

*Full Length Research Paper*

# Ordinal logistic regression analysis of hypertension data and identifying factors that influence the incidence of hypertension in Gondar University Teaching Hospital, North- west Ethiopia

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Hypertension is the force of blood pushing up against the walls of blood vessels and it is defined as a systolic blood pressure  $\geq 140$  mm Hg and/or diastolic blood pressure  $\geq 90$  mm Hg. It is estimated to cause 9.4 million deaths every year. This study aims to conduct ordinal logistic regression analysis of hypertension severity and identifying associated factors for severity of hypertension, using the data of Gondar University Referral Hospital, North west Ethiopia. The cumulative logit or the proportional odds regression model is one of the popular choices used to study covariate effects on ordinal responses. The proportional odds model was used to model the severity of hypertension and to identify associated factors for its severity. The fit of the model was illustrated with 420 hypertension records obtained from Gondar University Referral Teaching Hospital (in the chronic illness medication and follow up clinic). Findings of this study show that age of patients (OR= 2.195, P = 0.0051), residence (OR= 1.954, P = 0.0008), alcohol use (OR= 2.329, P = 0.0027), using salty foods (OR= 1.970, P = 0.0007), habit of using vegetable/fruit (OR= 0.516, P = 0.0010), doing physical exercise (OR= 0.571, P = 0.0062) and BMI (OR= 3.293, P <0.0001) had significant association with severity of hypertension. Policies and plans have to be put in place to motivate vegetable/fruit users, to decrease the consumption of salty foods, non-alcohol drinkers, normal body mass index and concerned bodies need to implement hypertension prevention strategies.

**Key words:** Hypertension severity, ordinal logistic regression, proportional odds model.

## INTRODUCTION

Hypertension is the force of blood pushing up against the walls of blood vessels and it is defined as a systolic blood pressure  $\geq 140$  mm Hg and/or diastolic blood pressure  $\geq 90$  mm Hg. The risk of dying from high blood pressure in

low- and middle-income countries is more than double that in high-income countries. In the high income countries, only 7% of deaths caused by high blood pressure occur under age 60; in the African Region, this

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has increased to 25% (WHO, 2010). Non-Communicable Diseases (including hypertension) are becoming an increasingly important public health problem as epidemiological transition is progressing in Ethiopia (Awoke et al, 2014). World Health Organization reported that the prevalence of hypertension in Ethiopia was 35.2% for the crude adjusted estimates of both sexes (WHO, 2010).

Hypertension is the growing public health problem in many developing countries including Ethiopia. However, its prevention, early diagnose and control have not received greater attention. Hypertension does not have its own signs and symptoms like other chronic disease and its treatments are not given on time. It causes many deaths before it is treated, and it is usually known as silent killer disease. Hypertension increases the risk of ischemic heart disease, stroke, peripheral vascular disease and other cardiovascular diseases, and is also a risk factor for cognitive impairment and dementia and chronic kidney disease (Assefa et al., 2014). In this study, by classifying the severity of hypertension as severe, moderate and mild ordinal logistic regression model was applied to assess the effect of multiple covariates in different levels of hypertension severity.

## MATERIALS AND METHODS

### Description of the hypertension data

The target population of this study was hypertensive patients at Gondar University Hospital chronic illness medication and follow up clinic; their age is age  $\geq 18$  years. They came to this clinic before April 30, (2016) for hypertension treatment (continuation or check-up). So the data were collected from February 1 to April 30, 2016 for three months. The total numbers of patients that started hypertension follow up treatment were 482. From the total patients, only 420 patients had a complete outcome and were available at this three month of data collection period. 29 patients did not come to the clinic during their appointment (check-up) time and the charts of 33 patients were not recorded in the data properly; hence they are excluded from the study.

### Inclusion and exclusion criteria

The study considers all hypertensive diseased patients in chronic illness medication and follow up clinic; their age is  $\geq 18$  years, and they started hypertensive follow up treatment before April 30, 2016. They came for check-up during their appointment time for three months. However, the study excludes those patients on hypertensive follow up treatment whose age  $< 18$  years and patients who did not come to the clinic during these three months; patients who had an appointment time of more than three months. Disabled hypertensive patients were also excluded from the study.

### Variables of the study

The dependent variable for this study is the severity of hypertension which is reviewed from their medical charts. This includes mild, moderate and severe level of hypertension. The severity (level) of hypertension was classified from the blood pressure measurement of two numbers systolic and diastolic reading in mmHg and

according to the World Health Organization criteria for severity of hypertension classified as mild (systolic 140-159, diastolic 90-99), moderate (systolic 150-179, diastolic 100-109) and severe (systolic  $\geq 180$ , diastolic  $\geq 100$ ) [WHO, 1999].

This study considers many explanatory variables, including socio-demographic variables (Age (in year), sex (M, F), marital status (Single, Married, Others), level of education (Illiterate, Informal education, Formal education)), lifestyle factors (Diet, alcohol use, smoking, physical activity), co-morbidity (Obesity, kidney Disease, Diabetes mellitus) and genetic and family related factors (Family history Hypertension). The duration that these respondents have been hypertensive was not taken into consideration as independent variable for this analysis.

### Ordinal logistic regression model

SAS statistical software was used for the analysis. The issue of correlation among independent variables (multicollinearity) has been checked by using tolerance and variance inflation factor (VIF) method. Logistic regression model can be classified as multinomial, ordinal and binary. In this investigation ordinal logistic regression model was used. The ordinal logistic regression procedure empowers one to select the predictive model for ordered dependent variables. Logistic regression model can be classified as multinomial, ordinal and binary. In this investigation ordinal logistic regression model was used. The ordinal logistic regression procedure empowers one to select the predictive model for ordered dependent variables. The ordinal logistic regression model describes the relationship of an ordered response variable and a set of explanatory variables. The explanatory variables may be continuous or discrete (or any type). The explanatory variables may be continuous or discrete (or any type).

Ordinal response models have major importance in social sciences as well as demography and many social phenomena. The responses are discrete or qualitative rather than continuous or quantitative in nature. Hypertension is the continuous variable, but here it has been changed of ordinal by classifying as severe, moderate and mild. Many such analyses involve an outcome or dependent variable that is ordinal and in this study the logistic regression model was the statistical model of choice. The most popular model in ordinal logistic is the proportional odds model.

### Proportional Odds (PO) model

Proportional odds model is used as a tool to model the ordinal nature of a dependent variable by defining the cumulative probabilities differently instead of considering the probability of an individual event. It considers the probability of that event and all events that are ordered before it. When response categories are ordered, logits can directly incorporate the ordering.

### Uni-variable ordinal logistic regression analysis

Nineteen variables were selected and 19 uni-variable ordinal logistic regression models were developed to assess the relationship between severity of hypertension and the selected variables. Any variable whose uni-variable test has a  $p\text{-value} \leq 0.25$  will be a candidate for Multiple Ordinal Logistic Regression Analysis.

### Multiple ordinals logistic regression analysis

Once the variables were identified by uni-variable ordinal logistic regression analysis, we began with a model containing all of the

**Table 1.** Frequency and percentage of severity of hypertension GoUTH, 2016.

	Frequency	Percent	Valid percent	Cumulative percent
Severe	187	44.5	44.5	44.5
Moderate	148	35.2	35.2	79.8
Mild	85	20.2	20.2	100.0
Total	420	100.0	100.0	

**Table 2.** Distribution of socio-demographic related determinant factors of HTNGoUTH, 2016.

		HTN severity			Total (%)
		Severe (%)	Moderate (%)	Mild (%)	
Sex of patients	Male	44.23	35.10	20.67	100
	Female	44.81	35.38	19.81	100
Age of patients	18-40	27.27	36.36	36.36	100
	41-59	43.52	37.96	18.52	100
	60+	49.59	33.74	16.67	100
Religion	Christian	46.58	31.68	21.74	100
	Muslim	42.34	37.96	19.71	100
	Other	44.26	36.89	18.85	100
Marital status	Single	45.65	34.06	20.29	100
	Married	45.89	34.93	19.18	100
	Other	41.91	36.76	21.32	100
Educational background	illiterate	39.86	35.51	24.64	100
	Informal education	42.74	39.52	17.74	100
	Formal education	50.00	31.65	18.35	100
Occupation	Employee	40.84	37.70	21.47	100
	Unemploye	47.60	33.19	19.21	100
Residence	Urban	50.44	35.40	14.16	100
	Rural	37.63	35.05	27.32%	100

selected variables. The variables, Age of patients, Residence, Alcohol use, using salty foods, habit of using vegetable/fruit, doing physical exercise, BMI are found significant to be entered into the multiple ordinal logistic regression analysis.

## RESULTS

This study used hypertension data collected from hypertension diseased patients linked to Gondar University Hospital chronic illness medication and follow up clinic. Four hundred twenty hypertension diseased patients were included. From the total hypertension diseased patients' data 44.5% (187) were severe, 35.2% (148) were moderate and 20.2% (85) were mild (Table 1). Table 2 shows the distribution of socio-demographic

related variables with the severity of hypertension. 44.23, 35.10 and 20.67% men had severe, moderate and mild hypertension as compared to 44.81, 35.38 and 19.81% women, respectively. Other variables also can be interpreted in a similar way.

Table 3 shows the distribution of risk factor variables related with the severity of hypertension. 42.6% of individuals who have hypertension in their family had severe hypertension as compared to 46% of individuals who do not have hypertension in their family. 35.5% of individuals who have hypertension in their family had moderate hypertension as compared to 35% of individuals who do not have hypertension in their family. Similarly, 21.89% of individuals who have hypertension in their family had mild hypertension as compared to 19% of

**Table 3.** distribution of related risk factors determinant of HTNGoUTH, 2016.

		HTN severity			Total (%)
		Severe (%)	Moderate (%)	Mild (%)	
Family history of HBP	Yes	42.60	35.50	21.89	100
	No	46.00	35.00	19.00	100
Disease other than HBP	Yes	43.12	33.03	23.85	100
	No	46.04	37.62	16.34	100
Smoking habit	Current smoker	46.94	28.57	24.49	100
	Former smoker	38.76	36.43	24.81	100
	Non smoker	47.15	37.82	15.03	100
Alcohol drinking habit	Current drinker	48.39	35.08	16.53	100
	Former drinker	46.23	34.91	18.87	100
	Never drinker	27.27	36.36	36.36	100
Khat chewing habit	Yes	45.28	34.43	20.28	100
	No	43.75	36.06	20.19	100
Using salty foods	Yes	50.22	35.68	14.10	100
	No	37.82	34.72	27.46	100
Using excessive fatty foods	Yes	45.49	34.30	20.22	100
	No	42.66	37.06	20.28	100
Using vegetable /fruits	Yes	36.32	35.79	27.89	100
	No	51.30	34.78	13.91	100
Doing physical exercise	Yes	37.63	34.54	27.84	100
	No	50.44	35.84	13.72	100
Stress	Yes	43.46	35.98	20.56	100
	No	45.63	34.47	19.90	100
Sleeping time per 24 hrs	<=5 h	47.45	32.85	19.71	100
	5.1-7.9 h	43.17	38.85	17.99	100
	>=8 h	43.06	34.03	22.92	100
Body mass index(BMI)	Obese	48.19	35.34	16.47	100
	Overweight	46.23	34.91	18.87	100
	Normal/ underweight	27.69	35.38	36.92	100

individuals who do not have hypertension in their family. Similarly, other variables can be interpreted like this.

The result of Akaike's Information Criteria (AIC) suggests that the main effect model is reasonable since a model with low AIC is preferred model. Therefore, a cumulative consideration of the above tests confirmed that the main effect model is appropriate. The models can be also compared by using BIC value. From the SAS

output the -2log likelihood values for main effect and interaction effect model are 780.199 and 639.970, respectively. This implies that the BIC values of the two models are 851.0254 and 904.9132, respectively. Since the main effect model has smaller values, it is concluded that the main effect model is appropriate (Tables 4 to 6). The hypothesis that the model adequately fits the data can be examined by the Pearson and Deviance tests.

**Table 4.** Parameter estimates resulting from uni-variable ordinal logistic regression of each explanatory variable.

Parameter	DF	Wald Chi-square	Pr>ChiSq
Sex	1	0.0324	0.8570
Age	2	15.3092	0.0005
Religion	2	0.1490	0.928
Marital status	2	0.5185	0.7716
Level of education	2	3.5259	0.2715
Employment status	1	1.5966	0.2564
residence	1	11.1981	0.0008
Family history of HTN	1	0.5935	0.4411
Co-morbidity disease	1	1.5389	0.2548
Smoking habit	2	8.1419	0.2671
Alcohol drinker habit	2	14.6066	0.0007
Khat chewing	1	1.8089	0.2786
Using salty foods	1	10.5252	0.0012
Using excessive fatty foods	1	0.0120	0.9129
Vegetable/fruit use	1	14.1175	0.0002
Doing physical exercise	1	10.3764	0.0013
Stress	1	0.1613	0.6880
Sleeping time per 24 hr	2	0.7033	0.7035
Body mass index	2	14.4635	0.0007

**Table 5.** Analysis of maximum Likelihood and odds ratio estimates.

Parameter	Estimate	S. E.	Wald	df	Sig.	Exp <sup>β</sup>	95% CI	
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Intercept=1	-2.5083	0.4386	32.7079	1	<.0001	-	-	-
Intercept=1	-0.6512	0.4191	2.4143	1	0.0202	-	-	-
Age(60 and above)	0.8536	0.2729	9.7812	1	0.0018	2.348	1.375	4.009
Age (between 41-59)	0.7217	0.3034	5.6578	1	0.0174	2.058	1.135	3.730
Urban residence	0.5561	0.1928	8.3206	1	0.0039	1.744	1.195	2.545
Current drinker	0.8282	0.2707	9.3569	1	0.0022	2.289	1.347	3.892
Former drinkers	0.6033	0.3048	3.9165	1	0.0478	1.828	1.006	3.322
Using salty foods	0.6101	0.1927	10.0247	1	0.0015	1.841	1.262	2.685
Vegetable/fruit use	-0.6858	0.1939	12.5080	1	0.0004	0.504	0.344	0.737
Doing physical exercise	-0.4571	0.1951	5.4859	1	0.0192	0.633	0.432	0.928
Obese BMI	0.9739	0.2699	13.0225	1	0.0003	2.648	1.560	4.495
Overweight BMI	0.7764	0.3076	6.3720	1	0.0116	2.174	1.190	3.972

**Table 6.** Model comparison

Model	AIC
Null model	886.954
Main effect model	838.199
Interaction	845.970

The result reveals that the goodness of fit test is fulfilled, which is confirmed by both the deviance and Pearson

with P-values of 0.2124 and 0.6325, respectively. Consequently, the observed and expected cell counts

**Table 7.** The Likelihood Ratio, Score and Wald tests for overall measures of goodness of fit of the final model: BETA=0 GoUTH, 2016.

Test	Chi-square	df	Pr>chsq.
Likelihood ratio	79.4352	10	<0.0001
Score	72.0415	10	<0.0001
Wald	71.3289	10	<0.0001

**Table 8.** Collinearity checking of dependent variables with independent variables.

Coefficients <sup>a</sup>			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Residence	0.960	1.042
	Alcohol drinking habit	0.935	1.069
	Using salty foods	0.976	1.024
	vegetable or fruit use	0.975	1.026
	Doing physical exercise	0.976	1.024
	Body mass index	0.979	1.022
	Age	0.981	1.019

<sup>a</sup>Dependent Variable: Level of HBP.

**Table 9.** Multicollinearity checking of independent variables.

Coefficients <sup>a</sup>			
Model		Collinearity statistics	
		Tolerance	VIF
1	Residence	0.960	1.041
	Alcohol drinking habit	0.943	1.061
	Using salty foods	0.977	1.024
	vegetable or fruit use	0.979	1.022
	Doing physical exercise	0.979	1.022
	Body mass index	0.984	1.017

<sup>a</sup>Dependent Variable: Age.

are similar and the value of each statistic is small (Table 7). As shown in Table 8, the tolerance of all the variables greater than 0.1 implies there is no a problem of collinearity between the dependent and independent variables. Moreover, the VIF values are greater than 10, which indicates there is no problem of multicollinearity. As shown in Table 9, the tolerance of all the variables greater than 0.1 implies there is no a problem of multicollinearity between age and other independent variables. Moreover, the VIF values are greater than 10, which indicates there is no a problem of multicollinearity between age and other independent variables. Similarly, we can continue for other independent variables.

## DISCUSSION

The study shows that there is significant association between age of patients and the severity of hypertension. Older age group patients (that is, 60 and above), who develop hypertension belong to "severe hypertension" category and they are also liable to high prevalence of hypertension. The result is consistent with Mulugeta (2015), Assefa et al. (2014), Kassawmar et al. (2015), Mungati et al. (2014), Erhun et al. (2005), Marwiro (2012) and Kumar et al. (2002) that age [being aged] has significant effect on the occurrence of hypertension. This study also agrees with national academy on an aging

society.

There is a significant difference in developing hypertension between urban and rural residences. This shows that people living in urban areas have a high risk of developing hypertension than people living in rural areas. The study result is consistent with Iwelunmor et al. (2014). The study shows that there is significant association between alcohol drinking habit of patients and the severity of hypertension. Current alcohol drinker individuals are more likely to develop severe hypertension than never drinker individuals. This implies most current alcohol drinker individuals who develop hypertension belong to “severe HTN” category and they are also liable to high prevalence of hypertension. This result of the study agrees with that of Mulugeta (2015), Erhun et al. (2005), Birhanu (2014) and Kumar et al (2002); alcohol drinking was a significant factor of hypertension. There is high significant difference between individuals with excessive salty food user and non-users in terms of developing hypertension. That is, individuals who are salty food users are more likely to develop “severe hypertension” than those non-users. In addition, the result reveals that the overall prevalence of hypertension is high with those individuals who are salty food users. This result of the study agrees with that of Seid (2014), Mulugeta (2015) and Mizumoto (2004); use of excessive salty foods was the significant factor of hypertension.

There is high significant difference in developing hypertension between vegetable/ fruit users and non-users. That is, individuals who are vegetable or fruit users are less likely to develop “severe hypertension” than non-users. In addition, the result reveals that the overall prevalence of hypertension is high with those individuals who are non-users. The study result is consistent with the result of Mulugeta (2015) that use of fruit or vegetable was significantly associated with hypertension. Consequently, vegetable or fruit users are less susceptible to develop severe hypertension.

There is a high significant difference in developing hypertension between individuals who are physically active and not physically active individuals. Among all hypertension developed in physically inactive individuals most of them belong to “severe hypertension” category and it is also responsible for high incidence of hypertension. This shows people who are physically inactive are at a high risk of hypertension than physically active individuals. The study result is consistent with Seid (2014), Mulugeta (2015), Akilew et al. (2012) and Kumar et al. (2002) that not doing physical activity is significantly associated with hypertension.

The study shows that there is significant association between body mass index of patients and the severity of hypertension. Obese individuals are more likely to develop severe hypertension than normal/underweight body mass index individuals. This implies most “obese body mass index” individuals who develop hypertension

belong to “severe hypertension” category and they are also liable to high incidence of hypertension. The study result is consistent with Seid (2014), Mulugeta (2015), Henok (2014), Assefa et al. (2014), Kassawmar et al. (2015), Jenei et al. (2002), Erhun et al. (2005), Akilew et al. (2012), Marwiro (2012), Mizumoto (2004), Birhanu (2014), Jasmine et al. (2013), Kumar et al. (2002) that body mass index was a significant factor of hypertension.

## Conclusions

The study examined the socio-demographic and risk factor determinants of hypertension in GoUTH. Results of proportional odds model show that socio-demographic and risk factor variables are very important for determinant of hypertension outcome. The finding of the study shows that different factors such as patients' age, Residence, Alcohol use, using salty foods, habit of using vegetable/fruit, Doing physical exercise and BMI have statistically significant effect on the outcome of hypertension.

## RECOMMENDATION

Based on the findings of this study, the following issues should be considered and promoted for improving the prevention of hypertensive condition in community people. The government and concerned bodies should work on the preventive strategies of hypertension including promoting and advocating healthy lifestyles, by improvement of dietary habits, eradication of alcohol consumption, decreasing the consumption of salty foods, increasing physical activity and encouraging vegetable or fruit users.

## Limitation of the study

One of the limitations of this study is all patients who were proposed to be included in the study did not come to the clinic during the three months of data collection time and hence the proposed sample size decreased. The other major limitation of this study is related to the problem of the availability of complete secondary data. Patients did not volunteer to give response during primary data collection. Some variables were not included in the study due to lack of equipment and limitation of resource or budget (like waist-to-hip ratio).

## ABBREVIATIONS

**AIC**, Akaike information criteria; **BMI**, Body mass index; **GoUTH**, Gondar university teaching hospital; **HTN**, Hypertension; **OLR**, Ordinal logistic regression; **OR**, Odds ratio; **OPD**, Outpatient department; **PO**, Proportional



odds; **POM**, Proportional odds model; **PPOM**, Partial proportional odds model; **WHO**, World health organization; **WHOROEM**, World health organization Regional office for the Eastern Mediterranean.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

## REFERENCES

- Akilew A, Awoke T, Alemu S, Megabiaw B (2012). Prevalence and associated factors of hypertension among adults in Gondar, Northwest Ethiopia: a community based cross-sectional study. *BMC cardiovascular disorders* 12(1):1-6.
- Assefa Z, Haftu G, Alemayehu K (2014). Prevalence and associated factors of hypertension among adult population in Mekelle city, Northern Ethiopia. *International Journal of innovative pharmaceutical sciences and research* 2(3):653-668.
- Awoke M, Damen HM, Ahmed A, Tekebash A (2014). Epidemiology of Major Non-communicable Diseases in Ethiopia: A Systematic Review. *BMC journal of Health, population and nutrition* 32(1):1-3
- Erhun WO, Olayiwola G, Agbani EO, Omotoso NS (2005). Prevalence of hypertension in a university community in South West Nigeria. *African Journal of Biomedical Research* 8(1):15-19.
- Jasmine S, Sundar S, Joseph Maria AS, Parameswari VS, Kalpana S, Shantharam D (2013). Prevalence and determinants of hypertension among urban school children in the age group of 13-17 years in, Chennai, Tamilnadu. *Epidemiol* 3(130):2161-1165.
- Jenei Z, Pall D, Katona E, Kakuk G, Polgar P (2002). The epidemiology of hypertension and its associated risk factors in the city of Debrecen, Hungary. *Public health* 116(3):138-144.
- Iwelunmor J, Collins OA, Richard C, Bamidele T, Plange-Rhule J, Richard A, Gbenga O (2014). Prevalence determinants and systems-thinking approaches to optimal hypertension control in West Africa. *Globalization and health* 10(1):1-8.
- Kassawmar A, Dadi AF, Alene KA (2015). Prevalence of hypertension among federal ministry civil servants in Addis Ababa, Ethiopia: a call for a workplace-screening program. *BMC cardiovascular disorders* 15(1):1-6.
- Kumar P, Desai VK, Kosambia JK (2002). Prevalence of hypertension amongst the employees of a mega industry of South Gujarat. *Indian Journal of Community Medicine* 27(1):19.
- Marwiro A (2012). Prevalence and Risk Factors for Hypertension among Bulawayo City Council Employees, 2010.
- Mizumoto K (2004). Hypertension and risk factors related to lifestyle among women aged 40 years and over in Phuthamon district, Nakhon Pathom Province, Thailand. (Unpublished MPHCM thesis) Mahidol university, Thailand.
- Mulugeta M (2015). Systematic Reviews of Prevalence and Associated Factors of Hypertension in Ethiopia: Finding the Evidence. *Science Journal of Public Health* 3(4):514-519. doi: 10.11648/j.sjph.20150304.19
- Mungati M, Manangazira P, Takundwa L, Gombe N, Rusakaniko S, Tshimanga M (2014). Factors affecting diagnosis and management of hypertension in Mazowe District of Mashonaland Central Province in Zimbabwe: 2012. *BMC Cardiovascular Disorders* 14(1):1-12.
- Seid H (2014). Evaluation of the risk factors of hypertension in patients visiting adult emergency outpatient department of Tikur Anbessa specialized hospital. (Unpublished MEMC thesis), Addis Ababa University, Addis Ababa, Ethiopia.
- World Health Organization (WHO) (1999). International Society of Hypertension Guidelines for the Management of Hypertension
- World Health Organization (WHO) (2010). Global status report on noncommunicable diseases.
- World Health Organization (WHO) (2010). A global brief on Hypertension. Marvin M, m.d. High blood pressure. (<http://doc.med.yale.edu/heartbk/12.pdf>). Accessed on December, 20, 2015