

Hypertension Analysis from the National Income Dynamics Survey-South Africa
Field Work in Zimbabwe Investigating the Usefulness of Home Blood Pressure
Monitors to Control Hypertension

by

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Thesis submitted in partial fulfillment of
the requirements for the degree of Master of Science in the
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ABSTRACT

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Abstract

This study was conducted using data that was collected as part of the National Income Dynamic Study (NIDS). We hypothesized that in the NIDS study conducted in South Africa this phenomenon would be observed as a rise in the first blood pressure and a drop to normal on the second reading. We then set out to investigate whether this phenomenon would be more pronounced among those with limited access to medical services such as those in the rural areas, those from low-income homes, the population with little or no education and lastly the black or colored population. Our analysis revealed that the white coat effect did indeed exist significantly among black races and the colored race but was not dependent on sex, education level, or income level. Based on the inaccuracies that come from the white coat effect and the resulting preference for home or ambulatory blood pressure readings we then set out to investigate whether those with home blood pressure monitors would have better blood pressure control than those individuals without home blood pressure monitors. This investigation was carried out in Zimbabwe for 10 weeks and will go on for a year. From the 10week results, it would seem those individuals with home blood pressure monitors achieved better blood pressure control than individuals without home blood pressure monitors. It seems this was a function of a higher number of clinic visits that were made by those with home

blood pressure monitors compared to individuals who did not have home blood pressure monitors.

Dedication

This thesis is dedicated to my home country Zimbabwe. The country that raised me and instilled within me the values that I hold so dear and have brought me this far. The country that has been the driving force behind my academic pursuits.

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Acknowledgements

I would like to acknowledge Dr. Duncan Thomas for all the help he gave me in working on the thesis as well as the field work. I would also like to acknowledge Duke Global Health Institute for the funding and an A-class education.

1. INTRODUCTION

1.1 Definition of the white Coat Effect

The white coat effect has been described in numerous papers as the rising of a patient's blood pressure in the clinical setting giving the impression that the patient has hypertension when in fact they do not.[1] The phenomenon is attributed to either the white coats or just being in the clinic which falsely raises one's blood pressure. This phenomenon has also been exhibited in hypertensive patients who record a higher blood pressure reading in the clinical setting compared to their ambulatory blood pressure. In our investigation due to the limitation of the data we had available we defined the white coat effect as having a difference in the 1st and 2nd blood pressure reading that was obtained in the field, where the 2nd blood pressure reading was lower than the 1st blood pressure reading.

1.2 Cardiovascular effects of the white Coat effect

The white coat effect has important clinical implications. A study undertaken by Paolo et al (1997) revealed that there was a relationship between the white-coat effect and the cardiovascular complications of hypertension.[3] The study showed that subjects with a high white-coat effect showed a greater degree of hypertensive complications than those with intermediate or a low white-coat effect. The researchers used a two-way ANOVA to show that both ambulatory blood pressure and the white-coat effect were related to the degree of target organ damage and to left ventricular hypertrophy.[3] In addition, daytime blood pressure and the white-coat effect showed an interactive effect

on hypertensive complications, as the influence of the white-coat effect on end organs increased with increasing levels of ambulatory blood pressure. Similarly, a study conducted by Strandberg et al (2000) also revealed that white coat hypertension or a large white coat effect is not an innocent phenomenon. It tends to co-/exist with metabolic risk factors and predicts total and cardiovascular mortality during long-term follow-up.[4]

1.3 The effect of the white coat effect on prescribing measures

When white-coat hypertensives are prescribed antihypertensive medication there is usually a decrease in clinic blood pressure, but little or no change in the ambulatory blood pressure.[5] Thus drug treatment is not necessarily indicated if anything could be harmful in causing a patient to be hypotensive. If not harmful, there is literature that there are no health benefits on morbid events if one treats patients with white-coat hypertension.[34] Since hypertension is a chronic disease such medication tends to be costly when taken for one's lifetime. Another issue is the follow-up of white-coat hypertensives; there is general agreement that blood pressure outside the office should be monitored indefinitely. Some patient may have been wrongly classified as white-coat hypertensives which is a label that stays with them even if they may progress to develop sustained hypertension.[5]

1.4 Definition of the white Coat effect using NIDS data

In the NIDS survey the researchers obtained two blood pressure readings from participants older than 15years who were present in the home at the time of the survey. These readings were supposed to give an indication of the prevalence of hypertension in

the population. Since these readings were collected in a the home setting, an environment presumably comfortable for the respondent one would expect little variation between the 1st and 2nd blood pressure reading. More specifically, one would not expect the white coat effect to be exhibited in the home setting, especially when the readings were taken by none-clinical personnel.

However, if this phenomenon was exhibited in the home setting it would be more pronounced in the clinical setting as shown by the study conducted by Myers et al (1997). In their investigation, they discovered that of the 147 patients enrolled; the proportion of patients with a white coat effect (defined as office — ambulatory blood pressure $\geq 20/10$ mm Hg) was significantly ($P < .001$) higher when based upon the family physician's routine blood pressure readings (91/147), compared to special readings taken by the family physician for the study (54/147) or readings taken by a research nurse (30/147). [6]

We were trying to highlight that the measured prevalence of hypertension in the survey far exceeds the level that is reported by the respondents. This paper investigates one reason why measures in a population survey might be wrong: it is possible that respondents find the measurement itself stressful and that raises their blood pressure. An ideal study for this purpose might measure blood pressure several times through the course of a long interview and compare a measure at the beginning of the interview with measures at other points in the interview. That is not possible with any existing data. However, you can compare two measures taken a few minutes apart. If bringing out the equipment and putting on an unfamiliar cuff is stressful, we would expect the first

measure to be higher than the second measure. We would also expect this effect to be larger for people who have little experience with the health system and people who are less well-educated.

In this analysis, the goal was to analyze the 1st and 2nd blood pressure readings collected from this study to determine whether they varied, and if so, did the variation follow any particular pattern. We set out to investigate whether the 1st reading always higher, equal or lower to the second reading. Furthermore, we also investigated whether the variations in the 1st and 2nd blood pressure reading were affected by socio-economic status, race, or geographic location.

These variations are important to analyze because one can imagine the error that could result from inconsistent readings in both diagnosing and treating patients. However, this was not a clinical study and so cannot be used in diagnosis but can certainly carry clinical implications. Secondly, if the variation in readings is more prominent in one socio-economic class than another, this could serve as a highlight of certain disparities that exist.

1.5 Parameters used to investigate the white coat effect

Previous literature states that the white coat effect became more pronounced with age and was more prevalent among females than males.[10,11] Myers and Reeves studied the incidence of white coat hypertension (office-ambulatory BP greater than 20/10 mm Hg) in their hypertensive population. A white coat effect was present in 70/87 women, but only in 36/65 men. A severe white coat effect also was more frequent in women

(41/87) than in men (8/65). We set out to investigate whether the same pattern would be observed in this sample population from South Africa.

There are other factors that have been investigated and found to be related to hypertension and the white coat effect that we set out to investigate. For example, an article by Zimmerman et al reports that acutely, stress has been shown to increase blood pressure by increasing cardiac output and the heart rate without affecting total peripheral resistance. Acute stress has been found to increase levels of catecholamines, cortisol, vasopressin, endorphins and aldosterone, which may in part explain the increase in blood pressure. Furthermore, acute stress reduces renal sodium excretion, which contributes to an increase in blood pressure. Several studies suggest that prolonged stress may predispose people and animals to prolonged hypertension and certain populations are at risk for the development of stress-induced hypertension. It is likely that prolonged stress-induced hypertension is the result of neurohormonal trophic factors which cause vascular hypertrophy or atherosclerosis. Because stress can affect measurement of blood pressure due to the phenomenon of 'white-coat hypertension', ambulatory blood pressure monitoring is emerging as an important feature in the evaluation of patients with hypertension.

In particular socio-economic stressors have been studied in relation to hypertension. Primary hypertension is almost twice as prevalent among American blacks as among whites. In the United States there have been numerous studies that have revealed that there is a strong association between SES and race, and it is suggested that the higher prevalence of hypertension and cardiovascular disease in blacks may be attributed to

psychosocial factors, including those related to SES. The possible pathways by which SES affects cardiovascular disease include effects of chronic stress mediated by the brain, differences in lifestyles and behavior patterns, and access to health care.[27] Therefore we also hypothesized that those without access to health care would exhibit the white coat effect more than those with regular visits. We hypothesized those who were least educated, young, black as well as those who lived in the rural areas would more likely exhibit a greater variation between the 1st and 2nd blood pressure reading.

2. METHOD:

2.1 Study population

The data for this study was derived from the National Income Dynamics Study (NIDS). The study was conducted from February to November 2008 by the University of Cape Town. The National Income Dynamics Study (NIDS) was designed as a random sample of the South African population. Households were drawn from the Statistics South Africa (SSA) Master Sample after stratifying the country by region and rural/urban (as defined by SSA). SSA calculated weights to take the sampling design into account and render a sample that is representative of the entire South African population. Thus, the rates of hypertension recorded in the data are indicative of the level in the South African population. One of the goals was to track and understand the shifting face of poverty by closely following more than 28 000 people, representative of the entire population of SA. NIDS was conducted in 2008, by 300 fieldworkers spread out across the country to complete a detailed set of questionnaires with 7305 households. The National Income Dynamics Study (NIDS) used a combination of household and individual level questionnaires. Data was collected from nine provinces of the country in search of the 28 000 people that formed part of the 7305 selected households in 2008. The households were chosen based on the calculated sample weight. The basis of the calculation of the design weights is the information that Stats SA provided to NIDS about the process of two-stage sampling from the Master sample. Two sets of calculations were necessary in deriving the design weights. First there was a calculation of the probability of sampling each primary sampling unit, PSU and, second, there is a calculation about the

probability of including each specific household in each PSU in the NIDS sample. The latter corrects for household non-response. From these calculations a total of 400 PSU's consisting of 24 dwelling units each were targeted. The field workers were instructed to only approach the designated units only.

Within the households, respondents were asked to list all individuals that have lived under this "roof" or within the same compound/homestead at least 15 days during the last 12 months OR who arrived in the last 15 days and this was now their usual residence. In addition the persons listed should share food from a common 'pot' and share resources from a common resource pool. If there is more than one household in a dwelling unit, a separate household control sheet must be completed for every household. All those listed on the household roster are considered household members. All *resident* household members became NIDS panel members.

It is expected that every 2-3years data will be collected from the same individuals even if they move to a different region. The NIDS was conducted as a multi-stage clustering.

2.2 Information gathered

The 2008 NIDS questionnaires gathered information on all members of the household. Information gathered included socio-economic indicators such as education status, household plus individual annual income, living standards, as well as demographic information such as sex, race and age. Each respondent's over 15 years old had their blood pressure measured at the end of the interview.

Important for our investigation was how the blood pressure was measured in the field. When measuring blood pressure the subjects were instructed to sit quietly, for about 5 minutes before taking the measurement. The respondent were to sit up straight (not slouched) on a chair, with both feet on the ground. Legs/ankles must not be crossed. The respondent could not eat, drink or talk while the measurement is being taken.

Tight-fitting clothing was removed from the upper left arm. The cuff was placed around the upper left arm so that the marker on the cuff was 2 cm from the natural crease across the inner part of the elbow. The tube ran down the center of the arm approximately even to the middle finger. The cuff was wrapped snugly but not tight around the arm, with the palm of the participant's hand turned upward. The cuff was secured by wrapping it firmly around the respondents arm and fastening with the Velcro. The field workers should have been be able to fit the first joint of two fingers under the cuff. The two blood pressure readings were taken 3minutes apart.

2.3 Definitions and statistical analysis

The dependent variables we used were the systolic blood pressure and the diastolic blood pressure, these analyses were done separately for simplicity. The independent variables used included race, sex, age, geographic location and education status. In the analysis we kept the original population groups collected which were black, white (reference) and colored, Asian/Indian was dropped because the number of participants in those groups was low. Education was stratified into four classes, namely no education, completed primary school (1st to 7th grade), —some secondary education

(8th grade till 11th grade) then the reference group was those who completed secondary education and higher. The highest education group was picked as a reference group because it had the lowest prevalence of hypertension. Age was broken down to four classes, 15-29 years old which was the reference group, 30-44 years old, 45-59 years old and 60 years old and over. 7

The definitions of rural and urban were designated by Statistics South Africa as urban formal, urban informal, tribal, rural formal. In all years, formal dwelling includes dwelling/house or brick structure on a separate stand or yard or on farm, flat or apartment in a block of flats, town/cluster/semi-detached house (simplex, duplex or triplex), unit in retirement village, dwelling/house/flat in backyard and room/flatlet. Whereas an informal dwelling was defined as a make-shift structure formally referred to as a shack. An urban area is one which has been legally proclaimed as being urban e.g. towns, cities and metropolitan areas. Non-urban, or rural areas include commercial farms, small settlements, rural villages and other areas which are further away from towns and cities. The definition includes semi-urban areas which are not part of a legally proclaimed urban area, but adjoin it. In our study we combined urban formal and urban informal into urban, and rural formal and tribal were combined into rural. Due to the small size of the rural informal sample and for ease of analysis, tribal and rural informal areas were combined into rural area.

3. RESULTS:

3.1 Crude Results of mean blood pressures recorded

After a crude analysis of the 1st systolic blood pressure reading and the 2nd blood pressure readings, it was noted that there were differences. These differences are recorded in table 1 below. When grouped according to sex, age groups, education level, race and geographical location, it was found that the 2nd systolic blood pressure reading was less than the 1st systolic blood pressure reading. Another observation that was made was that males(125.6) had a higher mean systolic blood pressure reading compared to females(123.8). The mean systolic blood pressure readings increased with an increase in age. When broken down by education level, those without any form of formal education had the highest systolic blood pressure reading (140.5), followed by those who completed 7th grade, then those with some tertiary education, then those who completed secondary school then the group with the lowest mean systolic blood pressure were those with some secondary education. Among the different racial groups coloreds were found to have the highest mean systolic blood pressure reading(130.5) followed by whites at (129.1) then black at 124.6 then lastly Indians at 122.95. Urban dwellers were found to have a higher systolic blood pressure reading than rural dwellers.

Table 1: Crude Systolic Blood Pressure Readings by Sex, Age, Education level, Race and Geographical location

	Mean 1st Systolic BP Reading	Mean 2nd Systolic BP reading	Mean 1st & 2nd Systolic BP Reading
All	126.8	124.5	125.65
Males	127.9	125.6	126.75
Females	126	123.8	124.9
Age			
15-29	115.8	113.4	114.6
30-44	124.6	122.5	123.55
45-59	137.7	135.2	136.45
60+	148.9	147	147.95
Education			
No education	141.6	139.4	140.5
Complete primary (Gr7)	131.9	129.1	130.5
Some secondary	121	118.7	119.85
Complete secondary	121.4	119.7	120.55
Some tertiary	125.4	124.3	124.85
Race			
Black	125.8	123.4	124.6
Colored	131.6	129.4	130.5
Indian	123.1	122.8	122.95
White	129.5	128.7	129.1
Location			
Urban (formal+informal)	126.7	124.9	125.8
Rural	126.8	124.2	125.5

3.2 Comparison of the variation in readings between the 1st and 2nd systolic BP Reading

Blood pressure is a biological variable that varies from moment to moment based on stress level, activity level, and genetic make-up among other reasons. That considered one would need to make sure that the variation in blood pressure that we noted was not due to chance but rather had some form of consistency that would suggest that there are certain factors driving the difference in blood pressure. To do this, we did an analysis of how often the 1st blood pressure was lower than the second compared to how often the 2nd reading was lower than the 1st and our analysis revealed the table below. As noted the number of times the first reading would be lower than the second reading was not as often as it was higher.

Table 2: Comparison of the variation in readings between the 1st and 2nd systolic BP Reading

	% with 2 nd Systolic BP reading >1 st Systolic BP Reading	% with 2 nd Systolic BP reading < 1 st Systolic BP Reading
All	32	53
Males	31	53
Females	33	53
Age		
15-29	32	55
30-44	33	51
45-59	32	52
60+	33	50
Education		
No education	32	54
Complete primary (Gr7)	32	55
Some secondary	32	54
Completed secondary	30	43
Some tertiary	31	37
Race		
Black	33	55
Colored	31	50
Indian	30	37
White	33	35
Location		
Urban	30	43
Rural	30	54

3.3 Prevalence of hypertension in the study population

The prevalence of hypertension was investigated using different parameters. There were two blood pressure recordings collected for each patient plus each patient was asked whether they were on medication for hypertension which produced different prevalence rates for each parameter. Firstly, we used the WHO definition of hypertensive which is systolic greater than 140 and diastolic blood pressure greater than 90. As table 1 shows, the prevalence of hypertension was higher on the 1st reading than the 2nd reading across all the categories. The analysis also showed that the prevalence of hypertension was higher among females than males on both the 1st and 2nd. When the definition of hypertension was changed to include those on medication as well the same trend in which the prevalence was higher among women than men was again observed. Lastly, the prevalence of hypertension was found to increase with age.

Table 3: The study population aged 15years and older participating in the NIDS study of 2008 by self-reported population group and the prevalence of hypertension using the cut-off point of 140/90 on the 1st and 2nd blood pressure reading and anti-hypertension treatment

	Total number of enrollees	% Hypertensive on 1 st blood pressure reading	% Hypertensive on 2 nd blood pressure Reading	% Hypertensive on 1 st & 2 nd Blood Pressure Reading	% Hypertensive on 1 st & 2 nd Blood Pressure Reading and/or on medication
Males	6285	13.16	11.49	9.45	14.54
Females	9354	16.01	13.55	11.81	21.89
15-29	6318	2.88	1.79	1.30	3.18
30-44	3973	12.99	10.82	8.88	15.63
45-59	3047	27.99	24.65	21.37	36.43
60+	2176	34.56	30.88	27.30	45.77
Black	12151	14.44	12.31	10.63	17.71
Colored	2214	19.38	16.26	13.64	24.57
Indian	230	11.30	9.57	8.26	16.52
White	904	10.40	9.85	7.52	21.90

3.4 OLS regression of the difference between 1st & 2nd systolic BP reading

The crude analysis revealed that there were differences between the 1st reading and the 2nd reading. We ventured to investigate whether there were any factors that determined whether one's second blood pressure reading will be different from the first reading. This was done by running an OLS(ordinary least squares) regression of the difference between the first and second systolic reading (recorded under column 1 in Table 4) controlling for sex, race, education, age, plus rural or urban dwelling. The OLS regression revealed that the only significant difference was among the races. The coefficient for the black race was 1.06 (t-value 2.5) while the coefficient for colored was 1.27 (t-value 2.4). These results of the OLS regression are shown in column 1 in table 2.

3.5 Logit Difference between 1st & 2nd systolic BP reading greater than 0mmHg

We then ventured to investigate if there was a difference between the 1st and 2nd systolic reading greater than 0 mmHg using a logit regression controlling for sex, race, age, education, rural or urban dwelling. The results of the regression are shown in table 4 column 2. The same pattern was observed in that the only significant difference was noticed with race in which the coefficient for the black race was 1.38 (t-value 3.8) and the coefficient for colored was 1.38 (t-value 3.6).

3.6 Logit Difference between 1st & 2nd systolic BP reading greater than 3mmHg

Thereafter we conducted a logit regression of the difference between the 1st and 2nd systolic reading if the difference was greater than 3mmHg (as shown in column 3) again controlling for sex, race, age, education, rural or urban dwelling. The cut-off of three was picked because this would be a difference large enough to be noticed. The only significant difference was noticed with race in which the coefficient for the black race was 1.33 (t-value 3.1) and the coefficient for colored was 1.43 (t-value 3.6) as shown in table 4 column 3.

3.7 OLS regression of the difference between 1st & 2nd diastolic BP reading

A similar analysis was conducted for the diastolic blood pressure readings. This was done to investigate if the same patterns would be observed with the diastolic readings that had been observed with systolic readings. Firstly, an OLS regression of the difference between the first and second diastolic reading as shown in table 4 column 4 was conducted. The regression was conducted controlling for sex, race, education, age, plus rural or urban dwelling. The analysis revealed that the only significant difference was noticed with race in which the coefficient for the black race was 0.95 (t-value 2.7) and the coefficient for colored was 1.21 (t-value 3.1).

3.8 Logit regression of difference between 1st & 2nd diastolic BP reading

The next analysis that was done was a logit regression of the difference between the 1st and 2nd diastolic reading if the difference is greater than zero (see table 4 column 5) again controlling for sex, race, age, education, rural or urban dwelling. The only significant difference was noticed with race in which the coefficient for the black race was 1.31 (t-value 3.5) and the coefficient for colored was 1.39 (t-value 3.6).

3.9 Logit regression of difference between 1st & 2nd diastolic reading if difference is greater than 3mmHg

Lastly, a logit regression of the difference between the 1st and 2nd diastolic reading if the difference is greater than 3mmHg (see table 4 column 6) again controlling for sex, race, age, education, rural or urban dwelling. The only significant difference was noticed with race in which the coefficient for the black race was 1.33 (t-value 3.1) and the coefficient for colored was 1.29 (t-value 3.6).

Table 4 OLS regression & logit regression between 1st and 2nd systolic and diastolic BP readings

	OLS Difference between 1 st Systolic blood pressure reading and 2 nd Systolic blood pressure reading Column 1	LOGIT Difference between Systolic Reading 1 and Reading 2 if difference is >0mmHg Column 2	LOGIT Differenc e between systolic reading 1 and systolic reading 2 if differenc e is >3mmHg Column 3	OLS Difference between Diastolic Blood Pressure Reading 1 and Diastolic Blood pressure Reading 2 Column 4	LOGIT Difference between Diastolic Reading 1 and Diastolic Reading 2 if difference is >0mmHg Column 5	LOGIT Difference between diastolic reading 1 and diastolic reading 2 if difference is >3mmHg Column 6
Female [†]	-0.08 [0.4]	0.96 [1.0]	0.99 [0.4]	0.30 [1.9]	1.04 [1.2]	1.09 [2.2]*
Black [†]	1.06 [2.5]*	1.38 [3.8]**	1.33 [3.1]**	0.95 [2.7]**	1.31 [3.5]**	1.33 [2.8]**
Colored	1.27 [2.4]*	1.38 [3.6]**	1.43 [3.6]**	1.21 [3.1]**	1.39 [3.6]**	1.29 [2.2]*
No education [†]	0.69 [1.8]	1.06 [1.0]	1.04 [0.6]	0.72 [2.2]*	1.13 [1.9]	1.22 [3.1]**
Complete primary (Gr7)	0.09 [0.2]	1.04 [0.7]	1.00 [0.0]	0.31 [0.8]	1.09 [1.4]	1.10 [1.4]
Some secondary	-0.18 [0.4]	0.96 [0.6]	0.89 [1.6]	0.31 [0.8]	1.05 [0.6]	1.04 [0.5]
AGE:						
30-44 [†]	-0.31 [1.3]	0.97 [0.6]	0.97 [0.6]	-0.20 [1.0]	1.03 [0.6]	0.92 [1.8]
45-59	0.10 [0.3]	1.02 [0.3]	1.07 [1.2]	0.12 [0.5]	1.07 [1.3]	0.94 [1.2]
60+	-0.55 [1.4]	0.95 [0.9]	1.02 [0.3]	0.21 [0.6]	1.11 [1.6]	1.10 [1.5]
Rural [†]	0.48 [1.5]	1.14 [2.1]*	1.10 [1.7]	-0.17 [0.9]	1.05 [0.9]	1.02 [0.3]

*Coefficient is given as top figure whereas bracketed figure is the t-value, bracketed values without the asterisk indicate that the coefficient was not significant, whereas those with an asterisk indicate that the coefficient was significant and the more asterisks the more significant the differences.

†The reference groups were, male for sex, white for race, higher education for education, age 15-29 for age and urban for geographical location.

4. DISCUSSION:

The prevalence of hypertension was higher on the 1st reading than the 2nd reading across all the categories. This could be attributed to the white coat effect which is sometimes observed in the clinical setting where the 1st blood pressure reading is hypertensive whereas the second reading is found to not be hypertensive. However, we do have to acknowledge that the readings were not taken in the clinical setting so this would not be the ideal setting even though it is a plausible theory. Since these measurements were taken in the home with clinical equipment it is possible that those with a greater difference in the 1st and second blood pressure reading were not familiar with such equipment and so it aroused the adrenergic response that we talk of. One could extrapolate that that if this response was seen in the home setting which is an environment that the subject is used to what more in the clinical setting, an unfamiliar environment. There are possibly two factors that could be attributed to the response noted, firstly unfamiliarity with the equipment used or unfamiliarity with the clinical environment and personnel. Therein lies a shortfall in our study in that we could not test the respondent's response to the clinical environment but we were able to test what could possibly be a response to unfamiliar clinical equipment.

This is still concerning because earlier work done by Myers et al (1995) revealed that the white coat effect could be exhibited with non-clinical staff and in a non-clinical setting, which would suggest the white coat effect was triggered by the unfamiliar clinical equipment.[6] This white coat effect tended to be more pronounced in the clinical setting.[6] Therefore it is possible that the numbers and we came up with for individuals

demonstrating the white coat effect could be even more so increased in the hospital setting.

The observation that the prevalence of hypertension being higher among females than males on both the 1st and 2nd reading has been explained by the American Heart Association. Based on the American Heart Association a woman taking oral contraceptives is more likely to develop high blood pressure if she's overweight, has had high blood pressure during pregnancy, has a family history of high blood pressure or has mild kidney disease.[7] This same pattern was observed by Myers et al(1995) in a study in which they were investigating the sex differences in the presentation of the white coat effect. Myers et al discovered that female sex and office SBP were significantly ($P < 0.001$) correlated with the presence of a white coat or severe white coat effect.[10] Therefore, female patients with treated hypertension were more likely than men to have a white coat component to their high office BP readings.[10]

Our investigation revealed that there were more women taking medication for hypertension than men. This observation could be explained by cultural dynamics. It is possible that the women who were interviewed were not employed which is why they were home at the time of the study and hence not as physically active so their health was not as good.

Lastly, the prevalence of hypertension was found to increase with age. This would be expected as people age and their health deteriorates one might expect to see an increase in the prevalence of hypertension. The rise in systolic blood pressure resulting in

hypertension that is seen with aging is due primarily to increased peripheral vascular resistance during the early years and to increased large artery stiffness during the late years.[8] These changes in artery compliance are further compounded by the sedentary lifestyle that is led by most elderly people further contributing to the increase in hypertension prevalence with age. This pattern has been observed by other authors in studies that revealed that the prevalence of hypertension and the white coat effect was significantly correlated to age.[14]

The above mentioned pattern was interesting in that it somewhat contradicted work done by Stamler et al. In Dr. Stamler's paper he notes that Countless epidemiological surveys have shown that there are striking interindividual and interpopulation differences in blood pressure.[28] In most—but not all—populations, blood pressure generally rises (more or less) with age from youth into older age.[29] He reports that the exceptions are isolated preliterate groups in remote locations, where average systolic and diastolic blood pressures are optimal at all adult ages, manifesting little or no upward slope with age—and where lifestyles differ markedly compared to those of other populations worldwide. Data from migration studies—for example, the Luo Migrant Study in Kenya and the Ye Migrant Study in China—strongly indicate that changes in lifestyle and nutrition explain increases in blood pressure and vascular disease following migration and adoption of diets broadly similar to those of host populations.[30,31] In addition, an inverse relation between socioeconomic status (SES) and blood pressure has also been recorded repeatedly in many population studies of

specific ethnic groups, for example, African Americans and non-Hispanic white Americans.[31,32] All these findings support the conclusion that such group differences in blood pressure have little or no basis in population genetics (whatever the role of interindividual genetic differences in accounting for interindividual BP differences). Thus, lifestyle and dietary factors are likely to be important. That considered, one might then consider South Africa to be a unique case in that one would think that South Africa would exhibit the same pattern as noted in Kenya where blood pressure did not increase with age. However, despite being in the developing world South Africa showed data where blood pressure increased with age as seen in the developed countries.

The proposed white coat effect was also present among the races. This phenomenon was found to be more prevalent among the black and colored races compared to the white population. This could be attributed to apartheid that had just ended in 1994 which left the black and colored races at the bottom of the socio-economic ladder.[12] This could lead to nervousness within clinical settings therefore leading to an increase in the patient's sympathetic response. This response seems to differ by culture or setting. For example, earlier studies done in London revealed that caucasians had a greater WCE (white coat effect) than did non-Caucasians ($P < 0.001$ for SBP and DBP) and hypertensives had greater WCE than did normotensives ($P < 0.0001$ for SBP and DBP).[11] In that article by Gualdiero et al (2000) the white coat effect (WCE) was defined as an alerting reaction to the circumstances of the clinical measurement that explains why certain patients would have high office blood pressures but relatively normal readings during daytime ambulatory monitoring. The authors then concluded that

factors such as race, age and BMI may exert important influences on the size of WCE possibly via effects on sympathetic nervous system activity.[11] The literature seems to suggest the racial differences on the expression of the white coat effect is a function of how each group responds to stress.[13] So it is possible that blacks and coloreds might consider the health environment stressful whereas white people might not be. It is also possible that white people may have been better suited to handle to handle health care related stress and so they did not show as great a white coat response.

It would also be important to note that in as much as the respondent's blood pressure showed a fair amount of fluctuation. For some individuals the second reading was found to be higher than the first reading whereas other individuals maintained a constant reading. As such this method of measuring blood pressure has come under a fair amount of scrutiny with researchers suggesting that ambulatory blood pressure is a more accurate measure of blood pressure. Studies have also revealed that ambulatory blood pressure carries greater clinical and prognostic significance compared to clinical reading which is subject to the white coat effect.[9] Ambulatory readings do have their advantages. However, we have to acknowledge certain limitations with using ambulatory blood pressure readings. Firstly, for ambulatory readings to be effective the patient has to be motivated enough to consistently measure their blood pressure. However, if the patient is not consistent then the value of these ambulatory blood pressure readings can be somewhat questionable. In addition, ambulatory blood pressure readings require a certain level of literacy and competency on the part on the patient so as for the patient to

be able to measure their blood pressure effectively and accurately. However, as we noted in our study there were a fair number of individuals who had not received a formal education therefore it is possible such individuals would struggle measuring their own blood pressure.

5. CONCLUSION:

Some of the respondent's who's blood pressure was measured showed a difference in the 1st and 2nd blood pressure reading. An analysis, of these differences revealed that the proportion of individuals exhibiting a higher 1st blood pressure was not equivalent to those showing a higher 2nd blood pressure which suggests the difference in the 1st and 2nd blood pressure reading was not due to chance. We speculated that this difference could be attributed to the white coat effect due to respondent's unfamiliarity with clinical equipment due to socioeconomic limitations such as education, race, sex, and geographical location. Of the socioeconomic factors investigated, race was found to be the factor that contributed significantly to the difference noted. The difference in the two blood pressure readings recorded was found to be more prevalent among the black and colored races compared to the white population. There was no significant difference in the two blood pressure readings among the different education levels, sexes, age groups, and rural versus urban residence.

Continuation of Research to Field Work:

Research country: Zimbabwe

Research Clinics: Glen View HRE, Hatfield HRE, Domboshava

Field Work Dates: May 2010-15 July 2010 19

6. INTRODUCTION

6.1 Ambulatory BP vs Clinical BP

The second part to our study involved a field project to Zimbabwe related to hypertension that was prompted by the fact that we realized most people were being misdiagnosed because of the white coat effect noted in the clinic setting. To avoid this misdiagnosis of hypertension most clinicians in the western world are relying more so on ambulatory blood pressure readings in addition to the clinical blood pressure readings. However, in most third world countries for example Zimbabwe, most clinicians rely on clinical blood pressure readings. So, we set out to investigate if newly diagnosed patients who were given home blood pressure monitors achieved better blood pressure control than other newly-diagnosed hypertensive patients who did not have home blood pressure monitors if both groups were receiving the same treatment. We developed the hypothesis that patients with home blood pressure monitors would achieve better blood pressure control compared to patients who do not have home blood pressure monitors.

The study was a pilot study that set out to investigate if having a home blood pressure monitor helped participants achieve better blood pressure control compared to usual care which did not include home blood pressure monitors. In this study ambulatory blood pressure readings were defined as blood pressure readings that a patient measures at home using a home blood pressure monitor at set intervals preferably twice a day. The blood pressure readings obtained at home are then recorded in a log book which is then presented to the physician and is used to guide decisions on treatment. Clinical readings

are the blood pressure readings recorded in the clinic or hospital when a patient visits, some physicians use these BP readings to guide their decision making. There are advantages to both types of readings. For example, clinical readings are conducted by experienced medical staff and so is less prone to error. The shift towards using ambulatory blood pressure readings has stemmed from studies done both in Europe and the US in which blood pressure control in people with hypertension (assessed in the clinic) and the proportion achieving targets are increased when home blood pressure monitoring is used rather than standard blood pressure monitoring in the healthcare system.[2,3] The difference in blood pressure control between the two methods was small in some studies but contributed to an important reduction in vascular complications in the hypertensive population.[16,17] It is important to note that in the above mentioned articles ambulatory blood pressure readings were obtained over a period of 24hours whereas in our study we defined ambulatory blood pressure readings as those readings that the patients took at two intervals in the home setting.

In most third world countries they do not use ambulatory blood pressure readings because most patients do not have neither can they afford home blood pressure monitors. As a result, the utility of the use of home blood pressure monitors in helping patients to control their hypertension has not been investigated in Zimbabwe. The project set out to investigate if newly diagnosed patients who were given home blood pressure monitors achieved better blood pressure control than other newly-diagnosed hypertensive patients who did not have home blood pressure monitors if both groups were receiving the same

treatment. We developed the hypothesis that patients with home blood pressure monitors would achieve better blood pressure control compared to patients who do not have home blood pressure monitors. The reason being, those with home blood pressure monitors would have constant knowledge of how well their blood pressure was controlled and they could then respond accordingly by either changing their diet or exercise regimen.

6.2 Reasons supporting ambulatory BP readings as more accurate than clinical BP readings

Numerous reasons have been given as to why ambulatory readings would be more accurate than clinical readings. One reason that has been cited is the —white coat effect. The white coat effect has been described in numerous papers as the rising of a patient's blood pressure in the clinical setting giving the impression that the patient has hypertension when in fact they do not.[18] The phenomenon is attributed to the either the white coats or just being in the clinic which falsely raises one's blood pressure. Based on this, there is fear that a physician might diagnose a patient as hypertensive when in actual fact they are not and the patient could possibly be put on medication that is not necessary and worse still might be harmful. [19]

Secondly, because literature reports that with a normotensive patient, daytime pressures taper to lower levels during the evening hours and fall even further at night. The pressure dip typically occurs between 2 and 4 a.m. This dip in nocturnal pressure has prognostic implications. The absence of this decline places patients at an increased risk of cardiovascular disease, particularly elderly patients, and has been identified as an early marker of microalbuminuria in diabetic patients.[21,22] Ambulatory blood pressure can

be used to identify patients who do not exhibit the dip and so these patients can be treated accordingly.

Also, since hypertension does not immediately show symptoms at presentation numerous diagnoses are also missed. Most people only find out they have hypertension at routine clinic visits when their vitals are measured. Other individuals only realize they have hypertension when they present with symptoms-however this is worrying because symptoms are usually evident when there is notable end organ damage, and so patients might present with chest pain, headaches, vision loss or edema.

Ambulatory blood pressure readings can be used to identify patients with resistant hypertension that does not require treatment. Resistant hypertension is the term applied when adequate blood pressure control cannot be achieved despite the use of appropriately combined antihypertensive therapies in proper dosages for a sufficient duration.[23] This clinical dilemma has been attributed to cases of patient noncompliance, white-coat hypertension, and cases of pseudo-hypertension (where brachial artery calcification precludes collapse by the pressure cuff, leading to spuriously high readings). These patients typically have persistently elevated clinic pressures and normal or equivocal home or ABPM readings but fail to demonstrate any evidence of target-organ damage.[24] Therefore these patients do not need hypertension treatment. However, the current methods of prescribing medications based on clinical readings would miss such patients but the use of ambulatory blood pressure readings would pick up such patients.

Lastly, there have been comparative studies done using cost, symptoms, left ventricular hypertrophy (LVH), and intensity of pharmacotherapy in patients followed by conventional clinic monitoring and by ABPM. The study showed that there was no difference in cost, incidence of LVH, or level of reported symptoms between the two study groups. Antihypertensive therapy could be discontinued in 26 percent of the ABPM patients, compared with 7.3 percent ($P < 0.001$) of the patients in the clinic-monitoring group. In addition, hypertension was controlled with single-drug therapy in 27.2 percent of the ABPM patients, whereas multiple-drug therapy was required in 42.7 percent ($P < 0.007$) of the clinic-monitoring patients. [17,18]

6.3 The use of home blood pressure to control hypertension in Zimbabwe

Once one considers all the shortfalls of clinical blood pressure readings one might hypothesize that having a home blood pressure monitor would help patients achieve better blood pressure control. However, this has not been tested in Zimbabwe with its different socio-economic standards one might not see a similar benefit in the use home blood pressure monitors to achieve better blood pressure control. Our study set out to investigate whether the use of home blood pressure monitors in Zimbabwe among newly diagnosed hypertensive patients would achieve better blood pressure controlled compared to individuals without home blood pressure monitors.

6.4 standard of care in Zim. Vs the USA

In the course of the study we realized that the standard of care in Zimbabwe is different from the standard of care in the USA. In the USA they utilize the JNC 7 guidelines when diagnosing and treating hypertension. The JNC 7 guidelines have different stages of hypertension and recommendations on how to treat each. The stages are normal blood pressure is $<120/80$, prehypertension is $120-139/80-89$, stage I hypertension is $140-159/90-99$, then stage II hypertension is $\geq 160/100$. By these guidelines a patient who is found to have a normal blood pressure would be rechecked in 2 years, a patient who is prehypertensive would be rechecked in 1 year, a patient with stage 1 hypertension would need to have this reading confirmed within 2 months before any treatment is initiated, then lastly a patient with stage II hypertension would need to be evaluated or referred to source of care within 1 month, however, for those with higher pressures for example $>180/110$ mmHg there would be need for immediate evaluation and treatment within 1 week depending on the clinical situation and complications. Generally, stage I hypertension would be treated by diet and lifestyle recommendations, however, if he/she fails to achieve goal blood pressure then a medication would then be included. Stage II hypertension would be given diet and lifestyle recommendations in addition to 1 or 2 medications depending on how high their blood pressure is and the patients clinical scenario. The commonly used recommendations are the DASH diet which is recommended by the NIH for patients with hypertension or prehypertension.[20] The DASH diet eating plan has been proven to lower blood pressure in numerous studies. In addition to being a low salt (or low sodium) plan, the DASH diet provides additional

benefits to reduce blood pressure. It is based on an eating plan rich in fruits and vegetables, and low-fat or non-fat dairy.

The DASH eating plan has been proven to lower blood pressure in just 14 days, even without lowering sodium intake.[20] Best response came in people whose blood pressure was only moderately high, including those with prehypertension. For people with more severe hypertension, who may not be able to eliminate medication, the DASH diet can help improve response to medication, and help lower blood pressure. The DASH diet can help lower cholesterol, and with weight loss and exercise, can reduce insulin resistance.[20]

However, in Zimbabwe the standard of practice is different. The practice used in the clinics we visited were that, when a patient came in and their blood pressure was elevated they were referred to a physician since most clinics did not actually have a physician on site. Patients were referred to a physician for any blood pressure that was found to be $>140/90$. The patient would then visit the physician and if on that visit they were found to be hypertensive($>140/90$) they would be given a prescription for medication by the physician if they could afford to fill the prescription themselves or they would be referred back to the clinic where they would then receive either free or subsidized medication. Thereafter they would continue to be followed by the physician or they would go to the clinic to get their blood pressure checked every so often. Since most of the physicians they were referred to were not easily accessible, the patients we enrolled in our study continued to go to the clinic for follow-up visits once their

physician had confirmed that they had hypertension. In terms of the extent of lifestyle treatment that patients received, they were all informed that they should lower their salt intake. However, they were not informed about the DASH diet or even exercise.

7. METHODS

7.1 Study design

The study set out to investigate if newly diagnosed hypertensive patients who were given home blood pressure monitors achieved better blood pressure control than other newly-diagnosed hypertensive patients who did not have home blood pressure monitors if both groups were receiving the same treatment. The study also included a questionnaire that each participant was to answer which is included below. The questions were set to address any confounding factors that could cause a change in blood pressure besides the controlled factors.

The study recruited 55 subjects from 3 clinics; one clinic was in a low population density area(Hatfield), one in a high population density area(Highfield), and one in a rural area(Domboshava). Patients were assigned (at the flip of a coin) to either the intervention or control group. However, towards the end of the study, we had a good number of large size cuffs and if the subject who had been designated to the control group was too small for the large sized cuffs they were placed in the control group. The subjects in the intervention group were given a free blood pressure cuff and asked to measure their blood pressure with a digital blood pressure monitor twice a day, preferably at the same time each day. The subjects were advised to pick times that were convenient for their schedule to ensure adherence to the protocol. We visited the respondents at their homes at four points during this study: 4 weeks, 8 weeks, 6 months, and 12 months after enrolling in the study. We measured their blood pressure with a standard cuff and compared our reading with their home cuff to ensure accuracy at that visit.

7.2 Questionnaire

The questions were set to address any confounding factors that could cause a change in blood pressure besides the controlled factors. For example, the questions such as the participant's occupation, highest level of education, and the yearly or monthly earnings were meant to address obstacles that might hinder patients from following diet and lifestyle recommendations. Also, a participant's earnings could determine how equipped a participant would be to purchase nutritious food to in accordance with the DASH diet.

Questions such as their past medical history would be also important because patients with comorbidities such as congestive heart failure, diabetes, or osteoporosis could complicate a patient's treatment plan. Such comorbidities could also affect the patient's medication choice for the treatment of hypertension. Other questions such as the number of times the patient had been to the clinic were equally important because patient's with more visits to the physician might achieve better blood pressure control. This might not be a function of our intervention but rather the fact that the doctor had more opportunities to change their medications compared to someone who would not have visited the physician as much. The questionnaire also contained questions that asked how often the participant exercised in a week. Based on the DASH recommendations exercising can help control blood pressure therefore this factor would need to be controlled for while doing the data analysis to avoid bias.

Participants were also asked if they already owned blood pressure cuffs at home. None of the patients enrolled had home blood pressure monitors.

Lastly, each participant was asked whether or not they had received diet and lifestyle recommendations from the clinic they had attended. Participants who already had blood pressure monitors at home were not included in the study. None of the participants had home blood pressure monitors prior to enrollment. Thereafter, the participants were then asked if they understood these recommendations at which point they would be asked to tell us what they understood of the recommendations. In the event that a participant had not followed the diet and lifestyle recommendations, they were asked an open question as to why they did not follow the recommendations. This was done to further elude any other confounding factors that we might have not included in our analysis and research design.

The respondents were asked to complete the same questionnaire at each visit.

7.2 Eligibility criteria

Our subjects comprised of individuals older than 18 years old with newly diagnosed hypertension on their visit to the clinic. Hypertension was defined as a measured blood pressure greater than 140/90, if either diastolic or systolic reading was elevated then the subject was included in the study. The physician or nurse present at the clinic informed the subjects of the study and their eligibility to take part in the study. The individuals who gave consent to take part in the study gave their contact details to the head nurse who passed on the information to us. Participants were visited in their home

so as not to inconvenience the participants either financially or time wise by asking them to return to the clinic. At each visit the participants had their blood pressure measured before filling out the questionnaire as well as after filling out the questionnaire. If the difference between the 1st and 2nd reading was greater than 5mmHg we would wait for 15minutes to measure the respondent's blood pressure. If the third reading was different we would use the median blood pressure reading of the 3 readings recorded. The blood pressure monitor used was the Life Source Advanced Manual Inflate Blood Pressure Monitor UA 705V.

The study did not include vulnerable populations such as children, pregnant women, prisoners or cognitively impaired adults.

8. RESULTS

8.1 Percent hypertensive after 4weeks in the study

The study recruited 54 individuals, of which 22 were male and 32 females. 27 participants received home blood pressure monitors and 27 did not receive home blood pressure monitors. After the first 4 weeks 22% (6/27) of the individuals who received blood pressure cuffs were hypertensive. 7.4% (2/27) of the participants with home blood pressure monitors were borderline/pre-hypertensive with a diastolic reading of 90. 56% (15/27) of the control group participants were still hypertensive on the 2nd BP reading that was taken 4weeks after enrollment.

The study enrolled 21 males and 33 females, all of which were hypertensive at the 1st blood pressure reading. Of the 21males 38% were still hypertensive at the 2nd blood pressure reading. Of the 33 females 38% of them were still hypertensive at the 2nd blood pressure reading. The study enrolled 16 individuals who fell in the age group of 30-40, of which 28% of them were still hypertensive at the 2nd blood pressure reading. We also enrolled 19 individuals in the 41-50 age group of which 32% of them were still hypertensive at the 2nd blood pressure reading at 4 weeks. In the 51-60 age group there were 14 subjects of which 25% of them were still hypertensive at the 2nd blood pressure reading which occurred at 4weeks. Lastly we enrolled 5 subjects who were 60+ years old of which 80% of them were still hypertensive at the 2nd reading which occurred at 4weeks.

Table 5 : Crude Analysis of the Study group

	Total number of enrollees	% Hypertensive at 1 st blood pressure reading	% Hypertensive on 2 nd blood pressure Reading
Males	21	100	38
Females	33	100	38
30-40	16	100	28
41-50	19	100	32
51-60	14	100	25
61+	5	100	80
Low density	24	100	50
High density	22	100	32
Rural	8	100	13

8.2 Percent hypertensive after 8weeks in the study

At the 8week reading 7.4 % (2/27) of the participants who received blood pressure cuffs were still hypertensive. 4% (1/27) of the individuals that received home blood pressure monitors was borderline at the 8 week reading. At the 8 week reading 48% (13/27) of the control group were still hypertensive.

8.3 Determinants of blood pressure control in the intervention group

10% of all the participants received diet and lifestyle recommendations from the clinic. While only 5% of all the participants reported any type of exercise during the week. Therefore as a result of the low numbers we could not do a meaningful analysis

using that data. The intervention group had a total of 38 clinic visits within the 1st 4 week enrollment period. The control group had a total number of 22 clinic visits in the 1st 4 weeks during enrollment. The intervention group had a total of 22 clinic visits between the 4week and 8week reading period. The control group had a total of 14 clinic visits between the 4week reading and the 8week reading. This seemed to be the main determinant of blood pressure control. As a result of more clinic visits made by the intervention group more of these individuals had their medications changed more often.

There were more people on medication who were given home blood pressure cuffs. Those who had been given home blood pressure cuffs had more clinic visits within each four week interval. 90% of the respondents chose not to disclose their monthly or yearly income. The study lost 7 individuals who were reported by their families to have moved to South Africa in search of employment. Two individuals had to have their home blood pressure monitor replaced because the monitor kept reporting error messages. However, none of the individuals who received home blood pressure monitors reported any trouble in using or understanding their home blood pressure monitors.

8.4 Mean Systolic Blood Pressure Readings at the 1st, and 2nd Recordings

The next data analysis we did was comparing the mean systolic blood pressure reading from the 1st and 2nd visit. There was a general decrease in the systolic blood pressure reading from the 1st to the 2nd recordings. However, the data for the age group 30-40 did not seem to follow the pattern observed in previous studies which generally showed an increase in blood pressure with age. One of the reasons to explain why this

group did not show the same pattern, firstly this is the age group with which we lost the most participants to follow up. Otherwise, those with blood pressure cuffs achieved a lower blood pressure reading on the 2nd visit compared to the 1st visit, except for the 60+ age group. The reason for this could be that we were only able to enroll 6 individuals for the study in that age group of which 4 received home blood pressure monitors and 2 did not. It is possible that the 2 individuals who did not receive home blood pressure monitors did not have hypertension as severe as the 4 who received the home blood pressure monitors.

Table 6: Mean Systolic Blood Pressure Readings at the 1st, and 2nd Recordings

	Mean Systolic BP Reading @ 1 st visit before intervention	Mean 2nd Systolic BP reading after 4weeks for subjects with BP cuffs	Mean 2nd Systolic BP reading after 4weeks for subjects without BP cuffs
Males	158.7	134.4	148.8
Females	160	134	140.6
Age			
30-40	162.8	146	140.8
41-50	156.8	133.8	145
51-60	158.3	132	136
60+	160.5	140	145
Location			
Low density	158.8	139.8	146
High density	159	131	142.7
Rural	163	130	141.3

9. DISCUSSION

Individuals who received blood pressure cuffs achieved better blood pressure control at both the 4 and 8 week time points. However, this was not a function of diet and exercise control as hypothesized earlier but rather a function of more health care visits. Despite this we can still conclude that having blood pressure monitors at home was useful in controlling the intervention group's blood pressure. Because of the subtle nature of hypertension most individuals affected only realize that they are affected when they make clinic visits, which is done either routinely at 1 month or 6 month visits. The other times that hypertension is evident is when patients start becoming symptomatic with signs such as headache, chest pain or edema. In all these cases they would have probably had hypertension for a while before symptoms start showing which makes their treatment more difficult and sometimes treatment might lower the blood pressure but too much damage would have been done to the organs. Therefore there is a need to be able to detect and control hypertension early which can be done with home blood pressure monitors.

In our study those with home blood pressure monitors reported more visits to the healthcare personnel when they realized their blood pressure was elevated. These visits were prompted by an elevated blood pressure reading that alerted the patient that their current medication was not controlling their hypertension. In contrast, the control group had no way of knowing their blood pressure was elevated except for the times they visited the clinic which was usually scheduled at 4 week intervals. Consequently the intervention group had their medication changed more often so as to achieve optimum

blood pressure control whereas the control group only had their blood pressure medication changed twice during the 8 week period.

The individuals we lost in the study comprised the youngest age group and all were reported to have moved to South Africa in search of employment during the FIFA the Soccer World Cup. This was not surprising because of the current rise in unemployment in Zimbabwe that has led to an increase in migration to South Africa in search of employment. Also, since there are no visa required of Zimbabweans visiting South Africa it makes the process easy while the world cup provided numerous opportunities for employment.

However, before recommending the use of home blood pressure monitors certain measures have to be in place. For example there would be a need to calibrate and validate the machines that individuals are using in the homes. Gerin et al (2002) assessed the adequacy of existing British Hypertension Society (BHS) and Association for the Advancement of Medical Instrumentation (AAMI) validation standards for automatic blood pressure monitoring devices.[15] Their investigation revealed that a major limitation of home monitors is the lack of attention given to the number of individual patients for whom a monitor may be inaccurate. They reported that a blood pressure monitor that meets the AAMI and BHS validation criteria may report blood pressures in error by more than 5 mmHg for more than half of the people. There would also need to be measures in place to account for or replace malfunctioning equipment. For example in our study, we had to replace 2 of the cuffs because they kept reporting error messages.

Also, before making the recommendation there's also a need to educate the patient population. Most patients in our study did not receive diet and lifestyle recommendations or the perils of poor blood pressure control. Therefore, those without blood pressure cuffs missed clinic appointments citing that they felt physically well so did not feel the need to visit the physician. Similarly, there is also a need to educate those who receive blood pressure monitors of the cut-off figures to be weary of.

There were some limitations with the study design. Firstly, the number of participants enrolled was low. This was mainly limited by budget constraints, and we realized that this could only serve as a pilot study. Also, there were certain questions in the questionnaire that individuals did not feel comfortable answering especially questions about wages and salaries they earned which could be a reflection of their socio-economic status. This could have an impact on their blood pressure control in that their socio-economic situation could determine their diet. Since diet has been shown to affect blood pressure control this is a parameter that was equally important and could affect our results. Lastly, not all the participants received diet and lifestyle recommendations. Since this is the first line of recommended treatment this is an important step. However, it seems the standard of care in Zimbabwe is different and since the participants were from different clinics it seems some clinics were offering these recommendations whereas other clinics were not.

An interesting trend that was noted was that individuals who had received home blood pressure monitors were measuring their friends and family's blood pressure as well

and a fair number of individuals were found to have hypertension that they had not realized. Even though there were only 6 individuals that were discovered through such trials by those with the home blood pressure monitors, one can possibly extrapolate that a larger effect might have been realized if we had more participants. This also showed that there are benefits to having home blood pressure monitors to both the participant and none-participants within the home.

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