10.11)	1.78 (0.41 -7.70)	1.75 (0.38 -8.15)

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2	7				
3	Self-report of TB'		P=0.66	P=0.96	P=0.72
4	No Yes	332 / 1156 (28.7%) 11 / 43 (25.6%)	1 0.85(0.43 -1.71)	1 1.02(0.49 -2.13)	1 1.15(0.54 -2.46)
5	1	, , , , , , , , , , , , , , , , , , , ,	2		
7	All characteristic	cs are based on 2010 survey	/. Hypertension defined	as systolic BP \geq 140mm	Hg or diastolic BP ≥90
, 8	mmHg, in an ave	rage of 2 readings. Sociod	emographic factors adju	isted for age group, sex,	and employment.
9	Location factors	adjusted for age group, sex,	employment, and dista	distance from nearest clinic a	as continuous
10		a factors adjusted for age g	individuals who woro o	ligible for 2010 survey	Fit as continuous
10	stage. Qualities	inked in each distance quar	tilo shown for informati	ingible for 2010 survey.	and in linkage with
12	each 1 km increa	se in distance ⁶ Stage I. Sve	stolic BP 140–159 or dia	istolic BP 90–99. Stage II	· Systolic BP 160–179
13	or diastolic BP 10	0–119: Hypertension urgen	cv: Svstolic BP ≥180 or	diastolic BP ≥ 120 . ⁷ Repo	rts being diagnosed in
14	the past 12m or o	currently on treatment			
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Figure 1. Flow diagram of eligible and included participants in a baseline community-based hypertension screen in 2010 and follow-up observation during 2011/2012

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Figure 2. Pro notification c	portion of indiv of elevated bloo	iduals linked t d pressure (w	o hypertensive eighted estima	care two years a tes)	fter

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51 52 53 54 55 56 57 58 59 60	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml





Figure 2. Proportion of individuals linked to hypertensive care two years after a new notification of elevated blood pressure (weighted estimates)

253x142mm (300 x 300 DPI)



Supplementary Table 1. Comparison of characteristics between those for whom a blood pressure measurement was taken in the 2010 survey, and those with no blood pressure measurements

	Eligible for survey ¹ BP measurements		No BP measurement ²
	N=26,184	N=11,694	N=14,490
Median (IQR) age (years)	32 (20–50)	34 (21–53)	30 (20–47)
Age group			P<0.001 ³
<30	12,164 (46.5%)	5106 (43.7%)	7058 (48.7%)
35-44	5523 (21.1%)	2194 (18.8%)	3329 (23.0%)
45-59	4584 (17.5%)	2251 (19.2%)	2333 (16.1%)
60+	3913 (14.9%)	2143 (18.3%)	1770 (12.2%)
Sex			P<0.001
Male	9959 (38.0%)	3453 (29.5%)	6506 (44.9%)
Female	16,225 (62.0%)	8241 (70.5%)	7984 (55.1%)
Marital status			P<0.001
Single (never married)	8113 (31.2%)	3462 (29.8%)	4651 (32.4%)
Married/informal union	14,959 (57.6%)	6556 (56.3%)	8403 (58.6%)
Widow/sep/divorced	2910 (11.2%)	1618 (13.9%)	1292 (9.0 %)
Missing	202	58	144
Education			P<0.001
None	4558 (17.5%)	2389 (20.5%)	2169 (15.1%)
Less than complete	13,466 (51.6%)	6244 (53.5%)	7222 (50.1%)
secondary			
Complete secondary/above	8051 (30.9%)	3040 (26.0%)	5011 (34.8%)
Missing	109	21	88
Employed			P<0.001
Yes	5860 (22.7%)	1779 (15.3%)	4081 (28.6%)
No	19,997 (77.3%)	9828 (84.7%)	10,169 (71.4%)
Missing	327	87	240
Residence			P<0.001
Urban	1953 (7.5 %)	617 (5.3 %)	1336 (9.2 %)
Peri-urban	8084 (30.9%)	3604 (30.8%)	4480 (31.0%)
Rural	16,092 (61.6%)	7464 (63.9%)	8628 (59.7%)
Missing	55	9	46
SES tertile			P<0.001
Low	8566 (33.6%)	4193 (36.4%)	4373 (31.4%)
Middle	8330 (32.7%)	3818 (33.1%)	4512 (32.4%)
High	8569 (33.7%)	3522 (30.5%)	5047 (36.2%)
Missing	719	161	558

¹Individuals who were on the eligibility list for the 2010 survey (aged ≥15 years as of Dec 2009 and resident in the DSS), were successfully contacted (92% of all on the list) and still eligible at the time of contact (75% of those contacted). ²Includes 14,370 individuals who refused consent, and 120 individuals who consented but for whom blood pressure measurements were not available. ³P-value from Chi-squared test comparing those with blood pressure measurements and those without.

Supplementary Table 2. Comparison of characteristics between those who participated in the general health survey in 2011 or 2012 and those who did not, among 1706 individuals with undiagnosed hypertension in 2010

	Participated in	Did not participate	Participated in	No participation in
	2011/2012	in 2011/2012	2011-2016	later survey
	N=1199 (70.3%)	N=507 (29.7%)	N=1421 (83.3%)	N=285 (16.7%)
Median (IQR) age (years)	50 (38–66)	43 (29–58)	50 (37–65)	41 (28–57)
Age group	· · ·	P<0.001 ¹	ζ γ	P<0.001 ²
<30	193 (16.1%)	140 (27.6%)	248 (17.5%)	85 (29.8%)
35-44	242 (20.2%)	124 (24.5%)	284 (20.0%)	82 (28.8%)
45-59	360 (30.0%)	125 (24.7%)	430 (30.3%)	55 (19.3%)
60+	404 (33.7%)	118 (23.3%)	459 (32.3%)	63 (22.1%)
Sex		P<0.001		P<0.001
Male	308 (25.7%)	234 (46.2%)	394 (27.7%)	148 (51.9%)
Female	891 (74.3%)	273 (53.8%)	1027 (72.3%)	137 (48.1%)
Marital status		P<0.001		P<0.001
Single (never married)	250 (20.9%)	94 (18.7%)	287 (20.2%)	57 (20.2%)
Married/informal union	666 (55.5%)	342 (67.9%)	817 (57.5%)	191 (67.7%)
Widow/sep/divorced	283 (23.6%)	68 (13.5%)	317 (22.3%)	34 (12.1%)
Education		P<0.001		P<0.001
None	363 (30.3%)	119 (23.6%)	424 (29.8%)	58 (20.5%)
Less than complete	581 (48.5%)	220 (43.6%)	678 (47.7%)	123 (43.5%)
secondary				
Complete secondary/above	255 (21.3%)	166 (32.9%)	319 (22.4%)	102 (36.0%)
Employed		P<0.001		P<0.001
Yes	178 (14.8%)	119 (23.6%)	220 (15.5%)	77 (27.3%)
No	1021 (85.2%)	385 (76.4%)	1201 (84.5%)	205 (72.7%)
Residence		P=0.04		P=0.16
Urban	36 (3.0 %)	28 (5.5 %)	48 (3.4 %)	16 (5.6 %)
Peri-urban	398 (33.2%)	159 (31.4%)	470 (33.1%)	87 (30.6%)
Rural	765 (63.8%)	319 (63.0%)	903 (63.5%)	181 (63.7%)
SES tertile		P=0.24		P=0.05
Low	459 (38.7%)	189 (38.1%)	544 (38.7%)	104 (37.5%)
Middle	364 (30.7%)	171 (34.5%)	431 (30.7%)	104 (37.5%)
High	364 (30.7%)	136 (27.4%)	431 (30.7%)	69 (24.9%)
BMI category		P=0.008		P<0.001
Underweight	50 (5.7 %)	25 (7.2 %)	58 (5.6 %)	17 (9.0 %)
Normal weight	294 (33.6%)	146 (42.3%)	351 (34.0%)	89 (47.3%)
Overweight	229 (26.2%)	84 (24.3%)	269 (26.1%)	44 (23.4%)
Obese	301 (34.4%)	90 (26.1%)	353 (34.2%)	38 (20.2%)
Distance to nearest clinic (km)	. ,	P=0.22		P=0.50
0- <1.5	263 (21.9%)	121 (23.9%)	320 (22.5%)	64 (22.5%)
1.5-2.5	269 (22.4%)	127 (25.1%)	323 (22.7%)	73 (25.7%)
>2.5-3.9	310 (25.9%)	131 (25.9%)	365 (25.7%)	76 (26.8%)
>3.9	357 (29.8%)	127 (25.1%)	413 (29.1%)	71 (25.0%)

¹P-value from Chi-squared test comparing individuals who participated in 2011-2012 (N=1199) with those who did not (N=507). ²P-value from Chi-squared test comparing individuals who participated in 2011-2015 (N=1421) with those who did not (N=285).

Supplementary Table 3. Factors¹ associated with linkage to hypertension care within 2 years after home-based diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in 2011 or 2012 (N=1199), using inverse probability weighting to account for non-participation in the blood pressure screen

	Linked to care/N (%)	Crude OR (95% CI) ³	Age- & sex-adjusted OR (95% CI) ³	Adjusted OR (95% CI) ^{3,4}
Sociodemographic factors				
Age group		P<0.001	P<0.001	P<0.001
<30	10 / 193 (5.2 %)	1	1	1
35-44	40 / 242 (16.5%)	3.82 (1.85 -7.87)	3.20 (1.55 -6.62)	3.26 (1.54 -6.90)
45-59	126 / 360 (35.0%)	10.35 (5.28 -20.32)	8.64 (4.39 -16.99)	9.35 (4.73 -18.46)
60+	167 / 404 (41.3%)	13.75 (7.05 -26.81)	12.27 (6.29 -23.91)	13.48 (6.82 -26.61)
Sex		P<0.001	P<0.001	P<0.001
Male	47 / 308 (15.3%)	1	1	1
Female	296 / 891 (33.2%)	2.86 (2.03 -4.03)	2.57 (1.81 - 3.66)	2.77 (1.91 -4.00)
Marital status		P<0.001	P=0.09	P=0.09
Single (never married)	55 / 250 (22.0%)	1	1	1
Married/informal union	178 / 666 (26.7%)	1.35 (0.95 -1.91)	1.35 (0.91 -1.99)	1.36 (0.92 -2.01)
Widow/sep/divorced	110 / 283 (38.9%)	2.40 (1.63 -3.54)	0.94 (0.61 -1.44)	0.95 (0.61 -1.45)
Education		P<0.001	P=0.86	P=0.89
None	132 / 363 (36.4%)	1	1	1
Less than complete	160 / 581 (27.5%)	0.64 (0.48 -0.84)	1.09 (0.80 -1.49)	1.07 (0.78 -1.46)
secondary				
Complete	51 / 255 (20.0%)	0.42 (0.29 -0.61)	1.06 (0.69 -1.63)	1.10 (0.71 -1.70)
secondary/above				
Employed		P<0.001	P=0.01	P=0.01
Yes	31 / 178 (17.4%)	1	1	1
Νο	312 / 1021 (30.6%)	2.21 (1.46 -3.34)	1.74 (1.13 -2.69)	1.76 (1.14 -2.72)
SES tertile		P=0.36	P=0.32	P=0.26
Low	125 / 459 (27.2%)	1	1	1
Middle	99 / 364 (27.2%)	1.01 (0.74 -1.38)	1.11 (0.79 -1.55)	1.12 (0.81 -1.57)
High	115 / 364 (31.6%)	1.23 (0.90 - 1.66)	1.28 (0.93 - 1.77)	1.31 (0.95 -1.82)
Location factors				
Residence		P=0.03	P=0.40	P=0.68
Urban	10 / 36 (27.8%)	1	1	1
Peri-urban	95 / 398 (23.9%)	0.91 (0.42 -1.96)	0.84 (0.37 -1.89)	0.73 (0.32 -1.67)
Rural	238 / 765 (31.1%)	1.32 (0.62 - 2.79)	1.03 (0.47 - 2.27)	0.69 (0.30 -1.59)
Nearest clinic (km) ⁵		. ,		· · · ·
0- <1.5	56 / 263 (21.3%)			
1.5-2.5	71 / 269 (26.4%)	P<0.001	P=0.001	P=0.002
>2.5-3.9	93 / 310 (30.0%)	1.15 (1.08 -1.23) ⁶	$1.13(1.05-1.21)^6$	1.12 (1.04 -1.20) ⁶
>3.9	123 / 357 (34.5%)	· · · ·	· · · · ·	
Clinical factors	, , ,			
BMI category		P<0.001	P=0.06	P=0.14
$<25 \text{ kg/m}^{2}$	70 / 344 (20.3%)	1	1	1
$25 - <30 \text{ kg/m}^2$	62 / 229 (27.1%)	1.56 (1.05 -2.33)	1.13 (0.73 -1.74)	1.19 (0.77 -1.84)
≥30 kg/m ²	110 / 301 (36.5%)	2.42 (1.69 - 3.45)	1.57 (1.05 -2.34)	1.51 (1.00 -2.28)
Hypertension stage ⁷		P<0.001	P<0.001	P<0.001
Stage I	142 / 730 (19.5%)	1	1	1
Stage II	134 / 342 (39.2%)	2,72 (2.04 - 3.63)	2,20 (1.62 - 2.99)	2,15 (1.58 - 2.93)
Hypertension urgency	67 / 127 (52.8%)	4.79 (3.22 -7.13)	3.14 (2.06 - 4.78)	3.10 (2.04 - 4.71)
Self-report of diabetes ⁸		P=0.28	P=0.50	P=0.56
No	339 / 1191 (28 5%)	1	1	1
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Self-report of TB ⁸		P=0.81	P=0.77	P=0.48
No	332 / 1156 (28.7%)	1	1	1
Yes	11 / 43 (25.6%)	0.92 (0.45 -1.86)	1.12 (0.51 -2.49)	1.34 (0.59 -3.04)

¹All characteristics are based on 2010 survey. ²Hypertension defined as systolic BP ≥ 140mmHg or diastolic BP ≥90 mmHg, in an average of 2 readings. ³Weighted for non-response; weights calculated as the inverse probability of survey participation, in strata defined by age group, sex, education level and place of residence. ⁴Sociodemographic factors adjusted for age group, sex, marital status and employment. Location factors adjusted for age group, sex, marital status, employment, and distance from nearest clinic as continuous covariate. Clinical factors adjusted for age group, sex, marital status, employment, distance from nearest clinic, and hypertension stage. ⁵Quartiles based on distribution in all individuals who were eligible for 2010 survey. Fit as continuous covariate; n (%) linked in each distance quartile shown for information only. ⁶OR for linear trend in linkage with ref. sion urg. trment. each 1 km increase in distance. ⁷Stage I: Systolic BP 140–159 or diastolic BP 90–99; Stage II: Systolic BP 160–179 or diastolic BP 100–119; Hypertension urgency: Systolic BP ≥180 or diastolic BP ≥120. ⁸Reports being diagnosed in

the past 12m or currently on treatment.

Supplementary Table 4. Factors¹ associated with linkage to hypertension care within 5 years (2011 to 2015) after home-based diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in a subsequent survey (N=1421) using inverse probability weighting to account for non-participation in the blood pressure screen

	Linked to care/N (%)	Crude OR (95% CI) ³	Age- & sex-adjusted OR (95% CI) ³	Adjusted OR (95% Cl) ^{3,4}
Sociodemographic factors	•••		· · ·	·
Age group		P<0.001	P<0.001	P<0.001
<30	25 / 248 (10.1%)	1	1	1
35-44	75 / 284 (26.4%)	3.22 (1.97 -5.29)	2.69 (1.64 -4.43)	2.93 (1.77 -4.87)
45-59	211 / 430 (49.1%)	8.67 (5.48 -13.70)	7.50 (4.73 -11.89)	8.05 (5.05 -12.84)
60+	265 / 459 (57.7%)	12.37 (7.84 -19.53)	11.65 (7.35 -18.47)	11.49 (7.25 -18.22)
Sex		P<0.001	P<0.001	P<0.001
Male	92 / 394 (23.4%)	1	1	1
Female	484 / 1027 (47.1%)	3.06 (2.35 -3.99)	2.98 (2.25 -3.94)	2.85 (2.15 -3.79)
Marital status		P<0.001	P=0.66	P=0.64
Single (never married)	98 / 287 (34.1%)	1	1	1
Married/informal union	298 / 817 (36.5%)	1.16 (0.88 -1.55)	1.04 (0.76 -1.44)	1.07 (0.77 -1.48)
Widow/sep/divorced	180 / 317 (56.8%)	2.78 (1.99 -3.87)	0.90 (0.61 -1.32)	0.92 (0.62 -1.35)
Education		P<0.001	P=0.55	P=0.66
None	217 / 424 (51.2%)	1	1	1
Less than complete secondary	269 / 678 (39.7%)	0.60 (0.47 -0.76)	1.13 (0.85 -1.50)	1.13 (0.86 -1.50)
Complete	90 / 319 (28.2%)	0.36 (0.26 -0.49)	0.98 (0.68 -1.41)	1.05 (0.73 -1.53)
Employed		P<0.001	P-0.007	P-0.007
Ves	61 / 220 (27 7%)	1	1	1
No	515 / 1201 (42 9%)	2 04 (1 48 - 2 81)	1 62 (1 14 -2 29)	1 62 (1 14 -2 29)
SFS tertile	515/1201 (42.570)	P=0.49	P=0.71	P=0.58
	224 / 544 (41 2%)	1	1 -0.71	1 -0.56
Middle	162 / <u>1</u> 21 (27 8%)	0.89 (0.68 - 1.15)	1 0 95 (0 71 -1 27)	1 0 07 (0 73 -1 30)
High	103 / 431 (37.8%) 183 / $131 (12.5%)$	1.04 (0.80 - 1.15)	1.08(0.81-1.43)	(0.73 - 1.50)
Location factors	105 / 451 (42.5%)	1.04 (0.80 -1.35)	1.08 (0.81 -1.43)	1.15 (0.85 -1.50)
Residence		P=0.07	P=0.89	P=0.61
Urban	18 / 48 (37 5%)	1	1	1
Peri-urban	173 / 470 (36 8%)	1 03 (0 56 -1 92)	0 95 (0 50 -1 79)	0 84 (0 44 -1 62)
Bural	385 / 903 (42 6%)	1 34 (0 73 -2 46)	1 01 (0 54 -1 88)	0.75 (0.39 -1.46)
Nearest clinic (km) ⁵	303 / 303 (42.070)	1.54 (0.75 2.40)	1.01 (0.54 1.00)	0.75 (0.55 1.40)
0- <1 5	111 / 320 (34 7%)			
1 5-2 5	128 / 323 (39.6%)	P=0.001	P=0.03	P=0.05
>2 5-3 9	147 / 365 (40 3%)	$1 10 (1 04 - 1 17)^{6}$	$1.08(1.01-1.15)^{6}$	$1.07(1.00-1.14)^{6}$
>3.9	190 / 413 (46.0%)	1.10 (1.04 1.17)	1.00 (1.01 1.15)	1.07 (1.00 1.14)
	2007 120 (101070)			
BMI category		P<0.001	P=0.004	P=0.008
$<25 \text{ kg/m}^{2}$	133 / 409 (32.5%)	1	1	1
$25 - <30 \text{ kg/m}^2$	99 / 269 (36.8%)	1.28 (0.92 -1.77)	0.88 (0.61 -1.26)	0.90 (0.62 -1.31)
≥30 kg/m ²	186 / 353 (52.7%)	2.44 (1.81 - 3.29)	1.55 (1.10 -2.18)	1.53 (1.08 - 2.17)
Hypertension stage ⁷		P<0.001	P<0.001	P<0.001
Stage I	264 / 863 (30.6%)	1	1	1
Stage II	215 / 415 (51.8%)	2.49 (1.95 -3.17)	2.01 (1.54 - 2.62)	2.12 (1.55 -2.89)
Hypertension urgency	97 / 143 (67.8%)	5.02 (3.42 -7.37)	3.18 (2.10 - 4.82)	3.29 (2.01 -5.39)
Self-report of diabetes ⁸	37, 210 (0710/0)	P=0.05	P=0.08	P=0.32
No	568 / 1410 (40.3%)	1	1	1
Yes	8 / 11 (72.7%)	3.84 (0.98 -15.03)	3.09 (0.88 -10.81)	5.18 (0.21 - 128.15)

alf report of TD ⁸		D-0 72	D_0.96	D=0.20
No	560 / 1376 (40 7%)	r=0.73 1	۲=U.80 1	r=0.30 1
Yes	16 / 45 (35.6%)	0.89 (0.48 -1.68)	1.07 (0.49 -2.33)	1.57 (0.67 -3.71)
Yes ¹ All characterist mmHg, in an av survey participa ⁴ Sociodemograf sex, employmen individuals who shown for infor BP 140–159 or 6 Systolic BP ≥180	16 / 45 (35.6%) tics are based on 2010 survey. verage of 2 readings. ³ Weighte ation, in strata defined by age phic factors adjusted for age g nt, and distance from nearest nt, distance from nearest clinic o were eligible for 2010 survey mation only. ⁶ OR for linear tre diastolic BP 90–99; Stage II: Sy 0 or diastolic BP ≥120. ⁸ Report	0.89 (0.48 -1.68) ² Hypertension defined ed for non-response; w group, sex, education l roup, sex, and employe clinic as continuous cov c, hypertension stage, a . Fit as continuous cov end in linkage with each rstolic BP 160–179 or d is being diagnosed in th	1.07 (0.49 -2.33) as systolic BP ≥ 140mm eights calculated as the i evel and place of resider ment. Location factors a variate. Clinical factors a and BMI. ⁵ Quartiles base ariate; n (%) linked in ea n 1 km increase in distance iastolic BP 100–119; Hyp he past 12m or currently	1.57 (0.67 -3.71) Hg or diastolic BP ≥90 nverse probability of nce. djusted for age group ed on distribution in al ch distance quartile ce. ⁷ Stage I: Systolic ertension urgency: on treatment.

Supplementary Table 5. Factors¹ associated with linkage to hypertension care within 5 years (2011 to 2015) after home-based diagnosis of hypertension² in 2010, among individuals who were previously undiagnosed and participated in a subsequent survey (N=1421)

	Linked to care/N (%)	Crude OR (95% CI) ³	Adjusted OR (95% Cl) ^{3,4}	Adjusted OR (95% CI) ^{3,5}
Sociodemographic factors	•••		•	•
Age group		P<0.001	P<0.001	P<0.001
<30	25 / 248 (10.1%)	1	1	1
35-44	75 / 284 (26.4%)	3.22 (1.97 -5.29)	2.43 (1.47 -4.01)	2.61 (1.56 -4.34)
45-59	211 / 430 (49.1%)	8.67 (5.48 -13.70)	6.58 (4.13 -10.47)	6.96 (4.35 -11.14)
60+	265 / 459 (57.7%)	12.37 (7.84 -19.53)	10.23 (6.44 -16.25)	10.11 (6.37 -16.06)
Sex		P<0.001	P<0.001	P<0.001
Male	92 / 394 (23.4%)	1	1	1
Female	484 / 1027 (47.1%)	3.06 (2.35 -3.99)	2.54 (1.91 -3.39)	2.46 (1.84 -3.30)
Times participated				
Once	61 / 321 (19.0%)			
Twice	119 / 335 (35.5%)	P<0.001	P<0.001	P<0.001
3 times	160 / 327 (48.9%)	$1.57 (1.44 - 1.71)^6$	1.40 (1.27 -1.53) ⁶	1.39 (1.26 -1.52) ⁶
4 times	147 / 287 (51.2%)			
5 times	89 / 151 (58.9%)			
Marital status		P<0.001	P=0.60	P=0.55
Single (never married)	98 / 287 (34.1%)	1	1	1
Married/informal union	298 / 817 (36.5%)	1.16 (0.88 -1.55)	1.14 (0.82 -1.60)	1.16 (0.83 -1.63)
Widow/sep/divorced	180 / 317 (56.8%)	2.78 (1.99 - 3.87)	1.00 (0.67 -1.48)	1.01 (0.68 -1.50)
Education		P<0.001	P=0.74	P=0.67
None	217 / 424 (51.2%)	1	1	1
Less than complete	269 / 678 (39.7%)	0.60 (0.47 -0.76)	1.12 (0.84 -1.49)	1.12 (0.84 -1.50)
secondarv	, , ,		· · · · · ·	, , , , , , , , , , , , , , , , , , ,
Complete	90 / 319 (28.2%)	0.36 (0.26 -0.49)	1.09 (0.75 -1.59)	1.16 (0.79 -1.69)
secondary/above				
Employed		P<0.001	P=0.03	P=0.03
Yes	61 / 220 (27.7%)	1	1	1
No	515 / 1201 (42.9%)	2.04 (1.48 - 2.81)	1.48 (1.04 -2.10)	1.48 (1.04 -2.10)
SES tertile		P=0.49	P=0.68	P=0.56
Low	224 / 544 (41.2%)	1	1	1
Middle	163 / 431 (37.8%)	0.89 (0.68 -1.15)	0.98 (0.73 -1.32)	1.00 (0.74 -1.35)
High	183 / 431 (42.5%)	1.04 (0.80 -1.35)	1.11 (0.83 -1.48)	1.15 (0.86 -1.54)
Location factors	100 / 101 (110/0/			1.10 (0.00 1.0.)
Residence		P=0.07	P=0.63	P=0.61
Urban	18 / 48 (37 5%)	1	1	1
Peri-urban	173 / 470 (36 8%)	1 03 (0 56 -1 92)	0.82 (0.43 - 1.57)	0 76 (0 40 -1 48)
Bural	385 / 903 (42.6%)	1 34 (0 73 -2 46)	0.93 (0.49 -1.74)	0.85 (0.45 -1.61)
Nearest clinic (km) ⁷	303 / 303 (42.070)	1.34 (0.73 2.40)	0.55 (0.45 1.74)	0.05 (0.45 1.01)
0- <1 5	111 / 320 (34 7%)			
1 5-2 5	128 / 323 (39.6%)	P=0.001	P=0.06	P=0.10
1.3-2.3 \2 5_2 0	147 / 365 (40.3%)	1 - 0.001 1 10 (1 04 - 1 17) ⁸	1 - 0.00 1 07 (1 00 - 1 14) ⁸	1 - 0.10 1 06 (0 00 -1 13) ⁸
~2.5-5.5	147 / 303 (40.3%)	1.10 (1.04 -1.17)	1.07 (1.00 -1.14)	1.00 (0.33 -1.13)
~3.9	190 / 413 (40.0%)			
BMI category		P<0.001	P-0.003	P-0.007
$< 25 \text{ kg/m}^2$	133 / 209 (32 5%)	1	1	1
$25 - <30 \text{ kg/m}^2$	99 / 269 (26 8%)	1 28 (0 92 -1 77)	0.88 (0.61 -1.28)	0 89 (0 61 -1 30)
$>30 kg/m^2$	186 / 352 (50.070)	2 / 1 (1 81 - 2 20)	1 58 (1 11 -2 25)	154(107-200)
Hypertension stage ⁹	100 / 555 (52.770)	P<0 001	P<0 001	1.3+ (1.07-2.22) Ρ<Λ ΛΛ1
Stage I	264 / 863 (30 6%)	1	1	1
Stage I	204/000 (00.0/0) 215/115 (E1 00/)	⊥ 2 /19 (1 05 _2 17 \	⊥ ۲ 00 (1 67 _ 7 00 \	1 2 36 /1 71 2 76 \
Juge II	213 / 413 (31.0%) 07 / 143 (67.0%)	2.47 (1.77-7.1/)	2.13 (1.07 -2.00)	2.30 (1.71 - 3.20)
Hypertension urgency	J//14J(0/.8%)	J.UZ (J.42-7.37)	5.44 (2.25-5.25)	3.74 (Z.Z5-0.ZU)
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Self-report of diabetes ¹⁰		P=0.05	P=0.03	P=0.28
No	568 / 1410 (40.3%)	1	1	1
Yes	8 / 11 (72.7%)	3.84 (0.98 -15.03)	3.67 (1.14 -11.80)	5.64 (0.25 -126.50)
Self-report of TB ¹⁰		P=0.73	P=0.91	P=0.56
No	560 / 1376 (40.7%)	1	1	1
Yes	16 / 45 (35.6%)	0.89 (0.48 -1.68)	0.96 (0.43 -2.13)	1.31 (0.52 -3.27)

¹All characteristics are based on 2010 survey. ²Hypertension defined as systolic BP \geq 140mmHg or diastolic BP \geq 90 mmHg, in an average of 2 readings. ³Weighted for non-response; weights calculated as the inverse probability of survey participation, in strata defined by age group, sex, education level and place of residence. ⁴Adjusted for age, sex and number of times participated in subsequent surveys as a continuous covariate. ⁵Sociodemographic factors adjusted for age group, sex, number of times in subsequent surveys, and employment. Location factors adjusted for age group, sex, number of times in subsequent surveys, and employment. Clinical factors adjusted for age group, sex, number of times in subsequent surveys, employment, hypertension stage, and BMI. ⁶OR for linear trend in reported linkage with each unit increase in survey participation. ⁷Quartiles based on distribution in all individuals who were eligible for 2010 survey. Fit as continuous covariate; n (%) linked in each distance quartile shown for information only. ⁸OR for linear trend in linkage with each 1 km increase in distance. ⁹Stage I: Systolic BP 140–159 or diastolic BP 90–99; Stage II: Systolic BP 160–179 or diastolic BP 100–119; Hypertension urgency: Systolic BP \geq 180 or diastolic BP \geq 120. ¹⁰Reports being diagnosed in the past 12m or currently on treatment.

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page	Comments
Title and abstract	1	(a) Indicate the study's design with a commonly	1	
		used term in the title or the abstract		
		(b) Provide in the abstract an informative and	2	
		balanced summary of what was done and what	-	
		was found		
Introduction		was tould		
Background/rationale	2	Explain the scientific background and rationale	4	Lines 2-23
Buenground, futionale	-	for the investigation being reported	·	
Objectives	3	State specific objectives including any	4-5	L ines 25-32
objectives	5	prespecified hypotheses	15	
		prespective hypotheses		
Methods				
Study design	4	Present key elements of study design early in the paper	5	Lines 36-43
Setting	5	Describe the setting, locations, and relevant	5	Lines 36-43
		dates, including periods of recruitment,		
		exposure, follow-up, and data collection		
Participants	6	(a) Give the eligibility criteria, and the sources	6	Lines 70-79
		and methods of selection of participants.		
		Describe methods of follow-up		
		(b) For matched studies, give matching criteria	N/A	
		and number of exposed and unexposed		
Variables	7	Clearly define all outcomes exposures	5-6	Lines 45-67
v unuoios	,	predictors potential confounders and effect	5 0	
		modifiers Give diagnostic criteria if applicable		
Data sources/	8 *	For each variable of interest, give sources of	5-6	Lines 15-67
masurament	0	data and datails of methods of assessment	5-0	Lines 45-67
measurement		(measurement) Describe comparability of		
		assessment methods if there is more than one		
		group		
Bias	9	Describe any efforts to address potential sources	7	Lines 94 - 103
		of bias		
Study size	10	Explain how the study size was arrived at	9	Lines 129 - 141
Quantitative	11	Explain how quantitative variables were		Lines 69 - 79
variables		handled in the analyses. If applicable, describe	6	
		which groupings were chosen and why		
Statistical methods	12	(a) Describe all statistical methods, including	6-7	Lines 69 - 103
		those used to control for confounding		
		(b) Describe any methods used to examine	6	Lines 73 – 76
		subgroups and interactions		
		(c) Explain how missing data were addressed	7	Lines 94 - 103
		(d) If applicable, explain how loss to follow-up	N/A	
		was addressed		
		(e) Describe any sensitivity analyses	7	Lines 94 - 103
Docults			,	
Particinants	13*	(a) Report numbers of individuals at each stage	8-9	Lines 113 - 141
i articipanto	15	(a) report numbers of murviduals at each stage	0-9	Lines 115 - 141

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		of study-eg numbers potentially eligible,		
		examined for eligibility, confirmed eligible,		
		included in the study, completing follow-up,		
		and analysed		
		(b) Give reasons for non-participation at each	8-9	Lines 113 - 141
		stage		
		(c) Consider use of a flow diagram		Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg	9	Lines 139 - 149
2 obornprite uniu		demographic clinical social) and information	-	
		on exposures and potential confounders		
		(b) Indicate number of participants with missing	N/A	No data was missing for
		data for each variable of interest		participants who complete
		(c) Summarise follow-up time (eq. average and	9	Lines 138 - 149
		total amount)	,	
Outcome data	15*	Report numbers of outcome events or summary	9-10	Lines 151 - 161
e accorne unu	1.7	measures over time	2 10	2
Main results	16	(a) Give unadjusted estimates and if applicable	10	Lines 163 - 180
		confounder-adjusted estimates and their		
		precision (eg. 95% confidence interval). Make		
		clear which confounders were adjusted for and		
		why they were included		
		(b) Report category boundaries when		Table 2
		continuous variables were categorized		
		(c) If relevant consider translating estimates of	9-10	Lines $151 - 161$ (we report
		relative risk into absolute risk for a meaningful	, 10	absolute prevalence of
		time period		linkage prior to our
				multivariable model
				estimations)
Other analyses	17	Report other analyses done—eg analyses of	10	Lines 177 – 180
other undryses	17	subgroups and interactions and sensitivity	10	Supplementary Tables
		analyses		Supplementary Tubles
D' '		uluijses		
Discussion	10		11	1: 102 101
Key results	18	Summarise key results with reference to study	11	Lines 183-191
T ::4.4:	10		12	Lines 240, 249
Limitations	19	Discuss limitations of the study, taking into	13	Lines 240-248
		account sources of potential bias or imprecision.		
		Discuss both direction and magnitude of any		
T () (*	20	potential bias	12	1: 100.004
Interpretation	20	Give a cautious overall interpretation of results	13	Lines 150-254
		considering objectives, limitations, multiplicity		
		or analyses, results from similar studies, and		
	~ ~ ~	other relevant evidence	1.2	T: 040.042
Generalisability	21	Discuss the generalisability (external validity)	13	Lines 248-249
		of the study results		
Other information				
			1	Eunding statement
Funding	22	Give the source of funding and the role of the	1	Funding statement
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable,	1	runding statement

article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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