Prevalence, awareness, treatment and control of hypertension with associated factors among adults in slums of Nairobi, Kenya

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ABBREVIATIONS

AMC: Amsterdam Medical Centre
AMREF: African Medical and Research Foundation
APHRC: African Population Health Research Centre
BP: Blood pressure
CBO: Community Based Organization
CIA: Central Intelligence Agency
CVD: Cardio Vascular Disease
GDP: Gross Domestic Product
HIV: Human Immunodeficiency Virus
INDEPTH: International Network for the continuous Demographic Evaluation of Populations and their Health in Developing Countries
ISH: International Society of Hypertension
KEMRI: Kenya Medical Research Institute
KIT: Koninklijk Instituut voor de Tropen (Royal Tropical Institute)
MD: Medical Degree
MSF: Médecins sans Frontières
NA : Not Applicable
NGO: Non Governmental Organization
NUHDSS: Nairobi Urban Health Demographic Surveillance System
OR: Odds Ratio
SAGE: Strategic Advisory Group of Experts
SD: Standard Deviation
SMS: Short Message Service
SPSS: Statistical Package for the Social Sciences
SSA: Sub-Saharan Africa
TBC: Tuberculosis
WHO: World Health Organization

ABSTRACT

Steven van de Vijver, MD, 2009

Prevalence, awareness, treatment and control of hypertension and associated factors among adults in slums of Nairobi, Kenya

Key words: hypertension, slum, epidemiology, determinants, Sub-Saharan Africa, prevalence

The thesis is based on secondary data from a wider study on CVD implemented by the African Population Health Research Centre under supervision of Catherine Kyobutungi.

Problem statement: Hypertension is the single most important cause of CVD morbidity and mortality in the world. Especially in low- and middle-income countries there is a rising prevalence partly due to urbanization.

Objectives: To assess prevalence, awareness, treatment and control of hypertension and associated factors in slums of Nairobi in order to formulate recommendations to improve prevention.

Methods: A cross-sectional study based on the Nairobi Urban Health Demographic Surveillance System (NUHDSS), with hypertension defined as BP >=140/90 or current use of medication.

Results: Overall, 19.1% were hypertensive with significant higher outcomes among females, older people, and Kamba ethnicity. Education, wealth and occupation were not significant determinants. The overall awareness among hypertensives was 21.0% which is lower in males, young people and those having an informal job. 15.1% of hypertensives is on current treatment with significant more females, elderly and those that finished secondary school or higher. Among hypertensives 5.1% have their blood pressure controlled, this was significantly higher in females.

Discussion: Compared to other populations there is moderate prevalence of hypertension but overall low rates of awareness, treatment and control. Level of treatment among those aware of hypertension, and control among those on treatment are almost similar as high-income settings. Age and sex were the strongest determinants for hypertension whereas the association with socio-economic factors remains weak in this setting.

Conclusion: To improve treatment and control of hypertension in slums, awareness should increase among patients, health care providers and policy makers.

BACKGROUND

Personal introduction

In 2004 I started the Dutch specialisation of tropical medicine. After two and a half years of training in surgery and gynaecology, and the core course of this Masters in International Health at the KIT I completed the specialisation. My first mission was for Médecins sans Frontières (MSF) in a hospital in Baraka, located in the eastern province South-Kivu in the Democratic Republic of Congo. It was a very interesting period where my working activities contained ward rounds, theatre, delivery room, outpatient centre, HIV and TB clinics, cholera outbreak unit, seven distant health care centres and trainings of community health workers. I loved the diversity of the job. But after almost one year I decided that I had to choose between the different activities for my further career. Although my former training was mainly focused on surgery and gynaecology and I really liked to spend hours in operation theatre and delivery room, I felt that primary health care was for me the most important place to make a significant change in level of health in a region. I decided that I needed more training in this field and went back to The Netherlands, an outstanding place to specialise in primary health care. In combination with this specialisation I decided to complete my Masters in International Health to create a global perspective on primary health care.
In the TropEd program I choose courses where I could learn how vaccination, HIV and TB, could be integrated in the primary health care.
On the other hand I am learning in the Dutch family medicine training not only clinical skills of primary health care but also about the organisation and set-up of different primary health care topics. I am specifically interested in their innovative guidelines on the management of cardiovascular disease. This subject has triggered me because I had discovered in my clinical work in Africa that cardiovascular diseases are also in low- and middle- income economies a fast growing concern. Especially in the regions where the people need help the most, and these diseases are the least expected: the urban slums. Hopefully this thesis provides more information how this problem can be approached in the slums of low- and middle-income countries.

Background information on the country and study sites

Nairobi, where the two slums of the research are located, is the capital of Kenya.
The Republic of Kenya is situated in eastern Africa, between the countries Somalia, Ethiopia, Uganda and Tanzania and the Indian Ocean. With a GDP of 1470 US dollars per capita in 2008 it is a lower middle income country. But the incomes are unequally divided with a GINI coefficient of 42.5. Half of the population lives below the poverty line. Three quarters of the labour force is engaged in agriculture and one quarter in industry and services, but there is unemployment of 40% (World Bank; CIA Factbook).

In 2008 the mean age of the country was 18.0 years old, with 42.3% of the country below 14 years, and only 2.6% above 65 years. The population growth rate is 2.69%, with a fertility rate of 4.56 children born/woman and an infant mortality rate of 54.7/1000 live births (WHO Statistical Information System). The life expectancy in 2008 was 57.86 years; the adult prevalence rate of HIV is 6.7%, which makes Kenya to rank in the top ten of the world. Bacterial and protozoal diarrhoea, hepatitis A, and typhoid fever are the major infectious disease, combined with vector borne diseases like malaria and Rift Valley fever.
There are various ethnic groups in the country: Kikuyu 22%, Luhya 14%, Luo 13%, Kalenjin 12%, Kamba 11%, Kisii 6%, Meru 6%, other African 15%, non-African (Asian, European, and Arab) 1%. The religion is mainly Christian with 45% protestant and 33% Roman Catholic, only 10% is Muslim. The official language is English and Kiswahili. (CIA Factbook). In 2003 the literacy rate (age 15 and can read and write) was 85.1% (90.6% in males and 79.9% in females), with a school life expectancy of 10 years (females 9 years).

Last year 22% of the population lived in urban areas but this grows with a 4% annual rate of urbanization. The people mainly go to Nairobi, with approximately 3,5 million inhabitants the biggest city of Eastern Africa. More than half of the city population is estimated to live in slums (Amnesty International Report, 2009). In Nairobi there are more than forty different identified slums, most of them on the eastern part of the city. The slums of the research, Korogocho and Viwandani, are also located in this direction on 5-10 kilometres from the city centre. Korogocho is regarded as one of the biggest slums of Nairobi with estimations of population between 120.000 and 200.000 inhabitants (Amnesty International Report, 2009; Korogocho website), on just a few square kilometres. This explains the name Korogocho which means in Swahili ‘shoulder to shoulder’.

Since 2000 the African Population Health Research Centre (APHRC) is running the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) in parts of Korogocho and Viwandani. The study population in May 2003 was 57,440 people living in 22,457 households. The study population in Korogocho slum was 25,040 while Viwandani had 28,690 people. Typically for slums worldwide the population under surveillance is highly mobile. One year later the figures had changed in respectively 59698, 26533 and 33165.
As mentioned in the introduction of the NUHDSS below, the two study populations vary widely in a number of aspects. In Viwandani, the population is mainly comprised of labour migrants working in the neighbouring industrial area, while the Korogocho population is mainly comprised of long-term settlers mostly engaged in the informal sector. These communities are characterized by high crime rates, high risky sexual behaviours, low school participation and high unemployment rates. Compared to the rest of Kenya, the slums exhibit worse child health indicators with low vaccination rates, and high prevalence of diarrhoea and acute respiratory infections. Poor environmental sanitation is the hallmark of these communities. Toilet coverage is very low, there are no sewers or drainage systems and there

is limited access to safe drinking water. Houses characteristically have no ventilation and are often overcrowded (data from APHRC).

Description of health care delivery system
In the APHRC document is stated the information below, that the slums of Nairobi are characterized by lack of social services. Health and education services are mainly provided by the private and informal sector. The health care delivery system in slum communities is dominated by the private-for-profit sector. About 82% of the health facilities in the two slums are private-for-profit. Most of these facilities are not formally registered by the City Council and thus are poorly regulated. Public health facilities are located outside these communities and are limited in number. The utilization of public health facilities is therefore poor due to geographical access problems especially during the evenings (due to insecurity) as well as due to perceived low level of quality of care, inadequate stock of drugs and inadequate diagnostic facilities. There are about five facilities run by faith-based non-governmental organizations (NGOs) and by community-based organizations (CBOs).
Some primary health care services in public health facilities such as antenatal care and immunization are offered free of charge, but generally services in both public and private facilities are paid for. According to data from the NUHDSS, about 46% of deaths occur in a health facility (hospital, or clinic) while about 42% occur at home. About 6% of deaths are said to occur on the way to a health facility.

The top 10 health conditions for which people seek health care, according to a NUHDSS survey of health facilities that serve the populations of the two slum communities during 2002, were in order of frequency:

1. Malaria
2. Diarrhea
3. Typhoid
4. Skin infections
5. Pneumonia
6. Sexual Transmitted Infections
7. Abortion
8. Other respiratory infections
9. Stomach aches
10. Tuberculosis

The initial objectives of the NUHDSS were to establish the mortality and migration profiles of the slum dwellers and compare this with the profiles of other sections of the Kenyan population. Additionally the likely causes of death for children, mothers and other population groups to inform future policies for the delivery of health care services for the slum population were also collected. With the main reason to provide a sustained source of data on mortality among the urban poor which is largely lacking in Sub-Saharan Africa (SSA).

In these last years several studies are nested within the platform of information of the NUHDSS since it provides an accurate denominator of the population base in the slums of Nairobi.
The NUHDSS have performed studies on verbal autopsy, HIV, migration, education, poverty and urbanization. Each household is visited every four months to gather the information on the status of its residents. The main data that is collected is dead, alive, out-migrated, or in-migrated, but additional data covers livelihoods, social economic status, marriage, social

networks, occupation, education and migration history among others. Their most recent study is on risk factors for cardiovascular diseases (CVD).

The NUHDSS is part of the INDEPTH Network (www.indepth-network.org), which connects demographic surveillance systems in low- and middle- income countries with each other.

Besides the studies related to the NUHDSS the APHRC is also doing research in other places and countries in SSA. The subjects differ from cervical cancer, HIV, TBC and malaria to education, migration, sexual behaviour.

Statement of the problem

Cardiovascular disease (CVD) is the major health burden worldwide. Although it long has been thought of as a health problem exclusively for the Western world, in 1999 almost 80% of the global CVD deaths were contributed by the middle and low income countries. In 2010 CVD is expected to be the leading cause of death in low- and middle- income countries (WHO, 2002).
The leading cause of CVD worldwide is hypertension (Murray and Lopez, 1997). In 2000 more than a quarter of the world's adult population (nearly one billion) had hypertension, and this is projected to increase by almost 40% in 2025 (Kearney, et al., 2005). This high prevalence, and its role as major risk factor for CVD makes hypertension the single most important cause of morbidity and mortality in the world (Rodgers, et al., 2004; Ezzati, et al., 2002).
In the low- and middle- income economies there seems to be a steep increase of the prevalence of hypertension, as the blood pressure in more than half of the populations in low or middle income countries is higher than in the US (Fuentes, et al., 2000). Also in the Sub-Saharan Africa (SSA) there is a high prevalence of hypertension (WHO, 2005), although the awareness and treatment in African setting is still very low (Bovet et al., 2002; Agyemang, et al., 2006). Stroke mortality in urban East-African region (Dar es Salaam) is more than five times higher than in England, and most likely the main reason for this is high prevalence of hypertension and poor control of this risk factor (Walker et al., 2000).

One of the reasons of the increase of the prevalence of hypertension is the urbanization (Godfrey and Julien, 2005). The rates of hypertension are higher in urban than in rural settings (Fuentes, et al., 2000; Addo et al., 2007; Agyemang et al., 2006). This is mainly associated by contextual and behavioural reasons like for example life style and dietary changes (Godfrey and Julien, 2005) that together form a complex system for developing hypertension as can be seen in figure 1.
Large proportions of the urban population in low- and middle-income countries are living in slums (UN-HABITAT, 2003). The living conditions in these slums have a major impact on health and health care (Ross and Mirowsky, 2001). With the psychosocial constraints of violence, insecurity and stress there is also an increased risk on cardiovascular disease (Chambers, et al., 2009; Pawar, et al., 2008; Hill and Chambers, 2005). Assessment of hypertension awareness and management is crucial for developing strategies to prevent the increasing burden of morbidity and mortality from hypertension related complications (WHO/ISH statement on management of hypertension, 2003). At the moment most treatment of hypertension is happening only in the end stage when several complications occur, which makes the intervention very costly and less effective. In order to create more effective treatment and lower costs there should be more focus on prevention and management. There

is major inequity in care for hypertension (MacMahon, et al., 2008). 90% of the 50 billion dollars that are spent on hypertension is happening in the high-income countries, although the low and middle income countries have a five times higher burden of CVD. It is a concern to observe that ten years ago this enormous burden of cardiovascular diseases in low- and middle- income economies was already predicted by the Global Burden of Disease Project, and that still the major health development funds, like the World Bank and Bill and Melinda Gates Foundation, are not addressing this growing need (MacMahon, et al., 2008).

Information on CVD and their risk factors such as hypertension and their management in slums is very limited. There are some studies in the slums of Dar es Salaam, the capital of neighbouring country Tanzania, which report alarming results of increasing and high prevalence of hypertension (Bovet et al., 2008; Njekelela et al., 2009), but there is a strong need to get more results on prevalence and insight into which people are at risk. The aim of this study was therefore to explore the magnitude of the problem of hypertension, awareness, treatment and control, and their determinants in the slums of Nairobi. As in other settings factors like age, sex, ethnicity, occupation, education and wealth play a role in CVD (Grotto, et al., 2007; Grotto, et al., 2008), this study aims to get more insight into factors that may contribute to CVD in a slum setting. Hopefully the results of this thesis are useful in developing effective interventions for the local and international NGO's like MSF and AMREF that are active in the slums of Nairobi. A common and reliable methodology to study the epidemiology of chronic diseases in low- and middle- income countries is with a demographic surveillance system (Van Minh, et al., 2008; INDEPTH Network, 2009). There are also other risk factors for hypertension and cardiovascular disease like obesity, alcohol consumption, smoking, diabetes, hypercholesterolemia and other factors (Wong, et al., 2005) that are included in the main study of the APHRC but is not part of this thesis.

Conceptual framework

For the APHRC study on CVD an adaptation of the conceptual framework of Wong and colleagues (Wong, et al., 2005) is used, shown in figure 1. This is quite a complete framework on CVD. As my thesis is only focusing on the hypertension part of the CVD, and only specific determinants, I have made an adjustment of this study for my own conceptual framework, shown in figure 2. It demonstrates that the thesis focuses on the role of the six determinants on all four dimensions of hypertension (prevalence, awareness, treatment, control). In the upper part the three non-modifiable risk factors (sex, age, ethnicity) are presented and below the three contextual risk factors (education, wealth, occupation).

Figure 1: Conceptual framework for risk perception and risk factors for cardiovascular diseases (Wong, et al., 2005)

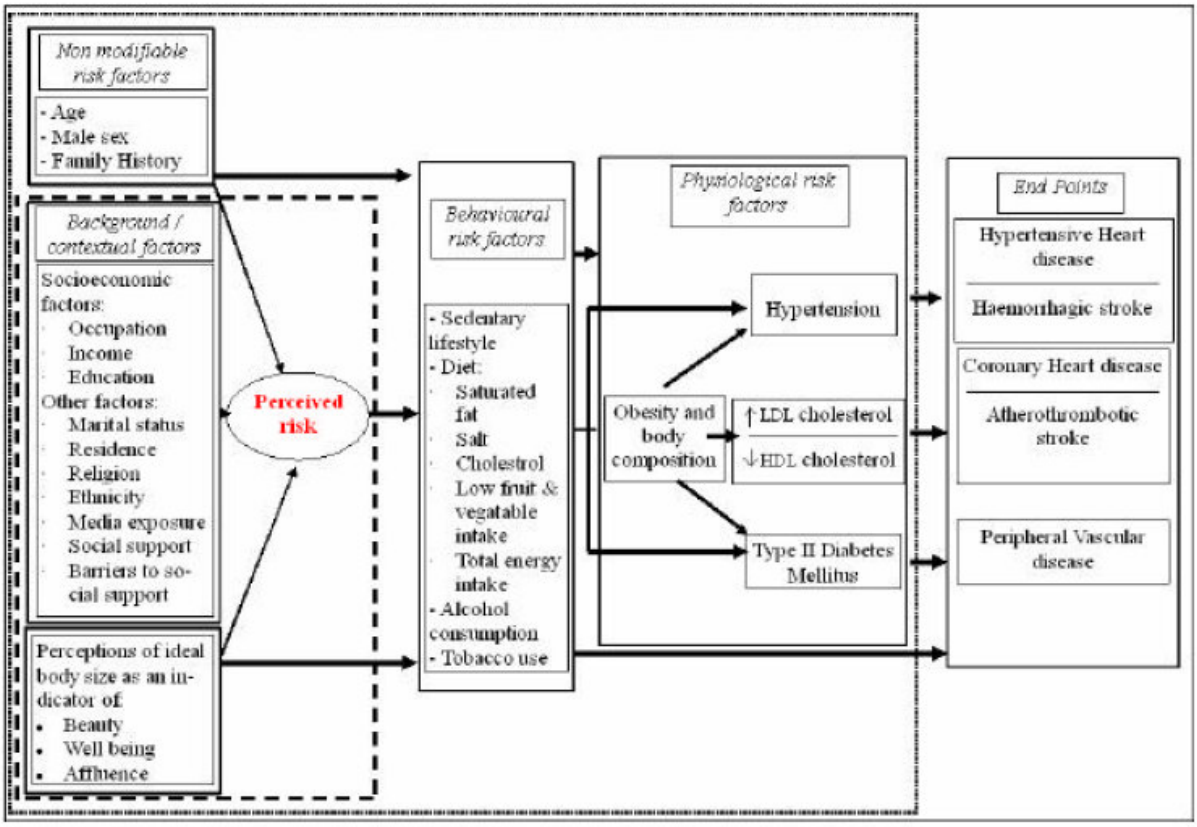
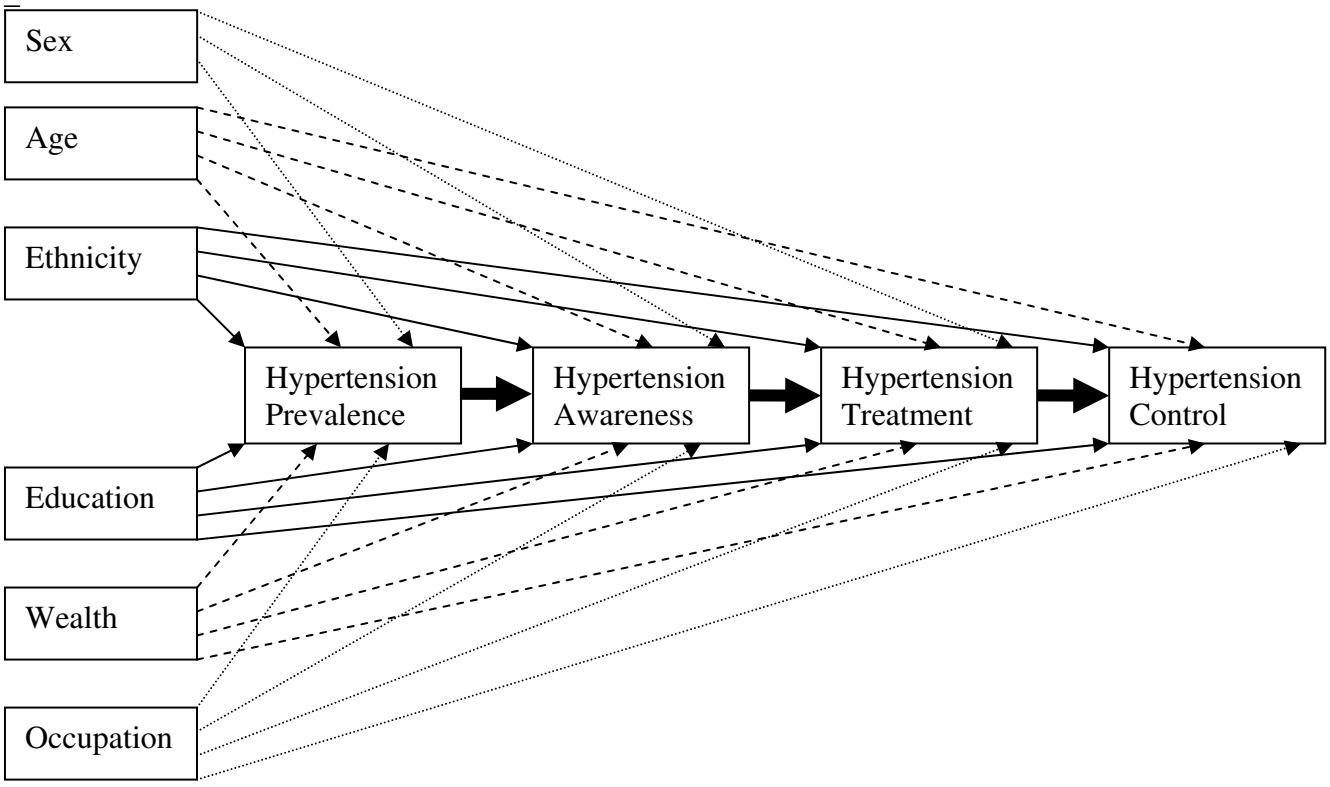


Figure 2: Conceptual framework of six possible determinants on hypertension



STUDY OBJECTIVES

Overall objective:
To assess the current situation on prevalence, awareness, treatment and control of hypertension, by various determinants, in the slums of Nairobi in order to formulate recommendations for improved care of hypertension in this location.

Specific objectives:

- To assess the current situation on prevalence, awareness, treatment and control of hypertension in the slums of Nairobi
- To explore the correlation of hypertension to various factors such as age, sex, ethnicity, hypertension awareness, education, occupation and wealth in Nairobi slum area.

Study questions:

- To assess the prevalence of hypertension in adults in different age groups in the slums of Nairobi
- To assess determinants of hypertension: sex, age, ethnicity, education, wealth and occupation
- To assess the awareness of adults in the slums of Nairobi of their hypertensive state
- To assess determinants of awareness: sex, age, ethnicity, education, wealth and occupation
- To assess the treatment of adults with hypertension in the slums of Nairobi
- To assess determinants of treatment: sex, age, ethnicity, education, wealth and occupation
- To assess the level of control with medication of adults with assumed hypertension
- To assess determinants of this control: sex, age, ethnicity, education, wealth and occupation

METHODS

Design
The study of the APHRC is a cross sectional survey based on household visits in an urban slum population of Nairobi. For my thesis I use the data from this study for a secondary data analysis.

Setting
The Cardiovascular Disease (CVD) study under the title: 'Assessing the linkages between socioeconomic status, perceived personal risk, and risk factors for cardiovascular and related non-communicable diseases in a population of slum dwellers in Nairobi, Kenya', is nested within the National Urban Health Demographic Surveillance System.
The research is divided in several smaller studies. In collaboration with Catherine Kyobutungi, she is working for APHRC and responsible for the research, we have decided that I focus on the part of hypertension.
In the CVD study the household visit does not only include measurement of blood pressure but also glucose, lipids, body and waist measurements and an extensive questionnaire.

Patients
Inclusion criteria
The inclusion criteria the APHRC has applied are: 18 years and above, given informed consent to participate and not physically or mentally incapacitated.

Sample size
For the quantitative cross sectional survey, the APHCR considered a range of scenarios that would yield a sample size able to detect differences in the prevalence of behavioural and physiological risk factors among males and females in each of the two slums.
As mentioned in the study, the sample size is based on calculations on the risk factor (for which data are available) with the lowest estimated prevalence based on their assumptions, i.e. obesity. The obesity prevalence amongst females is estimated to be about half of the figure for Nairobi province (which is 12% at Kenyan Health Survey) and the prevalence amongst males to be about half what it is among females (i.e. 6% and 3% respectively). A difference of at least 3% in % of obesity is considered to be relevant. Since sample size depends on effect size, using a strategy with a small effect size (3%) ensures sufficient power, to detect differences in the other risk factors which have much higher prevalence/larger effect sizes, and to conduct subgroup analyses of factors with unknown effect sizes (but expected to be >3%) such as socioeconomic groups. Additionally since the prevalence of most physiological risk factors increases with age, the sample size is also sufficient to detect differences between the different age groups (18-29, 30-39, 40-49, 50-59, over 65 years) used in the analysis.
Using SAS UnifyPow software a sample size was obtained of 796 individuals per sex and per slum, to detect a difference in prevalence of obesity between males and females of at least 3% (if it exists), with 95% probability and 80% power. The total sample size was therefore 3184 i.e. 796 x 4 (2 sexes, 2 slums). A high non-participation was expected, mainly from refusals (given the requirement for biological samples) and failure to turn up for the interview. Taking into account a 15% non-participation rate, the effective sample size was calculated at 3746 individuals.

Besides this minimum amount of people in the study population due to the different risk factors there was also an aim to constitute strata divided by slum of residence (Korogocho,

Viwandani), gender (female, male) and age group (18-29, 30-39, 40-49, 50-59, over 65 years), which makes 20 strata in total. The minimum per strata was 250 respondents. The target overall sample was therefore 5000 respondents. This approach of strata with different age groups and sex is designed to facilitate statistical analysis and comparison between these strata. In these 5000 respondents there are sufficient numbers from the different categories of the six determinants.
The recruitment of the participants in the NUHDSS study is done by visiting all households in the designated areas of the slums of Korogocho and Viwandani. These two areas have been carefully selected at the start of the NUHDSS study as being highly representative of the overall slum population. All the people living in these marked households are included in the NUHDSS. Every three months the demographic information of the inhabitants is updated by the most recent household visits. From these NUHDSS database participants have been randomly sampled in order to fill the different strata of the CVD study.

Ethical
All patients that are included in the research have access to treatment. In collaboration with other NGO's two extra health posts have been set up just to treat all the patients that come up from this study. Given that these conditions are chronic in nature, a more long-term arrangement has been put in place to ensure that the people found to have hypertension get treatment even beyond the life of the project.
The research of the APHRC has been approved after ethical review by the Kenya Medical Research Institute (KEMRI)/National Ethical Review Committee. The thesis has been approved by the Research Ethics Committee at the Royal Tropical Institute (KIT). The participation of the people is on voluntary base, with written informed consent. Confidentiality of the results is ensured, mainly by using codes as identifiers for anonymity.

Data collection
In this study we use existing data that have been collected in the study of the APHCR. The APHCR collected their data from the household visits from the NUHDSS study.
We use data on prevalence, awareness, treatment and control of hypertension, sex, age, ethnicity, education, wealth, and occupation.

Measurement instruments
The techniques of the research are structured interviews with examination of the blood pressure. At the end of the questionnaire, which took on average twenty minutes, the physical examination was taken. The staff was instructed to follow strict regulations while taking the blood pressure: respondent should remain seated, and hold the monitoring device on the upper arm and hold it at heart level against his/her chest. The blood pressure was measured three times consecutively, using mainly the left arm. To minimise observer bias there was digital equipment.
The equipment selected used for blood pressure is recommended by the WHO STEPs group. It is the OMRON ® (Digital Automatic Blood Pressure Monitor). For the case definitions the standards of the SAGE and STEPs surveys is used. Which means for hypertension: Mean systolic BP >= 140 mmHg; or diastolic BP >= 90 mmHg; or both; or self-reported current use of anti-hypertensive medication. The average of the second and the third measurement is used as final result. To secure that the data used are reliable there was a cut-off from systolic above 30.
Results below this threshold were not accepted in the study.

Definitions
Awareness of hypertension was defined as self-reporting of any prior diagnosis of hypertension by a health-care professional. Treatment of hypertension was defined as receiving prescribed antihypertensive medication for management of high blood pressure in the last year. Control of hypertension was defined as the proportion of patients on antihypertensive therapy with systolic blood pressure of less than 140mm Hg and diastolic blood pressure of less than 90 mm Hg.

In principal there were 23 different categories of tribes, see Annex 2. This has been simplified into five main groups for data analysing (i.e. the four most dominant ethnic groups and the rest and missing combined under 'others').

In Annex 3 there is an overview of the three different measurements of wealth. First, assets were determined as the wealth people own, including house, furniture and other belongings. Second expenditures were determined as being the cash money that is owned and can be spend on daily needs, and third the composite which is a combination of assets and expenditure. All three categories were measured both in tertiles and in quintiles.
In the literature different ways of measuring wealth in poor settings are found (Addo, et al., 2009; Bovet, et al., 2002; Njelekela, et al., 2009). After discussion with the local people it was decided to use expenditure tertiles, as the standard for wealth, as it might be guiding in the opportunity for people to buy medication or healthy food and therefore is likely to have the strongest link with hypertension.
The first tertile is the poorest group; the third tertile is the richest. 'Not applicable' was used for the people in the study that did not know, or would not like to share their expenditure, or if the results was missing.

The determinant occupation is defined in four mutually exclusive categories. These four categories are merged from the ten original categories, see Annex 4. 'Formal' means having an official working contract. 'Not applicable' are the people where the information on their job was not clear or missing.

Quantitative data were after the interview entered in an MS Access database for management. The data are analyzed by STATA 10 and SPSS (version 15.0) in second phase. The data on age, sex and measurement of hypertension had to be all complete in order to be included in the statistics.
To assess the prevalence of hypertension, awareness, treatment amongst the six determinants (age, sex, occupation, education, wealth, and ethnicity) Chi-square cross tables were measured. As all the determinants are closely interrelated the logistic regression was started with full models including all six determinants. In stepwise approach the best described model was measured. As age and sex appeared so strong associated with hypertension age adjusted and sex specified measurements were performed. In all the analyses a p-value of less than 0.05 was considered statistically significant, and 95% confidence intervals were used.

Quality of measurements
The APHCR made a list to ensure quality in the research.
- Interviewers, team leaders and supervisors are rigorously trained in interview techniques and how to use the equipment.
- Questionnaires are translated into Swahili and back to English. Interviews are conducted in Swahili.

- Team leaders do spot checks of at least 5% randomly selected interviews conducted by each field worker supervised.
- Supervisors are present during data collection to ensure that procedures are followed correctly.
- Supervisors check 5% randomly selected forms filled by interviewers. Forms are checked for errors, missing information, inconsistent responses and where necessary, the field worker is asked to visit the respondent and clarify the information.
- At data entry level, 5% of all forms entered by each data entry clerk are entered in a separate database by the respective supervisor. If mismatches are found in 5% of the data initially entered by the clerk, all forms from that clerk are re-entered.
- A data manager oversees the data quality procedures. Where necessary, forms are sent back to the field for resolution.

I have accompanied the team at their field visits at the study sites in Korogocho and Viwandani in order to see if the quality control was in place. The minimum level of education for the staff that performed the interviews was secondary school finished with high grades. Most of the staff was from the slums itself to create better acceptance for participation. The team leader who supervised the staff in the field had a Masters degree in a health related subject. The supervisors that participated in the study required a PhD.

Timeline
In April 2008 the APHRC research started with the first questionnaires. In February 2009 the last questionnaires have been conducted. From February until July data were electronically entered, and cleaned by staff at the APHCR.

Financial
The research of the APHCR has been funded most specifically by the Wellcome Trust. This part of the research and thesis on hypertension is done on my own expenses.

Literature review
The literature that is used in this thesis was found with searches in the Pubmed database by the following search terms: hypertension, cardiovascular diseases, slum, low- and middle-income countries, Sub-Saharan Africa, epidemiology, prevalence, awareness, treatment, control, in different combinations. Besides the initial searches, the references of interesting articles were used for new information.

Limitations of methodology
The inclusion of participants is based on voluntary participation, this might influence the results. The information on contextual risk factors like education, wealth and occupation is gathered in interviews, in which the participant might influence the outcome as well.

RESULTS

7990 people have been sampled from the NUHDS database, see Annex 1, and in total 5190 successful household visits have been made (65.0%). Exclusion is caused by refusal and repetitive absence during home visits. After cleaning the data in SPSS for missing diastolic and systolic blood pressures, there were 5046 participants left to include in my research.
In Table 1 the overall characteristics of the study population are presented. By using chi-squares to determine significance, it becomes clear that in general males in the slums have received more education (P<0.001), have more money to spend (P<0.001), and have better professional circumstances with more formal jobs and less unemployment than their female counterparts (P<0.001). The mean systolic pressure of males was significantly higher than females (124.4 mmHg versus 122.9, P=0.003), whereas the diastolic pressure was higher among females (76.8 mmHg versus 75.4 mmHg), but not significant.

Table 1: Sociodemographic characteristics of study population

	Women		**Men**	
	N total (2323)	%	N total (2723)	%
Age (in years):				
18-29	539	23.2	592	21.7
30-39	547	23.5	581	21.3
40-49	572	24.6	591	21.7
50-59	333	14.3	551	20.2
60 <	332	14.3	408	15.0
Education:				
No school	433	18.6	226	8.3
Not finished primary school	615	26.5	578	21.2
Primary school	904	38.9	1202	44.1
Secondary school + higher	370	15.9	717	26.3
Ethnicity (see Annex 2)				
Luo	260	11.2	402	14.8
Luhya	252	10.8	402	14.8
Kamba	429	18.5	638	23.4
Kikuyu	979	42.1	884	32.5
Others	403	17.3	397	14.6
Wealth (see Annex 3):				
1st tertile (lowest in expenditure)	1009	43.4	830	30.5
2nd tertile	714	30.7	818	30.0
3rd tertile (highest in expenditure)	456	19.6	863	31.7
NA	144	6.2	212	7.8
Occupation (see Annex 4):				
Formal	408	17.6	738	27.1
Informal	1510	65.0	1834	67.4
Unemployed	307	13.2	101	3.7
Agriculture	14	0.6	8	0.3
NA	84	3.5	42	1.5
Blood pressure				
Mean systolic (SD)	122.9 (21.8)		124.4 (18.1)	
Mean diastolic (SD)	76.8 (13.0)		75.4 (11.6)	

The various results of the determinants ethnicity, wealth and occupation are adjusted and compressed in order to have a better overview and allow stronger calculations, see Annex 2,3,4

Prevalence

The overall prevalence of hypertension among the sampled population in the slums of Nairobi was 19.2%. In a first analysis of the data using cross tables in Chi square test significant correlations were found between hypertension and almost all determinants (sex, age, education, ethnicity and occupation P=0.001) except wealth (P=0.080).

Table 2: Prevalence (in %) of hypertension in sampled population

Sex	
Female	21.2
Male	17.4
	P < 0.001
Age (in years):	
18-29	6.0
30-39	10.1
40-49	18.7
50-59	28.2
60 <	42.8
	P < 0.001
Education:	
No school	28.5
Not finished primary school	25.1
Primary school	16.2
Secondary school + higher	12.5
	P < 0.001
Ethnicity	
Luo	15.3
Luhya	19.1
Kamba	20.9
Kikuyu	21.3
Others	15.1
	P < 0.001
Wealth:	
Expenditure 1st tertile	19.5
Expenditure 2nd tertile	17.7
Expenditure 3rd tertile	21.0
	P = 0.080
Occupation:	
Formal	19.3
Informal	18.9
Unemployed	12.7
Agriculture	45.5
	P < 0.001

To differentiate the results the prevalence of hypertension is specified along the subgroups female and male, see Table 3.

Table 3: Prevalence (in %) of hypertension in subgroups female/male

	Women (21.2)	Men (17.4)
Age (in years):		
18-29	4.5	7.4
30-39	10.8	9.5
40-49	24.0	13.7
50-59	32.1	25.8
60 <	49.7	37.3
	P < 0.001	*P < 0.001*
Education:		
No school	32.1	21.7
Not finished primary school	27.5	22.7
Primary school	16.2	16.2
Secondary school + higher	10.0	13.8
	P < 0.001	*P < 0.001*
Ethnicity		
Luo	20.4	11.9
Luhya	22.6	16.9
Kamba	23.1	19.4
Kikuyu	23.0	19.3
Others	14.4	15.9
	P= 0.006	*P = 0.010*
Wealth:		
Expenditure 1st tertile	21.3	17.3
Expenditure 2nd tertile	18.3	17.1
Expenditure 3rd tertile	25.4	18.7
	P = 0.015	*P = 0.670*
Occupation:		
Formal	18.4	19.8
Informal	22.3	16.0
Unemployed	13.4	10.9
Agriculture	35.7	62.5
	P = 0.001	*P < 0.001*

In Table 4 the results of the multiple regression with stepwise regression, which showed that occupation, education and wealth were not having significant association.

Table 4: multiple regression with all the determinants

Sex	OR	95% CI
Female	reference	
Male	0.68	0.57-0.81
Age (in years):		
18-29	reference	
30-39	1.86	1.33-2.62
40-49	3.60	2.61-4.96
50-59	6.67	4.81-9.24
60 <	13.25	9.40-18.69
Education		
No school	reference	
Not finished primary school	1.23	0.95-1.59
Primary school	1.19	0.91-1.56
Secondary school + higher	1.02	0.74-1.41
Ethnicity		
Luo	reference	
Luhya	1.14	0.83-1.57
Kamba	1.38	1.04-1.84
Kikuyu	1.04	0.79-1.36
Others	0.81	0.58-1.13
Wealth		
1st tertile	reference	
2nd tertile	1.00	0.83-1.22
3rd tertile	1.11	0.91-1.35
Occupation		
Formal	reference	
Informal	0.85	0.70-1.02
Unemployed	0.90	0.61-1.32
Agriculture	1.28	0.53-3.12

Sex

Prevalence of hypertension in the sampled population was among women significantly higher than in men, 21.2% versus 17.4%. Table 5 shows that the higher prevalence of hypertension among females is associated by higher use of medication but also in higher blood pressure (both systolic and diastolic) in the study population. Multiple regression, Table 4, shows that being a male was associated with less hypertension (OR 0.68, with CI 95% 0.57-0.81)).

Table 5: analysis of hypertension (in %) compared between females and males

	Hypertension	Current Medication	High blood pressure > 140/90	Systolic > 140	Diastolic >90
Female	21.2	4.6	19.7	15.2	12.1
Male	17.4	1.4	16.9	13.4	9.3
	P<0.001	P<0.001	P=0.009	P=0.083	P=0.001

Age
The prevalence of hypertension increased with age. When divided by sex subgroups the prevalence in the youngest age group is much higher for men than for women (7.4% versus 4.9%), but in the older groups it is the other way round. In the oldest group almost half (49.7%) of the females were hypertensives compared to 37.3% of the males (Table 3).
Of all the six determinants it is clear from the multiple regression analyses that age has the strongest association (Table 4).

Education
In Table 2 there seems to be a significant correlation between education and hypertension, with the prevalence of hypertension being higher in people with low education than those with high education. In females this trend seems even stronger with the prevalence in the category 'no school' (32.1%) more than three times higher than the group of secondary school and higher (10.0%). However, after adjustment for age (Table 6) people with high education were more likely than those with low education to have hypertension in both men and women. In multiple regression analysis this effect was no longer significant (Table 4).

Table 6: Age-adjusted Odds ratios and 95% confidence intervals of hypertension by study characteristics

	Women		Men	
Age (in years):	OR	95% CI	OR	95% CI
18-29	reference		reference	
30-39	2.59	1.59-4.24	1.30	0.86-1.97
40-49	6.76	4.30-10.62	1.98	1.34-2.91
50-59	10.16	6.35-16.25	4.32	3.01-6.21
60 <	21.20	13.35-33.67	7.40	5.12-10.67
Education:				
No school	reference		reference	
Not finished primary school	1.43	1.06-1.93	1.50	1.02-2.21
Primary school	1.39	1.00-1.94	1.62	1.10-2.37
Secondary school + higher	0.92	0.59-1.44	1.71	1.12-2.62
Ethnicity				
Luo	reference		reference	
Luhya	1.15	0.74-1.81	1.41	0.93-2.13
Kamba	1.20	0.86-1.79	1.79	1.24-2.60
Kikuyu	0.75	0.52-1.08	1.53	1.07-2.18
Others	0.46	0.30-0.72	1.19	0.78-1.80
Wealth:				
1st tertile	reference		reference	
2nd tertile	0.95	0.73-1.23	1.11	0.85-1.45
3rd tertile	1.33	1.01-1.76	1.12	0.86-1.45
Occupation:				
Formal	reference		reference	
Informal	1.05	0.78-1.42	0.72	0.57-0.90
Unemployed	0.99	0.63-1.57	0.84	0.42-1.69
Agriculture	0.85	0.26-2.73	2.85	0.66-12.25

Ethnicity
In men, the prevalence of hypertension was lower in Luo ethnic group than other ethnic groups. The differences between Luo and Kamba and Kikuyu still remained statistically significant after adjustment for age. Luo also had a slightly lower prevalence of hypertension than Luyha, Kamba and Kikuyu women, but a higher prevalence than other ethnic groups. Only the difference between Luo women and the group 'others' remained statistically significant after adjusted for age (Table 6), this continued in the multivariate regression (Table 4).

Wealth
Wealth is the only determinant that does not show a significant association on the prevalence of hypertension (Table 2). Only if the expenditure tertiles are divided by sex (Table 3) there seems to be a significant drop in the second tertile of the women. After age adjustment (Table 6) and in the multiple regression analysis (Table 4) wealth is no longer found to a significant determinant on hypertension. In the calculations the expenditure tertiles were even lowering the B-coefficient so it was not included in the multiple regression after backward stepwise approach (Table 7).

Table 7: Odds ratios and 95% confidence intervals of hypertension by study characteristics adjusted to age and ethnicity, after backward stepwise regression

	Women		Men	p
Age (in years):	OR	95% CI	OR	95% CI
18-29	reference		Reference	
30-39	2.62	1.60-4.29	1.30	0.86-1.97
40-49	6.76	4.29-10.64	1.95	1.32-2.87
50-59	10.72	6.68-17.20	4.34	3.02-6.24
60 <	25.30	15.74-40.66	7.40	5.12-10.70
Ethnicity				
Luo	reference		Reference	
Luhya	1.15	0.74-1.81	1.41	0.93-2.13
Kamba	1.20	0.80-1.79	1.79	1.24-2.60
Kikuyu	0.75	0.52-1.08	1.53	1.07-2.18
Others	0.46	0.30-0.72	1.19	0.78-1.80

Occupation
On first analysis there seems to be a significant association of the determinant occupation on the prevalence of hypertension (Table 2). After adjusted for age (Table 6) there was only a significant lower prevalence in males with informal jobs compared to males with formal jobs. But in the multivariate regression model the occupation was not significantly associated with hypertension (Table 4).

Awareness

Overall, 21.1% of the people that had hypertension were aware (203 out of 966 people).

Table 8: Overview of awareness of hypertension

	Hypertensive	Non-hypertensive	Total
Aware of hypertension	203 (4.0%)	77 (1.5%)	280 (5.5%)
Non- aware of hypertension	763 (15.1%)	4003 (79.4%)	4766 (94.5%)
Total	966 (19.1%)	4080 (80.9%)	5046 (100%)

Among the people that state that were aware of hypertension by self-reporting or earlier diagnosed 27.5% (which is 77 people of the 280) is not having hypertension in our research following the definition. They had a good blood pressure without use of medication.

Table 9: Prevalence of awareness, treatment and control among hypertensives (N=966 and control on treatment N=146)

	Awareness	**Treatment**	**Control**	**Control on Treatment**
Sex				
Female	29.8	22.0	6.9	31.5
Male	12.0	8.0	3.2	39.5
	P<0.001	*P<0.001*	*P=0.008*	*P=0.370*
Age (in years):				
18-29	4.4	4.4	2.9	66.7
30-39	5.3	4.4	3.5	80.0
40-49	25.2	17.0	6.4	37.8
50-59	22.9	16.1	4.0	25.0
60 <	26.0	19.2	6.0	31.1
	P<0.001	*P<0.001*	*P=0.528*	*P=0.088*
Education:				
No school	24.7	18.1	4.8	26.5
Not finished primary school	28.0	20.0	6.7	33.3
Primary school	13.2	8.8	4.4	50.0
Secondary school + higher	20.6	16.2	3.7	22.7
	P<0.001	*P = 0.001*	*P = 0.478*	*P=0.135*
Ethnicity				
Luo	17.8	10.9	5.0	45.5
Luhya	14.4	10.4	3.2	30.8
Kamba	17.6	12.6	2.2	17.9
Kikuyu	26.1	18.9	6.6	34.7
Others	20.7	15.7	7.4	47.4
	P= 0.021	*P = 0.055*	*P = 0.097*	*P=0.239*
Wealth:				
1st tertile	25.7	19.2	6.4	33.3
2nd tertile	18.5	12.2	3.0	24.2
3rd tertile	19.2	13.7	5.4	39.5
	P = 0.048	*P= 0.034*	*P = 0.140*	*P=0.392*
Occupation:				
Formal	21.7	15.4	5.4	35.3
Informal	20.2	14.3	4.8	33.3
Unemployed	26.9	21.2	9.6	45.5
Agriculture	10.0	10.0	0.0	0.0
	P = 0.540	*P = 0.565*	*P = 0.406*	*P=0.759*
Overall	*21.1 (N=203)*	*15.1 (N=146)*	*5.1 (N=49)*	*33.6 (N=49)*

Sex

There was a strong significant difference by sex in awareness of being hypertensive, with females being more than twice as aware (female 29.8% versus male 12.0%) (Table 9). In the multivariate regression the difference almost quadruples (Table 10).

Table 10: multiple regression with awareness with all the determinants

Sex	OR	95% CI
Female	reference	
Male	0.28	0.19-0.43
Age (in years):		
18-29	reference	
30-39	0.95	0.22-4.07
40-49	5.34	1.53-18.63
50-59	6.23	1.79-22.06
60 <	6.43	1.82-22.74
Education		
No school	reference	
Not finished primary school	1.40	0.85-2.31
Primary school	1.00	0.56-1.78
Secondary school + higher	1.78	0.85-3.72
Ethnicity		
Luo	reference	
Luhya	0.75	0.33-1.71
Kamba	1.20	0.60-2.41
Kikuyu	1.73	0.91-3.27
Others	1.35	0.61-2.96
Wealth		
1st tertile	reference	
2nd tertile	0.74	0.48-1.15
3rd tertile	0.78	0.51-1.21
Occupation		
Formal	reference	
Informal	0.63	0.41-0.97
Unemployed	0.92	0.41-2.08
Agriculture	0.18	0.02-1.54

Age

The level of awareness of hypertension within the group that is hypertensive rise significantly with age (Table 9). This trend is similar in males and females (Table 11). The multivariate regression (Table 10) shows that there is a significant cut-off in awareness at 40 years and above.

Education

Education significantly correlated with awareness. The significant correlation in the univariate analysis did no longer exist in the multivariate regression, Table 10.

Ethnicity

There was significant association between ethnicity and awareness of hypertension, with the Kikuyu being the most aware and the Luhya least aware of their hypertension status. When the results were stratified by sex, and in the multivariate regression, there was no significant association between ethnicity and hypertension awareness.

Table 11: Prevalence of awareness, treatment and control among hypertensives in subgroups by females/males (crosstabs in chi-square)

	Awareness		**Treatment**		**Control**		**Control***	
	N=492	N=474	N=492	N=474	N=492	N=474	N=108	N=38
	Women (29.8)	Men (12.0)	Women (22.0)	Men (8.0)	Women (6.9)	Men (3.2)	Women (31.5)	Men (39.5)
Age (in years):								
18-29	8.3	2.3	8.3	2.3	8.3	0.0	100.0	0.0
30-39	8.5	1.8	6.8	1.8	5.1	1.8	75.0	100.0
40-49	31.4	14.8	20.4	11.1	6.6	6.2	32.1	55.6
50-59	36.4	12.7	27.1	7.7	6.5	2.1	24.1	27.3
60 <	35.0	16.4	27.3	10.5	7.9	3.9	28.9	37.5
	P<0.001	*P = 0.012*	*P = 0.005*	*P = 0.126*	*P=0.955*	*P = 0.290*	*P=0.068*	*P=0.424*
Education:								
No school	29.9	10.2	23.0	4.1	6.5	0.0	28.1	0.0
Not finished primary school	34.9	19.1	25.4	13.0	8.9	3.8	34.9	29.4
Primary school	21.2	7.2	15.1	4.1	6.2	3.1	40.9	75.0
Secondary school + higher	40.5	13.1	29.7	11.1	2.7	4.0	9.1	36.4
	P = 0.026	*P = 0.013*	*P = 0.085*	*P = 0.013*	*P = 0.533*	*P = 0.565*	*P=0.277*	*P=0.098*
Ethnicity								
Luo	24.5	10.4	15.1	6.3	7.5	2.1	50.0	33.3
Luhya	22.8	7.4	17.5	4.4	5.3	1.5	30.0	33.3
Kamba	26.5	10.5	21.2	5.6	1.0	3.2	4.8	57.1
Kikuyu	35.3	14.0	25.3	10.5	8.9	3.5	35.1	33.3
Others	25.9	15.9	20.7	11.1	10.3	4.8	50.0	42.9
	P= 0.187	*P = 0.504*	*P = 0.450*	*P = 0.328*	*P = 0.089*	*P = 0.842*	*P=0.033*	*P=0.857*
Wealth:								
1st tertile	33.6	13.9	27.0	7.6	8.8	2.8	32.8	36.4
2nd tertile	25.2	12.1	16.8	7.9	3.1	2.9	18.2	36.4
3rd tertile	30.4	11.2	20.7	8.7	8.6	3.1	41.7	35.7
	P = 0.254	*P = 0.770*	*P= 0.079*	*P = 0.938*	*P = 0.099*	*P = 0.984*	*P=0.225*	*P=0.999*
Occupation:								
Formal	38.7	13.0	29.3	8.2	6.7	4.8	22.7	58.3
Informal	28.3	10.9	20.2	7.5	6.5	2.7	32.4	36.4
Unemployed	29.3	18.2	24.4	9.1	12.2	0.0	50.0	0.0
Agriculture	20.0	0.0	20.0	0.0	0.0	0.0	0.0	-
	P = 0.333	*P = 0.671*	*P = 0.370*	*P = 0.914*	*P = 0.530*	*P = 0.597*	*P=0.416*	*P=0.316*

Control* = Control among treatment group

Wealth

The first tertile has significantly the highest level of awareness (Table 9), with the second and third tertiles with almost similar percentages. However, in the multivariate regression (Table 10), wealth was not related to hypertension awareness.

Occupation
In occupation there seems to be a trend that unemployed have the highest percentage of awareness, and the farmers the lowest (Table 9). By specifying the results by sex (Table 11), or multivariate regression (Table 10) these results become insignificant.

Treatment

In the study 146 people are receiving current treatment (medication in the last twelve months), which is 15.1% of the hypertensive people (Table 9), and 70.9% of all the people that are aware and having hypertension (N=203).

Sex
There was a significant difference in hypertension treatment between female and male (22.0% versus 8.0%, P<0.001) (Table 11). In the multivariate regression the difference quadruples (Table 12).

Table 12: multiple regression with treatment with all the determinants

Sex	OR	95% CI
Female	reference	
Male	0.25	0.16-0.40
Age (in years):		
18-29	reference	
30-39	0.78	0.17-3.50
40-49	3.16	0.88-11.34
50-59	4.44	1.23-15.98
60 <	4.38	1.20-15.90
Education		
No school	reference	
Not finished primary school	1.59	0.91-2.77
Primary school	1.12	0.58-2.17
Secondary school + higher	2.60	1.15-5.90
Ethnicity		
Luo	reference	
Luhya	0.96	0.35-2.63
Kamba	1.67	0.71-3.90
Kikuyu	2.36	1.07-5.17
Others	2.09	0.82-5.29
Wealth		
1st tertile	reference	
2nd tertile	0.66	0.40-1.08
3rd tertile	0.73	0.45-1.19
Occupation		
Formal	reference	
Informal	0.68	0.42-1.12
Unemployed	0.99	0.41-2.41
Agriculture	0.30	0.03-2.64

Age
The percentage of treatment was significant higher in older age than in younger people. When specified by sex this trend seems indifferent among males (Table 11). In the multivariate regression the correlation with older age and higher percentage of treatment starts being significant from 50 years and above (Table 12).

Education
In the univariate analysis there was a significant association between education and treatment (Table 9). In the multivariate regression (Table 12) it becomes clear that people that finished secondary school or higher, were significantly more likely than people that have not attended school, to receive hypertension treatment.

Ethnicity
Similar as in awareness, also in treatment the Kikuyu have the highest treatment rate and Luhya the lowest treatment rate (Table 9). In the multivariate regression (Table 12) only the difference between Luo and Kikuyu remained significant.

Wealth
Significantly more people are on treatment in the first tertile according to univariate analysis (Table 9). Specified by sex (Table 11) or in multivariate regression (Table 12) this trend disappears.

Occupation
As for the other determinants occupation seems to have a similar trend in treatment as awareness with people in agriculture having low percentage, 10%, and unemployed the highest percentage on treatment with 21.2% (Table 9). The multivariate regression (Table 12) shows no significant correlation.

In the multivariate regression of treatment among the people that are aware there were no significant results. This might be due to the fact that the number of people being aware of their hypertension was low (N=203).

From the 146 people that stated to have taken medication in the last year, 97 have taken it also in the last two weeks. 6 of them have started in the last two weeks so they might not yet have an influence on the blood pressure. In both groups (medication last two weeks versus medication last year) less than one third has controlled their blood pressure (31.4% versus 32.0%) (Table 13). If two weeks instead of last year would be regarded as current treatment the result of treatment among hypertensives would drop from 15.1% to 10.2%. And the treatment among people that were aware of hypertension would drop from 70.9% to 47.8%. In the multiple regression analysis of only those respondents that took treatment during the last 2 weeks before the survery there is a higher B-coefficient 0.202. Besides the other factors in age, sex and education, it shows here also a significant difference (OR 1.80 and SD 1.08-3.00) that formal jobs have higher rates of treatment.

Table 13: differences in treatment 2 weeks or 12 months (crosstabs in chi-square)

	Total (% among hypertensives)	% use among people aware HT	% of blood pressure controlled
Treatment 12 months	146 (14.9%)	70.9	31.4
Treatment 2 weeks	97 (10.0%)	47.8	32.0

Control
In the group of hypertensives (966) only 49 (5.1%) have a blood pressure below 140/90. In the group of people receiving treatment (146) it makes 33.6% (Table 9).

In line with the findings of higher rates of women being on treatment, the chi-square analysis shows a significantly higher percentage of control of hypertension in women than in men (Table 9). But among people that are on treatment males were more often controlled than females (39.5% versus 31.5%), although this was not significant (Table 9).

In all the other determinants there was no significant association with hypertension control (Table 9). When the results were specified by sex, (Table 11), there was also no significant relationship although older women had a higher tendency to be controlled than their younger counterparts (P=0.068) (Table 11).

Besides the determinant of ethnicity in the female group there are no other significant results from the crosstabs chi-square analysis both in the total population of controlled people on treatment (Table 9), as divided by sex (Table 11).

There is almost no difference in effective control between people that have taken medication the last two weeks (32.0%) or only in the last year (31.4) as Table 13 shows.

The group of people that is controlled is so small (N=49) that in the multiple regression there was also a poor outcome with a B-coefficient of 0.10 and no significant association of any of the determinants.

DISCUSSION

Summary

19.1% of the study population has been diagnosed with hypertension. The prevalence of hypertension among females is significant higher than among males. In the univariate Chi-square analysis almost all determinants (sex, age, education, ethnicity, and occupation) showed strong significant correlation with the prevalence of hypertension. In the multivariate regression only the physiological factors of sex, age (where the prevalence almost doubles in every age-group) and ethnicity (Kamba people more at risk) remained significant. The socio-economic factors like education, wealth and occupation were not significant in the multivariate regression.
21.1% of the hypertensives were aware of their risk factor and 15.1% were treated. Interestingly 27.5 % of the people that believed they were hypertensive were not according the definition used in this study. Females are almost four times more aware and treated than men, also the older people were more aware and treated. An informal job shows less awareness than a formal job, and secondary school or higher, and Kikuyu-people have more chance of treatment.
Only 5.1% of the hypertensives had their blood pressure controlled, where the sex difference (females 6.9% versus men 3.2%) is the only significant correlation among all determinants.

Study Population

There is a difference in the amount of women and men in the study. Although in the design of the study, like earlier explained, the aim was to have equal numbers of both sexes, it was not possible to fill the strata in the oldest female groups, as can be seen in Annex 1. This is the consequence of the fact that more males than females are living in the slums. Because of this shortage of women the two groups of hypertension are now by accident almost equal (492 females and 474 males).
The findings that males have more education, are wealthier and have better professional circumstances might be partly explained by cultural reasons. The results of more wealth, more education and better occupational situation for males are also seen in similar studies (Njelekela, et al., 2009; Damasceno, et al., 2009).
Based on various considerations like different lifestyles and genetics the 23 ethnic groups were not fused with each other. In order to aim for relevant outcomes the four most dominant groups (Luo, Luhya, Kamba, Kikuyu) are separately analysed, while the rest is categorised as 'others'.
The eleven different forms of occupation were not clearly distinguished. In the literature there are also many different ways (Bovet, et al., 2002; Njelekela, et al., 2009; Addo, et al., 2009; Agyemang, et al, 2006) on describing employment in these specific settings. In order to categorise it for the slums I have used 'formal' and 'not formal'. Most people have informal jobs which might be difficult to distinguish from unemployed as they have no formal contracts but try to arrange some business for themselves. It is interesting to see that there is such a low percentage unemployment, especially among men (3.7%). This might possibly be due to the explanation from the local health workers that there is a culture that Kenyan men are ashamed to say that they are unemployed so they could use different terms for their working activities. Following some estimations more than half of the population of Korogocho is unemployed (Korogocho website, 2009)

The result that the mean systolic blood pressure in males (124.8) was higher than in females (122.9) is already known from general reviews (Safar and Smulvan, 2004) and similar studies in the slums of East Africa (Njelekela, et al., 2009;, Edwards, et al., 2000), although there is

also an international review which states that it is only happening in half of the populations (Fuentes, et al., 2000). In comparison with studies in the slums of Tanzania (Bovet, et al., 2002; Njelekela, et al., 2009) the mean blood pressures in our study are low. This is even more remarkable considering the relative high percentage of elderly in our study. This might explain the higher blood pressures than measurements in similar study in slums of Nigeria (Luwoyin, et al., 2002). In one of the studies in Tanzania (Edwards, et al., 2000) there is the same combination of males having higher systolic and females having higher diastolic blood pressures. There is no clear reason for this phenomenon.

Prevalence

With a prevalence of 19.1% of the study sample, it is slightly on the lower side if compared to other populations that have been studied worldwide and in Africa (Fuentes, et al., 2000; Addo, et al., 2007; Agyemang, 2006; Pereira, et al., 2009). The studies in the slums of Tanzania have much higher prevalences of hypertension, with percentages up to 30 to 50 percent (Bovet et al., 2002; Njelekela, et al., 2009). The relatively low prevalence in this study is even more remarkable given the fact that the estimate of 19.1 % is likely to be an overestimation due to over-representation of the older age groups. Also in the Indian setting the results of urban population are reaching between thirty and fifty percent (Zachariah, et al., 2003; Chaturvedi, et al., 2007). With India there might be a genetic difference and higher level of income but there is no clear explanation why this prevalence around Nairobi is so much lower compared to Tanzania. One of the reasons might be an underestimation because of the high rate of non-responders, see limitations. But there are also studies done in slums where the prevalence is even lower (Suryawongpaisal, et al., 1991).
77 people (1.5%) have been diagnosed with hypertension in the past but had no high blood pressure measured and were not using medication so they were not included in the prevalence of hypertension.
Compared to earlier studies done on hypertension among similar population in urban areas of Kenya (Katsivo and Apeagyi, 1991; Poulter, et al., 1990) the prevalence has increased enormously.

Sex

The prevalence of hypertension is higher among females than males. The higher prevalence of hypertension for females is in line with the study of Fuentes, et al., (2000) where is stated that in 41% of the low- and middle- income economies females have more hypertension and 18% men, and 41% no gender difference.
There are other studies (Addo, et al., 2007; Agyemang, et al., 2006) that show similar results. In the study of Bovet, et al., (2002) in the slums of Tanzania it was the same (27% versus 30%) but in the more recent study of Njelekela, et al., (2009) males were more often hypertensive (51% and 42%), and in the review of Pereira, et al., (2009) the prevalence in Africa is almost equal (40,5% versus 40,3%).
It is unclear why the females of Nairobi, like in Cape Town in South Africa, Jaipur in India and Isfahan in Iran in the study of Fuentes, et al., (2000) have more hypertension than their male counterparts.

It is interesting to see that the hypertension of females in Nairobi slums is not only higher than males because of the current use of medication, but also in high blood pressure, and it seems even in high systolic blood pressure (Table 5). This is remarkable because the means of the male systolic blood pressure is significantly higher than the female, as was shown in Table 1.

One of the potential reasons for the higher prevalence of hypertension among females could be the pregnancy induced hypertension (Povoa, et al., 2008). But in the age group where most pregnancies occur 18-29 the prevalence of hypertension in females is even lower than men (4.5 versus 7.4), and in the age group 30-39 it seems almost the same (10.8 versus 9.5). Pregnancy might still influence the difference in the age group 40-49 as eclampsia is occurring more often at higher age (Leeman and Fontaine, 2008), but this seems not to be the reason for such a huge difference (24.0 versus 13.7).

Age

The association of age on hypertension is visible in all studies (Agyemang, et al., 2006; Njelekela, et al., 2009; Damasceno, et al., 2009). The result that is shown in Table 3 where the prevalence among males is much higher than among females in younger age, but that the females are taking over when they get older has been described in the literature (Martins, et al., 2001). One of the reasons could be the protective effect of sex hormones (Dubey, et al., 2002). Also in the slum setting this phenomenon is described (Bovet, et al., 2002; Damasceno, et al., 2009).

Education

The reason of the seemingly negative association of education on hypertension in Table 2 is mainly due to the fact that the group with no schooling is mostly the elderly and therefore having more hypertension. In the age adjusted model (Table 6) and multivariate regression (Table 4) this negative association has disappeared. In the male group it is even reversed with higher education having a higher risk of hypertension (Table 6). In other studies (Agyemang, et al., 2006; Bovet, et al., 2002) there seems to be higher prevalence in people with low education, but unfortunately in some studies this has not been adjusted for age (Damasceno, et al., 2009).

It is interesting that in our study there is a difference between males where hypertension rises with education, while in females there is a trend that education is protective, although it is not significant. This difference is not found in other literature.

Ethnicity

There seems to be significant differences in prevalence among the main ethnicities in the slums of Nairobi. There is no other literature published on hypertension compared between these specific groups, although there is much published on differences of hypertension prevalences among various ethnicities (Dwivedi and Beevers, 2009). The different lifestyles and genetics are the most reasonable explanation for these significant differences, but would require additional research to confirm. It is not clear why this is stronger among males than in females.

Wealth

In line with other research in similar setting (Addo, et al., 2009) the richest people have the highest prevalence. There doesn't seem to be a clear explanation for the drop of prevalence in the second tertiles, specifically in women. But as this effect is no longer seen in the multivariate regression it is likely to have been confounded by other factors.. Although in the literature from high income countries there is an association seen of wealth (Grotto, et al., 2008), in other studies in similar circumstances (Bovet, et al., 2002) wealth is not as strong as education or other factors.

It is interesting to see that in low- and middle- income countries the rich people are more at risk of developing hypertension, whereas in the high-income countries it is more the poor people (Grotto, et al., 2008). More research is needed to determine where the cut-off is.

Occupation
Although the crosstabs Chi-square analysis shows a significant high prevalence of hypertension among farmers, and low among the unemployed population there is no significant result from the multivariate regression. As the correlation disappeared on age adjustment, it is possible that age was the confounding factor in a similar way as it was for education. In the literature also most of the studies show no clear results (Agyemang, et al., 2006; Bovet, et al., 2002; Njelekela, et al., 2009), only in the study in Ghana shows that people with more formal jobs have higher prevalence (Addo, et al., 2009)

Awareness
20,1% of awareness seems to be very low compared to other countries, even in Africa most populations seem to be above the 50% (Fuentes, et al., 2000; Pereira, et al., 2009). Other studies show also higher results (Zachariah, et al., 2003; Chaturvedi, et al., 2007; Agyemang, et al., 2006; Damasceno, et al., 2009) In the slums of Tanzania the awareness was higher, with females 37% and 23% males in the study of Bovet, et al., (2002). It is not clear what the reason for this could be.

Sex
Following the published reviews of Fuentes, et al., (2000) and Pereira, et al., (2009) in almost all studied populations women are more aware of their hypertension than men. But it is remarkable why this difference is almost quadrupled (OR: 0.28) in our study. The lower awareness could be twofold. Either the blood pressure of men is measured as frequently as women, but men forgot more often that this has happened. The other reason could be that the blood pressure of males is less measured. Probably it is a combination of both. In other studies there seems a trend that males are less bothered by the diagnosis of hypertension (Bovet, et al., 2008). Another reason could be the high mobility of males. They are moving more than females between different slums in search for work. So it could be that males and females have been equally tested on their blood pressure, but that the males have moved already to another place, and that new males are entering the slums that are not aware of their hypertension. In that case it would be interesting to have national outcomes where all slums are integrated. Hopefully in that case more than only 1 in 8 men will be aware of their hypertension.
It is also likely that females have more often their blood pressure measured because of the maternity care. It could also be the other way round: that because more women are on treatment, they are also more aware.

Age
As other studies (Chaturvedi, et al., 2007; Agyemang, et al., 2006; Damasceno, et al., 2009) it is in our study clear that older people are more aware of hypertension. One of the reasons could be that health workers are more likely to measure the blood pressure for older people coming to the clinic and therefore diagnosing the blood pressure.

Education
In some studies there is a clear raise in awareness with longer education (Ashfaq, et al., 2007; Damasceno, et al., 2009). In the study in Ghana (Agyemang, et al., 2006) it is the other way round, but not significant. In our study there was no significant association in the multiple regression although it was interesting to see that in both sexes the group that finished primary school has the lowest percentage of awareness.

Ethnicity
It seems that Kikuyu have higher percentages of awareness but there could be confounding factor as in the multiple regression there is no significance. In the literature there is not much published on these ethnicities.

Wealth
Wealth and awareness have no significant correlation in this study and these results are not comparable as there are no studies found in similar setting comparing results from awareness in correlation with wealth.

Occupation
The multivariate regression shows that there is less awareness in people with informal jobs regarding formal jobs. One of the reasons could be that in some jobs there might be health screening. Another reason could be that people in formal jobs have a health insurance or get their medical bills refunded by their employer, leading to higher attendance of medical services and therefore also higher chance of being diagnosed and on treatment. Like earlier mentioned, this association is not seen in other studies.

Treatment
The reason that we have chosen for 12 months instead of 2 weeks is because the research is done in low income setting where there might be a chance these people have sometimes gaps of two weeks of medication because of financial restrictions. But in general they try to use the medication as often as possible.
Compared to other literature (Fuentes, et al., 2000; Pereira, et al., 2009; Zachariah, et al. 2003; Agyemang, et al., 2006; Chaturvedi, et al., 2007) the 14.5% of hypertensive people that receive treatment is very low. In general between one third and half of the hypertensives receive treatment. An explanation may be that these studies are not done among slum dwellers.
Compared with the study in the slums of Tanzania and Mozambique, the rates in our study are even higher (Bovet, et al., 2002; Damasceno, et al., 2009). The reason might be that in Nairobi there is a relatively high presence of NGO's and health care providers in comparison with other slums.

Sex
In most populations women have much higher rates of treatment than men (Chaturvedi, et al., 2007; Bovet, et al., 2002; Pereira, et al., 2009; Agyemang, et al., 2006) sometimes even double (Fuentes, et al., 2000), but not as in our study where it almost triples (22.0% versus 8.0%), and in the multivariate regression quadruples.

Age
In line with the literature (Chaturvedi, et al., 2007; Agyemang, et al., 2006) there is in our study a significant increase in treatment with age. When compared by sex this correlation is in our study not existing in males and in the multivariate regression the cut off is above fifty. There is no clear explanation for this. This sex difference is not found in the literature.

Education
In the multivariate regression secondary school and higher has more treatment. The only study found on correlation between treatment and education in similar setting is not showing significant results (Agyemang, et al., 2006).

Wealth
The same significant pattern in the determinant wealth in awareness was also present in treatment. In multivariate regression they are both not significant. In the literature there is not much published for similar settings.

Occupation
It is interesting to see that farmers have the lowest awareness as well as treatment and unemployed the highest as this trend seems not be in line with their age groups. With farmers being mostly above 60 where the awareness is much higher, and unemployed in the youngest group where awareness and treatment seems to be lowest. In the literature it is shown that people with manual work have less treatment (Agyemang, et al., 2006).

Control
5.1% of the hypertensive people is in our study controlled, which is much lower than other populations in Africa and the rest of the world (Pereira, et al., 2009; Addo, et al., 2009; Chaturvedi, et al., 2007; Zachariah, et al., 2003). It shows similar results with the slums in Tanzania and Mozambique (Damasceno, et al., 2009; Bovet, et al., 2002).
Among people that have received medication the percentage of being controlled (35.0%) is higher than some studies (Pereira, et al., 2009) and lower than others (Damasceno, et al., 2009), but it seems even higher than some results of high-income countries (Agyemang, et al., 2005)

Also other studies show that more females are being controlled (Pereira, et al., 2009; Chaturvedi, et al., 2007)
The significant outcomes of ethnicity in the female group on control seem odd. Only 4.5% of the Kamba women are controlled whereas all the other female ethnicities are around 50%. But the Kamba males have even the highest percentage of control (57.1%.) In the literature it is known that ethnicity can have significant effect on control (Agyemang, et al., 2005).
For wealth, occupation and education also in the other studies (Addo, et al., 2009; Agyemang, et al., 2006) there is no significant association measured on control of hypertension.

Strengths and limitations of the study

Limitation in the study is that the definition hypertension has a relatively low threshold with >140 and >90 in just one visit. It would be better to have measured it in two or maybe three different visits (Chobanian, et al., 2003; Bovet, et al., 2008). This could mean that the actual prevalence of hypertension is lower than the prevalence reported in our study.
Although the blood pressure has a circadian rhythm (Hermida, et al., 2007) we have not included this in the study, measurements have taken place throughout the day.
Besides the blood pressure there were various other tests done during the study, like glucose and lipids from blood sample. This might have had a stressful influence on the participants which could create an increase of the blood pressure.

The patient sample, from the NUHDS demographic surveillance system, that has been used for the research and this thesis seems to be representative for the population in a slum neighbourhood in Nairobi. However, there are two factors that might influence the outcomes of my research. The first one is the stratified patient sample used. The design of the study was to create five different age groups, from both neighbourhoods in both sexes, see Annex 1. In order to have reliable calculations the aim was to fill the strata with the same amount of people. Finally the age-groups of 50-59 and 60 and above are both 14.3%.
This is not a natural composition of the slum population. In general the distribution in a slum is that the group above fifty years is closer to 10% than to the 26% that is used in this research. Therefore older age groups are over-represented in the study sample, which probably resulted in an overestimation of the prevalence of hypertension.
The other fact that might influence the results is the non-response of sampled participants. From the 7790 people sampled only 65% has participated in the study. This large group of people that have not responded might bias the current study population. The people that have not responded might be specific for certain ethnicities, or people with different lifestyles (antisocial with stress and alcoholism) that might be prone to hypertension. This might have led to an underestimation of the prevalence of hypertension.

In the multivariate regression on prevalence of hypertension age and sex are clearly the strongest indicators; one of the reasons might be that these are physical markers. It is difficult to measure how reliable the answers are on occupation, education and wealth. As earlier mentioned there could be an answering bias because of cultural reasons. It could be that therefore there are no clear outcomes in these categories.

The definition of having hypertension remains a discussion. Because of the extremely low income setting we have decided that current treatment is including the last year. This is to include the people that had no money to pay for the last two weeks but are normally using antihypertensive medication. The group that has been diagnosed with hypertension in the past but has now normal blood pressure and no use of medication during the past 12 months is excluded from the hypertension group.
Unfortunately we could not assess if these people have improved their blood pressure with life style changes.
The definition of awareness was also difficult to correctly interpret as it was not time bound. Therefore it was difficult to distinguish between people diagnosed in the past but currently having no hypertensive status because of absence of causing factors like pregnancy, and people being aware of their current hypertensive status.

Another limitation is that the results of prevalence, awareness, treatment and control are influencing each other. If the awareness is very high under a certain group, the chance is bigger that they have also high percentages of treatment. And vice versa people that are on treatment are usually aware of the diagnosis. Ideally the percentage of treatment should be measured among people that are aware and not among people that are hypertensive. The problem is that most of the times the numbers are too small and as most literature is presenting their studies among hypertensives, it is difficult to compare results.

The limitation of this study is that hypertension is only a risk factor by proxy. It is not known what the mortality is caused by hypertension in these settings. The risk factors and their assumed association with mortality are mostly taken from studies in high economic settings. It's not clear if one can extrapolate the mortality rates of these risk factors to slum settings. It could be that the high rates of hypertension in the elderly in slums have just minor influence on their health. Even in the high income countries it seems that the risk factor of hypertension has sometimes different effect on mortality, like for example in the very old people, above eighty (Zeglin, et al., 2009)

Another limitation of this thesis is that there is only focus on hypertension whereas all cardiovascular risk factors, as obesity, smoking, diabetes, etc, should be included in order to determine effective interventions. Other substudies of APHRC will concentrate on these questions.

The strength of this research is that the sample size of this study is high and is a good representation of the slum population. Another positive aspect is that is one of the few studies assessing hypertension among slum dwellers. The quality of the structure of the research is also an important strength.

CONCLUSIONS

In this study it becomes evident that hypertension is existing in substantial rates in the slums of Nairobi, although it fortunately has not reached yet the prevalence of more developed regions. But according to the literature this prevalence will extensively grow in the nearby future. Based on this research we can draw some conclusions in order to adequately respond to this epidemic.

A remarkable conclusion is that although the mean systolic pressure of females is lower than males, females have higher prevalence of hypertension. This female domination in hypertension is seen more often in populations in low- and middle- income countries. Until now there is no clear explanation for this difference. The other way round you can question what the protective factors are for men in low- and middle- income setting compared to high-income, as females have approximately the same prevalence in both settings.

Sex and age are the strongest determinants and are confounding all other determinants. The association of socio-economic (education, wealth and occupation) factors with hypertension remains weak in this slum setting. This might partly also be explained by answer-bias.
In ethnicity there were also some significant differences of prevalence in hypertension between the different tribes. Until now the assumption is made that this difference is because of a combination of lifestyle and genetics but it is not specifically known why the Kamba and Kikuyu people have significantly higher prevalence of hypertension than the Luo's.

Only one in five persons with hypertension is aware, where half of them are treated and one third of the treated is controlled (Annex 5). Especially among the males the awareness is very low. This reflects also in their lower percentages of treatment and control than females.
The overall rates of treatment among aware and control among treated are almost the same as found in high-income countries, and this is also seen in the literature (Pereira, et al., 2009). So the biggest achievement is to gain in awareness (Annex 5).

In this research and the literature is found that the prevalence of hypertension is probably higher in more developed urban regions of the low- and middle- income countries (Chaturvedi, et al., 2007; Fuentes, et al., 2000; Pereira, et al., 2009), but the main problem is that in the slums there is a scarcity of means and knowledge to detect the hypertension, so the awareness is much lower. Therefore there are more people walking around with undetected and so untreated hypertensions in the slums than in the richer areas. And in this research is shown that once people in the slums are aware the rates of treatment and control are comparable with standards in high-income countries. Therefore raising awareness to services is likely to be an effective intervention.

Recommendations

Prevalence

Based on the results of determinants in prevalence of hypertension I would recommend to do more research on the reason of these differences. Why do females have higher prevalence than man, why is it that Kamba and Kikuyu people have more hypertension than Luo's? In order to get more insight in these questions it is essential to get more information on their lifestyle, access to health services, health seeking and presence of other cardiovascular risk factors. My main recommendation is to focus in prevalence not only on hypertension, but on the whole spectrum of cardiovascular risk factors in order to know on which people should be targeted. The health strategy can not be based on the prevalence of hypertension alone. Future studies should include relevant information on diet, physical exercise, amount of stress, smoking, alcohol intake, family history of cardiovascular disease and physical outcomes like Body Mass Index, waist circumference, glucose and lipid levels.

This information can hopefully also explain better the different outcomes (females>males) of this thesis and assist in designing effective interventions: for example whether to focus on the absence of physical exercise and lobby for sports facilities in the slums, or whether it is better to concentrate on the high prevalence of smoking by a ban on advertising of tobacco.
To develop an effective strategy additional research is needed. Hopefully the above mentioned information is gathered with the other parts of the CVD research of the APHRC.
In a general perspective it would be useful as well to explore what the association is between hypertension and mortality in these settings. Because it might be that in the end the people living in specific slums are not dying earlier from hypertension because they suffer more from other diseases.

Besides the recommendation of more research in the slums of Nairobi, there should be also more studies on CVD in slums worldwide in order to see if there are similar trends and results as in Nairobi.
This recommendation of more research is not only containing slums but there is much more to explore in the field of hypertension and CVD. For example what the association is of education on hypertension. Why is higher education in slums causing most probably higher risk to develop hypertension, whereas in high-income countries education has a protective effect on hypertension? Studies should be done where the cut-off is that education becomes protective, and if there is a trend also outside Nairobi that women with education in low income countries seem to have better outcome than males.
People with education of secondary school and higher are also more treated so it might a recommendation as well from the perspective of public health on CVD to stimulate education and study programs.

A last practical recommendation regarding prevalence is that, as you could see in this study, age and sex are strongly confounding factors. Hopefully future studies include this in their study design in measurements of prevalence of hypertension in correlation with determinants.

Awareness

One of the main conclusions of this research is that the awareness of hypertension is too low in these slum settings. My first recommendation is to include blood pressure measurement as a standard procedure for every adult that is visiting the primary health care centre. Independent of what their complaint might be. In that way the people understand the essential

value of their blood pressure. Ideally every person above fifty years should come voluntarily to the primary health care centre to have their blood pressure measured, but that needs probably some mentality change before that happens, and also more paramedical personnel. When the blood pressure of patients is elevated they should be informed and asked to come back to measure it a second time and third time in order to confirm the diagnosis.
Nurses should be trained about the techniques on measuring blood pressure, and doctors should be encouraged to add it into their physical examination. This can be stimulated if governments and NGO's include CVD in their monthly statistics.

It is important as well to measure blood pressure on other places than health care centres. One of the reasons that people with formal jobs are more aware than people with informal jobs might be that their blood pressure is measured as an employee. It is useful to think about other innovative places and ways to detect hypertension (for example at the railway station or barber)

My second recommendation regarding awareness is proper documentation. Once people are detected with hypertension it is important to document this in a sustainable way and give a clear explanation about hypertension so people become more aware of their risk factor. As you can see in the research there is also a group that has been diagnosed with hypertension but after that has been lost in the health care system. If people are confirmed with hypertension or other CVD risk factor they should receive a special patient file. MSF is already introducing these files in their health centres in Kibera, another slum in Nairobi, and the WHO has also designed special forms. Ideally every patient has its own health file digital or in their cell-phone, which most people own, so they have it always with them and can be asked for appointments by SMS.

Treatment
Treatment is in this research still seen only as an intervention with medication. My recommendation related to treatment is to do research about the effect of lifestyle changes on hypertension. It is important to know if this is a realistic and effective form of treatment in these slum settings. Especially if more people are diagnosed with blood pressure it is important to have cheap and effective interventions.
It is also important to know how much more effective control of hypertension with medication is for overall morbidity and mortality because chronic treatment is expensive for people with low income.

A very concrete recommendation that I hope to follow up myself is to explore how effective treatment in the slums is. In collaboration with the APHRC I am designing a study to follow up these 966 people that have been detected with hypertension.

If there is an overload in hypertensive and CVD patients because of the high input and there is a scarcity in goods and people you might prioritize which patients need treatment. The other cardiovascular risk factors should be included in making this choice. For example should the patients with hypertension and diabetes combined get treatment first? They have a high probability to die inside ten years because of these factors.

Control
It's a challenge to develop health programs on chronic disease that can be used in places like the slums of Nairobi where almost no health care facilities exists. There should be a system installed that empowers the structure from awareness all the way down to control (Annex 5).

It is important to think of creative solutions regarding the recommendations. Because with all the recommendations mentioned, there is a lot of financial and human resources needed. And until now the main institutions (World Bank, Bill&Melinda Gates Foundation, Global Fund) are not funding these activities. So also in finance we should become creative.
Collaboration with the largely funded HIV programs can form a possibility. This connection could be through biomedical research to explore the physiological association of HIV on hypertension and other cardiovascular risk factors are and vice versa. This joined effort would be even more effective through coordinating the integration of their programs in the health system.
The history of the setup for HIV treatment should be an inspiration for the roll out of CVD programs. Fifteen years ago there was the same challenge how HIV could be treated in places where no health care system was in place, and finally it worked.
The stages of HIV and CDV are in many ways quite similar:
In both diseases (if you see hypertension not as a disease, you can fill in diabetes instead) it is essential that everyone in the population should be aware of their status: healthy and unhealthy people. Both HIV and CDV patients are not suffering from complaints in the beginning, although their body is deteriorating. So the first challenge is to get people tested. At first people who pass by the health care system with general complaints should be tested, but ideally would be if people at risk (in the case of HIV sex-workers, army, etc; in the case of CVD obese people, smokers, etc) are tested as well. Than the person should get information on the disease and be explained that in the first stage of the disease there is often no medication needed but it is essential to concentrate on life style. Then regular controls should take place and treatment of occasional complications. In a later stage people would start with medication, and they should understand that this medication is life long.
These steps are almost identical, and the key elements of treating the HIV epidemic are the same as CVD epidemic: know your status, lifestyle and adherence to medication. So hopefully we can learn some valuable lessons from all the experiences and research done in these fields.
The other parallel is that both diseases are often seen as independent problems being set up in a vertical program, whereas they should both be integrated in the horizontal programs of the primary health care. The care for these patients should be decentralized from the doctors in the academic and district hospitals to the nurses in the field. This needs revolutionary thinking, but in the case of HIV this is succeeded.
But there are other revolutionary possibilities for large scale treatment and control of hypertension and CVD in slums. Sometimes public-private actors like health insurance schemes and microfinance programs open new doors for medical treatment.
I personally try to follow up this recommendation to study innovative, efficient and affordable systems of control of hypertension in low income settings, with my ongoing research in Nairobi in following up the 966 persons that are detected with hypertension. Hopefully this research and thesis on hypertension is the start of something bigger.
My priority in all the above mentioned recommendations is awareness. With this thesis I hope to start raising awareness by showing the fact that there is a problem of cardiovascular diseases in the slums. This awareness should not only be among the patients, but also among nurses, doctors, funders, policymakers, global institutions and government. Hypertension is still thought of as a disease for the Western world and this paradigma should be broken on different levels.

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ANNEXES

Annex 1: Overview of sampling in different age groups

Site	Sex	Age-group	Stratum	Number in sample	Sampling %	Cumfreq in sample	Cumpct in sample	Number in the sampled population
Korogocho	f	18-29	11	440	12,8%	440	5,5%	3441
Korogocho	f	30-39	12	390	23,9%	830	10,4%	1634
Korogocho	f	40-49	13	360	41,1%	1190	14,9%	876
Korogocho	f	50-59	14	342	90,7%	1532	19,2%	377
Korogocho	f	60+	15	304	96,5%	1836	23,0%	315
Korogocho	m	18-29	16	490	15,2%	2326	29,1%	3230
Korogocho	m	30-39	17	430	21,3%	2756	34,5%	2019
Korogocho	m	40-49	18	410	30,0%	3166	39,6%	1365
Korogocho	m	50-59	19	370	52,0%	3536	44,3%	712
Korogocho	m	60+	20	315	91,6%	3851	48,2%	344
Viwandani	f	18-29	1	560	11,6%	4411	55,2%	4822
Viwandani	f	30-39	2	520	25,8%	4931	61,7%	2014
Viwandani	f	40-49	3	460	76,5%	5391	67,5%	601
Viwandani	f	50-59	4	166	100,0%	5557	69,5%	166
Viwandani	f	60+	5	63	100,0%	5620	70,3%	63
Viwandani	m	18-29	6	600	11,2%	6220	77,8%	5344
Viwandani	m	30-39	7	600	13,8%	6820	85,4%	4349
Viwandani	m	40-49	8	540	30,0%	7360	92,1%	1802
Viwandani	m	50-59	9	450	78,9%	7810	97,7%	570
Viwandani	m	60+	10	180	100,0%	7990	100,0%	180

Annex 2: Overview ethnicity and prevalence in hypertension

	Numbers in study population	Prevalence of hypertension (%)
Ethnicity		
Ajuran	1	0,0
Borana	134	11,9
Embu	30	16,7
Gabra	8	25,0
Garre	165	16,4
Kalenjin	13	23,1
Kamba	1067	20,9
Kikuyu	1863	21,3
Kisii	167	12,0
Kuria	7	42,9
Luhya	654	19,1
Luo	662	15,3
Masai	5	0,0
Mbeere	9	22,2
Meru	48	22,9
Mijikenda	2	50,0
Pokomo	1	0,0
Samburu	1	0,0
Somali	148	16,2
Sukuma	1	0,0
Swahili	1	0,0
Non-Kenyan	11	18,2
Missing	30	6,5
		P=0,048

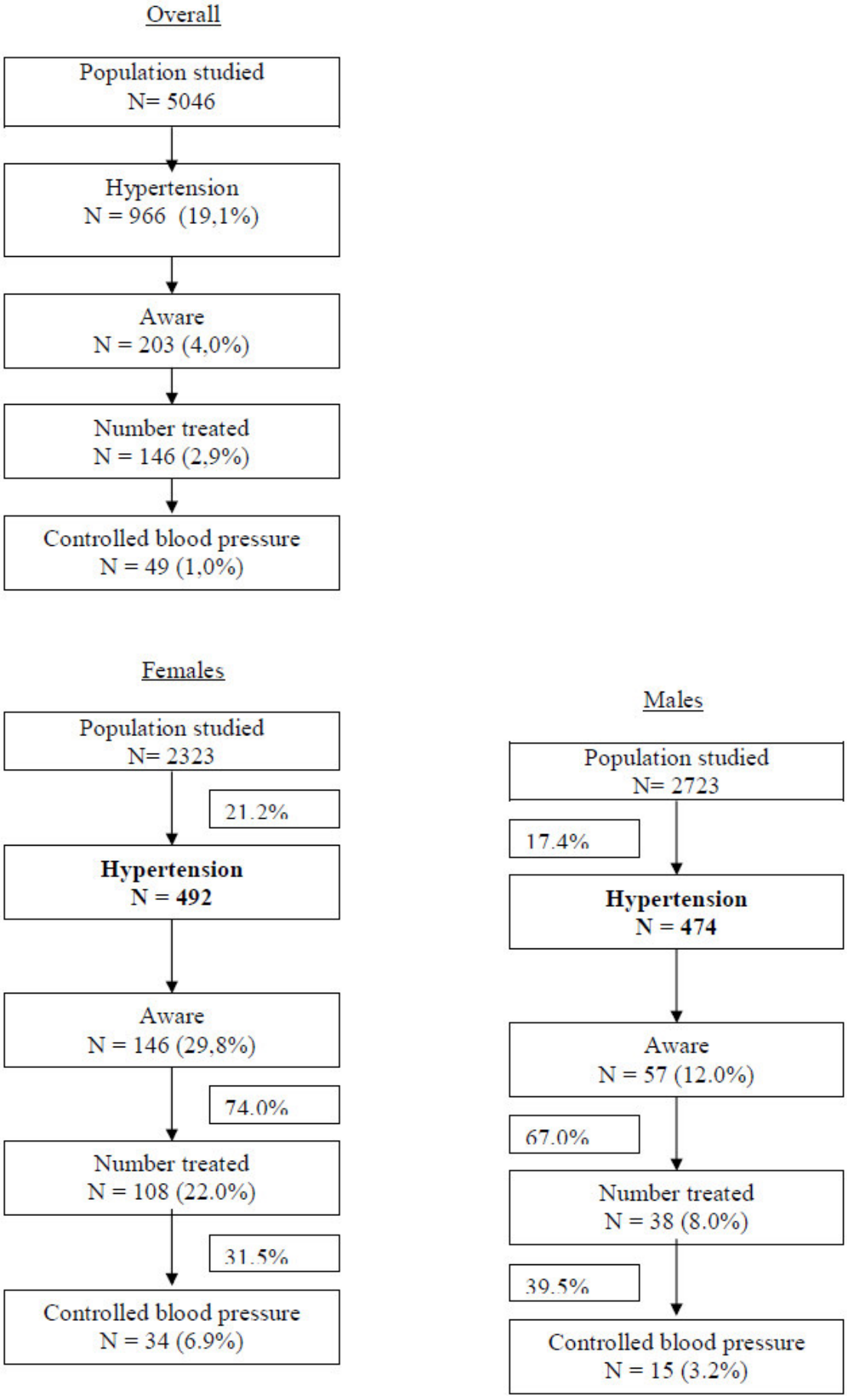
Annex 3: Overview wealth and prevalence in hypertension

	Numbers in study population	Prevalence of hypertension in percentage
Wealth		
Asset 1st tertile	1097	20,0
Asset 2nd tertile	1658	18,5
Asset 3rd tertile	1928	19,7
		P=0,542
Asset 1st quintile	446	19,7
Asset 2nd quintile	994	19,7
Asset 3rd quintile	945	17,9
Asset 4th quintile	986	19,1
Asset 5th quintile	1312	20,0
		P=0,757
Expenditure 1st tertile	1839	19,5
Expenditure 2nd tertile	1532	17,7
Expenditure 3rd tertile	1319	21,0
		P=0.080
Expenditure 1st quintile	1128	19,4
Expenditure 2nd quintile	1033	20,3
Expenditure 3rd quintile	917	16,2
Expenditure 4th quintile	815	20,0
Expenditure 5th quintile	797	20,8
		P=0,106
Composite 1st tertile	1122	21,6
Composite 2nd tertile	1772	18,2
Composite 3rd tertile	1789	19,0
		P=0,072
Composite 1st quintile	499	17,6
Composite 2nd quintile	888	22,3
Composite 3rd quintile	1049	18,6
Composite 4th quintile	1163	18,7
Composite 5th quintile	1084	19,0
		P=0,152

Annex 4: Overview occupation and prevalence in hypertension

	Numbers in study population	Prevalence of hypertension in percentage
Occupation		
Formal casual	355	20,3
Formal own business	293	17,7
Formal salaried	444	21,2
Informal casual	1100	15,5
Informal own business	1866	21,8
Informal salaried	336	14,9
Rural agriculture	5	40,0
Urban agriculture	17	47,1
Unemployed	402	12,7
Missing	228	26,1
		P < 0,001

Annex 5


Overall
Population studied
N= 5046
Hypertension
N = 966 (19,1%)
Aware
N = 203 (4,0%)
Number treated
N = 146 (2,9%)
Controlled blood pressure
N = 49 (1,0%)
Females
Population studied
N= 2323
21.2%
Hypertension
N = 492
Aware
N = 146 (29,8%)
74.0%
Number treated
N = 108 (22.0%)
31.5%
Controlled blood pressure
N = 34 (6.9%)
Males
Population studied
N= 2723
17.4%
Hypertension
N = 474
Aware
N = 57 (12.0%)
67.0%
Number treated
N = 38 (8.0%)
39.5%
Controlled blood pressure
N = 15 (3.2%)