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Sustained effect of health insurance and facility quality improvement on blood pressure in adults with hypertension in Nigeria: A population-based study

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ABSTRACT

Background: Hypertension is a leading risk factor for death in sub-Saharan Africa. Quality treatment is often not available nor affordable. We assessed the effect of a voluntary health insurance program, including quality improvement of healthcare facilities, on blood pressure (BP) in hypertensive adults in rural Nigeria.
Methods: We compared changes in outcomes from baseline (2009) to midline (2011) and endline (2013) between non-pregnant hypertensive adults in the insurance program area (PA) and a control area (CA), through household surveys. The primary outcome was the difference between the PA and CA in change in BP, using difference-in-differences analysis.
Results: Of 1500 eligible households, 1450 (96.7%) participated, including 559 (20.8%) hypertensive individuals, of which 332 (59.4%) had follow-up data. Insurance coverage increased from 0% at baseline to 41.8% at endline in the PA and remained under 1% in the CA. The PA showed a 4.97 mm Hg (95% CI: −0.76 to +10.71 mm Hg) greater decrease in systolic BP and a 1.81 mm Hg (−1.06 to +4.68 mm Hg) greater decrease in diastolic BP from baseline to endline compared to the CA. Respondents with stage 2 hypertension showed an 11.43 mm Hg (95% CI: 1.62 to 21.23 mm Hg) greater reduction in systolic BP and 3.15 mm Hg (−1.22 to +7.53 mm Hg) greater reduction in diastolic BP in the PA compared to the CA. Attrition did not affect the results.
Conclusion: Access to improved quality healthcare through an insurance program in rural Nigeria was associated with a significant longer-term reduction in systolic BP in subjects with moderate or severe hypertension.

1. Introduction

Hypertension is one of the main risk factors for premature death in adults in sub-Saharan Africa (SSA) due to associated cardiovascular disease (CVD) [1]. The age-standardized prevalence of hypertension in SSA increased from 19.1% in 1990 to 25.9% in 2010 [2]. Reduction of blood pressure (BP) greatly reduces the risk of CVD [3]. However, antihypertensive treatment coverage in SSA is low due to low awareness of hypertension, and poor availability of quality care for hypertension [4,5]. In addition, hypertension treatment is often not affordable for patients. In Nigeria, almost 66% of healthcare expenditures are paid out-of-pocket by patients [6]. We investigated whether a health insurance program targeted at low-income groups, which included quality improvement of health facilities, could be used to provide effective care for hypertension in rural Nigeria. We previously demonstrated that the Kwara State Health Insurance (KSHI) program (formerly known as the Hygeia Community Health Care program) resulted in a significant reduction in BP in subjects with hypertension (21% of the target population [5]), two years after the introduction of the program [7]. However,

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sustainability of such program effects is essential. Here, we report the longer-term effect of the KSHI program on BP in the hypertensive population and, in addition to our previous study, we evaluated the contribution of improved quality of care in the program clinics.

2. Methods

The KSHI program is a voluntary health insurance program that aims to improve access to affordable quality healthcare for people in rural communities of Kwara State, Nigeria. The program provides coverage for primary and limited secondary healthcare, including antihypertensive treatment. In addition, the program improves the quality of care in healthcare facilities participating in the program by upgrading of facilities, training of staff in guideline-based care, and hospital management support (see supplemental material [eMethods] for a more detailed description of the program) [7].

2.1. Study design and population

We used a quasi-experimental design to measure the effect of the KSHI program on BP in hypertensive adults. We compared changes in outcomes from baseline (pre-program) with those found at midline after 2 years of follow up (short-term) and at endline after 4 years of follow-up (longer-term), in a program area (PA) and in a control area (CA) where the program was not implemented. The difference in changes from baseline between the PA and CA represents the true program effect.

The study population of non-pregnant adults with hypertension was derived from a population-based sample of the Afon and Ajasse Ipo districts in Kwara State. Both districts were low-income rural communities with comparable availability and quality of healthcare services at baseline (see supplemental material [eMethods] for more details on the population and setting) [7]. The KSHI program has been offered to households in the Afon district (the PA) since 2009. The program was not operational in the CA, Ajasse Ipo. Consecutive population-based household surveys were conducted to measure changes in outcomes over time. Household members were interviewed and BP was measured in both areas during the baseline survey in May and June 2009, before the roll out of the insurance program [7]. Households were revisited during the same months for the midline (2011) and endline (2013) surveys. All non-pregnant adults (aged ≥18 years) among 3023 community-dwelling adults who were hypertensive at baseline were eligible for this study. Only eligible individuals with complete follow-up data were included in the analysis.

2.2. Sampling and sample size

A stratified probability sample was drawn from a random sample of enumeration areas and a random sample of households in 2009. The target sample size was 1500 households which was defined based on outcomes to measure the socioeconomic impact of the program [7]. More information about the sampling procedures is given in the supplemental material (eMethods).

2.3. Data collection

Questionnaires to collect demographic, socioeconomic, and medical information were administered by trained interviewers. BP was measured 3 times on the upper left arm in upright position after at least 5 minutes of rest using a validated automated BP device (Omron M6 Comfort; Omron Corporation). The mean value of the second and third measurement was used for analyses [7]. In both areas, respondents with systolic blood pressure (SBP) ≥140 mm Hg or diastolic blood pressure (DBP) ≥90 mm Hg were advised to see a healthcare professional and were provided with an information leaflet. A medicine cabinet survey was conducted in 2013, in which all medications present in the household were identified, each medication was linked to individual household members, and the source (formal or informal provider) was registered [8].

2.4. Ethical review

Ethical clearance was obtained from the ethical review committee of the University of Ilorin Teaching Hospital (04/08/2008, UITH/CAT/189/11/782). Informed consent was obtained from all participants by signature or by fingerprint [7].

2.5. Data analysis

Hypertension was defined as measured SBP ≥140 mm Hg, and/or DBP ≥90 mm Hg, and/or (self-reported) drug treatment for hypertension [7]. *Hypertension stages 1 and 2* were defined as SBP between 140–159 and ≥160 mm Hg respectively and/or DBP between 90–99 and ≥100 mm Hg respectively [9]. *Treatment of hypertension* was defined as individual-linked hypertension medication observed in the medicine cabinet survey, or self-reported hypertension medication use. *Control of BP* (controlled hypertension) was defined as measured SBP <140 mm Hg and DBP <90 mm Hg [7]. *Use of healthcare for hypertension* was defined as a visit to a formal healthcare provider for hypertension in the last 12 months. A *formal healthcare provider* included public and private hospitals and clinics, primary healthcare centers, private physicians and nurses, and pharmacists. *Informal providers* included patent medicine vendors and traditional medicine practitioners and vendors [7].

The difference between the PA and CA in the change in mean SBP and DBP from baseline to midline and baseline to endline was predefined as the primary outcome to measure the effect of the program on health status in the population with hypertension at baseline [7]. Additionally, a pre-defined subgroup analysis based on hypertension severity at baseline was performed. The differences in control of BP and in antihypertensive drug treatment coverage between respondents in the PA and CA over time constituted secondary outcome measures. In addition to these outcome measures, we used proxies for quality of care to evaluate differences in quality between the two areas, in the endline survey. These included the intensity of healthcare utilization for hypertension, source of hypertension medication (formal healthcare provider versus an informal provider) and association with BP reduction, and adherence to antihypertensive medication.

2.6. Statistical analysis

We analyzed the data using Stata (version 12.0; StataCorp). We analyzed population characteristics of the participants with hypertension in the PA and CA using descriptive statistics. We compared groups using bivariable analysis (Kruskal–Wallis test for continuous variables, Pearson χ^2 test or Fisher exact test for categorical variables, and nonparametric trend test for ordinal scales) [7]. Difference-in-differences analyses with fixed effects [10] were performed to compare changes in outcome over time. With this approach, all respondents in the PA were considered to be in the intervention group irrespective of whether respondents were actually insured. Such an intention-to-treat approach eliminates the bias introduced by self-selection into (or out of) the insurance program and incorporates potential spillover effects on uninsured respondents who might also benefit from the quality improvement of the healthcare facilities in the PA [7]. Biomedical and socioeconomic confounders were defined a priori and included in the models irrespective of statistical significance. The variables included were body mass index, diabetes mellitus, smoking status, assets, the value of household food consumption and expenditures on nonfood items (a socioeconomic measure that proxies a household's yearly income, hereinafter referred to as consumption), employment, household size, being the head of the household, and marital status. The common trend assumption in a difference-in-differences analysis is that the two groups compared show the same trend over time without the intervention [10]. Baseline differences between the groups being compared may influence the effect of the intervention or the effect of the baseline screening of BP and possibly undermine the common trend assumption. Therefore, we corrected for baseline differences by including an interaction between time (follow-up survey year) and a priori selected characteristics, if significant at a 0.10 significance level [11]. These included interactions between follow-up survey year and age, gender, baseline BP (primary outcomes) or baseline hypertension severity (secondary outcomes), educational level, religious affiliation and consumption. Furthermore, we performed a multivariable linear regression analysis to evaluate the association between the location where respondents obtained antihypertensive medication (source of medication) and BP reduction from baseline to endline. Confounders were selected a-priori and included in the model when statistically relevant ($P < 0.10$). All estimates were corrected for clustering at enumeration area level and lower levels of clustering such as household and individual level. To evaluate the effect of missing data (mainly because of attrition), sensitivity analyses using inverse probability weighting were performed for the main outcome measures.

3. Results

3.1. Survey response rate and attrition

Of the 1500 sampled households, 187 households could not be located and were replaced by other households to reach the sample size of 1500, at baseline. Of 1500 eligible households, 1450 (96.7%) participated in the survey, including 559 non-pregnant adults identified with hypertension at baseline (309 of 1637 non-pregnant adults in the PA [18.9%] and 250 of 1048 in the CA [23.9%]). Longitudinal data were available for 332 hypertensive adults (59.4%); 194 (62.8%) in the PA and 138 (55.2%) in the CA (Fig. 1).

Thirty-one respondents (10%) died between 2009 and 2013 in the PA compared to 19 respondents (7.6%) in the CA ($P = 0.32$). Frequently reported causes of death were infectious diseases and old age. In both the PA and CA, stroke was the cause of death for two subjects, and diabetes complications for one subject.

3.2. Population characteristics at baseline

Median age was 60 (IQR, 48–70) in the PA compared to 55 (IQR, 47–62) ($P = 0.05$) in the CA. The percentage of females was 71.6% in the PA compared to 59.4% ($P = 0.02$) in the CA. Median BMI was 22.7 (IQR, 20.3–26.2) in the PA compared to 24.2 (IQR, 21.1–27.8) ($P = 0.02$) in the CA. Median consumption was USD 655.8 (IQR, 426–1079) in the PA compared to USD 819.6 (IQR, 583–1190) ($P = 0.001$) in the CA. In

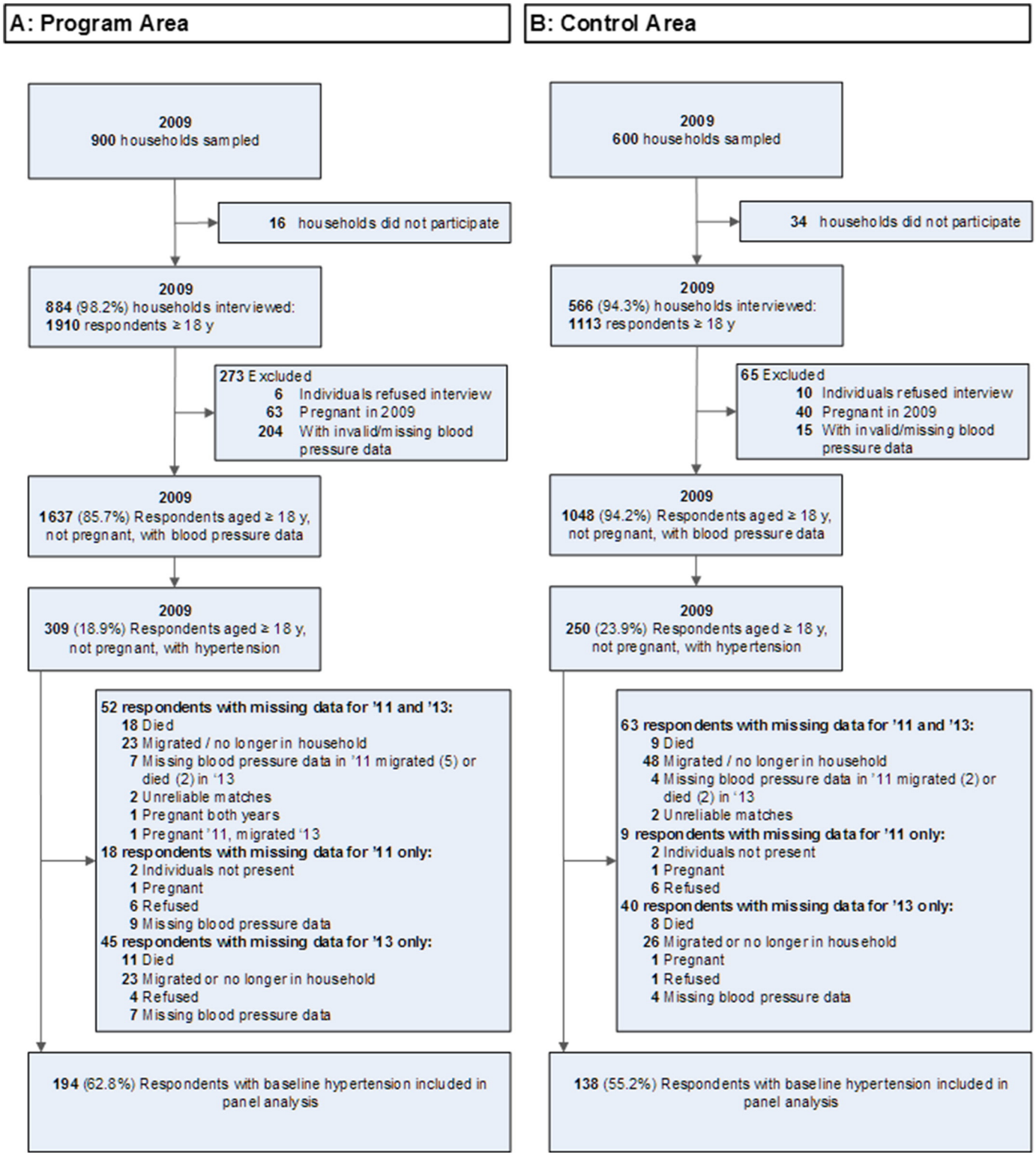

Fig. 1. Participation in the 2009, 2011 and 2013 surveys and reasons for attrition.

the PA, 71.6% of the household heads of the participants had no formal education compared to 48.6% in the CA ($P = 0.001$). In the PA 29.4% of the respondents had visited a formal healthcare provider in the 12 months prior to the baseline survey compared to 39.9% of respondents in the CA ($P = 0.05$). Mean BP and median healthcare expenditure were similar in the two areas at baseline (Table 1).

3.3. Insurance enrollment

None of the hypertensive respondents in the PA and one respondent in the CA (0.5%) were insured at baseline (Table 1). Both at midline and endline, 41.8% of the respondents were insured in the PA. None of the respondents in the CA were insured at the midline and endline surveys.

Table 1
Characteristics of respondents with hypertension at baseline in 2009, 2011 and 2013.

Characteristic	2009			2011			2013		
	Control area ($N = 138$)	Program area ($N = 194$)	P-value[a]	Control area ($N = 138$)	Program area ($N = 194$)	P-value[a]	Control area ($N = 138$)	Program area ($N = 194$)	P-value[a]
Male sex, *n* (%)	56 (40.6)	55 (28.4)	0.02	56 (40.6)	55 (28.4)	0.02	56 (40.6)	55 (28.4)	0.02
Age, median (IQR)	55 (47–62)	60 (48–70)	0.05	57 (49–64)	62 (50–72)	0.05	59 (51–66)	64 (52–74)	0.05
BMI, median (IQR)	24.2 (21.1–27.8)	22.7 (20.3–26.3	0.02	24.2 (21.1–28.1)	22.5 (20.2–26.8)	0.03	24.2 (20.8–28.7)	23.1 (20.3–27.1)	0.07
SBP, mean (SD)	156.4 (23.3)	154.6 (18.9)	0.60	150.7 (24.4)	145.3 (24.7)	0.06	154.2 (30.8)	149.5 (24.9)	0.34
DBP, mean (SD)	98.0 (12.5)	96.0 (10.4)	0.33	95.0 (13.4)	91.3 (13.7)	0.005	94.9 (16.3)	92.1 (13.7)	0.24
Aware of HT, *n* (%)	11 (8.0)	15 (7.7)	0.94	39 (28.3)	61 (31.4)	0.53	39 (28.3)	62 (32.0)	0.47
Treated for HT, *n* (%)	10 (7.2)	13 (6.7)	0.85	18 (13.0)	28 (14.4)	0.72	37 (26.8)	48 (24.7)	0.67
Controlled HT, *n* (%)	7 (5.1)	3 (1.5)	0.10	37 (26.8)	75 (38.7)	0.02	38 (27.5)	57 (29.4)	0.71
HT severity									
HT stage 1[b], *n* (%)	67 (48.6)	109 (56.2)	0.17	46 (33.3)	49 (25.3)	0.11	36 (26.1)	58 (29.9)	0.45
HT stage 2[c], *n* (%)	64 (46.4)	82 (42.3)	0.46	55 (39.9)	70 (36.1)	0.48	64 (46.4)	79 (40.7)	0.31
HT controlled, *n* (%)	7 (5.1)	3 (1.5)	0.10	37 (26.8)	75 (38.7)	0.02	38 (27.5)	57 (29.4)	0.71
DM, *n* (%)	9 (6.5)	5 (2.6)	0.10	9 (6.5)	3 (1.5)	0.03	14 (10.1)	10 (5.2)	0.08
Smoke, *n* (%)	5 (3.6)	12 (6.2)	0.33	4 (2.9)	12 (6.2)	0.20	3 (2.2)	6 (3.1)	0.74
Alcohol, *n* (%)	11 (8.0)	8 (4.1)	0.14	16 (11.6)	8 (4.1)	0.01	19 (13.8)	7 (3.6)	0.001
Educational level household head, *n* (%)									
No formal education	67 (48.6)	139 (71.6)	<0.001	67 (48.6)	139 (71.6)	<0.001	67 (48.6)	139 (71.6)	<0.001
Primary	31 (22.5)	34 (17.5)		31 (22.5)	34 (17.5)		31 (22.5)	34 (17.5)	
Secondary	16 (11.6)	8 (4.1)		16 (11.6)	8 (4.1)		16 (11.6)	8 (4.1)	
Tertiary	24 (17.4)	13 (6.7)		24 (17.4)	13 (6.7)		24 (17.4)	13 (6.7)	
Consumption per capita in US$,[d] median (IQR)	819.6 (583–1190)	655.8 (426–1079)	0.001	773.7 (519–1096)	620.3 (412–887)	0.001	801.1 (529–1126)	613.2 (406–973)	<0.001
Insured, *n* (%)	1 (0.7)	0 (0.0)	0.42	0 (0.0)	81 (41.8)	<0.001	0 (0.0)	81 (41.8)	<0.001
Visited formal healthcare provider in last 12 months, *n* (%)	55 (39.9)	57 (29.4)	0.05	55 (39.9)	103 (53.1)	0.02	66 (47.8)	100 (51.5)	0.51
Annual healthcare expenditures in US$[e], median (IQR)	6.0 (2.5–14.5)	6.1 (2.0–15.0)	0.49	5.1 (1.6–5.7)	2.5 (1.0–7.9)	0.001	8.5 (2.9–17.6)	4.2 (1.6–14.0)	0.002

Abbreviations: BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HT: hypertension, IQR: interquartile range, DM: diabetes mellitus.
[a] Indicates difference control − program area (categorical variables: χ^2 test/Fisher exact test, continuous variables: Kruskal–Wallis, ordinal variables: NP trend test).
[b] Defined as systolic blood pressure between 140 and 159 mm Hg and/or diastolic blood pressure between 90 and 99 mm Hg.
[c] Defined as systolic blood pressure of at least 160 mm Hg and/or diastolic blood pressure of at least 100 mm Hg.
[d] Indicates household expenditures on food and nonfood items (socioeconomic measure of wealth), corrected for inflation.
[e] Excludes premium, corrected for inflation.

3.4. Program effect

3.4.1. Effect on blood pressure

Mean SBP decreased by 9.30 mm Hg from baseline to midline and by 5.11 mm Hg from baseline to endline in the PA compared to 5.67 mm Hg and 2.25 mm Hg respectively in the CA. Mean DBP decreased by 4.67 mm Hg from baseline to midline and 3.82 mm Hg from baseline to endline in the PA, compared to 2.99 mm Hg and 3.12 respectively in the CA (Fig. 2). After adjusting for confounders, the decrease in SBP that could be attributed to the program was 5.5 mm Hg (95% CI, 0.60 to 10.41 mm Hg; $P = 0.03$) at midline and 4.97 mm Hg (95% CI, −0.76 to +10.71 mm Hg; $P = 0.09$) at endline for SBP and 2.88 mm Hg (95% CI, 0.46 to 5.30 mm Hg; $P = 0.02$) at midline and 1.81 mm Hg (95% CI, −1.06 to +4.68 mm Hg; $P = 0.21$) at endline for DBP (Table 2). The sensitivity analysis to estimate the effect of attrition yielded very consistent results with an estimated effect of the program of 5.54 mm Hg (95% CI, −0.32 to +11.40 mm Hg; $P = 0.06$) SBP and 1.94 mm Hg (95% CI, −0.95 to +4.83 mm Hg, $P = 0.19$) DBP in 2013 (eTable1).

The program effect on BP at midline was mainly driven by respondents with stage 1 hypertension at baseline who showed a 6.03 mm Hg (95% CI, 0.14 to 11.92 mm Hg; $P = 0.05$) greater decrease in SBP and a 3.64 mm Hg (95% CI, 0.11 to 7.17 mm Hg; $P = 0.04$) greater decrease in DBP compared to the CA. The program effect at endline was mainly driven by respondents with stage 2 hypertension at baseline who showed an 11.43 mm Hg (95% CI, 1.62 to 21.23 mm Hg; $P = 0.02$) greater decrease in SBP and a 3.15 mm Hg (95% CI, −1.22 to +7.53 mm Hg; $P = 0.16$) greater decrease in DBP compared to the CA (Table 3, eFigures 2–3).

3.4.2. Blood pressure control

The number of respondents with controlled BP increased from 3 respondents (1.5%) at baseline to 57 respondents (29.4%) at endline in the PA and from 7 respondents (5.1%) at baseline to 38 respondents (27.5%) at endline in the CA (Table 1). When correcting for confounders the program effect was estimated at an 11 percentage point (95% CI, 1 to 21; $P = 0.03$) increase in BP control at midline and a 4 percentage point (95% CI, −5 to 13; $P = 0.38$) increase at endline (Table 2).

3.4.3. Hypertension treatment coverage

Coverage of antihypertensive drug treatment increased from 13 respondents (6.7%) at baseline to 48 respondents (24.7%) at endline in the PA and from 10 respondents (7.2%) at baseline to 37 respondents (26.8%) at endline in the CA (Table 1). When correcting for confounders the program effect was estimated at a 9 percentage point (95% CI, 0 to 17; $P = 0.046$) increase in treatment coverage at midline and a 5 percentage point (95% CI, −5 to 14; $P = 0.36$) increase at endline (Table 2).

3.4.4. Quality of hypertension care

At endline, 25.3% of the respondents in the PA and 21% of the respondents in the CA ($P = 0.37$) reported healthcare use for hypertension. Monitoring of hypertension was more intense in the PA with a mean number of visits in the year prior to the endline survey of 8.5 (SD: 5.03) in the PA compared to 4.8 (SD: 4.06) in the CA ($P = 0.002$) (eTable2). Respondents in the PA who visited a healthcare professional had less out-of-pocket expenditures for hypertension care during their last visit (2.10 USD [SD: 6.02] compared to 7.11 USD [SD: 5.74], $P = 0.001$) (eTable2).

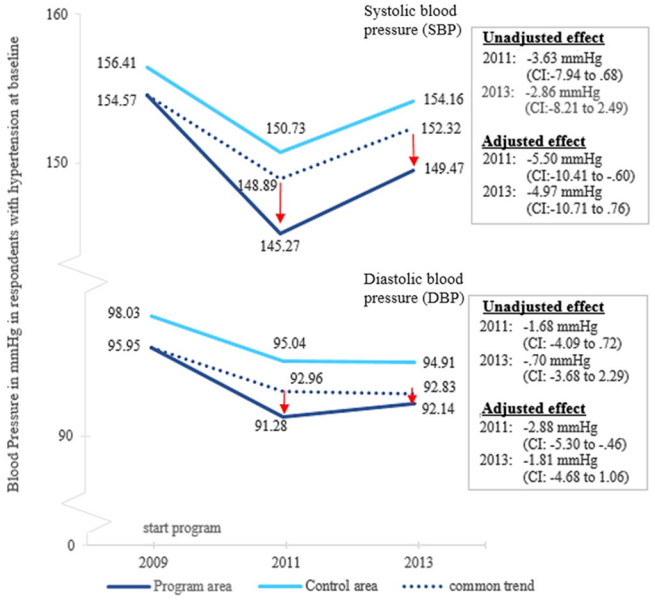

Fig. 2. Change in mean blood pressure over time in respondents with hypertension at baseline. Note: The common trend assumption is the assumption that in absence of the program, the program area would follow the trend observed in the control area, this is visualized in the figure above by the 'common trend' line. The difference between the common trend and the program area, represented by the arrows is the program effect. Sample size for unadjusted and adjusted analysis was 996. All adjusted estimates corrected for: being household head, marital status, work in past year, household size, yearly per capita consumption excluding healthcare expenditures — corrected for inflation, wealth indicator based on asset score 2009, diabetes, smoking and BMI-class. Interactions of time (follow-up survey year) with education, age and baseline SBP and DBP respectively were included in all adjusted estimates. All estimates were corrected for clustering at enumeration area level and lower levels such as household and individual level.

Thirty-eight out of 45 (84.4%) respondents on treatment in the PA at endline, for whom the source of medication was known, obtained their antihypertensive medication from a formal healthcare provider compared to 16 out of 37 respondents (43.2%) in the CA ($P < 0.001$) (eTable2). Respondents using medication obtained from a formal healthcare provider showed a 10.96 mm Hg (95% CI, 1.31 to 20.61 mm Hg; $P = 0.03$) greater decrease in SBP and a 7.03 mm Hg (95% CI, 3.07 to 11.00 mm Hg; $P = 0.001$) greater decrease in DBP from baseline to endline compared to respondents who were not using medication (both areas combined). Respondents who obtained medication from an informal provider, showed similar non-significant decrease in BP compared to respondents who were not using antihypertensive medication (decrease of 3.72 mm Hg SBP; 95% CI, −10.78 to +18.23 mm Hg; $P = 0.61$ and 1.75 mm Hg DBP; 95% CI, −6.07 to +9.57 mm Hg; $P = 0.66$) (eTable3). Respondents who were on treatment in the PA were more likely to be highly adherent to their treatment (86.1%), compared to respondents in the CA (50%, $P = 0.003$) (eTable2).

4. Discussion

Access to improved quality healthcare through health insurance was associated with a significant longer-term reduction in BP in subjects with moderate to severe (stage 2) hypertension, who are at highest risk of CVD [12,13]. The observed difference in SBP reduction between the PA and CA of 11.43 mm Hg, four years after start of the program, translates into a more than 38% reduction in the risk of stroke and a more than 26% reduction in the risk of ischemic heart disease [3]. Improved access to higher quality care in the PA has likely contributed to the greater BP reduction. Respondents on treatment in the PA were twice as likely to obtain their medication from a formal healthcare provider compared to respondents on treatment in the CA. Almost 60% of respondents in the CA purchased (often cheaper) medication from informal providers. This medication did not add any benefit over not using any medication in reducing BP, suggesting poor quality treatment. In addition, respondents in the PA were more intensely monitored, reported better adherence to treatment, and incurred lower out-of-pocket expenditures for hypertension care compared to the CA.

Mean BP in the overall hypertensive population (stage 1 and 2) decreased in both the PA and the CA between baseline and midline. This is most likely the result of the increased awareness of hypertension after our baseline survey, which resulted in increased treatment coverage in both the PA and the CA. However, a twofold greater reduction in mean BP was observed in the PA compared to the CA, probably due to

Table 2
Effect of the insurance program on respondents with hypertension at baseline.

	Difference-in-differences[a]					
	Unadjusted analyses			Adjusted analyses		
	Coefficient	95% CI	*P*- value	Coefficient	95% CI	*P*-value
Systolic blood pressure (SBP)						
Difference in change 2011 from baseline between areas	−3.63	(−7.94 to .68)	0.098	−5.50	(−10.41 to −.60)	0.028
Difference in change 2013 from baseline between areas	−2.86	(−8.21 to 2.49)	0.291	−4.97	(−10.71 to .76)	0.088
Diastolic blood pressure (DBP)						
Difference in change 2011 from baseline between areas	−1.68	(−4.09 to .72)	0.168	−2.88	(−5.30 to −.46)	0.020
Difference in change 2013 from baseline between areas	−0.70	(−3.68 to 2.29)	0.644	−1.81	(−4.68 to 1.06)	0.213
Controlled hypertension (HT)						
Difference in change 2011 from baseline between areas	0.15	(.06 to .25)	0.002	0.11	(.01 to .21)	0.029
Difference in change 2013 from baseline between areas	0.05	(−.05 to .16)	0.310	0.04	(−.05 to .13)	0.377
Drug treatment for hypertension (HT)						
Difference in change 2011 from baseline between areas	0.02	(−.07 to .11)	0.658	0.09	(.001 to .17)	0.046
Difference in change 2013 from baseline between areas	−0.02	(−.11 to .08)	0.760	0.05	(−.05 to .14)	0.360

The coefficient for the variable "Difference in change from baseline between areas" measures the difference in change from baseline between the program area and the control area and reflects the true effect of the program in 2011 and 2013 respectively.

[a] Number of observations for unadjusted and adjusted analysis was 996 (332 patients with each 3 observations). All adjusted estimates corrected for: being household head, marital status, work in past year, household size, yearly per capita consumption excluding healthcare expenditures — corrected for inflation, wealth indicator based on asset score 2009, diabetes, smoking and BMI-class. The following interactions were included in all adjusted estimates: for SBP and DBP outcomes: interaction of time (follow-up survey year) with education, age and baseline SBP and DBP respectively. For controlled HT: interaction of time (follow-up survey year) with education and baseline HT severity. For treatment HT: interaction of time (follow-up survey year) with education, religion, age, sex and baseline HT severity. All estimates were corrected for clustering at enumeration area level and lower levels such as household and individual level.

Table 3
Effect of the insurance program on respondents with hypertension at baseline; stratified by baseline hypertension severity.

	Difference-in-differences[a]					
	Unadjusted analyses			Adjusted analyses		
	Coefficient	95% CI	*P*- value	Coefficient	95% CI	*P*- value
Baseline stage 1[b] hypertension (HT)						
Systolic blood pressure (SBP)						
Difference in change 2011 from baseline between areas	-4.97	(−10.49 to .55)	0.077	−6.03	(−11.92 to −.14)	0.045
Difference in change 2013 from baseline between areas	−1.47	(−7.78 to 4.84)	0.643	−1.64	(−7.93 to 4.65)	0.605
Diastolic blood pressure (DBP)						
Difference in change 2011 from baseline between areas	−2.38	(−5.81 to 1.06)	0.172	−3.64	(−7.17 to −.11)	0.043
Difference in change 2013 from baseline between areas	−1.63	(−5.44 to 2.18)	0.397	−2.01	(−5.70 to 1.68)	0.282
Baseline stage 2[c] hypertension (HT)						
Systolic blood pressure (SBP)						
Difference in change 2011 from baseline between areas	−1.96	(−9.01 to 5.08)	0.580	−5.54	(−14.43 to 3.34)	0.218
Difference in change 2013 from baseline between areas	−5.67	(−14.86 to 3.51)	0.222	−11.43	(−21.23 to −1.62)	0.023
Diastolic blood pressure (DBP)						
Difference in change 2011 from baseline between areas	−1.19	(−5.43 to 3.04)	0.576	−2.50	(−6.24 to 1.25)	0.188
Difference in change 2013 from baseline between areas	−.28	(−4.64 to 4.07)	0.897	−3.15	(−7.53 to 1.22)	0.155

The coefficient for the variable "Difference in change from baseline between areas" measures the difference in change from baseline between the program area and the control area and reflects the true effect of the program in 2011 and 2013 respectively.

[a] The number of observations for the unadjusted and adjusted analysis was 528 for hypertension stage 1 and 438 for hypertension stage 2 (3 observations for each individual with measured hypertension at baseline). 30 observations (10 individuals with a normal blood pressure at baseline who were classified as hypertensive because they were using antihypertensive treatment) were excluded from this analysis. All adjusted estimates corrected for: being household head, marital status, work in past year, household size, yearly per capita consumption excluding healthcare expenditures — corrected for inflation, wealth indicator based on asset score 2009, diabetes, smoking and BMI-class. The following interactions were included in all adjusted estimates: interaction of time (follow-up survey year) with education, age and baseline SBP and DBP respectively. All estimates were corrected for clustering at enumeration area level and lower levels such as household and individual level.

[b] HT stage 1 is defined as systolic blood pressure between 140 and 159 mm Hg and/or diastolic blood pressure between 90 and 99 mm Hg.

[c] HT stage 2 is defined as systolic blood pressure of at least 160 mm Hg and/or diastolic blood pressure of at least 100 mm Hg.

better quality care in the PA [7]. Sustained BP reductions require long term access and adherence to uninterrupted quality treatment [14]. Even in high income countries where access to care is guaranteed, it is difficult to motivate patients to adhere to antihypertensive medication and treatment monitoring for longer periods of time [15,16]. This may explain the increase in BP in both areas observed between midline and endline in respondents with mild (stage 1) hypertension. In addition, in any ageing cohort, BP increases over time [17]. However, in the PA, SBP reduction was sustained in the longer-term in respondents with more severe hypertension, who may be more motivated to continue treatment. This finding highlights the potential of health insurance programs, which include improvement of quality of care, to achieve sustained CVD risk factor control in vulnerable populations in LMICs.

A limited number of studies from LMICs evaluated the effect of insurance on health outcomes, and have provided conflicting results [18–27]. A lack of quality of care as well as possible methodological limitations such as small sample sizes, inadequate control for potential reverse causality, and other confounding factors, and the use of health outcome measures that are not suitable to capture changes in health status, have been mentioned as a potential reason for a lack of effect in some studies [19–21,25]. Most studies compared insured with non-insured individuals and selection bias in those insured is likely to occur. In addition, very few studies evaluated longer-term effects [24,26,27], which is essential to determine whether health insurance can be effective for treatment of chronic conditions. Our study demonstrates that access to high quality care through health insurance resulted in sustained health effects. The strength of our study is the longer-term prospective follow up, and the conservative intention-to-treat analysis approach to eliminate selection bias. In our study, 58% of the individuals in the PA were not enrolled in the insurance program at the time of the surveys, thereby diluting the effect of insurance. However, this reflects a real world situation in which not all individuals choose to enroll and increases the generalizability of our results to other rural settings in SSA. It is remarkable that we were able to demonstrate longer-term health benefits using such a conservative analysis approach [7].

A limitation of our study was the non-randomized rollout of the insurance program. We used a second best approach by including a control group and by analyzing the data using difference-in-differences analysis. Socioeconomic status at baseline was higher and respondents were younger in the CA compared to the PA. Respondents unaware of their hypertension at baseline who are more educated and wealthier are probably more likely to seek care after BP screening. In addition, BP reduction is more difficult to achieve in older patients [28,29]. These baseline differences between groups are likely to reduce the estimated effect of the insurance program and explain the difference between the observed effects of the insurance program in the unadjusted and adjusted analyses. Longitudinal data were not available for 41.6% of the study population. Given the setting of our study in rural SSA, where migration is common and people are difficult to track, the observed attrition rate after four years is relatively low. In addition, the results of the sensitivity analyses indicated that our results were robust and that attrition did not affect our findings.

5. Conclusions

Increased access to and improved quality of healthcare through an insurance program was associated with a significant longer-term reduction in BP in subjects with moderate to severe hypertension, who are at highest risk of CVD. Scale-up of health insurance programs that cover costs of care and improve the quality of care is needed to combat the increasing burden of CVD in SSA.

Author contributions

Study concept and design: MEH, FWNMW, OAB, BK, EGW, PA, LMB, GKO, TMA and CS. *Acquisition of data*: MEH, OAB, BK, GKO and TMA. *Analysis and interpretation of data*: MEH, NTAR, FWNMW, DB, LMB, CS. *Drafting of the manuscript*: MEH, NTAR, FWNMW and CS. *Critical revision of the manuscript for important intellectual content*: OAB, BK, DB, EGW, PA, LMB, GKO and TMA. *Statistical analysis*: MEH, NTAR, FWNMW and DB. *Administrative, technical, or material support*: OAB, GKO and TMA. *Study supervision*: FWNMW, EGW, LMB, GKO, TMA and CS. *Final approval of the version to be submitted*: MEH, NTAR, FWNMW, OAB, BK, DB, EGW, PA, LMB, GKO, TMA and CS.

Declaration of Interest

Dr Adenusi is the managing director of Hygeia Community Health Care and Hygeia Foundation.

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Role of the sponsors

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ijcard.2015.09.036.

References

[1] S.S. Lim, T. Vos, A.D. Flaxman, G. Danaei, K. Shibuya, A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010, Lancet 380 (9859) (2012) 2224–2260.

[2] D. Adeloye, C. Basquill, Estimating the prevalence and awareness rates of hypertension in Africa: a systematic analysis, PLoS One 9 (8) (2014), e104300, http://dx.doi.org/10.1371/journal.pone.0104300.

[3] C.M. Lawes, S. Vander Hoorn, M.R. Law, P. Elliott, S. MacMahon, A. Rodgers, High blood pressure, Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors, World Health Organization, Vol Geneva 2004, pp. 281–390 (http://apps.who.int/iris/bitstream/10665/42792/1/9241580348_eng_Volume1.pdf#page=305. Accessed September 19, 2014).

[4] M.M. Ibrahim, A. Damasceno, Hypertension in developing countries, Lancet 380 (9841) (2012) 611–619.

[5] M.E. Hendriks, F.W.N.M. Wit, M.T.L. Roos, et al., Hypertension in sub-Saharan Africa: cross-sectional surveys in four rural and urban communities, J. Atashili (Ed.)PLoS One 7 (3) (2012), e32638, http://dx.doi.org/10.1371/journal.pone.0032638.

[6] The World Bank, Out-of-pocket health expenditure (% of total expenditure on health), http://data.worldbank.org/indicator/SH.XPD.OOPC.TO.ZS/countries/1W-C9-ZG-NG-ZF-A4?display=default2014 (Accessed September 1, 2014).

[7] M.E. Hendriks, F.W.N.M. Wit, T.M. Akande, et al., Effect of health insurance and facility quality improvement on blood pressure in adults with hypertension in Nigeria: a population-based study, JAMA Intern. Med. 174 (4) (2014) 555–563, http://dx.doi.org/10.1001/jamainternmed.2013.14458.

[8] A. Hardon, C. Hodgkin, D. Fresle, How to investigate the use of medicines by consumers, World Health Organization and University of Amsterdam, 2004.

[9] National High Blood Pressure Education Program, The seventh report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure, 2004 (http://www.ncbi.nlm.nih.gov/books/NBK9621/. Accessed November 28, 2014).

[10] S.B. Khandker, G.B. Koolwal, H.A. Samad, Handbook on Impact Evaluation: Quantitative Methods and Practices, The World Bank, Washington, D.C., 2009 (http://elibrary.worldbank.org/doi/book/10.1596/978-0-8213-8028-4. Accessed May 7, 2014).

[11] J. Wooldridge, Introductory Econometrics: A Modern Approach, Cengage Learning, 2012 (http://books.google.com/books?hl=en&lr=&id=aTsWAAAAQBAJ&oi=fnd&pg=PP1&dq=%22have+nothing+to+do+with+macroeconomic+forecasting.+For+example,+we+will%22+%22in+the+natural+sciences,+but+they+are+much+more+difficult+to+obtain+in%22+%22STEPS+IN+EMPIRICAL+ECONOMIC%22+&ots=oWnAvnXTQe&sig=DSjjfbOPOEnP0VuueEs1zqPhtsA. Accessed July 7, 2014).

[12] G. Mancia, R. Fagard, K. Narkiewicz, et al., 2013 ESH/ESC guidelines for the management of arterial hypertension: The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC), J. Hypertens. 31 (7) (2013) 1281–1357, http://dx.doi.org/10.1097/01.hjh.0000431740.32696.cc.

[13] E. Rapsomaniki, A. Timmis, J. George, et al., Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1 · 25 million people, Lancet 383 (9932) (2014) 1899–1911.

[14] B.M. Egan, Y. Zhao, R.N. Axon, W.A. Brzezinski, K.C. Ferdinand, Uncontrolled and apparent treatment resistant hypertension in the United States, 1988 to 2008, Circulation 124 (9) (2011) 1046–1058, http://dx.doi.org/10.1161/CIRCULATIONAHA.111.030189.

[15] World Health Organization, Adherence to Long-Term Therapies — Evidence for Action, World Health Organization, Vol Sabaté, E. Geneva, 2003 (http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=114059. Accessed October 15, 2014).

[16] J.R. Caldwell, S. Cobb, M.D. Dowling, D. de Jongh, The dropout problem in antihypertensive treatment: a pilot study of social and emotional factors influencing a patient's ability to follow antihypertensive treatment, J. Chronic Dis. 22 (8) (1970) 579–592.

[17] M. Hamer, R. von Känel, M. Reimann, et al., Progression of cardiovascular risk factors in black Africans: 3 year follow up of the SABPA cohort study, Atherosclerosis 238 (1) (2015) 52–54, http://dx.doi.org/10.1016/j.atherosclerosis.2014.11.019.

[18] A. Acharya, S. Masset Edoardo, F. Taylor, et al., The impact of health insurance schemes for the informal sector in low-and middle-income countries: a systematic review, World Bank Policy Res Work Pap., 6324, 2013 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2202686. Accessed June 26, 2013).

[19] M.-L. Escobar, C.C. Griffin, Shaw, The Impact of Health Insurance in Low- and Middle-Income Countries, Brookings Institution Press, Washington, D.C., 2010 (http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=349274. Accessed October 17, 2014).

[20] A.B. Comfort, L.A. Peterson, L.E. Hatt, Effect of health insurance on the use and provision of maternal health services and maternal and neonatal health outcomes: a systematic review, J. Health Popul. Nutr. 31 (4) (2014) S81–S105.

[21] U. Giedion, E.A. Alfonso, Y. Díaz, The Impact of Universal Coverage Schemes in the Developing World: A Review of the Existing Evidence, The World Bank, Washington DC, 2013 (http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Images/IMPACTofUHCSchemesinDevelopingCountries-AReviewofExistingEvidence.pdf. Accessed June 26, 2013).

[22] E.K. Ansah, S. Narh-Bana, S. Asiamah, et al., Effect of removing direct payment for health care on utilisation and health outcomes in Ghanaian children: a randomised controlled trial, PLoS Med. 6 (1) (2009), e1000007, http://dx.doi.org/10.1371/journal.pmed.1000007.

[23] S.N. Bleich, D.M. Cutler, A.S. Adams, R. Lozano, C.J.L. Murray, Impact of insurance and supply of health professionals on coverage of treatment for hypertension in Mexico: population based study, BMJ 335 (7625) (2007) 875, http://dx.doi.org/10.1136/bmj.39350.617616.BE.

[24] A. Wagstaff, M. Pradhan, Health Insurance Impacts on Health and Nonmedical Consumption in a Developing Country, World Bank, 2005 (http://books.google.com/books?hl=nl&lr=&id=hdliV0Fwlv0C&oi=fnd&pg=PA10&dq=Wagstaff+and+Pradhan.+2005.+Health+Insurance+Impacts+on+Health+and+Nonmedical+Consumption+in+a+Developing+Country.&ots=_OHe5sT1s4&sig=NQyB-RZKgmFOAKrt8nl4aoEe2MQ#v=onepage&q&f=false. Accessed February 4, 2015).

[25] R. Moreno-Serra, P.C. Smith, Does progress towards universal health coverage improve population health? Lancet 380 (9845) (2012) 917–923, http://dx.doi.org/10.1016/S0140-6736(12)61039-3.

[26] W.H. Dow, K.A. Gonzalez, L. Rosero-Bixby, Aggregation and Insurance Mortality Estimation, National Bureau of Economic Research, 2003 (http://www.nber.org/papers/w9827. Accessed February 4, 2015).

[27] L. Cheng, H. Liu, Y. Zhang, K. Shen, Y. Zeng, The impact of health insurance on health outcomes and spending of the elderly: evidence from China's new cooperative medical scheme: impact of NCMs on health outcomes and health spending, Health Econ. (April 2014)http://dx.doi.org/10.1002/hec.3053 (n/a - n/a).
[28] D.M. Lloyd-Jones, J.C. Evans, M.G. Larson, C.J. O'Donnell, E.J. Roccella, D. Levy, Differential control of systolic and diastolic blood pressure factors associated with lack of blood pressure control in the community, Hypertension 36 (4) (2000) 594–599.
[29] I. Hajjar, T.A. Kotchen, Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988–2000, JAMA 290 (2) (2003) 199–206.