Epidemiology of Cardiovascular Diseases Risk Factors and Hypertension in a Community-Based Suburban Population in Nepal

Biraj Man Karmacharya

A dissertation

submitted in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

University of Washington

2015

Reading Committee:
Annette L. Fitzpatrick, Chair
James P LoGerfo
Rajendra Prasad Koju

Program Authorized to Offer Degree:

School of Public Health-Epidemiology

University of Washington

Abstract

Epidemiology of Cardiovascular Diseases Risk Factors and Hypertension
in a Community-Based Suburban Population in Nepal

Biraj Man Karmacharya

Chair of the Supervisory Committee:
Annette L. Fitzpatrick
Research Professor**,** Family Medicine
Research Professor**,** Epidemiology

Background: The epidemiology of cardiovascular diseases (CVD) risk factors and the CVD risk profile, in the Nepalese population is not fully understood. Almost a third of the adult Nepalese population is estimated to be hypertensive, but there is still lack of information on the associations of socio-demographic characteristics and other CVD risk factors with hypertension. The level of knowledge, awareness, treatment and control of hypertension, and their associated factors is also poorly understood.

Objectives: This dissertation aimed to determine the prevalence of CVD risk factors including smoking, hypertension, low physical activity, low consumption of fruits and vegetables, diabetes, high total cholesterol and triglycerides, low HDL; describe CVD risk profiles and their

relationship with socio-demographic factors; investigate the association of prevalent hypertension with socio-demographic characteristics and CVD risk factors; and assess knowledge, awareness, treatment and control of hypertension, in a random sample of adults residing in Dhulikhel, Nepal.

Methods: In this cross-sectional study, we enrolled 1073 participants (18 years and older) from a random selection of one third of households in the town of Dhulikhel in central Nepal. Prevalence of CVD risk factors was ascertained using standard case definitions and cut-offs. We measured the adverse CVD risk profiles of the participants by summing the presence of the following conventional modifiable CVD risk factors: current smoker, overweight or obese, less than recommended physical activity, less than recommended consumption of fruits and vegetables and hypertension. Hypertension was defined as a systolic blood pressure 140 mm Hg or greater, or diastolic blood pressure 90 mm Hg or greater, or receiving antihypertensive medication. Hypertension knowledge was categorized dichotomously as being able to mention at least one risk factor of hypertension or not being able to mention any risk factors of hypertension. Among hypertensive patient, we assessed awareness (self-report that a doctor or other health worker had told the participant they had hypertension), treatment (self-report of being on medications for hypertension management) and control (SBP<140mm Hg and DBP<90mm Hg).

The prevalence estimates of CVD risk factors were standardized to the age of the Nepalese population reported in the 2011 census. Multinomial multivariate logistic regression with Generalized Estimating Equation (GEE) was used to estimate the adjusted associations, of different socio-demographic characteristics with adverse CVD risk profiles. Multivariate logistic

regression utilizing GEE was used to investigate the associations of socio-demographic characteristics and other CVD risk factors with hypertension prevalence, knowledge, awareness, treatment and control.

Results: Among the 1073 participants, 41.6% were males and 58.4% were females. The mean age of the participants was 40.3 years (SD: 16.3). Age standardized prevalence showed that more than a third of the participants were obese or overweight in both sexes (31.7% in males and 37.2% in females). Both former and current smoking rates were nearly double among males compared to females [current (27.7% versus 13.4%) and former (11.1% versus 5.6%)]. Nearly half of the participants had less than 5 servings of fruits and vegetables per day in both sexes. Thirty seven percent males and 41.4% females had less than the recommended level of physical activity. Hypertension was twice as common in males (37.3%) compared to females (17.3%). Among 479 participants, who had their blood samples collected for biochemical investigations, almost a third were found to be diabetic (35.5% in males and 25.5% in females). Men had twice as high a prevalence of high total cholesterol (5.7%) and high triglyceride (13.3) compared to women (2.9% and 5.3% respectively). Only 10.0% males and 13.7% females had no conventional modifiable CVD risk factors. Males had significantly higher adverse CVD risk profiles compared to females ($p=0.024$). In the multinomial multivariate model, age was significantly associated with an adverse risk profile in both sexes ($p<0.001$). In terms of ethnicity, Newars had significantly higher risk of having three or more CVD risk factors compared to Brahmins (OR: 4.54, 95% CI: 2.03-10.1; $p<0.001$). Those in the highest income quartile had significantly lower risk of having three or more CVD risk factors compared to those in the lowest quartile (OR: 0.50, 95% CI: 0.26-0.97;$p=0.042$).

In the multivariate model, males had significantly higher risk of hypertension (OR: 2.52, 95% CI: 1.69-3.75, p=<0.001) compared to females. Age was also significantly associated with hypertension prevalence (p<0.001). The Newar ethnic group had 5.65 times higher risk of hypertension (95% CI: 3.12-10.21, p<0.001) compared to Brahmins. Being overweight or obese were associated with an increased risk of 2.61 (95% CI: 1.81-3.77, p<0.001) and 6.74 (95% CI: 3.75-12.11, p<0.001) times respectively.

A total of 43.1% of the participants were not able to mention a single risk factor for hypertension. In the multivariate model, males were almost twice as likely to have knowledge of hypertension compared to females (OR: 2.04; 95% CI: 1.22-3.40, p=0.006). Among different ethnic groups, Newars were most likely to have knowledge of hypertension (OR: 2.13; 95% CI: 1.26-3.57, p<0.001) when compared to Brahmins. Compared to those with no formal education, those with up to high school and those with more than high school education were 2.89 times (95% CI: 1.85-4.50, <0.001) and 9.37 times (95% CI: 4.40-19.95, p<0.001) more likely to cite at least one risk factor of hypertension, respectively.

A total of 43.6% of the hypertensive participants were aware that they had high blood pressure. In multivariate model, only ethnicity appeared to be associated with awareness. A total of 76.1% of those who were aware of their hypertension status were currently on treatment. Only 35.3% of those on treatment had good blood pressure control.

Conclusions: Overall, the findings reported here suggest that the burden of CVD risk factors in Nepal might be greater than previously estimated. The CVD risk profile in this population was also very concerning. Newar ethnicity appears to be independently associated with hypertension compared to Brahmins. The levels of knowledge, awareness, treatment and control of

hypertension were very low. The lack of knowledge of hypertension was associated with women gender, Brahmin ethnicity and no formal education. We did not find significant associations of hypertension awareness with socio-demographic or other CVD risk factors.

TABLE OF CONTENTS

LIST OF TABLES

Chapter 2

Chapter 3

Chapter 4

ACKNOWLEDGEMENTS

My passion for learning skills to benefit communities rather than just patients, and wider society rather than just individuals led me to pursue epidemiology. The Department of Epidemiology at the University of Washington, with its team of unparalleled faculties, staffs and students provided incomparable support through this endeavor. My adviser Prof. Annette Fitzpatrick embodied the attributes of an ideal mentor, or the *'Guru'* who never hesitates to put all her efforts to ensure the overall growth of the mentee. I was also fortunate to be guided by my committee members Drs. James P LoGerfo, Khun Chuen Gary Chan, Ali Mokdad and Rajendra P Koju, who continuously encouraged me to think beyond the boundaries of this study.

As I look back, I realize that the learning from this journey transcended academic realm. It was an ultimate venture of discovering oneself, understanding others and forging relationships. I am thus nothing, but the product of my dreams and the support of my well-wishers. My family members (dad Raj Bhai, mom Bindu, brothers Rajiv and Robin, sister Ruby, sisters-in-law Meeta and Resha, nieces Rebisha and Myra, and all my relatives), staying half way around the world always made sure that distance didn't affect their care towards me. My wife Angira and son Abiral left everything they had, without asking a question, just to accompany me in seemingly unknown and uncertain world. They taught me the strength of love and the limitless boundaries of sacrifice for the ones you love. Dhulikhel Hospital and the Department of Community Programs families left no stones unturned to make this study successful and always continued to inspire me to strive for greater heights. My friends in Seattle, within and outside the campus, who never made me feel away from home cannot be thanked enough. I am especially grateful to Binod and Archana with whom I share memories that I will cherish for life. Archana, an epitome

of determination and dedication as well as sincerity and simplicity, has been my closest friend, most honest critic, wisest guide and an exceptional ally.

I am also deeply indebted to the Fulbright Program for providing me the scholarship and an opportunity to meet some of the greatest minds from around the world. Prof. Carey Farquhar, whom I had the privilege to work for, continuously supported my academic pursuits. The participants of the Dhulikhel Heart Study, gave their time with the belief that someday the knowledge we gain from their stories would help alleviate the sufferings of others. To all of them, who devoted themselves with this belief, I acknowledge whatever I have achieved till now and seek blessings for all that I plan to attain in future.

DEDICATION

To my father Raj Bhai Karmacharya and mother Bindu Karmacharya, who trained me to dream big; and my wife Angira Shrestha who always believed in my dreams.

CHAPTER 1

INTRODUCTION

Cardiovascular Diseases Risk Factors in Low and Middle Income Countries

Cardiovascular Diseases (CVD) form the leading cause of death worldwide attributing to about 18 million deaths annually.[1] Almost eighty percent of these deaths occur in low and middle income countries (LMICs).[1] This increasing burden of CVD in LMICs corresponds to the epidemiologic transition that includes improved control of infectious diseases, aging, and globalization of risks such as tobacco use, unhealthy diet and sedentary habits.[2] Moreover, increasing morbidity and mortality associated with CVD in LMICs are associated with a combination of rising prevalence of CVD risk factors and concomitantly, poor management among those who have already developed the diseases. This is further compounded by the fact that there is inadequate country-specific information in many countries, on the epidemiology of CVD risk factors, which is needed to develop contextual evidence-based prevention and management programs. Predictions based on the studies done in developed countries might not be accurate in the settings of LMICs because of different genetic variations and unique environmental and behavioral features. For example, numerous studies done among South Asians (both, among those living in South Asia and those who have migrated) have consistently shown that South Asians are at an increased risk of developing diabetes compared to other ethnic groups.[3-5] High rates of insulin resistance have been considered to be a unique risk factor for South Asians, [6,7] but recent studies also suggest the possibility of genetic predispositions leading

to early decline in Beta cell functions.[8-11] Thus, there is an urgent need for population-specific studies on CVD risk factors in LMICs.

Hypertension

Hypertension may be the most important risk factor for cardiovascular diseases (CVD) increasing the risk of stroke, coronary artery disease, heart failure, and atrial fibrillation, among others.[12] Numerous observational studies have proven that throughout middle and old age, blood pressure is strongly and directly related to vascular as well as total mortality.[13] It is also firmly established that untreated hypertension increases the risk of stroke, coronary heart disease, congestive heart failure, and mortality.[14,15] As a risk-factor, hypertension deserves special attention due to the magnitude of its impact and the presence of proven drug therapies that can yield positive results over a short period of time. Hypertension was reported as the leading risk factor for global disease burden in 2010, accounting for 7.0% of global Disability Adjusted Life Years (DALYs)[16], and ranks among the most important risk factors for CVD, contributing to 45% of the global CVD morbidity and mortality. It is responsible for about 9.4 million deaths worldwide, including at least 45% of deaths due to heart disease (total ischemic heart disease mortality), and 51% of deaths due to stroke.[16,17]

The associations of age, body mass index (BMI), high salt and alcohol consumption as risk factors for hypertension are well established.[18-25] However, there is still lack of information on the sociodemographic correlates of hypertension. Previous studies have suggested persisting differences in hypertension prevalence by races and ethnicities within different communities. A large study done in an ambulatory care setting in California reported that most minority subgroups had lower or similar odds of having hypertension compared with Non-Hispanic

Whites, except for Filipinos and Non-Hispanic Blacks whose odds were significantly higher after adjusting for patient demographic and clinical characteristics. [26] In another study from England, compared with Caucasians, Afro-Caribbeans had a significantly higher mean systolic blood pressure, with higher mean diastolic blood pressures evident among Afro-Caribbean women.[27] The association of socioeconomic status and hypertension is also not clear. In India, epidemiological studies from the mid- and late-twentieth century reported greater cardiovascular risk factor prevalence among the people with higher socioeconomic status.[28,29] However, a shift in this trend emerged in early 2000. Greater prevalence of hypertension was reported among less educated rural residents and industrial populations, presumably due to smoking, alcohol consumption, poor diet and stress.[30-32]

Since hypertension can be asymptomatic, people often do not seek medical care, leaving it undetected and untreated. Even among the diagnosed and treated, the control rate is very low.[33] In a multi-country study comprised of 3 high-income countries, 10 upper-middle-income and low-middle-income countries, and 4 low-income countries, only 46.5% of participants with hypertension were aware of their condition and only 32.5% of those on treatment had blood pressure controlled.[34] It was worse in low-income countries, with only 43.6% aware (versus 49.0% in high-income countries) and only 77.7% on treatment (versus 95.2 in high-income countries). Even within countries, the awareness, treatment and control were lower in the rural communities compared to urban ones, mainly in the low-income countries.[34]

Despite this appalling statistics, the understanding of factors associated with the awareness, treatment and control of hypertension is still very poor. Previous studies have highlighted the social determinants of hypertension awareness and control. In a large study from Vietnam, the

odds for hypertension awareness were higher among people at least 45 years old, who had family histories of hypertension, lived in urban areas, and who were underweight or overweight or obese.[5] Among hypertensives who were aware of their status, the odds for hypertension treatment were higher among people with family histories of hypertension or lived in urban areas. This study however, found that the treatment was higher in people with lower educational levels.[35] A study of NHANES participants reported that lack of awareness of hypertension and lack of adequate control with treatment disproportionately affect older people; poor hypertension control is not confined to the poor, uninsured or minorities.[36] The World Health Organization Study on Global Aging and Adult Health (SAGE) found that insurance and income were major social determinants of hypertension treatment. The highest income quintile had less than one third the odds of being untreated than the lowest income quintile.[37] In a cross-sectional study of 202 patients in a primary healthcare center in Karachi, Pakistan, a much lower awareness regarding hypertension and its prevention and treatment were observed among patients of lower socioeconomic status (SES).[38] However, in the Chicago Community Adult Health Study, which included a representative probability sample of adults in Chicago, socioeconomic disparities in hypertension prevalence and awareness were observed but not in treatment or control of diagnosed hypertension.[39]

Some preliminary studies suggest that the relationship of SES and hypertension-related behaviors might not be very straightforward. It was found that people who belong to the higher socioeconomic status have better health behaviors, such as consumption of more fruits and less tobacco and alcohol use, compared to those of lower SES. However, the prevalence of physical activity was lower among the higher SES group.[40,41] Awareness, treatment and control, together relate to a complex interplay of parameters related to individual knowledge, community support

and health systems. A sound contextual understanding of these associated factors are needed to develop targeted strategies for addressing the prevention and management of hypertension.

Cardiovascular Diseases Risk Factors in Nepal

Nepal is a South Asian country with a population of about 27 million, landlocked between India and China.[42] Although a small country of about 56,800 square miles, Nepal is unique in terms of geographic as well as ethnic diversity. There are about 100 registered population groups, who speak about 92 different languages and dialects.[43] With a Gross Domestic Product per capita of about 690 USD, Nepal is one of the poorest countries in the world and ranks 157 out of 187 countries in the Human Development Index, which is measured using the information on education, health and income.[44,45]

Nepal is currently experiencing an epidemiological transition in health similar to many other low and middle-income countries (LMICs). With average life expectancy increasing from 54 (1990) to 66.5 years (2011), it is now facing the double burden of communicable and non-communicable diseases (NCDs). Cardiovascular diseases (CVD) are the major NCD the country faces and form the third major cause of years of life lost (YLL).[46] In the last two decades, ischemic heart disease and stroke have increased by 100% and 75%, respectively, in terms of Disability Adjusted Life Years (DALYs) in Nepal.[46] This corresponds with the rising prevalence of CVD risk factors in the population. A repeat cross-sectional study in a suburban site in Nepal showed a three-fold increase of hypertension prevalence over 25 years.[47] The latest WHO STEPS survey on NCD risk factors reported that among 15 to 69 year-old Nepalese, almost one quarter are overweight or obese, and the prevalence of hypertension was 25%, out of which 88% were not on blood pressure lowering medications. Nearly 8% of the participants had impaired or

high fasting blood glucose and about 23% had high total cholesterol.[48] In a population based cross-sectional study in Eastern Nepal, Sharma et al (2011) found that 34% of the participants had hypertension, 6.3% were diabetic, 28% were overweight, and 32% were obese.[49]

Although the preliminary evidence strongly suggests a rapid increase in the burden of CVD in Nepal, there are still large gaps in the understanding of the major drivers of the CVD risk factors in the Nepalese population. This is a major hindrance to an evidence-based approach for prevention and management of CVD in Nepal.

Hypertension in Nepal

Although there are a number of studies on hypertension prevalence in Nepal, there is still lack of information on the association of sociodemographic characteristics and other CVD risk factors with hypertension as most studies did not account for confounders.[47,49] Only one study suggested that ethnicity might be independently associated with hypertension.[50] A community-based study in Eastern Nepal reported 22.7% of the population to be hypertensive and almost 42% of them were unaware of their condition. It also reported that 41.6% of the previously diagnosed hypertensives did not have their blood pressure controlled.[51] The latest nation-wide WHO STEPwise survey in Nepal also reported that almost 90% of the hypertensives were not on medications.[48] These findings correspond with other studies in the world that have consistently found that despite the ease in diagnosis and treatment, the awareness, treatment and control of hypertension remains low.[33]

Rationale of the Study

In an analysis that explored whether evidence from high-income countries is enough to tackle non-communicable diseases in LMICs, Ebrahim S et al. rightly mentioned that LMICs face a combination of these five scenarios: **First,** the population burden is not known. **Second,** the population burden is known but the causes are not known. **Third,** the causes are known but the methods of prevention are poorly understood. **Fourth,** models to improve patient treatment and care are required. **Fifth,** clear understanding of implementation approaches need to be determined.[52] This relates well to the context of Nepal.

Currently, the information on burden of cardiovascular disease and risk factors is still sparse and does not describe the differences that might exist between different socio-economic strata and ethnic groups. Lack of rigorous assessments of potential confounders, such as diet, physical activity, alcohol consumption has led to inconclusive findings that are hard to interpret. Moreover, most of the studies focused only on a few CVD risk factors and hence it was not possible to determine the overall CVD risk profile. Since it is recognized that CVD risk factors cluster and interact multiplicatively in increasing vascular risk, lack of information on CVD risk profile is a serious limitation in making population level risk assessments and guiding treatment of risk factors.[53,54]

The epidemiology of hypertension in Nepal is also poorly understood. Moreover, past studies have not encompassed the full spectrum of knowledge, prevalence, awareness, treatment and control of hypertension. Most importantly, the determinants of hypertension have not been thoroughly explored.

This study uses the data from the **Dhulikhel Heart Study (DHS)**, which aims to address the above-mentioned major limitations of the past studies on CVD risk factors in Nepal. The DHS is a cross-sectional population-based survey comprised of in-person questionnaires that includes conventional and less explored factors such as perceptions of blood pressure and its treatment, adherence to antihypertensive medications, anthropometric measurements, and relevant laboratory parameters analysis. This study aims to provide valuable insights into the problem of CVD risk factors with special reference to hypertension in a community-based suburban Nepalese population.

In this dissertation, we aimed to determine the prevalence of CVD risk factors including smoking, hypertension, low physical activity, low consumption of fruits and vegetables, diabetes, high total cholesterol and triglycerides, low HDL; describe CVD risk profiles and their relationship with socio-demographic factors; investigate the association of prevalent hypertension with socio-demographic characteristics and CVD risk factors; and assess knowledge, awareness, treatment and control of hypertension, in a random sample of adults residing in Dhulikhel, Nepal.

To our knowledge, this is the first population-based study in Nepal to investigate CVD risk factors comprehensively. Specifically, this study is unique because of the collection of extensive information on dietary history through food frequency questionnaires, standard medication adherence measurement, and assessment of other comorbid conditions. Inclusion of these variables will also reduce confounding in associations of hypertension and other CVD risk factors. It is also one of the few studies in Nepal that explores the epidemiology of hypertension in such depth. The household level data collection (as opposed to individual level collection

only) also helps to understand the family level association of CVD risk factors. The findings from this study will thus provide greater understanding of critical issues related to CVD prevention and management in a sub-urban population of a low-income country.

The study setting provides a unique opportunity to delve into aforementioned issues. Dhulikhel, the headquarter of Kavrepalanchowk district, located about 15 miles Southeast of Kathmandu is the smallest town in Nepal with a population of about 16,000.[42] Unlike other towns or cities, the population of Dhulikhel is fairly stable with limited in and out migration. It is also home to the pioneer community-based hospital in Nepal, Dhulikhel Hospital (DH), which is the sole major health service provider in the community. This provides a remarkable opportunity to link the study participants with their health data, which is a rarity in a developing country. The DH has close ties with the local community and is in a strong position to implement community-based health studies and intervention programs. Thus, the findings from this study can be translated into evidence-based local level actions, which are readily implementable in this community. Hence, we believe that this study will be the beginning of a long-term initiative that addresses all the scenarios, from the assessment of the burden to the identification of appropriate implementation approaches, as mentioned by Ebrahim S and colleagues.[52]

REFERENCES FOR CHAPTER 1

1. Murray CJ, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**(9859): 2197-223.
2. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. *Milbank Q* 2005; **83**: 731-57.
3. Mather HM, Keen H. The Southall Diabetes Survey: prevalence of known diabetes in Asians and Europeans. *Br Med J (Clin Res Ed)* 1985; **291**(6502): 1081-4.
4. Li YR, Zhu H, Kauffman M, et al. Paraoxonases function as unique protectors against cardiovascular diseases and diabetes: Updated experimental and clinical data. *Exp Biol Med (Maywood)* 2014; **239**(8): 899-906.
5. Nair M, Ali MK, Ajay VS, et al. CARRS Surveillance study: design and methods to assess burdens from multiple perspectives. *BMC Public Health* 2012; **12**: 701.
6. McKeigue PM. Metabolic consequences of obesity and body fat pattern: lessons from migrant studies. *Ciba Found Symp* 1996; **201**: 54-64; discussion -7, 188-93.
7. Gujral UP, Pradeepa R, Weber MB, Narayan KM, Mohan V. Type 2 diabetes in South Asians: similarities and differences with white Caucasian and other populations. *Ann N Y Acad Sci* 2013; **1281**: 51-63.
8. Mohan V, Amutha A, Ranjani H, et al. Associations of β-cell function and insulin resistance with youth-onset type 2 diabetes and prediabetes among Asian Indians. *Diabetes Technol Ther* 2013; **15**(4): 315-22.
9. Staimez LR, Weber MB, Ranjani H, et al. Evidence of reduced β-cell function in Asian Indians with mild dysglycemia. *Diabetes Care* 2013; **36**(9): 2772-8.
10. Florez JC. Newly identified loci highlight beta cell dysfunction as a key cause of type 2 diabetes: where are the insulin resistance genes? *Diabetologia* 2008; **51**(7): 1100-10.
11. Kanaya AM, Wassel CL, Mathur D, et al. Prevalence and correlates of diabetes in South asian indians in the United States: findings from the metabolic syndrome and atherosclerosis in South asians living in america study and the multi-ethnic study of atherosclerosis. *Metab Syndr Relat Disord* 2010; **8**(2): 157-64.

12. Rapsomaniki E, Timmis A, George J, et al. Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1·25 million people. *Lancet* 2014; **383**(9932): 1899-911.
13. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R, Collaboration PS. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet* 2002; **360**(9349): 1903-13.
14. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension* 2003; **42**(6): 1206-52.
15. Psaty BM, Lumley T, Furberg CD, et al. Health outcomes associated with various antihypertensive therapies used as first-line agents: a network meta-analysis. *JAMA* 2003; **289**(19): 2534-44.
16. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**(9859): 2224-60.
17. http ://www.who.int/healthinfo/global_burden_disease/cod_2008_sources_methods.pdf. 2008 (accessed Oct 26 2014.
18. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, phase II. The Trials of Hypertension Prevention Collaborative Research Group. *Arch Intern Med* 1997; **157**(6): 657-67.
19. He J, Whelton PK, Appel LJ, Charleston J, Klag MJ. Long-term effects of weight loss and dietary sodium reduction on incidence of hypertension. *Hypertension* 2000; **35**(2): 544-9.
20. Vollmer WM, Sacks FM, Ard J, et al. Effects of diet and sodium intake on blood pressure: subgroup analysis of the DASH-sodium trial. *Ann Intern Med* 2001; **135**(12): 1019-28.
21. Chobanian AV, Hill M. National Heart, Lung, and Blood Institute Workshop on Sodium and Blood Pressure : a critical review of current scientific evidence. *Hypertension* 2000; **35**(4): 858-63.
22. Kelley GA, Kelley KS. Progressive resistance exercise and resting blood pressure : A meta-analysis of randomized controlled trials. *Hypertension* 2000; **35**(3): 838-43.

23. Whelton SP, Chin A, Xin X, He J. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. *Ann Intern Med* 2002; **136**(7): 493-503.
24. Xin X, He J, Frontini MG, Ogden LG, Motsamai OI, Whelton PK. Effects of alcohol reduction on blood pressure: a meta-analysis of randomized controlled trials. *Hypertension* 2001; **38**(5): 1112-7.
25. Appel LJ, Champagne CM, Harsha DW, et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *JAMA* 2003; **289**(16): 2083-93.
26. Zhao B, Jose PO, Pu J, et al. Racial/Ethnic differences in hypertension prevalence, treatment, and control for outpatients in northern california 2010-2012. *Am J Hypertens* 2015; **28**(5): 631-9.
27. Lane D, Beevers DG, Lip GY. Ethnic differences in blood pressure and the prevalence of hypertension in England. *J Hum Hypertens* 2002; **16**(4): 267-73.
28. Sarvotham SG, Berry JN. Prevalence of coronary heart disease in an urban population in northern India. *Circulation* 1968; **37**(6): 939-53.
29. Chadha SL, Radhakrishnan S, Ramachandran K, Kaul U, Gopinath N. Epidemiological study of coronary heart disease in urban population of Delhi. *Indian J Med Res* 1990; **92**: 424-30.
30. Gupta R, Gupta VP, Ahluwalia NS. Educational status, coronary heart disease, and coronary risk factor prevalence in a rural population of India. *Bmj* 1994; **309**(6965): 1332-6.
31. Reddy KS, Prabhakaran D, Jeemon P, et al. Educational status and cardiovascular risk profile in Indians. *Proc Natl Acad Sci U S A* 2007; **104**(41): 16263-8.
32. Gupta R, Kaul V, Agrawal A, Guptha S, Gupta VP. Cardiovascular risk according to educational status in India. *Prev Med* 2010; **51**(5): 408-11.
33. Pereira M, Lunet N, Azevedo A, Barros H. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens* 2009; **27**(5): 963-75.
34. Chow CK, Teo KK, Rangarajan S, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. *JAMA* 2013; **310**(9): 959-68.

35. Son PT, Quang NN, Viet NL, et al. Prevalence, awareness, treatment and control of hypertension in Vietnam-results from a national survey. *J Hum Hypertens* 2012; **26**(4): 268-80.
36. Hyman DJ, Pavlik VN. Characteristics of patients with uncontrolled hypertension in the United States. *N Engl J Med* 2001; **345**(7): 479-86.
37. Basu S, Millett C. Social epidemiology of hypertension in middle-income countries: determinants of prevalence, diagnosis, treatment, and control in the WHO SAGE study. *Hypertension* 2013; **62**(1): 18-26.
38. Ashfaq T, Anjum Q, Siddiqui H, Shaikh S, Vohra EA. Awareness of hypertension among patients attending primary health care centre and outpatient department of tertiary care hospital of Karachi. *J Pak Med Assoc* 2007; **57**(8): 396-9.
39. Morenoff JD, House JS, Hansen BB, Williams DR, Kaplan GA, Hunte HE. Understanding social disparities in hypertension prevalence, awareness, treatment, and control: the role of neighborhood context. *Soc Sci Med* 2007; **65**(9): 1853-66.
40. Vaidya A, Aryal UR, Krettek A. Cardiovascular health knowledge, attitude and practice/behaviour in an urbanising community of Nepal: a population-based cross-sectional study from Jhaukhel-Duwakot Health Demographic Surveillance Site. *BMJ Open* 2013; **3**(10): e002976.
41. Vaidya A, Krettek A. Physical activity level and its sociodemographic correlates in a peri-urban Nepalese population: a cross-sectional study from the Jhaukhel-Duwakot health demographic surveillance site. *Int J Behav Nutr Phys Act* 2014; **11**(1): 39.
42. Nepal CBoS. National Population and Housing Census 2011, National Report. Kathmandu, 2012.
43. Gurung HB. Nepal, social demography and expressions: New Era; 2001.
44. UNDP. http://hdr.undp.org/sites/default/files/Country-Profiles/NPL.pdf. 2013.
45. http://databank.worldbank.org/data/views/reports/tableview.aspx. (accessed June 17 2015.
46. http://www.healthmetricsandevaluation.org/sites/default/files/countryprofiles/GBD%20Country%20Report%20-%20Nepal.pdf. 2013 (accessed Feb 15 2015).
47. Vaidya A, Pathak RP, Pandey MR. Prevalence of hypertension in Nepalese community triples in 25 years: a repeat cross-sectional study in rural Kathmandu. *Indian Heart J* 2012; **64**(2): 128-31.

48. Aryal K, Neupane S, Mehata S, et al. Non Communicable Diseases Risk Factors: STEPS Survey Nepal 2013. Kathmandu: Nepal Health Research Council, 2014.
49. Sharma SK, Ghimire A, Radhakrishnan J, et al. Prevalence of hypertension, obesity, diabetes, and metabolic syndrome in Nepal. *Int J Hypertens* 2011; **2011**: 821971.
50. Vaidya A. Is ethnicity an important determinant of high blood pressure in Nepalese population? A community-based cross sectional study in Duwakot, Nepal. *Kathmandu Univ Med J (KUMJ)* 2012; **10**(37): 20-3.
51. Vaidya A, Pokharel PK, Karki P, Nagesh S. Exploring the iceberg of hypertension: a community based study in an eastern Nepal town. *Kathmandu Univ Med J (KUMJ)* 2007; **5**(3): 349-59.
52. Ebrahim S, Pearce N, Smeeth L, Casas JP, Jaffar S, Piot P. Tackling non-communicable diseases in low- and middle-income countries: is the evidence from high-income countries all we need? *PLoS Med* 2013; **10**(1): e1001377.
53. Jackson R, Lawes CM, Bennett DA, Milne RJ, Rodgers A. Treatment with drugs to lower blood pressure and blood cholesterol based on an individual's absolute cardiovascular risk. *Lancet* 2005; **365**(9457): 434-41.
54. De Backer G, Ambrosioni E, Borch-Johnsen K, et al. European guidelines on cardiovascular disease prevention in clinical practice. Third Joint Task Force of European and Other Societies on Cardiovascular Disease Prevention in Clinical Practice. *Eur Heart J* 2003; **24**(17): 1601-10.

CHAPTER 2

PREVALENCE OF CARDIOVASCULAR RISK FACTORS IN NEPAL: FINDINGS FROM THE DHULIKHEL HEART STUDY.

ABSTRACT

Background: The epidemiology of cardiovascular diseases (CVD) risk factors and the CVD risk profile, in the Nepalese population is not fully understood.

Objectives: We aimed to estimate the prevalence of modifiable CVD risk factors; and to describe the CVD risk profiles and their relationships with socio-demographic factors in a sample of adults residing in Dhulikhel, Nepal.

Methods: In this cross-sectional study, we enrolled 1073 participants (18 years and older) from a random selection of one third of households in the town of Dhulikhel in central Nepal to estimate the prevalence of cardiovascular diseases risk factors including smoking, hypertension, low physical activity, low consumption of fruits and vegetables, diabetes, high total cholesterol and triglycerides, low HDL. The socio-demographic information was obtained using standard questions based on the Nepal Demographic Health Survey 2011. Obesity and overweight were defined as a BMI of 30.0 kg/m^2 or greater and 25.0 to 25.9 kg/m^2 respectively. Smoking history and physical activity were assessed using standard questionnaires. We also categorized participants as per WHO recommendations for consumption of fruits and vegetables (at least five servings of fruits and vegetables per day). Hypertension was defined as a systolic blood pressure

140 mm Hg or greater; or diastolic blood pressure 90 mm Hg or greater; or receiving antihypertensive medication. Blood samples were collected and analyzed in standard laboratory for HbA1C and lipid profiles. Diabetes mellitus was defined as an HbA1C of 6.5% or greater. Standard cut-offs for the levels of blood cholesterol, HDL and triglycerides were used. We measured the adverse CVD risk profiles of the participants by summing the presence of following conventional modifiable CVD risk factors: current smoker, overweight or obese, less than recommended physical activity, less than recommended consumption of fruits and vegetables and hypertension.

The prevalence estimates of CVD risk factors were standardized to the age of the Nepalese population reported in the 2011 census. Multinomial multivariate logistic regression with Generalized Estimating Equation (to account for correlation within households) was used to estimate the adjusted association, of different socio-demographic characteristics (age, sex, education, ethnicity, occupation, income, religion) with the adverse CVD risk profiles.[1] The category with no risk factors was considered as the reference for comparison. Adjusted odds ratio with 95% confidence intervals are reported.

Results: Among the 1073 participants, 41.6% were males and 58.4% were females. The mean age of the participants was 40.3 years (SD: 16.3) . Age standardized prevalence showed that more than a third of the participants were obese or overweight in both sexes (31.7% in males and 37.2% in females). Smoking rates were nearly double among males compared to females in both current (27.7% versus 13.4%) and former smoking (11.1% versus 5.6%) categories. Nearly half of the participants had less than 5 servings of fruits and vegetables per day in both sexes. Almost 36.8% males and 41.4% females had less than the recommended level of physical activity.

Hypertension was twice as common in males (37.3%) compared to females (17.3%). Only 479 had their blood samples collected for biochemical investigations (due to logistic challenges). Of these, almost a third were found to be diabetic (35.5% in males and 25.5% in females). Men had twice as high a prevalence of high total cholesterol (5.7%) and high triglyceride (13.3) compared to females (2.9% and 5.3% respectively). Only 10.0% males and 13.7% females had no conventional modifiable CVD risk factors. Males were found to have significantly higher adverse CVD risk profile compared to females (p=0.024). In the multinomial multivariate model, age was significantly associated with an adverse risk profile in both sexes (p<0.001). In terms of ethnicity, Newars had significantly higher risk of having three or more risk factors compared to Brahmins (OR: 4.54, 95% CI: 2.03-10.1; p<0.001). Those in the highest income quartile had significantly lower risk of having three or more risk factors compared to those in the lowest quartile (OR: 0.50, 95% CI: 0.26-0.97;p=0.042).

Conclusion: Overall, the findings suggest that the burden of CVD risk factors in Nepal may be greater than previously estimated. The CVD risk profile in this population is also very concerning. Higher age, Newar ethnicity and low income may be independently associated with an adverse cardiovascular risk profile.

INTRODUCTION

Nepal is currently experiencing an epidemiological transition in health similar to many other low and middle-income countries (LMICs). With average life expectancy increasing from 54 (1990) to 66.5 years (2011), it is now facing the double burden of communicable and non-communicable diseases (NCDs). Cardiovascular diseases (CVD) are the most important NCD the country faces and forms the third major cause of years of life lost (YLL).[2] In the last two decades, ischemic heart disease and stroke have increased by 100% and 75%, respectively, in terms of Disability Adjusted Life Years (DALYs) in Nepal.[2] This corresponds with the rising prevalence of CVD risk factors in the population. A repeat cross-sectional study in a suburban site in Nepal showed a three-fold increase of hypertension prevalence over 25 years. [3] The latest WHO STEPS survey on NCD risk factors reported that among 15 to 69 year-old Nepalese, almost one quarter are overweight or obese, and the prevalence of hypertension was found to be 25%, out of which 88% were not on blood pressure lowering medications. Nearly 8% of the participants had impaired or high fasting blood glucose and about 23% had high total cholesterol.[4] In a population based cross-sectional study in Eastern Nepal, Sharma SK et al (2011) found that 34% of the participants had hypertension, 6.3% were diabetic, 28% were overweight, and 32% were obese.[5]

Although preliminary evidence strongly suggests a rapid increase in the burden of CVD in Nepal, there are still large gaps in the understanding of the major drivers of CVD risk factors in the Nepalese population. This is a major hindrance to an evidence-based approach for prevention and management of CVD in Nepal. The Dhulikhel Heart Study was launched in November 2013 to get an in-depth understanding of the epidemiology of CVD and their associated risk factors

among all adult residents (18 years and older), n~4500, in the town of Dhulikhel in central Nepal.

This study examines the baseline data from the first waver of the Dhulikhel Heart Study (n=1073) to determine the prevalence of modifiable CVD risk factors and describes the CVD risk profiles and their relationship with socio-demographic factors in the population of Dhulikhel.

METHODS

Study Participants

All the households of the town were enumerated (n=2225) and assigned a unique household number. One third of the households in each of the nine wards (an administrative division) in the town of Dhulikhel were then selected randomly using STATA 12.0. All eligible adults 18 years and older living in Dhulikhel for the previous six months or longer in each of the selected households were requested to participate in the study. Individuals in institutionalized settings (living in hostels, motels), temporary residents living for less than six months, individuals unable to communicate due to physical or mental problems, pregnant women and those who refused to participate were not included in the study.

Data Collection

Data collection was done at the household-level by trained enumerators hired by Dhulikhel Hospital. All eligible members of the selected households were provided information on the study objectives and were enrolled after giving informed consent. The enumerator administered

an electronic tablet-based questionnaire using the open-ware Open Data Kit (ODK) (https://opendatakit.org) through which two different types of questionnaires were administered. The household questionnaire (Appendix 1) was administered to get information on household characteristics. Personal questionnaire (Appendix 2) was administered to get information on the individual participant. Information on socio-demographic characteristics, medical history, health care financing, information on health behaviors, physical and cognitive function were collected. The socio-demographic questions were asked using standardized questions based on the Nepal Demographic Health Survey 2011.[6] Age was calculated in years based from the date of birth of the respondents to date of the interview. Education was collected in years of formal schooling. Annual monetary income (Nepalese Rupees) of the household as well as of individual respondents was asked.

The interview was followed by anthropometric (height, weight, hip and waist circumference) and blood pressure measurement. Body weight was measured in a standing position with the participant wearing light clothing and no shoes in kilograms (kg) to the nearest 0.1kg by a modern digital weighing scale (Omron HBF-400, USA). After the participant stood straight without shoes on a flat floor, the height of the highest point of head (marked on the wall) was measured using a measuring tape to the nearest 1 cm. Waist circumference was measured with a fiber-glass tape, midway between the lower border of ribs and iliac crest on the mid axillary line. Hip circumference was measured at the greatest protrusions of the buttocks just below the iliac crest. Blood pressure was measured three times in a sitting posture on the right arm over loose clothes using a standard digital BP machine (Microlife, Switzerland). The mean of the three measurements was used for analysis. All the data collected in the ODK were downloaded in a secure main server every day.

Within the next few days after the questionnaire administration, a trained laboratory technician collected fasting venous blood sample from the participants at a mobile local blood collection center. Venous blood samples were drawn after 8-12 hour of overnight fasting into vacutainer tubes. Fasting blood glucose (FBG), Glycosylated hemoglobin (HbA1c), lipid profiles parameters [total cholesterol (TC), triacylglycerol (TAG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)] were analyzed at the Department of Clinical Biochemistry, Dhulikhel Hospital-Kathmandu University Hospital, Dhulikhel, Nepal. FBG, TC and TAG were estimated by enzymatic colorimetric method (Dialab GmbH, Austria) while HDL-C & LDL-C by selective direct immunoinhibition method (DiaSys Diagnostic Systems GmbH, Germany) using a Flexor Junior auto-analyzer (Vital Scientific, Netherlands). The HbA1c was estimated by using Nycocard system (Axis shield Co., Norway) that has been certified by National Glycohemoglobin Standardization Program (NGSP). All of the assays were routinely monitored by participation in external quality-control programs and using assayed chemistry & mission controls (Bio-Rad Laboratories and Diamond diagnostics, USA).

Definitions of the modifiable CVD risk factors

Obesity: Body mass index of the participants was calculated as weight in kg/ square of height in meter. Obesity, overweight, normal and underweight were defined as a BMI of 30.0 or greater, 25.0 to 25.9, 18.5 to 24.9 and less than 18.5 respectively.[7]

Smoking: Smoking history was ascertained using the questions based on the WHO STEPS survey questionnaire. Participants were categorized into current, former and non-smoker status.[8]

Physical Activity: Physical activity was assessed using the Global Physical Activity Questionnaire. [9] The participants were categorized into those that fulfilled the recommended level of activity (600 MET minutes per week) and those who had less than the recommended level of physical activity as per the WHO criteria.[10]

Diet: Dietary intake focused on the consumption of fruits and vegetables as an indication of healthy eating habits. Participants were categorized into those who met the WHO recommendation of consumption of fruits and vegetables (at least five servings of fruits and vegetables per day) and those who do not meet the recommendation.[11]

Hypertension: Hypertension was defined as a systolic blood pressure 140 mm Hg or greater; or diastolic blood pressure 90 mm Hg or greater; past history of diagnosis of hypertension; or receiving antihypertensive medication.[12]

Diabetes: Diabetes mellitus was defined as an HbA1C of 6.5% or greater.[13]

Hypercholesterolemia and High Total Cholesterol/HDL ratio: Blood cholesterol level was categorized into normal, high normal and high (hypercholesterolemia). Hypercholesterolemia was defined as total cholesterol 240 mg/dL or greater, or receiving cholesterol-lowering medication.[14] We also reported the proportion of participants with high Total Cholesterol to High Density Lipoprotein ratio (TC/HDL ratio), which is ≥ 4.5 (for males) and ≥ 4 (for females) given their relevance as predictors of CVD events.[15-17]

Adverse CVD Risk Profile: The adverse CVD risk profiles of the participants were determined by the presence of the number of following conventional modifiable CVD risk factors: current smoker, overweight or obese, less than recommended physical activity, less than recommended

consumption of fruits and vegetables and hypertension. Participants were categorized into those with presence of 0, any 1, any 2 and any 3 or more (maximum of 5) of the risk factors.[18,19,]

Data Analysis

Sample size estimation: Sample size estimation for prevalence was done using the formula $\mathbf{n=Z^2.P(1-P) / e^2}$ where e is maximum tolerable error for the prevalence estimate, Z is the Z statistic for the set level of confidence and P is the 'expected prevalence'.[20] Setting e= 0.05 and Z=1.96 (for 95% confidence) a sample size of 385 is required for determination of any level of prevalence. Since this study was expected to have at least a total N of 1000 (with about 500 for each sex), the study sample size was estimated to be adequate for determining the prevalence of the CVD risk factors.

Data Management and Statistical Analysis: All the data collected through the tablets were extracted into Microsoft Excel on a secured computer. The laboratory data were linked to the database through unique identifiers of the participants. Then the data were imported into STATA 12.0. Prevalence of the CVD risk factors in the study population are reported as percentage. The sample based sex-specific prevalence estimates were converted into age-standardized rates as per the national Census of 2011. Post-survey weights were not applied to take into account the non-response because the age distribution of the population in Dhulikhel reflects the national age distribution. Hence, standardization with the national age distribution was considered to be adequate.

Multinomial multivariate logistic regression with Generalized Estimating Equation (to account for correlation within households) was used to estimate the adjusted odds ratio, respectively, of

different socio-demographic characteristics (age, sex, education, ethnicity, occupation, income, religion) with the adverse CVD risk profiles.[1] The category with no risk factors was considered as the reference for comparison. Adjusted odds ratio with 95% confidence intervals are reported.

RESULTS

A total of 1372 eligible participants from 384 households of the nine wards were enumerated in the first wave of the DHS. Of these, the data collectors were able to contact 1103 (80%) participants. A total of 1073 provided informed consent and were recruited in the study. Hence, the total participation rate was 78.1%. Among the 1073 participants, only 479 had their blood samples taken for biochemical investigations due to logistic challenges. The blood sample collection of the remaining participants is ongoing.

Socio-demographic characteristics

Table 2-1 summarizes the socio-demographic characteristics of the participants. There were more female participants (58.4%) in the study. The mean age of the participants was 40.3 years (SD: 16.3). Almost a quarter of the participants (27.9%) belonged to an age group below 28 years. The majority of the males were employed (60.9%) compared to only about 25% employment among females ($p<0.001$). Newars were the predominant ethnic group. The individual income distribution varied among males and females ($p<0.001$). Whereas almost 45% of the males belonged to highest income quartile, only about 10% of females were in this category (<0.001). The educational attainment also varied significantly among males and females ($p<0.001$) with about 17.3% males and 41.9% females having no formal education.

Table 2- 1. Socio-demographic Characteristics of the Participants of the Dhulikhel Heart Study (N=1073)

	Total (N=1073)		Male (N=446)		Female (N=627)		p-values
	n	%	n	%	n	%	
Sex	1073		446	(41.6)	627	(58.4)	
Age (Mean, SD)	40.3	(16.3)	40.7	(16.4)	40	(16.3)	0.463*
Age Category							0.919¶
<25	265	(24.7)	107	(23.9)	158	(25.2)	
25-34	204	(19.0)	83	(18.6)	121	(19.3)	
35-44	209	(19.4)	82	(18.3)	127	(20.2)	
45-54	192	(17.8)	87	(19.5)	105	(16.7)	
55-64	110	(10.2)	48	(10.7)	62	(9.8)	
>65	93	(8.6)	39	(8.7)	54	(8.6)	
Marital Status							<0.001¶
Never married	225	(20.9)	102	(22.9)	123	(19.6)	
Currently Married	784	(73)	339	(76.0)	445	(71.0)	
Separated or Widowed	64	(5.9)	5	(1.1)	59	(9.4)	
Occupation							<0.001¶
Unemployed	489	(51.7)	99	(22.2)	390	(62.2)	
Employed	429	(18.2)	272	(60.9)	157	(25.0)	
Student	155	(30)	75	(16.8)	80	(12.7)	
Ethnicity							0.513¶
Brahmin	156	(14.5)	71	(15.9)	85	(13.6)	
Chhettri/Thakuri/Sanyasi	142	(13.2)	64	(14.4)	78	(12.4)	
Newar	527	(49.1)	214	(47.9)	313	(49.9)	
Gurung/Tamang/Sherpa/Bhote	228	(21.2)	91	(20.4)	137	(21.8)	
Dalits and others	20	(1.8)	6	(1.3)	14	(2.3)	
Monthly Income (Median, IQR in USD)#	33.9	(116.5)	116.5	(106.7)	0	(48.5)	
Individual income quartiles (Monthly)#							<0.001¶
Q1 (Lowest)	626	(58.3)	181	(40.5)	445	(70.9)	
Q2							
Q3	190	(17.7)	78	(17.4)	112	(17.8)	
Q4	257	(23.9)	187	(41.9)	70	(11.1)	
Education							<0.001¶
No formal education	340	(31.6)	77	(17.3)	263	(41.9)	
Less than high school	478	(44.5)	240	(53.8)	238	(37.9)	
High school or more	255	(23.7)	129	(28.9)	126	(20.1)	
Religion							0.818¶
Hindu	910	(84.8)	379	(85.0)	531	(84.7)	
Buddhist	142	(13.2)	58	(13.0)	84	(13.4)	
Other	21	(1.9)	9	(2.0)	12	(1.9)	

* *Unpaired t-test* ¶ *Chi-squared test*

Income was considered as self-reported cash income.

Prevalence of modifiable CVD risk factors

Tables 2-2a and 2-2b summarize the prevalence of modifiable CVD risk factors by sex. Age standardized prevalence showed that more than a third of the participants were obese or overweight in both sexes. Both current and former smoking prevalence were nearly double among males compared to females. Hypertension was twice as common in males (37.3%) compared to females (17.3%). Almost a third were found to be diabetic (35.5% in males and 25.5% in females). With regards to their lipid profiles, men had twice as high a prevalence of high total cholesterol (5.7%) and high triglyceride (13.3) compared to females (2.9% and 5.3% respectively).

Prevalence of adverse CVD risk profile

Tables 2-3a and 2-3b summarize the CVD risk profiles of the participants. Only 10.0% males and 13.7% females had no CVD risk factors (current smoker, overweight or obese, less than recommended physical activity, less than recommended consumption of fruits and vegetables and hypertension). Males were found to have significantly higher adverse CVD risk profile compared to females ($p=0.024$). A total of 27.3% of males had three or more risk factors whereas only about 21.0% of females belonged to the category. Age was also found to be significantly associated with an adverse risk profile in both sexes ($p<0.001$). Higher age groups had greater prevalence of three or more risk factors in both males and females. Newars had the highest prevalence of more than two risk factors with a total of 35.5 % in males and 26.2% in females.

Association of socio-demographic factors and adverse CVD risk profiles

In the full multinomial multivariate model adjusted for sex, age, ethnicity, marital status, occupation, education and income; age, ethnicity and income were found to be significantly associated with an adverse CVD risk profile (Tables 2-4a and 2-4b). In terms of ethnicity, Newars had a significantly higher risk of having three or more risk factors compared to Brahmins. Those in the highest income quartile were found to be at significantly lower risk of having three or more risk factors compared to those in the lowest quartile.

Table 2- 2a. Prevalence of CVD Risk Factors among participants of the Dhulikhel Heart Study (N=1073)

	MALES (N=446)				FEMALES (N=627)			
	DHS cohort		Age-standardized*		DHS cohort		Age-standardized*	
	N	%	N	95% CI	N	%	%	95% CI
BMI								
Underweight (<18.5)	28	(6.3)	5.8	(3.5-8.1)	36	(5.7)	5.8	(3.9-7.8)
Normal (18.5-24.9)	264	(59.2)	62.3	(57.6-66.9)	346	(55.2)	56.8	(52.6-61.0)
Overweight (25.0-29.9)	130	(29.2)	26.6	(22.0-31.2)	186	(29.7)	28.4	(24.5-32.2)
Obese (≥30)	24	(5.4)	5.1	(2.7-7.5)	59	(9.4)	8.8	(6.3-11.2)
Smoking[#]								
Current Smoker	137	(30.7)	27.7	(23.3-32.1)	88	(14.0)	13.4	(10.8-16.0)
Former Smoker	56	(12.6)	11.1	(8.3-13.9)	33	(5.3)	5.6	(3.8-7.3)
Fruits and Vegetable Consumption								
Less than 5 servings of fruits and/or vegetables per day	217	(48.6)	49.6	(44.3-54.9)	320	(51.0)	50.8	(46.2-55.4)
Physical Activity								
Less than recommended level by WHO (<600 MET-minutes/week)	164	(36.7)	36.8	(31.6-42.0)	259	(41.3)	41.4	(37.2-45.6)
High Blood Pressure[¶]								
Hypertension	167	(37.4)	37.3	(32.9-41.8)	131	(20.8)	17.3	(14.6-20.1)
Prehypertension	175	(39.2)	39.1	(34.2-44.0)	196	(31.2)	35.9	(31.8-39.9)

** Standardized to age based on national population census 2011.*

[#] ***Current smoker:*** *Smoked in last 30 days;* ***Former smoker:*** *Used to smoke but has not smoked in the last 30 days*

[¶] ***Hypertension:*** *SBP ≥ 140 mm Hg, or DBP ≥ 90 mm Hg, or receiving antihypertensive medication.* ***Prehypertension:*** *SBP 120-139 mm Hg, or DBP 80-89 mm Hg*

Table 2- 2b. Prevalence of CVD Risk Factors among participants of the Dhulikhel Heart Study (N=479)

	MALES (N=190)				FEMALES (N=289)			
	DHS Cohort		Age Standardized Prevalence*		DHS Cohort		Age Standardized Prevalence*	
	N	%	N	(95% CI)	N	%	N	(95% CI)
Diabetes								
Diabetic (Hb1C >6.4)	72.0	(38.3)	35.5	(29.8-41.2)	78.0	(27.0)	25.5	(20.6-30.5)
Pre-diabetic (HbA1C: 5.7-6.4)	78.0	(41.4	39.2	(32.8-45.5)	125.0	(43.4)	44.2	(38.5-49.9)
Non-diabetic (HbA1C < 5.7)	38.0	(20.2	25.2	(19.0-31.3)	85.0	(29.5)	30.1	(24.5-35.8)
Total Cholesterol								
High (≥ 240 mg/dl)	12	(6.3)	5.7	(1.8-9.6)	14	(4.8)	2.9	(1.6-4.2)
High Normal (200-239mg/dl)	30	(15.8)	15.1	(9.9-20.3)	43	(14.8)	11.2	(7.9-14.5)
Normal (<200mg/dl)	148	(77.9)	79	(72.5-85.6)	232	(80.2)	85.5	(82.2-89.4)
HDL								
Low (<35mg/dl)	56	(29.4)	11.8	(8.5-15.2)	62	(21.4)	9.4	(6.7-12.2)
Normal ((≥ 35mg/dl)	134	(70.5)	88.1	(84.7-91.4)	227	(78.5)	90.5	(87.7-93.2)
Total Cholesterol/HDL Ratio								
High**	76	(40)	41.4	(34.4-48.4)	124	(42.9)	37	(31.0-42.9)
Normal	114	(60)	58.5	(51.5-65.5)	165	(57)	62.9	(57.0-68.9)
Triglyceride								
High or Very High (>200 mg/dl)	27	(14.2)	13.3	(8.7-17.8)	21	(7.27)	5.3	(3.0-7.5)
Borderline High (150-199 mg/dl)	35	(18.4)	17.7	(13.4-22.1)	29	(10.0)	9.5	(6.5-12.5)
Normal (<150 mg/dl)	128	(67.3)	68.9	(63.0-74.7)	239	(82.7)	85.1	(81.4-88.8)

** Standardized to age based on national population census 2011.*

*** Total Cholesterol/HDL Ratio ≥ 4 for Males and ≥4.5 for Females*

Table 2- 3a. Adverse CVD Risk Profile among DHS Participants (N=1073)[¶]

	MALES									FEMALES								
	No Risk Factor		1 Risk Factor		2 Risk Factors		≥ 3 Risk Factors		*p-values**	No Risk Factor		1 Risk Factor		2 Risk Factors		≥ 3 Risk Factors		*p-values**
	n	(%)	n	(%)	n	(%)	n	(%)		n	(%)	n	(%)	n	(%)	n	(%)	
Total[§]	45	(10.0)	127	(28.4)	152	(34.0)	122	(27.3)		86	(13.7)	208	(33.1)	201	(32.0)	132	(21.0)	<0.001
Age									<0.001									
<25	18	(16.8)	45	(32.0)	34	(31.7)	10	(9.3)		43	(27.2)	76	(48.1)	35	(22.1)	4	(2.5)	
25-34	12	(14.4)	26	(31.3)	25	(30.1)	20	(24.1)		17	(14.0)	53	(43.8)	40	(33.0)	11	(9.0)	
35-44	8	(9.7)	21	(25.6)	29	(35.5)	24	(29.2)		15	(11.8)	33	(25.9)	46	(36.2)	33	(25.9)	
45-54	3	(3.4)	22	(25.2)	29	(33.3)	33	(37.9)		6	(5.7)	26	(24.7)	40	(38.1)	33	(31.4)	
55-64	3	(6.2)	7	(14.5)	21	(43.7)	17	(35.4)		3	(4.8)	11	(17.7)	22	(35.4)	26	(41.9)	
>65	1	(2.5)	6	(15.3)	14	(35.9)	18	(46.1)		2	(3.7)	9	(16.6)	18	(33.3)	25	(46.3)	
Marital Status									<0.001									<0.001
Never married	20	(19.6)	36	(35.2)	33	(32.3)	13	(12.7)		31	(25.2)	58	(47.1)	27	(21.9)	7	(5.6)	
Currently married	24	(7.0)	91	(26.8)	117	(34.5)	107	(31.5)		51	(11.4)	138	(31.0)	160	(35.9)	96	(21.5)	
Separated or widowed	1	(20.0)	0	(0.0)	2	(40.0)	2	(40.0)		4	(6.7)	12	(20.3)	14	(23.7)	29	(49.1)	
Employment Status									<0.001									<0.001
Unemployed	7	(7.0)	25	(25.2)	33	(33.3)	34	(34.3)		34	(8.7)	124	(31.7)	132	(33.8)	100	(25.6)	
Employed	23	(8.4)	71	(26.1)	100	(36.7)	78	(26.6)		29	(18.4)	44	(28.0)	52	(33.1)	32	(20.3)	
Student	15	(20.0)	31	(41.3)	19	(25.3)	10	(13.3)		23	(28.7)	40	(50.0)	17	(21.2)	0	(0.0)	
Ethnic Groups									<0.001									0.017
Brahmin	14	(19.7)	25	(35.2)	23	(32.3)	9	(12.6)		16	(18.8)	32	(37.6)	25	(29.4)	12	(14.1)	
Chhettri	7	(10.9)	19	(29.6)	21	(32.8)	17	(26.5)		16	(20.5)	31	(39.7)	22	(28.2)	9	(11.5)	
Newar	17	(7.9)	48	(22.4)	73	(34.1)	76	(35.5)		37	(11.8)	91	(29.0)	103	(32.9)	82	(26.2)	
Gurung	7	(7.6)	35	(38.4)	29	(31.8)	20	(21.9)		17	(12.4)	49	(35.7)	43	(31.3)	28	(20.4)	
Others	0	(0.0)	0	(0.0)	6	(100.0)	0	(0.0)		0	(0.0)	5	(35.7)	8	(57.1)	1	(7.1)	

[¶] Included Risk Factors: ***Current Smoking:*** *Smoked in the past 30 days;* ***Overweight:*** *BMI ≥ 30kg/m^2 or* ***Obese:*** *BMI≥25kg/m^2;* ***Less than Recommended Physical Activity:*** *Less than recommended level by WHO (<600 MET-minutes/week) ,* ***Less than Recommended Consumption of Fruits and Vegetables:*** *Less than 5 servings of fruits and/or vegetables per day,* ***Hypertension:*** *SBP ≥ 140 mm Hg, or DBP ≥ 90 mm Hg, or receiving antihypertensive medication*

*p=0.024 comparing CVD risk profiles between males and females; * Chi-squared test*

Table 2- 3b. Adverse CVD Risk Profile among DHS Participants (N=1073)¶

	MALES									FEMALES								
	No Risk Factor		1 Risk Factor		2 Risk Factors		≥ 3 Risk Factors		*p-values**	No Risk Factor		1 Risk Factor		2 Risk Factors		≥ 3 Risk Factors		*p-values**
	n	(%)	n	(%)	n	(%)	n	(%)		n	(%)	n	(%)	n	(%)	n	(%)	
Income (Quartiles)																		
Q1	23	(12.7)	55	(30.3)	54	(29.8	49	(27.0)	0.342	55	(12.3)	157	(35.2)	143	(32.1)	90	(20.2)	0.335
Q2																		
Q3	3	(3.8)	24	(30.7)	29	(37.1	22	(28.2)		19	(16.9)	27	(24.1)	38	(33.9)	28	(25. 0)	
Q4	19	(10.1)	48	(25.6)	69	(36.9	51	(27.2)		12	(17.1)	24	(34.2)	20	(28.5)	14	(20.0)	
Education									0.098									<0.001
No Formal Education	9	(11.6)	21	(27.2)	29	(37.6	18	(23.3)		21	(7.9)	66	(25.1)	91	(34.6)	85	(32.3)	
Less than high school	20	(8.3)	60	(25.0)	82	(34.1	78	(32.5)		33	(13.8)	81	(34.0)	80	(33.6)	44	(18.4)	
High school or more	16	(12.4)	46	(35.6)	41	(31.7	26	(20.1)		32	(25.4)	61	(48.4)	30	(23.8)	3	(2.3)	
Religion																		
Hindu	42	(11.0)	103	(27.1)	127	(33.5	107	(28.2)	0.339	77	(14.5)	175	(32.9)	170	(32.0)	109	(20.5)	0.621
Buddhist	3	(5.1)	22	(37.9)	20	(34.4	13	(22.4)		7	(8.3)	28	(33.3)	27	(32.1)	22	(26.1)	
Others	0	(0.0)	2	(22.2)	5	(55.5	2	(22.2)		2	(16.6)	5	(41.6)	4	(33.3)	1	(8.3)	

¶ Included Risk Factors: ***Current Smoking:*** *Smoked in the past 30 days;* ***Overweight:*** *BMI ≥ 30kg/m^2 or* ***Obese:*** *BMI≥25kg/m^2;* ***Less than Recommended Physical Activity:*** *Less than recommended level by WHO (<600 MET-minutes/week) ,* ***Less than Recommended Consumption of Fruits and Vegetables:*** *Less than 5 servings of fruits and/or vegetables per day,* ***Hypertension:*** *SBP ≥ 140 mm Hg, or DBP ≥ 90 mm Hg, or receiving antihypertensive medication*

**Chi-squared test*

Table 2- 4a Multinomial Logistic Regression Analysis to Determine the Association of Socio-Demographic

	Adjusted OR[¶]								
	1 Risk Factor			2 risk factors			3 risk factors		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Sex									
Female	Ref			Ref			Ref		
Male	1.18	(0.70-2.01)	0.518	1.46	(0.85-2.49)	0.162	1.75	(0.94-3.24)	0.076
Age Categories									
<25 years	Ref			Ref			Ref		
25-49 years	1.68	(0.82-3.44)	0.151	3.33	(1.58-7.03)	0.002	5.44	(2.09-14.14)	<0.001
≥ 50 years	3.34	(1.11-10.02)	0.031	10.68	(3.50-32.59)	<0.001	23.0	(6.47-82.0)	<0.001
Ethnicity									
Brahmin	Ref			Ref			Ref		
Chhetri	1.15	(0.53-2.47)	0.718	1.29	(0.55-3.03)	0.547	1.90	(0.70-5.13)	0.202
Newar	1.35	(0.72-2.51)	0.344	2.28	(1.13-4.61)	0.021	4.54	(2.03-10.1)	<0.001
Gurung	2.07	(1.00-4.27)	0.049	2.38	(1.06-5.33)	0.034	4.16	(1.67-10.36)	0.002

[¶] *Compared to those having none of the five CVD risk factors from table 3; adjusted for sex, age, ethnicity, marital status, income, occupation and education.*

Table 2- 4b Multinomial Logistic Regression Analysis to Determine the Association of Socio-Demographic Characteristics and Adverse CVD Risk Profiles among DHS Participants (N=1073)

	Adjusted OR¶								
	1 Risk Factor			2 Risk Factors			≥ 3 Risk Factors		
Socio-Demographic Characteristics	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Marital Status									
Unmarried	Ref			Ref			Ref		
Married	1.24	(0.68-2.27)	0.470	1.39	(0.79-2.45)	0.247	1.70	(0.75-3.86)	0.199
Separated or Widowed	0.79	(0.19-3.20)	0.747	0.57	(0.15-2.10)	0.400	1.33	(0.30-5.82)	0.699
Occupation									
Unemployed	Ref			Ref			Ref		
Employed	1.21	(0.54-2.68)	0.636	1.19	(0.55-2.60)	0.648	2.15	(0.95-4.83)	0.064
Student	1.17	(0.66-2.06)	0.584	1.01	(0.57-1.77)	0.958	1.04	(0.54-2.00)	0.886
Education									
No Formal Education	Ref			Ref			Ref		
Less than High School	1.34	(0.66-2.69)	0.408	1.55	(0.80-3.03)	0.190	1.85	(0.90-3.83)	0.094
High School or More	1.60	(0.66-3.83)	0.290	1.28	(0.52-3.12)	0.582	1.02	(0.37-2.77)	0.962
Income Quartile									
Q1 (Lowest Quartile)	Ref			Ref			Ref		
Q2									
Q3	0.69	(0.37-1.31)	0.268	0.86	(0.46-1.59)	0.636	0.91	(0.46-1.80)	0.795
Q4	0.53	(0.30-0.92)	0.026	0.59	(0.32-1.08)	0.090	0.50	(0.26-0.97)	0.042

¶ *Compared to those having none of the five CVD risk factors from table 3; adjusted for sex, age, ethnicity, marital status, income, occupation and education.*

DISCUSSION

This study adds important information to the growing body of literature on CVD risk factors in Nepal. It is clear that these risk factors, traditionally considered as the main drivers of CVD in developed countries, are now more common in developing countries such as Nepal.

Prevalence of conventional CVD risk factors

The prevalence of overweight or obesity in the current study was found to exceed by about 8% the results from the recent STEPS survey of 4143 nationally representative participants (15-69 years old).[4] However, our findings were very similar to other studies conducted in urban and suburban settings in Nepal. In one of the first population-based studies conducted in Eastern Nepal, Sharma et al. reported that the prevalence of overweight or obesity (BMI >25 kg/m^2) was about 32.5% in a sample of 14,423 participants.[5] Urbanization has been consistently linked to obesity in a number of different studies. In Nepal, a study comparing urban and rural Sherpa women showed higher BMI among urban women compared to their rural counterparts. This may be due to lesser physical activity in urban settings because of increased access to transportation and decreased physical labor in daily activities.[21] Given the fact that the majority of the population in the world, even in developing countries, is shifting towards urban areas, this has serious implications in terms of future trends in obesity.[22] The slightly higher prevalence of overweight or obesity among females in our study also concurs with other studies. Obesity rates were found to be higher in women compared to men who participated in the 2003 and 2007 NCD risk factors studies.[23,24] This difference was persistent in the 2013 survey as well.[4] The reasons behind this differential risk are not fully understood. Females are reported to have higher sedentary life-style compared to males in sub-urban and urban settings in this part of the world.

However, it is not clear whether that alone explains the differences. Weight gain during pregnancy and post-natal period is another major concern that needs further evaluation.

As in previous studies, this project also highlights the high prevalence of modifiable conventional risk factors like smoking, physical activity and dietary practices.[25,26] High prevalence of smoking in the current study is comparable to the recent national survey that showed that almost 27% males and 10.3% females were current smokers. Past studies have also suggested that tobacco use is one of the most important threats of non-communicable disease burden in Nepal and the Government of Nepal should seriously consider stricter enforcement of tobacco control policies.[27] The prevalence of consuming less than five servings of fruit and/or vegetables on average per day was lower in this study compared to the national estimates (98.9% in both males and females).[4] Since this population is representative of a sub-urban town with fewer rural residents than in the national survey, it is likely that the participants we evaluated had better access to fruits and vegetables. There was also a remarkably higher proportion of the participants who reported having low levels of physical activity (36.8% for males and 41.4% for females) in our study compared to the national survey (4.5% for males and 2.4% for females).[4] Easier transportation access and lesser proportion of farming population in the current study might have led to the difference in the physical activity levels.

Hypertension, as a CVD risk factor, deserves special attention due to the magnitude of its impact and the presence of proven drug therapies that can yield positive results over a short period of time. Unfortunately, hypertension remains an undetected condition and, among the detected, a poorly managed risk factor. The prevalence of hypertension in this study (38.7% in males and 19.4% in females) correlates closely with other studies from Nepal.[28] In the national survey of

NCD risk factors, 31.1% males and 20.6% females were found to be hypertensive. In a large population-based survey of adults ≥ 20 years old in Eastern Nepal, Sharma et al., reported hypertension prevalence to be 40.7% in males and 30% in females. A repeat cross-sectional study in a suburban site in Nepal showed a three-fold increase of hypertension prevalence (latest prevalence estimates: 38.3% in males and 30.8% in females) over 25 years.[3] A number of factors can be attributed to the high prevalence of hypertension in this population. High rates of overweight and obesity, less physical activity and high smoking rates, all of which have proven relationships with hypertension risk are the major drivers of hypertension in the Nepalese population. However, the role of dietary salt intake as well as ethnicity is poorly understood.

The prevalence of diabetes (35.5%) and pre-diabetes (41.4%) in this study as measured through the HbA1C cut offs is almost ten times higher than the recent national survey in Nepal that reported the prevalence of diabetes (defined as fasting blood glucose level of ≥ 126 mg/dl or currently on medication for raised blood glucose) to be 3.6% for both sexes (4.6 for males and 2.7 for females). Studies from the urban and sub-urban population in Nepal have shown higher prevalence but are still lower compared to our finding. In 2003, the Nepal Diabetes Association reported that among people aged 20 and older in urban Nepal, 14.6% were diagnosed to be diabetic and 9.1% were diagnosed to have impaired fasting glucose.[29] In another study of participants 40 years and older (n=1012) in urban areas, the prevalence of diabetes (previously known and newly diagnosed using fasting and 2 hour post-prandial blood glucose) was found to be 19%. [30] Ono K et al. reported 9.5% prevalence of type 2 diabetes and 13.8% prevalence of impaired fasting glucose in their study from a semi-urban population in Nepal comprising of 740 adults aged 21 to 94.[31]

Diabetes mellitus has become a major health concern in the South Asian region. It is expected that by 2030, South Asia will bear the greatest burden of diabetes in the world. [32] Numerous studies done in the population living in South Asia and also among those migrated to other places have consistently shown that South Asians are at an increased risk of developing diabetes compared to other ethnic groups.[33-35] High rates of insulin resistance has been considered to be a unique risk factor for South Asians, [36,37] but recent studies also suggest possibilities of genetic predispositions leading to early decline in Beta cell functions.[38-41] Although it can be argued that the high prevalence of overweight or obesity and almost 40% participants with less than recommended level of physical activity might be the major drivers of diabetes in this population, it is still difficult to fully explain the observed high level of diabetes prevalence, which might well be one of the highest reported so far in the South Asian region.[42] An in-depth study on the dietary pattern of the population will help gain major insights to the burden of diabetes in this population.

It should also be noted that our study measured HbA1C for diagnosing diabetes, which might have led to the detection of cases that might have been missed through blood glucose tests only. Before 2010, most of the diabetes societies recommended blood glucose analysis as the exclusive method to diagnose diabetes. In 2009, the International Expert Committee recommended the use of HbA1C for diagnosis of diabetes, which was subsequently endorsed by the American Diabetes Association.[13,43] If stringent quality assurance and assays standardized to criteria aligned to international reference values are assured, HbA1C measurement has major advantages in the diagnosis of diabetes compared to blood glucose measurement because of less pre-analytical and analytical variation.[44] Given the standard laboratory techniques employed in the current study, we consider it should not be an issue of concern. It is known that HbA1C is likely to be

influenced by presence of conditions that lead to rapid red cell turnover (e.g., hemolytic or iron deficiency anemias), hemoglobinopathies (depending on the assay employed). [45-47] However, it is unlikely that the current study population has high prevalence of these conditions. However, we realize that the possibilities of racial differences in HbA1C is not fully explored and understood in the South Asian population, and might possibly limit the interpretation of our findings.

Adverse CVD Risk Profiles

Assessment of CVD risk profiles was done to improve understanding of the overall burden of CVD risk on individuals more accurately. It is recognized that CVD risk factors cluster and interact multiplicatively in increasing vascular risk.[48] This knowledge led to the development of multivariable risk prediction algorithms incorporating the risk factors that help to develop risk scores for specific CVD, e.g., coronary heart disease, stroke, peripheral vascular disease or heart failure.[49] Hence, multivariable risk assessment has been advocated to estimate absolute CVD risk and to guide treatment of risk factors.[50] At the population level, this also provides an opportunity to model future incidence and burden of CVD. This study is the first of its kind in determining the CVD risk profiles in the Nepalese population.

With almost 90% of the population having at least one CVD risk factor and a third of the population having three or more CVD risk factors, it is clear that if appropriate measures are not taken, the population will suffer from an epidemic of CVD in the near future. Poor CVD risk profiles in older age groups is a consistent finding in studies worldwide. However, this study shows major concerns with regards to the presence of CVD factors even in young adults. Almost 90% of the participants aged 28-37 years have at least one CVD risk factor and males are more likely to have worse CVD risk profile. This not only reflects the great importance for the

development of CVD prevention programs in young adults but also a need for early screening of CVD.

While generic measures for the prevention and management of CVD risk factors are necessary, it is also important to explore and identify the possibilities of unique risk factors in the population so that more targeted evidence-based programs can be implemented. This study suggests strong ethnic differences in terms of risk profiles, with Newars and Gurungs being at highest risk compared to others. The etiology of these differences, persisting even after controlling for other possible confounders, is not clear. Vaidya et al. had suggested that there is ethnic variation in the blood pressure distribution in the Nepalese population, which might be acting independently of the different life-style factors. In his study of 641 sub-urban adults, even after adjusting for potential confounders, ethnic groups of Tibeto-Burman origin had 1.78 times higher risk (95% CI: 1.12-2.81) of hypertension compared to Indo-Aryans.[51] Ethnicity is a social construct that encompasses biological, sociocultural, psychological and behavioral components.[18] They also share a range of phenotypic characteristics due to common ancestry and dietary and behavioral characteristics due to sociocultural similarities. Thus, further studies that investigate the relationship of ethnicity related characteristics with CVD risk factors in Nepal are warranted.

Limitations

There are several limitations of the study. As a cross-sectional study, it is not possible to establish temporal relationships with many of the associated variables found to be related to the CVD risk factors. As in other surveys, it is possible that social desirability bias can lead to under-reporting of some of the health behaviors like smoking and physical activity. The generalizability of the findings from this study for the whole country is also challenging because of the different

socio-economic and ethnic make-up of this population. Since Dhulikhel Hospital, one of the largest tertiary level health facilities in the country lies in the small town of Dhulikhel and employ almost 400 staff, it is possible that the health literacy, behaviors and the health indicators of the participants in this study might be better than other regions of Nepal.

Conclusions

Despite some limitations, this study provides important insights into the prevalence of CVD risk factors, patterns of adverse CVD risk profiles and their socio-demographic correlates in this sub-urban Nepalese population. Since the enumerators did the data collection at the households of the participants, we assume that the problem of 'white-coat' hypertension often observed in surveys done in clinical settings is not a significant problem in this study. Extensive information on socio-demographic characteristics and health behaviors provides a unique opportunity to control for multiple potential confounders to determine the predictors of CVD risk factors more accurately. Overall, the findings suggest that the burden of CVD risk factors in Nepal may be greater than previously estimated. This study also highlights the need for more in-depth studies to investigate the relationship of dietary practices with CVD risk factors and also explore potential genetic and other behavioral factors that might predispose certain ethnic groups to have adverse CVD risk profiles. Lastly, the possibility to prospectively follow-up study participants provides a unique opportunity to accurately determine the role of various CVD risk factors with actual CVD incidence in this population in future.

REFERENCES FOR CHAPTER 2

1. Zorn C. Generalized estimating equation models for correlated data: A review with applications. *American Journal of Political Science* 2001: 470-90.
2. http://www.healthmetricsandevaluation.org/sites/default/files/countryprofiles/GBD%20Country%20Report%20-%20Nepal.pdf. 2013 (accessed Feb 15 2015).
3. Vaidya A, Pathak RP, Pandey MR. Prevalence of hypertension in Nepalese community triples in 25 years: a repeat cross-sectional study in rural Kathmandu. *Indian Heart J* 2012; **64**(2): 128-31.
4. Aryal K, Neupane S, Mehata S, et al. Non Communicable Diseases Risk Factors: STEPS Survey Nepal 2013. Kathmandu: Nepal Health Research Council, 2014.
5. Sharma SK, Ghimire A, Radhakrishnan J, et al. Prevalence of hypertension, obesity, diabetes, and metabolic syndrome in Nepal. *Int J Hypertens* 2011; **2011**: 821971.
6. Nepal Demographic and Health Survey 2011. Kathmandu, Nepal: Ministry of Health and Population, New ERA, and ICF International, Calverton, Maryland. , 2012.
7. Consultation WE. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; **363**(9403): 157-63.
8. WHO STEPS Surveillance Manual: The WHO STEPwise Approach to Chronic Disease Risk Factor Surveillance. Geneva, Switzerland: World Health Organization, 2005.
9. Global Physical Activity Questionnaire (GPAQ). Analysis guide. Geneva, Switzerland: World Health Organization.
10. Global Recommendations on Physical Activity for Health. Geneva, Switzerland: World Health Organization, 2010.
11. Joint FAO/WHO Workshop on Fruit and Vegetables for Health: Report of a Joint FAO/WHO Workshop,. Kobe, Japan: FAO and WHO, 2004.
12. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension* 2003; **42**(6): 1206-52.
13. Association AD. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2010; **33 Suppl 1**: S62-9.
14. Expert Panel on Detection Ea, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP)

Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA* 2001; **285**(19): 2486-97.

15. Millán J, Pintó X, Muñoz A, et al. Lipoprotein ratios: Physiological significance and clinical usefulness in cardiovascular prevention. *Vasc Health Risk Manag* 2009; **5**: 757-65.
16. Genest J, Frohlich J, Fodor G, McPherson R, Dyslipidemias WGoHaO. Recommendations for the management of dyslipidemia and the prevention of cardiovascular disease: summary of the 2003 update. *CMAJ* 2003; **169**(9): 921-4.
17. Holme I, Aastveit AH, Jungner I, Walldius G. Relationships between lipoprotein components and risk of myocardial infarction: age, gender and short versus longer follow-up periods in the Apolipoprotein MOrtality RISk study (AMORIS). *J Intern Med* 2008; **264**(1): 30-8.
18. Tao J, Ma YT, Xiang Y, et al. Prevalence of major cardiovascular risk factors and adverse risk profiles among three ethnic groups in the Xinjiang Uygur Autonomous Region, China. *Lipids Health Dis* 2013; **12**: 185.
19. Daviglus ML, Talavera GA, Avilés-Santa ML, et al. Prevalence of major cardiovascular risk factors and cardiovascular diseases among Hispanic/Latino individuals of diverse backgrounds in the United States. *JAMA* 2012; **308**(17): 1775-84.
20. **Daniel W**. Daniel WW (1999). Biostatistics: A foundation for analysis in the health sciences. 7th edition. New York. John Wiley and Sons. 7 ed. New York: John Wiley and Sons; 1999.
21. Smith C. Prevalence of obesity and contributing factors among Sherpa women in urban and rural Nepal. *Am J Hum Biol* 1998; **10**: 519-28.
22. Eckert S, Kohler S. Urbanization and health in developing countries: a systematic review. *World Health Popul* 2014; **15**(1): 7-20.
23. Nepal Non-Communicable Diseases Risk Factors Survey 2003. Kathmandu, Nepal: Ministry o Health and Population, 2004.
24. Nepal Non-Communicable Diseases Risk Factors Survey 2007. Kathmandu, Nepal: Ministry of Health and Population, 2008.
25. Vaidya A, Krettek A. Physical activity level and its sociodemographic correlates in a peri-urban Nepalese population: a cross-sectional study from the Jhaukhel-Duwakot health demographic surveillance site. *Int J Behav Nutr Phys Act* 2014; **11**(1): 39.
26. Vaidya A, Aryal UR, Krettek A. Cardiovascular health knowledge, attitude and practice/behaviour in an urbanising community of Nepal: a population-based cross-sectional

study from Jhaukhel-Duwakot Health Demographic Surveillance Site. *BMJ Open* 2013; **3**(10): e002976.

27. Sreeramareddy CT, Ramakrishnareddy N, Harsha Kumar H, Sathian B, Arokiasamy JT. Prevalence, distribution and correlates of tobacco smoking and chewing in Nepal: a secondary data analysis of Nepal Demographic and Health Survey-2006. *Subst Abuse Treat Prev Policy* 2011; **6**: 33.
28. Dhital S, Karki A. Dealing with the burden of hypertension in Nepal: current status, challenges and health system issues. *Regional Health Forum* 2013; **17**(1): 44-5.
29. Singh DL, Bhattarai MD. High prevalence of diabetes and impaired fasting glycaemia in urban Nepal. *Diabet Med* 2003; **20**(2): 170-1.
30. Shrestha UK, Singh DL, Bhattarai MD. The prevalence of hypertension and diabetes defined by fasting and 2-h plasma glucose criteria in urban Nepal. *Diabet Med* 2006; **23**(10): 1130-5.
31. Ono K, Limbu YR, Rai SK, et al. The prevalence of type 2 diabetes mellitus and impaired fasting glucose in semi-urban population of Nepal. *Nepal Med Coll J* 2007; **9**(3): 154-6.
32. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res Clin Pract* 2010; **87**(1): 4-14.
33. Mather HM, Keen H. The Southall Diabetes Survey: prevalence of known diabetes in Asians and Europeans. *Br Med J (Clin Res Ed)* 1985; **291**(6502): 1081-4.
34. Li YR, Zhu H, Kauffman M, et al. Paraoxonases function as unique protectors against cardiovascular diseases and diabetes: Updated experimental and clinical data. *Exp Biol Med (Maywood)* 2014; **239**(8): 899-906.
35. Nair M, Ali MK, Ajay VS, et al. CARRS Surveillance study: design and methods to assess burdens from multiple perspectives. *BMC Public Health* 2012; **12**: 701.
36. McKeigue PM. Metabolic consequences of obesity and body fat pattern: lessons from migrant studies. *Ciba Found Symp* 1996; **201**: 54-64; discussion -7, 188-93.
37. Gujral UP, Pradeepa R, Weber MB, Narayan KM, Mohan V. Type 2 diabetes in South Asians: similarities and differences with white Caucasian and other populations. *Ann N Y Acad Sci* 2013; **1281**: 51-63.
38. Mohan V, Amutha A, Ranjani H, et al. Associations of β-cell function and insulin resistance with youth-onset type 2 diabetes and prediabetes among Asian Indians. *Diabetes Technol Ther* 2013; **15**(4): 315-22.

39. Staimez LR, Weber MB, Ranjani H, et al. Evidence of reduced β-cell function in Asian Indians with mild dysglycemia. *Diabetes Care* 2013; **36**(9): 2772-8.
40. Florez JC. Newly identified loci highlight beta cell dysfunction as a key cause of type 2 diabetes: where are the insulin resistance genes? *Diabetologia* 2008; **51**(7): 1100-10.
41. Kanaya AM, Wassel CL, Mathur D, et al. Prevalence and correlates of diabetes in South asian indians in the United States: findings from the metabolic syndrome and atherosclerosis in South asians living in america study and the multi-ethnic study of atherosclerosis. *Metab Syndr Relat Disord* 2010; **8**(2): 157-64.
42. Jayawardena R, Ranasinghe P, Byrne NM, Soares MJ, Katulanda P, Hills AP. Prevalence and trends of the diabetes epidemic in South Asia: a systematic review and meta-analysis. *BMC Public Health* 2012; **12**: 380.
43. Committee IE. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care* 2009; **32**(7): 1327-34.
44. Sacks DB. A1C versus glucose testing: a comparison. *Diabetes Care* 2011; **34**(2): 518-23.
45. Wisdom K, Fryzek JP, Havstad SL, Anderson RM, Dreiling MC, Tilley BC. Comparison of laboratory test frequency and test results between African-Americans and Caucasians with diabetes: opportunity for improvement. Findings from a large urban health maintenance organization. *Diabetes Care* 1997; **20**(6): 971-7.
46. Bry L, Chen PC, Sacks DB. Effects of hemoglobin variants and chemically modified derivatives on assays for glycohemoglobin. *Clin Chem* 2001; **47**(2): 153-63.
47. WHO. Use of glycated haemoglobin (HbA1c) in the diagnosis of diabetes mellitus. *Diabetes Res Clin Pract* 2011; **93**: 299-308.
48. Jackson R, Lawes CM, Bennett DA, Milne RJ, Rodgers A. Treatment with drugs to lower blood pressure and blood cholesterol based on an individual's absolute cardiovascular risk. *Lancet* 2005; **365**(9457): 434-41.
49. D'Agostino RB, Vasan RS, Pencina MJ, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. *Circulation* 2008; **117**(6): 743-53.
50. De Backer G, Ambrosioni E, Borch-Johnsen K, et al. European guidelines on cardiovascular disease prevention in clinical practice. Third Joint Task Force of European and Other Societies on Cardiovascular Disease Prevention in Clinical Practice. *Eur Heart J* 2003; **24**(17): 1601-10.

51. Vaidya A. Is ethnicity an important determinant of high blood pressure in Nepalese population? A community-based cross sectional study in Duwakot, Nepal. *Kathmandu Univ Med J (KUMJ)* 2012; **10**(37): 20-3.

CHAPTER 3

HYPERTENSION AND ITS RISK FACTORS IN NEPAL: FINDINGS FROM THE DHULIKHEL HEART STUDY

ABSTRACT

Background: Although a number of studies on hypertension in Nepal highlight its high prevalence, there is still lack of information on the association of hypertension with socio-demographic characteristics and other cardiovascular diseases (CVD) risk factors.

Objectives: We investigated the association of prevalent hypertension with socio-demographic characteristics (age, gender, education, ethnicity, occupation and income) and CVD risk factors (smoking, low physical activity, low consumption of fruits and vegetables, diabetes, high total cholesterol and triglycerides, low HDL) in a suburban community in Nepal. We also developed and tested a prediction model of hypertension for this community.

Methods: In this cross-sectional study, we enrolled all eligible and consented18 years and older adults from a random selection of one third of households in the town of Dhulikhel in central Nepal. We determined the prevalence of cardiovascular diseases risk factors including smoking, hypertension, low physical activity, low consumption of fruits and vegetables, diabetes, high total cholesterol, high triglycerides and low HDL using standard case definitions and cut-offs. Blood pressure was measured three times in a sitting posture on the right arm over loose clothes using a standard digital BP machine (Microlife, Switzerland). The mean of the three measurements was used as the blood pressure of the participant for interpretation purposes.

Hypertension was defined as a systolic blood pressure 140 mm Hg or greater; or diastolic blood pressure 90 mm Hg or greater; or receiving antihypertensive medication.

The associations of each of the socio-demographic factors and modifiable CVD risk factors (smoking, low physical activity, unhealthy diet, alcohol consumption and obesity) with hypertension were analyzed in a multivariate logistic regression utilizing generalized estimating equation (GEE). We also developed prediction model for hypertension using backward stepwise logistic regression. Area under the receiver operating curve (AUC) was calculated to assess the performance of the model in a random sub-sample of half of the participants.

Results: We enrolled 1073 participants among which, 41.6% were males and 58.4% were females. The mean age of the participants was 40.3 years (SD: 16.3). Males were found to have significantly higher prevalence of hypertension (37.4%) compared to females (20.8%) ($p<0.001$). In the multivariate model, males had significantly greater risk of hypertension (OR: 2.52, 95% CI: 1.69-3.75, $p<0.001$) compared to females. Age was also significantly associated with hypertension prevalence ($p<0.001$). The Newar ethnic group had 5.65 times greater risk of hypertension (95% CI: 3.12-10.21, $p<0.001$) compared to Brahmins. Being overweight or obese was associated with 2.61 (95% CI: 1.81-3.77, $p<0.001$) and 6.74 (95% CI: 3.75-12.11, $p<0.001$) times greater risk respectively.

The prediction model led to the inclusion of sex, age, physical activity, smoking history, occupation (student status versus unemployed) and ethnicity as factors which increased the risk of hypertension in the model. The average AUC associated with the performance of the model was 0.808 (95% CI: 0.769-0.847)

Conclusion: In this study population, the prevalence of hypertension in a sample of Nepalese adults was high. Age, gender, ethnicity and BMI were independently associated with hypertension and may be used as targets for identifying individuals potentially in need of screening and treatment.

INTRODUCTION

Hypertension is considered the most important risk factor for morbidity and mortality in the world in terms of Disability Adjusted Life Years.[1] It is responsible for about 9.4 million deaths worldwide, including at least 45% of deaths due to heart disease (total ischemic heart disease mortality), and 51% of deaths due to stroke.[2,3]

There is ample evidence from observational studies that throughout middle and old age, usual blood pressure is strongly and directly related to vascular as well as total mortality,.[4] It is also firmly established that untreated hypertension increases the risk of stroke, coronary heart disease, congestive heart failure, and mortality.[5,6] Since hypertension can be asymptomatic, people often do not seek medical care, leaving it undetected and untreated. Even among the diagnosed and treated, the blood pressure control rate is very low.[7] Hence, hypertension remains an undetected condition and, among the detected, a poorly managed risk factor.

Older age, higher body mass index (BMI), higher salt and alcohol consumption are well established as the general risk factors for hypertension.[8-15] However, there is still lack of information on the sociodemographic correlates of hypertension. Previous studies have suggested persisting differences in hypertension prevalence by races and ethnicities within

different communities. A large study done in an ambulatory care setting in California reported that most minority subgroups had lower or similar odds of having hypertension compared with Non-Hispanic Whites, except for Filipinos and Non-Hispanic Blacks whose odds were significantly higher after adjusting for patient demographic and clinical characteristics. [16] In another study from England, compared with Caucasians, Afro-Caribbeans had a significantly higher mean systolic blood pressure, with higher mean diastolic blood pressures evident among Afro-Caribbean women.[17] The association of socioeconomic status and hypertension is also not clear. In India, epidemiological studies from the mid and late twentieth century reported greater cardiovascular risk factor prevalence among the people with higher socioeconomic status.[18,19] However, a shift in this trend emerged in early 2000. Greater prevalence of hypertension was reported among less educated rural subjects and industrial populations.[20-22]

Although there are a number of studies on hypertension prevalence in Nepal, there is still lack of information on the association of sociodemographic characteristics and other Cardiovascular Diseases (CVD) risk factors with hypertension as most did not account for confounders.[23,24] Only one study suggested that ethnicity (Tibeto-Burman) might be independently associated with hypertension.[25]

This study examines the baseline data from the Dhulikhel Heart Study to investigate the association of prevalent hypertension with socio-demographic characteristics, modifiable CVD risk factors, and comorbid CVD conditions in Nepal. It also aims to develop and test a prediction model of hypertension for the local community.

METHODS

Dhulikhel Heart Study

The Dhulikhel Heart Study was launched in December 2013 to gain an in-depth understanding of the epidemiology of CVD and associated risk factors among all adult residents (18 years and older), n~4500, in the town of Dhulikhel in central Nepal. The current study is based on the data collected for the first wave of the DHS baseline survey which included participants from one third of the randomly selected households of Dhulikhel (n=1073).

Study Participants

All the households of the town were enumerated (n=2225) and assigned a unique household number prior to the initiation of the study. One third of the households in each of the nine wards (administrative division) in Dhulikhel were then selected randomly using STATA 12.0 for first wave of the baseline exam. All the eligible residents 18 years and older living in Dhulikhel for the past six months or longer in the selected households were invited to participate in the study. Individuals in institutionalized settings (living in hostels, motels), individuals unable to communicate due to physical or mental problems, pregnant women and those who refused to participate were not included in the study.

Data Collection

Data collection was done at the household-level by trained study staff. All eligible members of the selected households were provided information on the study objectives, risks and benefits and were enrolled after receiving informed consent. The study staff administered an electronic

tablet-based questionnaire using the open-ware Open Data Kit (ODK) (https://opendatakit.org) through which two sets of questionnaires were administered. The household questionnaire (Appendix 1) was administered to obtain information on household characteristics. The personal questionnaire (Appendix 2) was administered for additional information on the individual participant. This included information on socio-demographic characteristics, medical history, health care financing, health behaviors and physical and cognitive function. The socio-demographic questions were based on the Nepal Demographic Health Survey 2011.[26] Age was calculated in years based on the date of birth of the respondents. Education was collected as years of formal schooling. Annual monetary income (Nepalese Rupees) of the household as well as of individual respondents was asked.

This was then followed by anthropometric (height, weight, hip and waist circumference) and blood pressure measurement. Body weight was measured in a standing position with the participant wearing light clothing and no shoes in kilograms (kg) to the nearest 0.1kg by a modern digital weighing scale (Omron HBF-400, USA). After the participant stood straight without shoes on a flat floor, the height of the highest point of head (marked on the wall) was measured using a measuring tape to the nearest 1 cm. Blood pressure was measured three times in a sitting posture on the right arm over loose clothes using a standard digital BP machine (Microlife, Switzerland). The mean of the three measurements was used as the blood pressure of the participant for interpretation purposes. All the data collected in the ODK were downloaded in a secure main server every day.

Within the next few days after the questionnaire administration, a trained laboratory technician collected fasting venous blood sample from the participants at a mobile blood collection center.

Venous blood samples were drawn after 8-12 hour of overnight fasting into vacutainer tubes. Fasting blood glucose (FBG), Glycosylated hemoglobin (HbA1c), lipid profiles parameters including total cholesterol (TC), triacylglycerol (TAG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were analyzed at the Department of Clinical Biochemistry, Dhulikhel Hospital-Kathmandu University Hospital, Dhulikhel, Nepal. FBG, TC and TAG were estimated by enzymatic colorimetric method (Dialab GmbH, Austria) and HDL-C & LDL-C by selective direct immunoinhibition method (DiaSys Diagnostic Systems GmbH, Germany) using a Flexor Junior auto-analyzer (Vital Scientific, Netherlands). HbA1c was estimated by using the Nycocard system (Axis shield Co., Norway) that has been certified by the National Glycohemoglobin Standardization Program (NGSP). All of the assays were routinely monitored by participation in external quality-control programs and using assayed chemistry & mission controls (Bio-Rad Laboratories and Diamond diagnostics, USA).

Definitions of the modifiable CVD risk factors

Obesity: Body mass index (BMI) of the participants was calculated as weight in kg/ square of height in meter. Obesity, overweight, normal and underweight were defined as a BMI of 30.0 or greater, 25.0 to 25.9, 18.5 to 24.9 and less than 18.5 respectively.[27]

Smoking: Smoking history was ascertained using the questions based on the WHO STEPS survey questionnaire. Participants were categorized into current, former and non-smokers.[28]

Physical Activity: Physical activity was assessed using the Global Physical Activity Questionnaire. [29] The participants were categorized into those that fulfilled the recommended level of activity (600 MET minutes per week) and those who had less than recommended level of

physical activity as per WHO criteria.[30]

Diet: A food frequency questionnaire (FFQ) was validated and used to collect dietary intake of participants. For this study we focused on the consumption of fruits and vegetables as an indication of healthy eating habits. Participants were categorized into those who met the WHO recommendation of consumption of fruits and vegetables (at least five servings of fruits and vegetables per day) and those who do not meet the recommendation.[31]

Hypertension: Hypertension was defined as systolic blood pressure 140 mm Hg or greater; or diastolic blood pressure 90 mm Hg or greater; past history of diagnosis of hypertension; or receiving antihypertensive medication.[5]

Diabetes: Diabetes mellitus was defined as HbA1C 6.5% or greater.[32]

Hypercholesterolemia and High Total Cholesterol/HDL ratio: Blood cholesterol level was categorized into normal, high normal and high (hypercholesterolemia). Hypercholesterolemia was defined as total cholesterol of 240 mg/dL or greater, or receiving cholesterol-lowering medication.[33] We also report proportion of participants with high total cholesterol to high density lipoprotein ratio (TC/HDL ratio), which is ≥ 4.5 (for males) and ≥ 4 (for females) given their relevance as predictors of CVD events.[34-36]

STATISTICAL ANALYSIS AND STUDY POWER:

The general characteristics of the participants were summarized in mean (standard deviation), or percentage. The association of each of the socio-demographic factors (age, gender, education, ethnicity, occupation and income), modifiable CVD risk factors (smoking, low physical activity,

unhealthy diet, alcohol consumption and obesity) and comorbid CVD conditions (diabetes, high total cholesterol, high total cholesterol/HDL ratio, low HDL, high TAG) with hypertension were first analyzed in an unadjusted logistic regression model utilizing generalized estimating equation (GEE). Then a multivariate logistic regression utilizing generalized estimating equation (GEE) including all the above variables (except diabetes, total cholesterol, HDL, TAG and total cholesterol/HDL ratio) was done (model 1). Finally, a second multivariate regression additionally adjusted for diabetes, total cholesterol, HDL, TAG and total cholesterol/HDL was also performed. Interactions with age and sex were also explored. The second regression model comprised of only 479 participants because of the lack of laboratory investigations in the entire sample. Odds ratios and 95% CI were reported for each of the parameters in the regression models.

For developing a prediction model, we used backward stepwise logistic regression. The variables we entered into the model were sex (categorical), age (continuous), marital status (categorical), occupation (categorical), ethnicity (categorical), income (continuous), education (continuous), BMI (continuous), smoking history (categorical), physical activity (continuous), fruit and vegetable consumption (continuous) and alcohol consumption (continuous). We set the significance level of 0.2 as the limit to include the variables in the model. The resulting model was then validated in a random sub-sample of half of the participants. This process was repeated five times and the average area under the receiver operating curve (AUC) (with 95% CI) was calculated. An AUC over 0.70 was considered to be acceptable.

Based on the power calculation for logistic regression, with a sample size of 1073 and study power of 80%, this study would be able to detect minimum odds ratio of 1.50 to 1.81 for the risk

factors associated with hypertension depending upon the prevalence of the risk factors and their estimated association with hypertension.[37,38]

RESULTS

A total of 1372 eligible participants from 384 households of the nine wards were enumerated in the first wave of the DHS. Of these, the data collectors were able to contact 1103 (80%) participants. A total of 1073 provided informed consent and were recruited into the study resulting in a total participation rate of 78.1%. Among the 1073 participants, only 479 had their blood samples collected for biochemical investigations (due to logistic challenges).

Table 3-1 shows the socio-demographic characteristics of the study participants by their hypertension status. Males had a significantly higher prevalence of hypertension (37.4%) compared to females (20.8%) ($p<0.001$). Prevalence of hypertension was also significantly different within the sub-categories of age, marital status, occupational status, ethnicity and education ($p<0.001$).

Table 3- 1 Socio-demographic Characteristics of the Participants of the Dhulikhel Heart Study by Hypertension status (N=1073)

	Total (N=1073)		Normotensive		Hypertensive		p-values
	n	%	n	%	n	%	
Sex							<0.001¶
Male	446	(41.6)	279	(62.5)	167	(37.4)	
Female	627	(58.4)	496	(79.1)	131	(20.8)	
Age (Mean, SD)	40.3 (16.3)		36.7 (15.0)		50.6 (15.0)		<0.001*
Age Category							<0.001¶
<25	265	(24.7)	249	(93.9)	16	(6.0)	
25-34	204	(19.0)	175	(85.7)	29	(14.2)	
35-44	209	(19.4)	140	(66.9)	69	(33.0)	
45-54	192	(17.8)	113	(58.8)	79	(41.1)	
55-64	110	(10.2)	58	(52.7)	52	(47.2)	
>65	93	(8.6)	40	(43.0)	53	(56.9)	
Marital Status							<0.001¶
Never married	225	(20.9)	195	(86.6)	30	(13.3)	
Currently Married	784	(73)	545	(69.5)	239	(30.4)	
Separated or Widowed	64	(5.9)	35	(54.6)	29	(45.3)	
Occupation							<0.001¶
Unemployed	489	(51.7)	347	(70.9)	142	(29.0)	
Employed	429	(18.2)	286	(66.6)	143	(33.3)	
Student	155	(30)	142	(91.6)	13	(8.3)	
Ethnicity							<0.001¶
Brahmin	156	(14.5)	136	(87.1)	20	(12.8)	
Chhettri/Thakuri/Sanyasi	142	(13.2)	112	(78.8)	30	(21.3)	
Newar	527	(49.1)	320	(60.7)	207	(39.2)	
Gurung/Tamang/Sherpa/Bhote	228	(21.2)	189	(82.8)	39	(17.1)	
Dalits and others	20	(1.8)	18	(90.0)	2	(10.0)	
Individual income quartiles (Monthly)#							0.001¶
Q1 (Lowest)	626	(58.3)	472	(75.4)	154	(24.6)	
Q2	0	(0)					
Q3	190	(17.7)	140	(73.6)	50	(26.3)	
Q4	257	(23.9)	163	(63.4)	94	(36.5)	
Education							<0.001¶
No formal education	340	(31.6)	228	(67.0)	112	(32.9)	
Less than high school	478	(44.5)	332	(69.4)	146	(30.5)	
High school or more	255	(23.7)	215	(84.3)	40	(15.6)	
Religion							0.038¶
Hindu	910	(84.8)	644	(70.7)	266	(29.2)	
Buddhist	142	(13.2)	115	(80.9)	27	(19.0)	
Other	21	(1.9)	16	(76.1)	5	(23.8)	

* *Unpaired t-test* ¶ *Chi-squared test*

In Table 3-2a we present the prevalence of BMI, smoking, dietary history, physical activity and alcohol consumption of the participants by their hypertension status. Table 3-2b shows the prevalence of diabetes as well as lipid parameters by the hypertension status. Prevalence of hypertension was significantly different within the sub-categories of BMI, smoking history, alcohol consumption, diabetes status, total cholesterol level and total cholesterol/HDL ratio ($p<0.001$).

Table 3- 2a. CVD Risk Factors of the Participants of the Dhulikhel Heart Study by Hypertension status (N=1073)

	Total		Normotensive		Hypertensive		P-value
	n	(%)	n	(%)	n	(%)	
BMI							<0.001¶
Underweight (<18.5)	64	(5.9)	53	(82.8)	11	(17.1)	
Normal (18.5-24.9)	611	(56.9)	496	(81.8)	115	(18.8)	
Overweight (25.0-29.9)	315	(29.3)	196	(62.2)	119	(37.7)	
Obese (≥30)	83	(7.7)	30	(36.1)	53	(63.8)	
Smoking							<0.001¶
Never Smoker	726	(67.6)	565	(77.8)	161	(22.1)	
Former Smoker	99	(9.2)	42	(42.4)	57	(57.5)	
Current Smoker	248	(23.1)	168	(67.7)	80	(32.2)	
Fruits and Vegetable Consumption							0.227¶
< 5 servings of fruits and/or veg per day	536	(49.9)	396	(73.8)	140	(26.1)	
≥ 5 servings of fruits and/or veg per day	537	(50.0)	379	(70.5)	158	(29.4)	
Physical Activity							0.010¶
<600 MET-minutes/week	423	(39.4)	287	(67.8)	136	(32.1)	
≥ 600 MET-minutes/week	650	(60.5)	488	(75.0)	162	(24.9)	
Alcohol							<0.001¶
None	735	(68.5)	560	(76.1)	175	(23.8)	
Low (<1 glass per week)	98	(9.1)	61	(62.2)	37	(37.7)	
Moderate (1-3 glass per week)	59	(5.5)	42	(71.1)	17	(28.8)	
High (3 or more glasses per week)	181	(16.8)	112	(61.8)	69	(38.1)	

¶ *Chi-squared test*

Table 3- 2b. CVD Risk Factors of the Participants of the Dhulikhel Heart Study by Hypertension status (N=479)

	Total		Normotensive		Hypertensive		p-value
	n	(%)	n	(%)	n	(%)	
Diabetes							<0.001¶
Non-diabetic (HbA1C < 5.7)	123	(25.6)	100	(81.3)	23	(18.7)	
Pre-diabetic (HbA1C: 5.7-6.4)	203	(42.3)	149	(73.4)	54	(26.6)	
Diabetic (Hb1C >6.4)	153	(31.9)	92	(60.1)	61	(39.8)	
Total Cholesterol							<0.001¶
Normal (<200mg/dl)	380	(79.3)	290	(76.3)	90	(23.6)	
High Normal (200-239mg/dl)	73	(15.2)	43	(58.9)	30	(41.1)	
High (≥ 240 mg/dl)	26	(5.4)	8	(30.7)	18	(69.2)	
HDL							0.450¶
Normal (≥ 35mg/dl)	361	(75.3)	260	(72.0)	101	(27.9)	
Low (<35mg/dl)	118	(24.6)	81	(68.6)	37	(31.3)	
Total Cholesterol/HDL Ratio							<0.001¶
Normal	279	(58.2)	218	(78.1)	61	(21.8)	
High	200	(41.7)	123	(61.5)	77	(38.5)	
Triglyceride							0.004¶
Normal (<150 mg/dl)	367	(76.6)	274	(74.6)	93	(25.3)	
Borderline High (150-199 mg/dl)	64	(13.3)	35	(54.6)	29	(45.3)	
High (>200 mg/dl)	48	(10.0)	32	(66.6)	16	(33.3)	

Table 3-3 describes the crude and adjusted association of socio-demographic and other CVD risk factors with hypertension. Multivariate model 1 adjusts for sex, age, marital status, occupation, ethnicity, income quartiles, education, religion, BMI, smoking, physical activity; whereas multivariate model 2 additionally adjusts for diabetes, total cholesterol, HDL, TAG and total cholesterol/HDL ratio.

The univariate analysis showed significant associations of hypertension with sex, age, marital status, occupation (being student versus unemployed), ethnicity, income quartile (highest quartile versus lowest quartile only), educational status, BMI categories, smoking history, physical activity, alcohol intake (low and high levels of alcohol consumption versus no consumption

only), diabetes status, total cholesterol level categories, total cholesterol and HDL ratio and triglyceride categories (borderline high versus normal). In multivariate model 1, only sex, age categories, ethnicity and BMI were found to be significantly associated. Similarly in multivariate model 2, only sex, age categories, ethnicity and BMI categories were found to be significantly associated. There were no significant interactions between age and sex. Hence, the interaction was not included in the multivariate models.

Table 3- 3. Multivariate Logistic Regression Analysis§ of Socio-Demographic and Other Factors Associated with Hypertension

			Univariate			Multivariate Model 1*			Multivariate Model 2**		
	n	(%)	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Sex											
Female	627	58.4	1			1			1		
Male	446	41.5	2.30	(1.76-3.00)	<0.001	2.52	(1.69-3.75)	<0.001	2.06	(1.09-3.87)	0.025
Age Category											
<25	265	24.7	1			1			1		
25-34	204	19.0	2.55	(1.32-4.92)	0.005	3.85	(1.60-9.22)	<0.001	5.20	(0.84-31.9)	<0.001
35-44	209	19.4	7.71	(4.26-13.96)	<0.001	18.58	(7.24-47.70)	<0.001	32.78	(4.83------)	<0.001
45-54	192	17.8	11.24	(6.24-20.26)	<0.001	22.60	(8.64-59.10)	<0.001	34.45	(4.97------)	<0.001
55-64	110	10.2	14.06	(7.38-26.78)	<0.001	26.98	(9.74-74.69)	<0.001	50.14	(6.88------)	<0.001
>65	93	8.6	22.39	(11.53-43.45)	<0.001	36.83	(12.38------)	<0.001	118.26	(14.60-----)	<0.001
Marital Status											
Never Married	225	20.9	1			1			1		
Currently Married	784	73.0	3.07	(2.00-4.71)	<0.001	0.75	(0.41-1.36)	0.356	0.78	(0.26-2.32)	0.661
Separated or Widowed	64	5.9	5.93	(3.16-11.13)	<0.001	0.73	(0.29-1.78)	0.491	0.91	(0.21-3.79)	0.899
Occupation											
Unemployed	489	51.7	1			1			1		
Employed	429	18.2	1.24	(0.94-1.64)	0.123	1.07	(0.72-1.57)	0.723	1.42	(0.77-2.63)	0.251
Student	155	30.0	0.20	(0.11-0.38)	<0.001	0.53	(0.23-1.21)	0.135	1.07	(0.22-5.14)	0.929
Ethnicity											
Brahmin	156	14.5	1			1			1		
Chhetri/Thakuri/Sanyasi	142	13.2	1.82	(0.98-3.37)	0.057	2.48	(1.21-5.07)	0.013	3.77	(1.29-11.02)	0.015
Newar	527	49.1	4.39	(2.66-7.24)	<0.001	5.65	(3.12-10.21)	<0.001	8.19	(3.26-20.60)	<0.001
Gurung/Tamang/Sherpa/Bhote	228	21.2	1.40	(0.78-2.50)	0.255	2.10	(1.05-4.18)	0.035	3.20	(1.13-9.04)	0.028
Dalits and other	20	1.8	0.75	(0.16-3.48)	0.717	1.32	(0.25-6.96)	0.382	-----	----------	------
Income Quartiles											
Q1 (Lowest Quartile)	626	58.3	1			1			1		
Q2	0	0									
Q3	190	17.7	1.13	(0.78-1.65)	0.492	1.11	(0.65-2.05)	0.724	0.84	(0.33-2.11)	0.716
Q4	257	23.9	1.81	(1.32-2.47)	<0.001	1.39	(0.73-2.67)	0.311	1.45	(0.53-3.95)	0.459

§ Multivariate logistic regression using Generalized Estimating Equation for correlation within household.
** Adjusted for the rest of the variables in the model (sex, age, marital status, occupation, ethnicity, income quartiles, education, religion, BMI, smoking, physical activit*
*** Adjusted for variables in model 1 and additionally diabetes status, total cholesterol, HDL level, Total Cholesterol/HDL ratio and Triglyceride*

Table 3- 4. Multivariate Logistic Regression Analysis[§] of Socio-Demographic and Other Factors Associated with Hypertension (Contd..)

			Univariate			Multivariate Model 1*			Multivariate Model 2**		
	n	(%)	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Education											
No formal education	340	(31.6)	1			1			1		
Less than high school	478	(44.5)	0.88	(0.65-1.18)	0.408	1.44	(0.91-2.27)	0.111	1.41	(0.68-2.92)	0.350
High school or more	255	(23.7)	0.31	(0.20-0.47)	<0.001	0.81	(0.42-1.55)	0.526	0.85	(0.29-2.46)	0.772
BMI											
Underweight or Normal (<24.9)	675	(62.9)	1			1			1		
Overweight (25.0-29.9)	315	(29.3)	2.61	(1.93-3.53)	<0.001	2.61	(1.81-3.77)	<0.001	3.16	(1.74-5.71)	<0.001
Obese (≥30)	83	(7.7)	7.45	(4.58-12.12)	<0.001	6.74	(3.75-12.11)	<0.001	8.28	(3.21-21.3)	<0.001
Smoking											
Never Smoke	726	(67.6)	1			1			1		
Former Smoker	99	(9.23)	4.97	(3.22-7.67)	<0.001	1.09	(0.62-1.89)	0.755	1.11	(0.48-2.52)	0.803
Current Smoker	248	(23.1)	1.82	(1.32-2.50)	<0.001	0.90	(0.59-1.38)	0.649	1.32	(0.66-2.66)	0.422
Physical Activity											
≥600 MET-minutes/week	650	(60.6)	1			1					
<600 MET-minutes/week	423	(39.4)	1.41	(1.07-1.85)	0.014	1.16	(0.83-1.61)	0.377	1.41	(0.84-2.35)	0.185
Fruits and Veg Consumption											
≥ 5 servings of fruits and/or veg per day	537	(50.0)	1			1			1		
< 5 servings of fruits and/or veg per day	536	(49.9)	1.21	(0.92-1.59)	0.164	1.05	(0.76-1.46)	0.738	0.84	(0.50-1.43)	0.543
Alcohol											
None	735	(68.5)	1						1		
Low (<1 glass per week)	98	(9.1)	1.75	(1.11-2.74)	0.014	1.05	(0.62-1.80)	0.838	1.14	(0.46-2.82)	0.767
Moderate (1-3 glass per week)	59	(5.5)	1.23	(0.68-2.24)	0.71	0.74	(0.36-1.52)	0.424	0.63	(0.22-1.78)	0.387
High (≥3 glasses per week)	181	(16.8)	2.03	(1.44-2.87)	<0.001	1.36	(0.82-2.25)	0.227	1.15	(0.50-2.64)	0.730

§ Multivariate logistic regression using Generalized Estimating Equation for correlation within household.
** Adjusted for the rest of the variables in the model (sex, age, marital status, occupation, ethnicity, income quartiles, education, religion, BMI, smoking, physical activity*
*** Adjusted for variables in model 1 and additionally diabetes status, total cholesterol, HDL level, Total Cholesterol/HDL ratio and Triglyceride*

Table 3-3. Multivariate Logistic Regression Analysis§ of Socio-Demographic and Other Factors Associated with Hypertension (Contd..)

	Univariate					Multivariate Model 1*			Multivariate Model 2**		
	n	%	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Diabetes											
Non-diabetic (HbA1C < 5.7)	123	25.6	1						1		
Pre-diabetic (HbA1C: 5.7-6.4)	203	42.3	1.79	(1.01-3.18)	0.044				1.16	(0.57-2.34)	0.674
Diabetic (Hb1C >6.4)	153	31.9	3.36	(1.86-6.06)	<0.001				1.39	(0.66-2.95)	0.381
Total Cholesterol											
Normal (<200mg/dl)	380	79.3	1						1		
High Normal (200-239mg/dl)	73	15.2	2.22	(1.31-3.76)	0.003				1.33	(0.67-2.64)	0.400
High (≥ 240 mg/dl)	26	5.4	6.65	(2.81-15.73)	<0.001				2.49	(0.80-7.78)	0.114
HDL											
Normal (≥ 35mg/dl)	361	75.3	1								
Low (<35mg/dl)	118	24.6	1.14	(0.72-1.81)	0.558						
Total Cholesterol/HDL Ratio											
Normal	279	58.2	1						1		
High	200	41.7	2.11	(1.41-3.18)	<0.001				1.80	(0.97-3.34)	0.059
Triglyceride											
Normal (<150 mg/dl)	367	76.6	1						1		
Borderline High (150-199 mg/dl)	64	13.3	2.43	(1.41-4.19)	0.001				1.57	(0.78-3.19)	0.204
High (>200 mg/dl)	48	10.0	1.50	(0.79-2.86)	0.211				1.22	(0.53-2.82)	0.628

§ Multivariate logistic regression using Generalized Estimating Equation for correlation within household.
** Adjusted for sex, age, marital status, occupation, ethnicity, income quartiles, education, BMI, smoking, physical activity)*
*** Adjusted for variables in model 1 and additionally HbA1C, total cholesterol, HDL level, and Triglyceride.*

For the prediction model, backward stepwise logistic regression model setting a significance level of 0.2 led to the inclusion of sex, age, physical activity, occupation (student status versus unemployed) and ethnicity in the model. (Table 3-4) In order to evaluate the ability of the multivariate model to distinguish between hypertensive and non-hypertensive, we determined the area under the receiver operating curve (AUC) in random sub-samples comprising half of the sample. The average AUC after five such iterations was 0.808 (95% CI: 0.769-0.847).

Table 3- 5. Variables in the Prediction Model for Hypertension Using Multivariate Logistic Regression Analysis.*

Variables	OR	95% CI	p-value
Sex (Male vs Female)	2.79	(2.03-3.83)	<0.001
Age (per year increase)	1.05	(1.04-1.06)	<0.001
Physical activity (per MET minute/week increase)	0.99	(0.99-1.00)	0.189
Student status (in occupation) versus unemployed	0.62	(0.31-1.21)	0.162
Ethnicity (vs Brahmins)			
Chhetri/Thakuri/Sanyasi	2.38	(1.23-4.61)	0.010
Newars	5.83	(3.43-9.92)	<0.001
Gurung/Tamang/Sherpa/Bhote	1.94	(1.05-3.59)	0.034

**Backward stepwise logistic regression model setting a significance level of 0.2*

AUC: 0.808 (95% CI: 0.769-0.847)

DISCUSSION

This study provides an in-depth understanding of hypertension and its risk factors in a suburban community in Nepal. The prevalence reported here (39.4% in males and 23.1% in females) is higher than recent national estimates of 31.1% in males and 20.6% in females.[39] One reason for this difference might be the age structure of the participants (15-69 years in the national survey

compared to 18 years and older in the current study). The prevalence of our study more closely resembles a large population-based survey in Eastern Nepal of participants ≥ 20 years old that reported hypertension prevalence to be 40.7% in males and 30% in females.[23] The high prevalence of hypertension even in young age-groups in this study is very concerning and reflects early development of hypertension in this population. This corroborates with the findings from a repeat cross-sectional study in a suburban site in Nepal that showed a three-fold increase of hypertension prevalence (latest prevalence estimates: 38.3% in males and 30.8% in females) over 25 years, with the greatest increase in those below 40 years.[24]

A number of factors can be attributed to the high prevalence of hypertension in this population. The high prevalence of overweight and obesity and less physical activity, all of which have proven relationship with hypertension risk, appear to be the major drivers of hypertension in this population. Urbanization has been consistently linked to obesity in a number of different studies.[40,41] In Nepal, a study comparing urban and rural Sherpa women showed that those in urban regions had higher BMI compared to their rural counterparts. This can primarily be due to lesser physical activity in urban settings because of increased access to transportation and decreased physical activity in every day work.[42] Given the fact that the majority of the world's population, including developing countries, is shifting towards urban areas, this has serious implications in terms of future trends in hypertension.[43]

The significant association of hypertension with male sex, higher age and higher BMI in the multivariate analyses support findings from previous studies.[44,45] However, the strong positive association of Newar ethnicity and hypertension, compared to Brahmins is a new finding in the context of Nepal and also holds special significance. Culturally Brahmins are more likely to

practice healthy food habits like abstinence from alcohol and smoking, as well as reduced salt and meat intake. On the contrary, Newars have strong cultural components involving food practices that encourage alcohol consumption and high intake of meat and spicy food (including higher salt intake). Other ethnic groups fall in between these extremes. This study was able to control for alcohol and fruits and vegetables consumption but not for salt intake, which has a strong association with high blood pressure. However, it is unlikely that the magnitude of association with ethnicity is due only to differences in salt consumption. Other possible factors, most likely genetic components need to be explored in future studies. Vaidya et al. had reported that even after adjusting for major confounding factors, the risk of hypertension was 1.78 (95% CI: 1.12-2.81) among Tibeto-Burmans compared to the Indo-Aryans. The majority of Newars are descendants from the Tibeto-Burman ethnic groups while Brahmins who are almost solely based on the Indo-Aryan origin.[25]

Previous studies from other parts of the world have shown differential associations of ethnicity with hypertension risk and also with the response to treatment and long-term outcomes.[16,17,46-50] Although exact mechanism for these differences have not been confirmed yet, newer investigations suggest possibilities of pathways that relate to genetic causes.[46,51,52] There have also been well documented ethnic differences in salt sensitivity that might lead to differential risks for hypertension.[53,54] Similarly, another epidemiological study suggested that there might be differential impact of obesity on hypertension risk in different ethnic groups.[55] It showed that the increase in the hypertension incidence associated with one-unit increase in BMI over around 8 years of follow-up was 2.5, 1.8 and 1.7 percentage points for Chinese, blacks and whites, respectively.

This study did not find significant associations of hypertension with other socio-demographic characteristics including education, income and occupation in the multivariate analysis. However, in the univariate analysis, there was an inverse relationship between years of education and hypertension prevalence. The highest income quartile had a significantly higher prevalence of hypertension compared to the lowest income quartile. It is likely that this study is not sufficiently powered to detect the association in multivariate models. The collinearity of the variables might have also influenced the detection of associations. Recent findings from a large multi-centric study in India suggest that the CVD risk profile comprising of number of CVD risk factors (including hypertension) is more prevalent among individuals in low educational, occupational and socioeconomic status.[56] The recent trend of association of low socioeconomic status (SES) with increased hypertension prevalence in developing countries is contrary to earlier findings when CVD risk factors were more common among those belonging to higher SES. In a systematic review published in 1998, lower SES was associated with higher mean blood pressure in almost all studies in developed countries. In contrast, such associations were not appreciable in developing countries.[57]

The prediction model developed in this study had good internal validaty with an AUC of 0.7394 (95% CI: 0.6916-0.7872). Prediction models developed using multivariable models with known risk factors are useful in risk stratification and help to identify segments of the population that are most likely to benefit from screening and other primary interventions.[58] In a systematic review of risk models to predict hypertension, age, sex, body mass index, diabetes, and blood pressure variables were the most common predictors. Our model was comprised of age, sex, alcohol consumption, occupation, physical exercise, fruits and vegetables consumption, education and religion. We did not include diabetes and lipid variables because of the smaller

sample size and doubtful utility of such a model. In resource-limited settings like Nepal, laboratory tests are not easily available for large scale screening. We thus utilized the easily obtainable socio-demographic and other CVD risk variables that may prove to be useful for screening programs and also for policy-decisions.

Our study has several limitations. As a cross-sectional study, it is not possible to assess temporality and thus it is difficult to infer causal relationship between assumed exposure and outcomes, especially when the exposures are factors that have developed over time (e.g., obesity). The study did not include factors that might have been related to birth-cohort effects, e.g., environmental exposures, unique dietary practices in past years, etc., thus potentially leading to 'age by cohort confounding'. Inadequate sample size to estimate the association of socio-demographic factors as well as diabetes and lipid related parameters with hypertension in multivariate model is another major limitation. This study was not able to include salt intake in analysis, thus leading to inability to control for the differences that might have been attributable to salt consumption. The prediction was limited by the fact that there was no external validation and the outcome measurement was based on prevalence rather than incidence. Since, the study was done in one suburban setting, it is also difficult to generalize the findings to the whole of Nepal.

However, the study provides new insights into the prevalence of hypertension and its risk factors in the context of Nepal. The random sampling technique, standardized measurements and extensive information on possible confounders are the major strengths of this study. It is one of the first studies to explore hypertension and its associated factors in such depth within a population, thus having high internal validity. This study further confirms that hypertension is

undoubtedly a major CVD risk factor in the community and also impacts younger age groups in suburban Nepal. If the alarming prevalence remains unabated, it will lead to catastrophic health outcomes as well as serious social and economic consequences in the future. To our knowledge, this is the first study to provide strong evidence on the ethnic differences of hypertension in a Nepalese community. This has important implications in terms of future research as well as development of culturally tailored prevention and management programs. This is also the first reported hypertension prevalence model created from a Nepalese population. We expect that this will serve as a basis for future advanced prediction modeling to facilitate evidence-based policy and program development and implementation. Since the study participants will be followed over time, this study will serve as a baseline comparison for future findings that will continue to shed further light in relation to hypertension and other CVD risk factors in this population.

REFERENCES FOR CHAPTER 3

1. Wang H, Dwyer-Lindgren L, Lofgren KT, et al. Age-specific and sex-specific mortality in 187 countries, 1970-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**(9859): 2071-94.
2. http ://www.who.int/healthinfo/global_burden_disease/cod_2008_sources_methods.pdf. 2008 (accessed Oct 26 2014.
3. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**(9859): 2224-60.
4. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R, Collaboration PS. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet* 2002; **360**(9349): 1903-13.
5. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension* 2003; **42**(6): 1206-52.
6. Psaty BM, Lumley T, Furberg CD, et al. Health outcomes associated with various antihypertensive therapies used as first-line agents: a network meta-analysis. *JAMA* 2003; **289**(19): 2534-44.
7. Pereira M, Lunet N, Azevedo A, Barros H. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens* 2009; **27**(5): 963-75.
8. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, phase II. The Trials of Hypertension Prevention Collaborative Research Group. *Arch Intern Med* 1997; **157**(6): 657-67.
9. He J, Whelton PK, Appel LJ, Charleston J, Klag MJ. Long-term effects of weight loss and dietary sodium reduction on incidence of hypertension. *Hypertension* 2000; **35**(2): 544-9.
10. Vollmer WM, Sacks FM, Ard J, et al. Effects of diet and sodium intake on blood pressure: subgroup analysis of the DASH-sodium trial. *Ann Intern Med* 2001; **135**(12): 1019-28.

11. Chobanian AV, Hill M. National Heart, Lung, and Blood Institute Workshop on Sodium and Blood Pressure : a critical review of current scientific evidence. *Hypertension* 2000; **35**(4): 858-63.
12. Kelley GA, Kelley KS. Progressive resistance exercise and resting blood pressure : A meta-analysis of randomized controlled trials. *Hypertension* 2000; **35**(3): 838-43.
13. Whelton SP, Chin A, Xin X, He J. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. *Ann Intern Med* 2002; **136**(7): 493-503.
14. Xin X, He J, Frontini MG, Ogden LG, Motsamai OI, Whelton PK. Effects of alcohol reduction on blood pressure: a meta-analysis of randomized controlled trials. *Hypertension* 2001; **38**(5): 1112-7.
15. Appel LJ, Champagne CM, Harsha DW, et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *JAMA* 2003; **289**(16): 2083-93.
16. Zhao B, Jose PO, Pu J, et al. Racial/Ethnic differences in hypertension prevalence, treatment, and control for outpatients in northern california 2010-2012. *Am J Hypertens* 2015; **28**(5): 631-9.
17. Lane D, Beevers DG, Lip GY. Ethnic differences in blood pressure and the prevalence of hypertension in England. *J Hum Hypertens* 2002; **16**(4): 267-73.
18. Sarvotham SG, Berry JN. Prevalence of coronary heart disease in an urban population in northern India. *Circulation* 1968; **37**(6): 939-53.
19. Chadha SL, Radhakrishnan S, Ramachandran K, Kaul U, Gopinath N. Epidemiological study of coronary heart disease in urban population of Delhi. *Indian J Med Res* 1990; **92**: 424-30.
20. Gupta R, Gupta VP, Ahluwalia NS. Educational status, coronary heart disease, and coronary risk factor prevalence in a rural population of India. *Bmj* 1994; **309**(6965): 1332-6.
21. Reddy KS, Prabhakaran D, Jeemon P, et al. Educational status and cardiovascular risk profile in Indians. *Proc Natl Acad Sci U S A* 2007; **104**(41): 16263-8.
22. Gupta R, Kaul V, Agrawal A, Guptha S, Gupta VP. Cardiovascular risk according to educational status in India. *Prev Med* 2010; **51**(5): 408-11.
23. Sharma SK, Ghimire A, Radhakrishnan J, et al. Prevalence of hypertension, obesity, diabetes, and metabolic syndrome in Nepal. *Int J Hypertens* 2011; **2011**: 821971.

24. Vaidya A, Pathak RP, Pandey MR. Prevalence of hypertension in Nepalese community triples in 25 years: a repeat cross-sectional study in rural Kathmandu. *Indian Heart J* 2012; **64**(2): 128-31.
25. Vaidya A. Is ethnicity an important determinant of high blood pressure in Nepalese population? A community-based cross sectional study in Duwakot, Nepal. *Kathmandu Univ Med J (KUMJ)* 2012; **10**(37): 20-3.
26. Nepal Demographic and Health Survey 2011. Kathmandu, Nepal: Ministry of Health and Population, New ERA, and ICF International, Calverton, Maryland. , 2012.
27. Consultation WE. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; **363**(9403): 157-63.
28. WHO STEPS Surveillance Manual: The WHO STEPwise Approach to Chronic Disease Risk Factor Surveillance. Geneva, Switzerland: World Health Organization, 2005.
29. Global Physical Activity Questionnaire (GPAQ). Analysis guide. Geneva, Switzerland: World Health Organization.
30. Global Recommendations on Physical Activity for Health. Geneva, Switzerland: World Health Organization, 2010.
31. Joint FAO/WHO Workshop on Fruit and Vegetables for Health: Report of a Joint FAO/WHO Workshop,. Kobe, Japan: FAO and WHO, 2004.
32. Association AD. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2010; **33 Suppl 1**: S62-9.
33. Expert Panel on Detection Ea, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA* 2001; **285**(19): 2486-97.
34. Millán J, Pintó X, Muñoz A, et al. Lipoprotein ratios: Physiological significance and clinical usefulness in cardiovascular prevention. *Vasc Health Risk Manag* 2009; **5**: 757-65.
35. Genest J, Frohlich J, Fodor G, McPherson R, Dyslipidemias WGoHaO. Recommendations for the management of dyslipidemia and the prevention of cardiovascular disease: summary of the 2003 update. *CMAJ* 2003; **169**(9): 921-4.

36. Holme I, Aastveit AH, Jungner I, Walldius G. Relationships between lipoprotein components and risk of myocardial infarction: age, gender and short versus longer follow-up periods in the Apolipoprotein MOrtality RISk study (AMORIS). *J Intern Med* 2008; **264**(1): 30-8.
37. Demidenko E. Sample size determination for logistic regression revisited. *Statistics in Medicine* 2007; **26**: 3385-97.
38. Demidenko E. Sample size and optimal design for logistic regression with binary interaction. *Statistics in Medicine* 2008; **27**: 36-46.
39. Aryal K, Neupane S, Mehata S, et al. Non Communicable Diseases Risk Factors: STEPS Survey Nepal 2013. Kathmandu: Nepal Health Research Council, 2014.
40. Ramadan J, Barac-Nieto M. Reported frequency of physical activity, fitness, and fatness in Kuwait. *Am J Hum Biol* 2003; **15**(4): 514-21.
41. Ekezie J, Anyanwu EG, Danborno B, Anthony U. Impact of urbanization on obesity, anthropometric profile and blood pressure in the Igbos of Nigeria. *N Am J Med Sci* 2011; **3**(5): 242-6.
42. Smith C. Prevalence of obesity and contributing factors among Sherpa women in urban and rural Nepal. *Am J Hum Biol* 1998; **10**: 519-28.
43. Eckert S, Kohler S. Urbanization and health in developing countries: a systematic review. *World Health Popul* 2014; **15**(1): 7-20.
44. Ong KL, Tso AW, Lam KS, Cheung BM. Gender difference in blood pressure control and cardiovascular risk factors in Americans with diagnosed hypertension. *Hypertension* 2008; **51**(4): 1142-8.
45. Nguyen NT, Magno CP, Lane KT, Hinojosa MW, Lane JS. Association of hypertension, diabetes, dyslipidemia, and metabolic syndrome with obesity: findings from the National Health and Nutrition Examination Survey, 1999 to 2004. *J Am Coll Surg* 2008; **207**(6): 928-34.
46. Kato N, Takeuchi F, Tabara Y, et al. Meta-analysis of genome-wide association studies identifies common variants associated with blood pressure variation in east Asians. *Nat Genet* 2011; **43**(6): 531-8.
47. Wang X, Poole JC, Treiber FA, Harshfield GA, Hanevold CD, Snieder H. Ethnic and gender differences in ambulatory blood pressure trajectories: results from a 15-year longitudinal study in youth and young adults. *Circulation* 2006; **114**(25): 2780-7.

48. Johnson JA. Ethnic differences in cardiovascular drug response: potential contribution of pharmacogenetics. *Circulation* 2008; **118**(13): 1383-93.
49. Kramer H, Han C, Post W, et al. Racial/ethnic differences in hypertension and hypertension treatment and control in the multi-ethnic study of atherosclerosis (MESA). *Am J Hypertens* 2004; **17**(10): 963-70.
50. Kato N. Ethnic differences in genetic predisposition to hypertension. *Hypertens Res* 2012; **35**(6): 574-81.
51. Newton-Cheh C, Johnson T, Gateva V, et al. Genome-wide association study identifies eight loci associated with blood pressure. *Nat Genet* 2009; **41**(6): 666-76.
52. Levy D, Ehret GB, Rice K, et al. Genome-wide association study of blood pressure and hypertension. *Nat Genet* 2009; **41**(6): 677-87.
53. Sullivan JM. Salt sensitivity. Definition, conception, methodology, and long-term issues. *Hypertension* 1991; **17**(1 Suppl): I61-8.
54. Luft FC, Weinberger MH. Heterogeneous responses to changes in dietary salt intake: the salt-sensitivity paradigm. *Am J Clin Nutr* 1997; **65**(2 Suppl): 612s-7s.
55. Stevens J, Truesdale KP, Katz EG, Cai J. Impact of body mass index on incident hypertension and diabetes in Chinese Asians, American Whites, and American Blacks: the People's Republic of China Study and the Atherosclerosis Risk in Communities Study. *Am J Epidemiol* 2008; **167**(11): 1365-74.
56. Gupta R, Deedwania PC, Sharma K, et al. Association of educational, occupational and socioeconomic status with cardiovascular risk factors in Asian Indians: a cross-sectional study. *PLoS One* 2012; **7**(8): e44098.
57. Colhoun HM, Hemingway H, Poulter NR. Socio-economic status and blood pressure: an overview analysis. *J Hum Hypertens* 1998; **12**(2): 91-110.
58. Echouffo-Tcheugui JB, Batty GD, Kivimaki M, Kengne AP. Risk models to predict hypertension: a systematic review. *PLoS One* 2013; **8**(7): e67370.

CHAPTER 4

KNOWLEDGE, AWARENESS, TREATMENT AND CONTROL OF HYPERTENSION IN NEPAL: FINDINGS FROM THE DHULIKHEL HEART STUDY

ABSTRACT

Background: Although almost a third of the adult population is estimated to be hypertensive in Nepal, information on the level of knowledge, awareness, treatment and control of hypertension, and their associated factors is still lacking.

Objectives: We assessed hypertension knowledge among participants of the Dhulikhel Heart Study (DHS); and assessed the awareness of hypertension, its treatment and blood pressure control among the hypertensive participants. We also explored the factors associated with knowledge, awareness, treatment and control of hypertension.

Methods: In this cross-sectional study, we enrolled all adults 18 years and older from a random selection of one third of the households in the town of Dhulikhel in central Nepal. We asked an open-ended question, *'Please tell me what you think are the reasons we develop high blood pressure.*' and recorded all the responses from the participants. The participants who mentioned at least one of the following risk factor for hypertension were categorized as having knowledge of hypertension: family (heredity), high salt intake, smoking, excess alcohol consumption, high fat diet, obesity, lack of exercise, stress, and unknown reasons.

All participants who were diagnosed as hypertensive (SBP ≥ 140 mm Hg, or DBP ≥ 90 mm Hg, or receiving antihypertensive medication) were further evaluated for awareness, treatment, and control of hypertension. A participant was considered to be aware of his/her hypertension status if he/she reported that a doctor or other health worker had told him/her that he/she had hypertension or high blood pressure. Participants who were aware of their hypertension status were further asked if they were on medications for lowering blood pressure. Any participant who self-reported taking medicines for lowering blood pressure was considered as 'treated'. Participants who were on antihypertensive treatment were further categorized into those who had their blood pressure controlled (SBP<140mm Hg and DBP<90mm Hg) and those who did not. We investigated the association of socio-demographic characteristics (age, sex, marital status, occupation, ethnicity, income quartiles, education, and religion) and other CVD risk factors (BMI categories, smoking status, physical activity, fruits and vegetables consumption, alcohol consumption) with hypertension knowledge awareness, treatment and control status.

A multivariate regression model utilizing generalized estimating equation (GEE) was done to quantify the independent association of the socio-demographic characteristics and the CVD risk factors with hypertension knowledge and awareness. For assessing differences of socioeconomic status (SES) and CVD risk factors with treatment and control of hypertension, we performed chi-squared tests.

Results: We enrolled 1073 participants, among which, 41.6% were males and 58.4% were females. The mean age of the participants was 40.3 years (SD: 16.3). A total of 43.1% of the participants were not able to mention at least one risk factor of hypertension. In the multivariate model, males were found to be almost twice as likely to have knowledge of hypertension

compared to females (OR: 2.04; 95% CI: 1.22-3.40, p=0.006). Among different ethnic groups, Newars were most likely to have knowledge of hypertension (OR: 2.13; 95% CI: 1.26-3.57, p<0.001 when compared with Brahmins). Those with less than high school education and high school graduates were 2.89 times (95% CI: 1.85-4.50, <0.001) and 9.37 times (95% CI: 4.40-19.95, p<0.001) more likely to report at least one risk factor of hypertension, respectively, compared to those with no formal education.

A total of 43.6% (n=130) of the hypertensive participants were aware that they had high blood pressure. A lower proportion of males were aware of their status compared to females (38.9 % versus 49.6%) (p=0.065). In multivariate models, Newar ethnicity was associated with hypertension awareness. A total of 76.1% of those who were aware of their hypertension status were currently on treatment. There were significant differences in treatment status by sex, occupation, age, income quartiles, BMI categories and fruits and vegetables consumption levels. Only 35.3% of those on treatment had their blood pressure under control. There were significant differences in blood pressure control status only in relation to BMI categories and smoking status.

Conclusion: The levels of knowledge, awareness, treatment and control of hypertension in this sample of Nepalese adults were very low. The knowledge of hypertension differs by gender, ethnicity and educational status. We did not find significant associations of hypertension awareness with socio-demographic or other CVD risk factors.

INTRODUCTION

Hypertension is the most important risk factor for cardiovascular disease (CVD) increasing the risk of stroke, coronary artery disease, heart failure, and atrial fibrillation, among others.[1] As a disease, hypertension deserves special attention due to the magnitude of its impact and the presence of proven drug therapies that can yield positive results over a short period of time. It was a leading risk factor for global disease burden in 2010, accounting for 7.0% of global disability adjusted life years (DALYs)[2]; and ranks among the most important risk factors for CVD, contributing to 45% of global CVD morbidity and mortality. Unfortunately, hypertension remains an undetected condition and, among the detected, a poorly managed risk factor. In a multi-country study, only 46.5% of participants with hypertension were aware of their condition and only 32.5% of those on treatment had blood pressure controlled.[3] The situation was worse in low-income countries, with only 43.6% aware (versus 49.0% in high-income countries) and only 77.7% on treatment (versus 95.2 in high-income countries). Even within countries, the awareness, treatment and control were lower in the rural communities compared to the urban, mainly in the low-income countries.[3]

A community-based study in Eastern Nepal reported that 22.7% of the population were hypertensive and 42% of them were unaware of their condition. In addition, 41.6% of the previously diagnosed hypertensives did not have their blood pressure controlled.[4] The latest nation-wide WHO STEPwise survey reported that almost 90% of those with measured hypertension were not on medications.[5] These findings correspond with other studies in the world that have consistently found that despite the ease in diagnosis and treatment, the awareness, treatment and control of hypertension remains low.[6]

Despite the gap in hypertension management, there are limited data available on the factors associated with the awareness, treatment and control of hypertension. Previous studies have highlighted the social determinants of hypertension awareness and control. In a large study from Vietnam; the odds for hypertension awareness were higher among people at least 45 years old; who had family histories of hypertension; lived in urban areas; and who were underweight, overweight or obese.[5] Among hypertensives who were aware of their status, the odds for hypertension treatment were higher among people who had low educational levels, family histories of hypertension or had lived in urban areas.[7] A study of NHANES participants reported that lack of awareness of hypertension and inadequate treatment disproportionately affect older people; uninsured or minorities.[8] The World Health Organization Study on Global Aging and Adult Health (SAGE) found that insurance and income were the major social determinants of hypertension treatment. The highest income quintile had less than one third the odds of being untreated than the lowest income quintile.[9] In a cross-sectional study of 202 patients in in Karachi, Pakistan, a much lower awareness regarding hypertension and its prevention and treatment were observed among patients of lower socioeconomic status (SES).[10] However, in the Chicago Community Adult Health Study, ,there were socioeconomic disparities in hypertension prevalence and awareness; but not in treatment or control of diagnosed hypertension.[11]

There is still a dearth of information from Nepal on this topic. Some preliminary studies suggest that the relationship of SES and hypertension related behaviors might not be very straightforward. People of higher socioeconomic status have better health behaviors like consumption of more fruits, less tobacco and alcohol, compared to those of lower SES. However, the prevalence of physical activity is lower among the higher SES group.[12,13] Awareness, treatment and control, together relate to a complex interplay of parameters related to individual

knowledge, community support and health systems. A sound contextual understanding of these associated factors are needed to develop targeted strategies for addressing the prevention and management of hypertension

This study utilized the baseline data of the Dhulikhel Heart Study, a population-based longitudinal study focused on CVD risk factors in a suburban town in central Nepal, to assess the knowledge on hypertension. Furthermore, we determined the level of awareness, treatment and control of hypertension among the hypertensive participants. We also explored the factors associated with the knowledge, awareness, treatment and control of hypertension.

METHODS

Dhulikhel Heart Study: The Dhulikhel Heart Study was launched in November 2013 to gain an in-depth understanding of the epidemiology of CVD and associated risk factors among all adult residents (18 years and older), n~4500, in the town of Dhulikhel in central Nepal. The current study is based on the data collected during the first wave of the DHS baseline survey which included participants from one third of the randomly selected households (n=1073).

Study Participants: All the households of the town were enumerated (n=2225) and assigned a unique household number prior to the initiation of the study. One third of the households in each of the nine wards (administrative division) in Dhulikhel were then selected randomly using STATA 12.0 for the first wave of the baseline exam. All the eligible residents 18 years and older living in Dhulikhel at least six months in the selected households were invited to participate in the study. Individuals in institutionalized settings (living in hostels, motels), individuals unable

to communicate due to physical or mental problems, pregnant women and those who refused to participate were not included in the study.

Data Collection: Data collection was done at the household-level by trained study staff. All eligible members of the sample households were provided information on the study objectives, risks and benefits; and were enrolled after receiving their informed consent. The study staff administered two questionnaires via an electronic tablet-based questionnaire using the open-ware Open Data Kit (ODK) (https://opendatakit.org). The household questionnaire (Appendix 1) was administered to obtain information on household characteristics. The personal questionnaire (Appendix 2) was administered for additional information at the individual level. This included information on socio-demographic characteristics, medical history, health care financing, information on health behaviors, physical and cognitive function. The socio-demographic questions were based on the Nepal Demographic Health Survey 2011.[14] Age was calculated in years based on the date of birth of the respondents. Education was collected as years of formal schooling. Annual monetary income (Nepalese Rupees) of the household as well as of individual respondents was asked.

The interview was followed by anthropometric (height, weight, hip and waist circumference) and blood pressure measurement. Body weight was measured in a standing position with the participant wearing light clothing and no shoes in kilograms (kg) to the nearest 0.1kg by a modern digital weighing scale (Omron HBF-400, USA). After the participant stood straight without shoes on a flat floor, the height of the highest point of head (marked on the wall) was measured using a measuring tape to the nearest 1 cm. Blood pressure was measured three times in a sitting posture on the right arm over loose clothes using a standard digital BP machine

(Microlife, Switzerland). The mean of the three measurements was used as the blood pressure of the participant for interpretation purposes. All the data collected in the ODK were downloaded in a secure main server every day.

Within the next few days after the questionnaire administration, a trained laboratory technician collected fasting venous blood sample from the participants at a mobile blood collection center. Venous blood samples were drawn after 8-12 hour of overnight fasting into vacutainer tubes. Fasting blood glucose (FBG), Glycosylated hemoglobin (HbA1c), lipid profiles parameters [total cholesterol (TC), triacylglycerol (TAG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)] were analyzed at the Department of Clinical Biochemistry, Dhulikhel Hospital-Kathmandu University Hospital, Dhulikhel, Nepal. FBG, TC and TAG were estimated by enzymatic colorimetric method (Dialab GmbH, Austria) while HDL-C & LDL-C by selective direct immunoinhibition method (DiaSys Diagnostic Systems GmbH, Germany) using a Flexor Junior auto-analyzer (Vital Scientific, Netherlands). The HbA1c was estimated using Nycocard system (Axis shield Co., Norway) that has been certified by the National Glycohemoglobin Standardization Program (NGSP). All of the assays were routinely monitored by participation in external quality-control programs and using assayed chemistry & mission controls (Bio-Rad Laboratories and Diamond diagnostics, USA).

Definitions of the CVD risk factors

Obesity: Body mass index (BMI) of the participants was calculated as weight in kg/ square of height in meter. Obesity, overweight, normal and underweight were defined as a BMI of 30.0 kg/m^2 or greater, 25.0 to 25.9 kg/m^2, 18.5 to 24.9 kg/m^2 and less than 18.5 kg/m^2 respectively.[15]

Smoking: Smoking history was ascertained using the questions based on the WHO STEPS

survey questionnaire. Participants were categorized into current, former and non-smoker status.[17]

Physical Activity: Physical activity was assessed using the Global Physical Activity Questionnaire. [18] The participants were categorized into those that fulfilled the recommended level of activity (600 MET minutes per week) and those who had less than the recommended level of physical activity as per the WHO criteria.[19]

Diet: Dietary intake was focused on the consumption of fruits and vegetables as an indication of healthy eating habits. Participants were categorized into those who met the WHO recommendation of consumption of fruits and vegetables (at least five servings of fruits and vegetables per day) and those who do not meet the recommendation.[20]

Hypertension: Hypertension was defined as systolic blood pressure 140 mm Hg or greater; or diastolic blood pressure 90 mm Hg or greater; past history of diagnosis of hypertension; or receiving antihypertensive medication.[21]

Diabetes: Diabetes mellitus was defined as an HbA1C of 6.5% or greater.[22]

Hypercholesterolemia and High Total Cholesterol/HDL ratio: Blood cholesterol level was categorized into normal, high normal and high (hypercholesterolemia). Hypercholesterolemia was defined as total cholesterol of 240 mg/dL or greater, or receiving cholesterol-lowering medication.[23] We will also report proportion of participants with high total cholesterol to high density lipoprotein ratio (TC/HDL ratio), which is ≥ 4.5 (for males) and ≥ 4 (for females) given their relevance as predictors of CVD events.[24-26]

Hypertension Knowledge, Awareness, Treatment and Control

Knowledge on Hypertension: We explored the level of knowledge regarding hypertension in the DHS participants. We asked an open-ended question, *'Please tell me what you think are the reasons we develop high blood pressure.*' and recorded all the responses from the participants.

The participants who mentioned at least one of the following risk factor for hypertension were categorized as having knowledge of hypertension: family (heredity), high salt intake, smoking, excess alcohol consumption, high fat diet, obesity, lack of exercise, stress and unknown reasons. We investigated the associations of hypertension knowledge with socio-demographic characteristics (age, sex, marital status, occupation, ethnicity, income quartiles, education, religion) and other CVD risk factors (BMI categories, smoking status, physical activity, fruits and vegetables consumption, alcohol consumption, diabetes status, total cholesterol level, HDL level, total cholesterol/HDL ratio and triglycerides level).

Awareness, Treatment and Control of Hypertension: All participants of DHS phase I baseline study who were diagnosed to be hypertensive were further asked about their awareness, treatment, and control of hypertension. A participant was considered to be aware of his/her hypertension status if he/she reported that a doctor or other health worker had told him/her that he/she had hypertension or high blood pressure. Participants who were aware of their hypertension status were further asked if they were on medications for lowering blood pressure. Any participant who self-reported taking medicines for lowering blood pressure was considered as 'treated'. Participants who were on antihypertensive treatment were further categorized into those who had their blood pressure controlled (SBP<140mm Hg and DBP<90mm Hg) and those who did not.

We investigated the association of socio-demographic characteristics (age, sex, marital status, occupation, ethnicity, income quartiles, education, and religion) and other CVD risk factors (BMI categories, smoking status, physical activity, fruits and vegetables consumption, alcohol consumption) with hypertension awareness, treatment and control status.

In addition, we investigated association of hypertension awareness with diabetes status, total cholesterol level, HDL level, total cholesterol/HDL ratio and triglycerides level; and the association of hypertension control with adherence to medications (measured using Morisky's Medication Adherence Scale-8[27,28,29]).

Data Analysis and Study Power

We tested for differences in hypertension awareness by socio-demographic characteristics and CVD risk factors using chi-squared tests. The association was further measured in an unadjusted logistic regression model utilizing generalized estimating equation (GEE) to control for clustering within households. Then, we quantified the independent associations of each SES and CVD risk factor using multivariate regression with generalized estimating equation (GEE) in two different models. The first model included all SES and CVD risk factors. We added diabetes and the lipid related variables in the second model.

Based on the power calculation for logistic regression, with a sample size of 321 and study power of 80%, this study was be able to detect minimum odds ratio of about 1.9 to 2.4 for the factors associated with awareness of hypertension according to prevalence of the risk factors.[30,31]

Similar methods were used separately to determine the association of different socio-demographic and other CVD risk factors with treatment and control status. However, these were not sufficiently powered and were aimed to serve as exploratory analyses to help generate hypothesis for designing further epidemiological and implementation science related studies on effective hypertension treatment and control strategies.

The sample size assessing association of hypertension knowledge with SES and CVD risk factor was 1073, resulting in the minimum detectable odds ratio of 1.5 with 80% power and significance level of 0.05.

RESULTS

Knowledge on hypertension

Table 4-1 presents the socio-demographic characteristics of the DHS participants based on their knowledge of hypertension. A total of 43.1% of the participants were not able to mention a single risk factor of hypertension. There were significant differences in the prevalence of knowledge on hypertension (i.e., mentioning at least one risk factor for hypertension) in relation to sex, age, marital status, occupation, ethnicity, income status, education and religion of the participants. There were also significant differences in hypertension knowledge among participants by their BMI status, smoking history, fruits and vegetables consumption, alcohol consumption and hypertension status. (Table 4-2).

Table 4- 1. Socio-demographic Characteristics of the Participants of the Dhulikhel Heart Study with reference to Knowledge of Hypertension (N=1073)

	(Total=1073)		Didn't mention single risk factor of HTN		Mentioned at least one risk factor of HTN		p-values
	n	%	n	%	n	%	
Total			463	(43.1)	610	(56.8)	<0.001
Sex	446	(41.56)	142	(31.8)	304	(68.1)	
Male	627	(58.43)	321	(51.2)	306	(48.8)	
Female							
Age (Mean, SD)	40.3 (16.3)		44.9 (17.3)		36.8 (14.6)		<0.001
Age Category							<0.001
<25	265	(24.7)	79	(29.8)	186	(70.1)	
25-34	204	(19.0)	76	(37.2)	128	(62.7)	
35-44	209	(19.4)	84	(40.1)	125	(59.8)	
45-54	192	(17.8)	90	(46.8)	102	(53.1)	
55-64	110	(10.2)	71	(64.5)	39	(35.4)	
>65	93	(8.6)	63	(67.7)	30	(32.2)	
Marital Status							<0.001
Never married	225	(20.9)	56	(24.8)	169	(75.1)	
Currently Married	784	(73)	365	(46.5)	419	(53.4)	
Separated or Widowed	64	(5.9)	42	(65.6)	22	(34.3)	
Occupation							<0.001
Unemployed	489	(51.7)	279	(57.0)	210	(42.9)	
Employed	429	(18.2)	148	(34.5)	281	(65.5)	
Student	155	(30)	36	(23.2)	119	(76.7)	
Ethnicity							<0.001
Brahmin	156	(14.5)	80	(51.2)	76	(48.7)	
Chhettri/Thakuri/Sanyasi	142	(13.2)	69	(48.5)	73	(51.4)	
Newar	527	(49.1)	170	(32.2)	357	(67.7)	
Gurung/Tamang/Sherpa/Bhote	228	(21.2)	132	(57.8)	96	(42.1)	
Dalits and others	20	(1.8)	12	(60.0)	8	(40.0)	
Individual income quartiles (Monthly)[#]							<0.001
Q1 (Lowest)	311	(41)	183	(58.8)	128	(41.1)	
Q2	69	(9.1)	48	(69.5)	21	(30.4)	
Q3	203	(26.7)	82	(40.3)	121	(59.6)	
Q4	175	(23)	29	(16.5)	146	(83.4)	
Education							<0.001
No formal education	340	(31.6)	249	(73.2)	91	(26.7)	
Less than high school	478	(44.5)	172	(35.9)	306	(64.0)	
High school or more	255	(23.7)	42	(16.4)	213	(83.5)	
Religion							<0.001
Hindu	910	(84.8)	361	(39.6)	549	(60.3)	
Buddhist	142	(13.2)	93	(65.4)	49	(34.5)	
Other	21	(1.9)	9	(42.8)	12	(57.1)	

Table 4- 2. CVD Risk Factors of the Participants of the Dhulikhel Heart Study with reference to Knowledge regarding Hypertension (N=1073)

	(Total =1073)		Didn't mention single risk factor of HTN		Mentioned at least one risk factor of HTN		p-value
	n	%	n	%	n	%	
BMI							0.037
Underweight (<18.5)	64	(5.9)	35	(54.6)	29	(45.3)	
Normal (18.5-24.9)	611	(56.9)	276	(45.1)	335	(54.8)	
Overweight (25.0-29.9)	315	(29.3)	121	(38.4)	194	(61.5)	
Obese (≥30)	83	(7.7)	31	(37.3)	52	(62.6)	
Smoking							<0.001
Never Smoker	726	(67.6)	281	(38.7)	445	(61.2)	
Former Smoker	99	(9.2)	43	(43.4)	56	(56.5)	
Current Smoker	248	(23.1)	139	(56.0)	109	(43.9)	
Fruits and Vegetable Consumption							<0.001
< 5 servings of fruits and/or veg per day	537	(50.0)	200	(37.3)	336	(62.6)	
≥ 5 servings of fruits and/or veg per day	536	(49.9)	263	(48.9)	274	(51.0)	
Physical Activity							0.232
<600 MET-minutes/week	423	(39.4)	192	(45.3)	231	(54.6)	
≥ 600 MET-minutes/week	650	(60.5)	271	(41.6)	379	(58.3)	
Alcohol							0.005
None	735	(68.5)	327	(44.4)	408	(55.5)	
Low (<1 glass per week)	98	(9.1)	29	(29.5)	69	(70.4)	
Moderate (1-3 glass per week)	59	(5.5)	19	(32.2)	40	(67.8)	
High (3 or more glasses per week)	181	(16.8)	88	(48.6)	93	(51.3)	
Hypertension Status*							0.005
Normal	391	(36.4)	194	(49.6)	197	(50.3)	
Prehypertension	384	(35.7)	154	(40.1)	230	(59.9)	
Hypertension	298	(27.7)	115	(38.5)	183	(61.4)	

¶ *Chi-squared test*

* ***Hypertension:*** *SBP ≥ 140 mm Hg, or DBP ≥ 90 mm Hg, or past history of diagnosis of hypertension, or receiving antihypertensive medication.*
Prehypertension: *SBP 120-139 mm Hg, or DBP 80-89 mm Hg*

Table 4-3 shows the findings from the univariate and multivariate logistics regression to determine the association of socio-demographic and other factors associated with knowledge on hypertension. In the multivariate model, males were found to be almost twice as likely to have knowledge of hypertension compared to females (OR: 2.04; 95% CI: 1.22-3.40). Among different ethnic groups, Newars were most likely to have knowledge of hypertension, than others ethnic groups (OR: 2.13; 95% CI: 1.26-3.57, compared to Brahmins). Hypertension knowledge was strongly associated with education. Compared to those with no formal education, those with less than high school and those with more than high school were 2.89 times (95% CI: 1.85-4.50) and 9.37 times (95% CI: 4.40-19.95) more likely to cite at least one risk factor of hypertension, respectively.

			Univariate			Multivariate Model*		
	n	(%)	OR	(95% CI)	p-value	OR	(95% CI)	p-value
Sex								
Female: Reference	627	(41.5)	1			1		
Male	446	(58.4)	2.25	(1.76-2.87)	<0.001	2.04	(1.22-3.40)	0.006
Age Category								
<25: Reference	265	(24.7)	1			1		
25-34	204	(19.0)	0.71	(0.48-1.04)	0.082	1.47	(0.76-2.84)	0.250
35-44	209	(19.4)	0.63	(0.43-0.91)	0.016	2.58	(1.27-5.26)	0.009
45-54	192	(17.8)	0.46	(0.31-0.67)	<0.001	1.99	(0.93-4.25)	0.074
55-64	110	(10.2)	0.23	(0.14-0.37)	<0.001	0.93	(0.38-2.26)	0.883
>65	93	(8.6)	0.18	(0.11-0.30)	<0.001	0.87	(0.31-2.46)	0.806
Marital Status								
Never married: Reference	225	(20.9)	1			1		
Currently Married	784	(73.0)	0.40	(0.29-0.56)	<0.001	1.39	(0.69-2.76)	0.347
Separated or Widowed	64	(5.9)	0.17	(0.09-0.32)	<0.001	1.59	(0.58-4.32)	0.360
Occupation								
Unemployed: Reference	489	(51.7)	1			1		
Employed	429	(18.2)	2.57	(1.97-3.34)	<0.001	0.85	(0.53-1.36)	0.522
Student	155	(30.0)	4.51	(3.00-6.79)	<0.001			
Ethnicity								
Brahmin: Reference	156	(14.5)	1			1		
Chhettri/Thakuri/Sanyasi	142	(13.2)	1.09	(0.67-1.76)	0.723	0.94	(0.49-1.79)	0.852
Newar	527	(49.1)	2.20	(1.49-3.26)	<0.001	2.13	(1.26-3.57)	0.004
Gurung/Tamang/Sherpa/Bhote	228	(21.2)	0.76	(0.49-1.18)	0.238	1.56	(0.75-3.23)	0.227
Dalits and others	20	(1.8)	0.69	(0.25-1.89)	0.478	1.38	(0.40-4.74)	0.602
Income quartiles								
Q1(Lowest Quartile): Reference	311	(4.1)	1			1		

Q2	69	(9.1)	0.64	(0.37-1.13)	0.128	0.52	(0.25-1.08)	0.083
Q3	203	(26.7)	2.18	(1.52-3.11)	<0.001	1.44	(0.79-2.62)	0.224
Q4	175	(23.0)	6.69	(4.28-10.4)	<0.001	2.65	(1.31-5.36)	0.007

Table 4- 3. Univariate and Multivariate Logistic Regression Analyses[§] of Socio-Demographic and Other Factors Associated with Knowledge on Hypertension (N=1073

Awareness of hypertension

Table 4-4 shows the socio-demographic characteristics of the participants by hypertension awareness status (n=321). A total of 43.6% of the hypertensive participants were aware that they had high blood pressure. A lower proportion of males was aware of their status compared to females (38.9% versus 49.6%), but the difference was not statistically significant (p=0.06). The aware participants were significantly younger (p<0.001). Similarly, other socio-demographic characteristics including marital status, occupation status, ethnicity, religion and educational status were significantly different between the aware and unaware groups. However, there was no significant difference in terms of income (quartiles) and the awareness status (p=0.19).

Table 4- 4. Socio-demographic Characteristics of the Participants of the Dhulikhel Heart Study by Hypertension Awareness Status (N=321)

	(Total=298)		Unaware		Aware		p-values
	n	(%)	n	(%)	n	(%)	
Sex							0.065¶
Male	167	(43.9)	102	(61.0)	65	(38.9)	
Female	131	(56.0)	66	(50.3)	65	(49.6)	
Age (Mean, SD)	50.6(15.0)		46.7 (14.8)		55.7 (13.7)		<0.001*
Age Category							<0.001¶
<25	16	(5.3)	14	(87.1)	2	(12.5)	
25-34	29	(9.7)	24	(82.7)	5	(17.2)	
35-44	69	(23.1)	45	(65.2)	24	(34.7)	
45-54	79	(26.5)	40	(50.6)	39	(49.3)	
55-64	52	(17.4)	25	(48.0)	27	(51.9)	
>65	53	(17.7)	20	(37.7)	33	(62.2)	
Marital Status							0.001¶
Never married	30	(10.0)	23	(76.6)	7	(23.3)	
Currently Married	239	(80.2)	137	(57.3)	102	(42.6)	
Separated or Widowed	29	(9.7)	8	(27.5)	21	(72.4)	
Occupation							0.001¶
Unemployed	142	(47.6)	69	(48.5)	73	(51.4)	
Employed	143	(47.9)	86	(60.1)	57	(39.8)	
Student	13	(4.3)	13	(100.0)	0	(0.0)	
Ethnicity							0.001¶
Brahmin	20	(6.7)	7	(35.0)	13	(65.0)	
Chhettri/Thakuri/Sanyasi	30	(10.0)	23	(76.6)	7	(23.3)	
Newar	207	(69.4)	106	(51.2)	101	(48.7)	
Gurung/Tamang/Sherpa/Bhote	39	(13.0)	30	(76.9)	9	(23.0)	
Dalits and others	2	(0.6)	2	(100.0)	0	(0.0)	
Individual income quartiles (Monthly)#							0.194¶
Q1 (Lowest)	154	(51.6)	80	(51.9)	74	(48.0)	
Q2							
Q3	50	(16.7)	33	(66.0)	17	(34.0)	
Q4	94	(31.5)	55	(58.5)	39	(41.4)	
Education							0.041¶
No formal education	112	(37.5)	53	(47.3)	59	(52.6)	
Less than high school	146	(48.9)	92	(63.0)	54	(36.9)	
High school or more	40	(13.4)	23	(57.5)	17	(42.5)	
Religion							0.003¶
Hindu	266	(89.2)	141	(53.0)	125	(46.9)	
Buddhist	27	(9.0)	23	(85.1)	4	(14.8)	
Other	5	(1.6)	4	(80.0)	1	(20.0)	

* *Unpaired t-test* ¶ *Chi-squared test*

Table 4-5 (a and b) describe the hypertension awareness of the participants by other CVD risk factors. BMI, smoking history, diabetes status, total cholesterol HDL ratio and triglyceride level categories were found to be significantly different between the aware and unaware groups ($p<0.05$).

Table 4- 5a. CVD Risk Factors of the Participants of the Dhulikhel Heart Study by Hypertension Awareness (N=298)

	Total		Unaware		Aware		p-values
	n	(%)	n	(%)	n	(%)	
BMI							0.009
Underweight (<18.5)	11	(3.6)	11	(100.0)	0	(0.0)	
Normal (18.5-24.9)	115	(38.5)	68	(59.1)	47	(40.8)	
Overweight (25.0-29.9)	119	(39.9)	65	(54.6)	54	(45.3)	
Obese (≥30)	53	(17.7)	24	(45.2)	29	(54.7)	
Smoking							0.028
Never Smoker	161	(54.0)	92	(57.1)	69	(42.8)	
Former Smoker	57	(19.1)	24	(42.1)	33	(57.8)	
Current Smoker	80	(26.8)	52	(65.0)	28	(35.0)	
Fruits and Vegetable Consumption							0.652
< 5 servings of fruits and/or veg per day	140	(46.9)	77	(55.0)	63	(45.0)	
≥ 5 servings of fruits and/or veg per day	158	(53.0)	91	(57.5)	67	(42.4)	
Physical Activity							0.273
<600 MET-minutes/week	162	(54.3)	96	(59.2)	66	(40.7)	
≥ 600 MET-minutes/week	136	(45.6)	72	(52.9)	64	(47.0)	
Alcohol							0.165
None	175	(58.7)	90	(51.4)	85	(48.5)	
Low (<1 glass per week)	37	(12.4)	24	(64.8)	13	(35.1)	
Moderate (1-3 glass per week)	17	(5.7)	9	(52.9)	8	(47.0)	
High (3 or more glasses per week)	69	(23.1)	45	(65.2)	24	(34.7)	

Table 4- 5b. CVD Risk Factors of the Participants of the Dhulikhel Heart Study by Hypertension Awareness (N=138)

	Total		Unaware		Aware		p-values
	n	%	n	%	n	%	
Diabetes							0.028
Non-diabetic (HbA1C < 5.7)	23	(16.6)	18	(78.2)	5	(21.7)	
Pre-diabetic (HbA1C: 5.7-6.4)	54	(39.1)	26	(48.1)	28	(51.8)	
Diabetic (Hb1C >6.4)	61	(44.2)	29	(47.5)	32	(52.4)	
Total Cholesterol							0.924
Normal (<200mg/dl)	90	(65.2)	48	(53.3)	42	(46.6)	
High Normal (200-239mg/dl)	30	(21.7)	15	(50.0)	15	(50.0)	
High (≥ 240 mg/dl)	18	(13.0)	10	(55.5)	8	(44.4)	
HDL							0.169
Normal (≥ 35mg/dl)	101	(73.1)	57	(56.4)	44	(43.5)	
Low (<35mg/dl)	37	(26.8)	16	(43.2)	21	(56.7)	
Total Cholesterol/HDL Ratio							0.021
Normal	61	(44.2)	39	(63.9)	22	(36.0)	
High	77	(55.8)	34	(44.1)	43	(55.8)	
Triglyceride							0.004
Normal (<150 mg/dl)	93	(67.3)	53	(56.9)	40	(43.0)	
Borderline High (150-199 mg/dl)	29	(21.0)	8	(27.5)	21	(72.4)	
High (>200 mg/dl)	16	(11.5)	12	(75.0)	4	(25.0)	

Table 4-6 shows the univariate as well as the multivariate regression models investigating the association of hypertension awareness with socio-demographic and CVD risk factors (BMI, smoking status, physical activity, fruits and vegetable consumption and alcohol consumption). While there were significant positive association between hypertension awareness status with lower age, marital status, ethnicity, education in the univariate model, these associations were not significant in the multivariate model.

Table 4- 6. Univariate and Multivariate Logistic Regression Analyses§ of Socio-Demographic and Other Factors Associated with Hypertension Awareness (N=298)

			Univariate			Multivariate Model *		
	n	%	OR	95% CI	p-value	OR	95% CI	p-value
Sex								
Female: Reference	167	(43.9)	1			1		
Male	131	(56.0)	0.65	(0.41-1.03)	0.071	0.80	(0.40-1.60)	0.541
Age Category								
<25: Reference	16	(5.3)	1			1		
25-34	29	(9.7)	1.43	(0.24-8.37)	0.686	0.21	(0.01-2.79)	0.240
35-44	69	(23.1)	3.70	(0.78-17.57)	0.099	1.79	(0.14-21.9)	0.649
45-54	79	(26.5)	6.70	(1.44-31.15)	0.015	4.56	----------	0.244
55-64	52	(17.4)	7.40	(1.53-35.70)	0.013	5.81	----------	0.180
>65	53	(17.7)	11.50	(2.37-55.71)	0.002	4.03	----------	0.299
Marital Status								
Never married: Reference	30	(10.0)	1			1		
Currently Married	239	(80.2)	2.40	(0.99-5.80)	0.051	0.71	(0.23-2.14)	0.550
Separated or Widowed	29	(9.7)	8.48	(2.63-27.34)	<0.001	1.74	(0.40-7.61)	0.458
Occupation								
Unemployed: Reference	142	(47.6)	1			1		
Employed	143	(47.9)	0.63	(0.39-1.00)	0.055	0.81	(0.44-1.49)	0.512
Student	13	(4.3)						
Ethnicity								
Brahmin: Reference	20	(6.7)	1			1		
Chhettri/Thakuri/Sanyasi	30	(10.0)	0.16	(0.04-0.57)		0.18	(0.04-0.72)	0.016
Newar	207	(69.4)	0.51	(0.19-1.35)		0.41	(0.14-1.21)	0.109
Gurung/Tamang/Sherpa/Bhote	39	(13.0)	0.16	(0.04-0.53)		0.18	(0.04-0.67)	0.011
Dalits and others	2	(0.6)						
Income quartiles								
Q1(Lowest Quartile): Reference	154	(51.6)	1			1		
Q2								
Q3	50	(16.7)	0.56	(0.29-1.09)		0.80	(0.30-2.12)	0.665
Q4	94	(31.5)	0.75	(0.45-1.27)		1.16	(0.44-3.05)	0.762

§ Multivariate logistic regression using Generalized Estimating Equation for correlation within household.

** Adjusted for the sex, age, marital status, occupation, ethnicity, income, education, BMI, smoking, physical activity*

Table 4- 6. Multivariate Logistic Regression Analysis[§] of Socio-Demographic and Other Factors Associated with Hypertension Awareness (N=298) (Contd)

			Univariate			Multivariate Model		
	n	%	OR	95% CI	p-value	OR	95% CI	p-value
Education								
No Formal Education	112	(37.5)	1			1		
Less than high school	146	(48.9)	0.52	(0.31-0.86)	0.011	0.77	(0.38-1.58)	0.488
More than high school	40	(13.4)	0.65	(0.31-1.36)	0.258	1.79	(0.62-5.20)	0.280
Religion								
Hindu: Reference	266	(89.2)	1			NA		
Buddhist	27	(9.0)	0.19	(0.06-0.58)	0.004	NA		
Others	5	(1.6)	0.28	(0.03-2.59)	0.266	NA		
BMI								
Underweight or Normal (<24.9)	126	(42.1)	1			1		
Overweight (25.0-29.9)	119	(39.9)	1.41	(0.84-2.35)	0.188	1.33	(0.72-2.45)	0.355
Obese (≥30)	53	(17.7)	2.11	(1.10-4.05)	0.024	1.49	(0.68-3.23)	0.311
Smoking								
Never Smoke	161	(54.0)	1			1		
Former Smoker	57	(19.1)	1.82	(0.99-3.37)	0.053	1.03	(0.48-2.22)	0.930
Current Smoker	80	(26.8)	0.70	(0.40-1.23)	0.224	0.77	(0.38-1.55)	0.477
Physical Activity								
≥ 600 MET-minutes/week	136	(45.6)	1			1		
<600 MET-minutes/week	162	(54.3)	1.31	(0.83-2.09)	0.237	1.05	(0.61-1.79)	0.847
Fruits and Veg Consumption								
≥ 5 servings of fruits and/or veg per day	158	(53.0)	1			1		
< 5 servings of fruits and/or veg per day	140	(46.9)	0.91	(0.58-1.45)	0.719	0.63	(0.36-1.09)	0.105
Alcohol								
None	175	(58.7)	1			1		
Low (<1 glass per week)	37	(12.4)	0.57	(0.27-1.20)	0.142	0.46	(0.20-1.07)	0.073
Moderate (1-3 glass per week)	17	(5.7)	0.90	(0.33-2.44)	0.840	1.25	(0.41-3.76)	0.690
High (≥3 glasses per week)	69	(23.1)	0.56	(0.31-1.01)	0.056	0.86	(0.39-1.90)	0.715

§ Multivariate logistic regression using Generalized Estimating Equation for correlation within household.
** Adjusted for the sex, age, marital status, occupation, ethnicity, income, education, BMI, smoking, physical activity*

Table 4- 6. Multivariate Logistic Regression Analysis[§] of Socio-Demographic and Other Factors Associated with Hypertension Awareness (N=298) (Contd)

	n	%	Univariate OR	95% CI	p-value	Multivariate Model * OR	95% CI	p-value
Diabetes								
Non-diabetic (HbA1C < 5.7)	23	(16.6)	1				NA	
Pre-diabetic (HbA1C: 5.7-6.4)	54	(39.1)	3.72	(1.23-11.28)	0.020		NA	
Diabetic (Hb1C >6.4)	61	(44.2)	3.79	(1.27-11.29)	0.016		NA	
Total Cholesterol								
Normal (<200mg/dl)	90	(65.2)	1				NA	
High Normal (200-239mg/dl)	30	(21.7)	1.13	(0.50-2.58)	0.757		NA	
High (≥ 240 mg/dl)	18	(13.0)	0.91	(0.33-2.49)	0.858		NA	
HDL								
Normal (≥ 35mg/dl)	101	(73.1)	1				NA	
Low (<35mg/dl)	37	(26.8)	1.62	(0.76-3.41)	0.204		NA	
Total Cholesterol/HDL Ratio								
Normal	61	(44.2)	1				NA	
High	77	(55.8)	1.12	(0.86-1.46)	0.393		NA	
Triglyceride								
Normal (<150 mg/dl)	93	(67.3)	1				NA	
Borderline High (150-199 mg/dl)	29	(21.0)	3.42	(1.38-8.48)	0.008		NA	
High (>200 mg/dl)	16	(11.5)	0.45	(0.13-1.49)	0.195		NA	

§ Multivariate logistic regression using Generalized Estimating Equation for correlation within household.
** Adjusted for the sex, age, marital status, occupation, ethnicity, income, education, BMI, smoking, physical activity*

Treatment of Hypertension

Table 4-7 shows the socio-demographic characteristics of the participants who were aware of their hypertension by their hypertension treatment status (n=130). A total of 76.1% of those who were aware of their hypertension status were currently on treatment. Those on treatment were significantly older compared to those not on treatment (57.3 years, SD: 1.2 versus 50.4, SD: 15.9). There were also significant differences in treatment by occupational status, ethnicity, income quartiles and religion.

Table 4-8 shows the relationship of hypertension treatment with other CVD risk factors (BMI categories, smoking history, fruits and vegetables consumption, physical activity level and alcohol consumption). There were significant differences in treatment status only in relation to BMI categories and category of fruits and vegetables consumed.

Table 4- 7. Socio-demographic Characteristics of the Participants of the Dhulikhel Heart Study by Hypertension Treatment Status (N=130)

	Total		Untreated		Treated		P-value
	n	%	n	%	n	%	
Total	130		31	(23.8)	99	(76.1)	
Sex							0.007
Male	65	(50.0)	22	(33.8)	43	(66.1)	
Female	65	(50.0)	9	(13.8)	56	(86.1)	
Age (Mean, SD)	55.7(13.7)		50.4 (15.9)		57.3 (12.6)		<0.001
Age Category							0.040
<25	2	(1.5)	1	(50.0)	1	(50.0)	
25-34	5	(3.8)	4	(80.0)	1	(20.0)	
35-44	24	(18.4)	7	(29.1)	17	(70.8)	
45-54	39	(30.0)	9	(23.0)	30	(76.9)	
55-64	27	(20.7)	4	(14.8)	23	(85.1)	
>65	33	(25.3)	6	(18.1)	27	(81.8)	
Marital Status							0.141
Never married	7	(5.3)	3	(42.8)	4	(57.1)	
Currently Married	102	(78.4)	26	(25.4)	76	(74.5)	
Separated or Widowed	21	(16.1)	2	(9.5)	19	(90.4)	
Occupation							<0.001
Unemployed	73	(56.1)	9	(12.3)	64	(87.6)	
Employed	57	(43.8)	22	(38.6)	35	(61.4)	
Student	0						
Ethnicity							0.171
Brahmin	13	(10.0)	6	(46.1)	7	(53.8)	
Chhettri/Thakuri/Sanyasi	7	(5.3)	2	(28.5)	5	(71.4)	
Newar	101	(77.6)	20	(19.8)	81	(80.2)	
Gurung/Tamang/Sherpa/Bhote	9	(6.9)	3	(33.3)	6	(66.6)	
Dalits and others	0	(0.0)					
Individual income quartiles (Monthly)[#]							0.018
Q1 (Lowest)	74	(56.9)	11	(14.8)	63	(85.1)	
Q2	0						
Q3	17	(13.0)	7	(41.1)	10	(58.8)	
Q4	39	(30.0)	13	(33.3)	26	(66.6)	
Education							0.106
No formal education	59	(45.3)	10	(16.9)	49	(83.0)	
Less than high school	54	(41.5)	14	(25.9)	40	(74.0)	
High school or more	17	(13.0)	7	(41.1)	10	(58.8)	
Religion							0.089
Hindu	125	(96.1)	28	(22.4)	97	(77.6)	
Buddhist	4	(3.0)	2	(50.0)	2	(50.0)	
Other	1	(0.7)	1	(100.0)	0	(0.0)	

[*] *Unpaired t-test* [¶] *Chi-squared test*

Table 4- 8. CVD Risk Factors of the Participants of the Dhulikhel Heart Study by Hypertension Treatment Status (N=153)

	Total		Treated		Untreated		p-value
	n	%	n	%	n	%	
BMI							0.013¶
Underweight (<18.5)							
Normal (18.5-24.9)	58	(37.9)	35	(60.3)	23	(39.6)	
Overweight (25.0-29.9)	64	(41.8)	37	(57.8)	27	(42.1)	
Obese (≥30)	31	(20.2)	27	(87.1)	4	(12.9)	
Smoking							0.248¶
Never Smoker	82	(53.5)	54	(65.8)	28	(34.1)	
Former Smoker	39	(25.4)	28	(71.7)	11	(28.2)	
Current Smoker	32	(20.9)	17	(53.1)	15	(46.8)	
Fruits and Vegetable Consumption							0.038¶
< 5 servings of fruits and/or veg per day	79	(51.6)	45	(56.9)	34	(43.0)	
≥ 5 servings of fruits and/or veg per day	74	(48.3)	54	(72.9)	20	(27.0)	
Physical Activity							0.936¶
<600 MET-minutes/week	73	(47.7)	47	(64.3)	26	(35.6)	
≥ 600 MET-minutes/week	80	(52.2)	52	(65.0)	28	(35.0)	
Alcohol							0.833¶
None	103	(67.3)	69	(66.9)	34	(33.0)	
Low (<1 glass per week)	16	(10.4)	9	(56.2)	7	(43.7)	
Moderate (1-3 glass per week)	8	(5.2)	5	(62.5)	3	(37.5)	
High (3 or more glasses per week)	26	(16.9)	16	(61.5)	10	(38.4)	

¶ *Chi-squared test*

Blood pressure control

In Table 4-9, we present socio-demographic characteristics and the adherence level of the participants who were on treatment for high blood pressure by their blood pressure control status (n=99). Only 35.3% had control of blood pressure (SBP<140mm Hg and DBP <90mmg Hg). There were no differences between those with and without controlled blood pressure with any socio-demographic characteristics and the medication adherence level, although this analysis was underpowered.

Table 4- 9. Socio-demographic Characteristics of the Participants of the Dhulikhel Heart Study by Hypertension Control Status (N=99)

	(Total)		Controlled		Not Controlled		p-values
	n	%	n	%	n	%	
Total	99		35	(35.3)	64	(64.4)	
Sex							0.610 ¶
Male	56	(56.5)	21	(37.5)	35	(62.5)	
Female	43	(43.4)	14	(32.5)	29	(67.4)	
Age (Mean, SD)		57.3 (12.6)		60.4 (13.1)		55.6 (12.1)	0.070*
Age Category							0.228 ¶
<25	1	(1.0)	1	(100.0)	0	(0.00)	
25-34	1	(1.0)	0	(0.0)	1	(100.0)	
35-44	17	(17.1)	3	(17.6)	14	(82.3)	
45-54	30	(30.3)	11	(36.6)	19	(63.3)	
55-64	23	(23.2)	7	(30.4)	16	(69.5)	
>65	27	(27.2)	13	(48.1)	14	(51.8)	
Marital Status							0.781 ¶
Never married	4	(4.0)	2	(50.0)	2	(50.0)	
Currently Married	76	(76.7)	27	(35.5)	49	(64.4)	
Separated or Widowed	19	(19.1)	6	(31.5)	13	(68.4)	
Occupation							0.054 ¶
Unemployed	64	(64.6)	27	(42.1)	37	(57.8)	
Employed	35	(35.3)	8	(22.8)	27	(77.1)	
Student							
Ethnicity							0.767 ¶
Brahmin	7	(7.0)	3	(42.8)	4	(57.1)	
Chhettri/Thakuri/Sanyasi	5	(5.0)	2	(40.0)	3	(60.0)	
Newar	81	(81.8)	29	(35.8)	52	(64.2)	
Gurung/Tamang/Sherpa/Bhote	6	(6.0)	1	(16.6)	5	(83.3)	
Dalits and others							
Individual income quartiles (Monthly)#							0.168 ¶
Q1 (Lowest)	40	(52.6)	18	(45.0)	22	(55.0)	
Q2	2	(2.6)	1	(50.0)	1	(50.0)	
Q3	11	(14.4)	4	(36.3)	7	(63.6)	
Q4	23	(30.2)	4	(17.3)	19	(82.6)	
Education							0.531 ¶
No formal education	49	(49.4)	20	(40.8)	29	(59.1)	
Less than high school	40	(40.4)	12	(30.0)	28	(70.0)	
High school or more	10	(10.1)	3	(30.0)	7	(70.0)	
Religion							0.291 ¶
Hindu	97	(97.9)	35	(36.0)	62	(63.9)	
Buddhist	2	(2.0)	0	(0.0)	2	(100.0)	
Other							
Adherence to Medications							0.200
Low	33	(33.3)	9	(27.2)	24	(72.7)	
Medium	32	(32.3)	10	(31.2)	22	(68.7)	
High	34	(34.3)	16	(47.0)	18	(52.9)	

Unpaired t-test ¶ *Chi-squared test*

Table 4-10 shows the relationship of blood pressure control with other CVD risk factors (BMI categories, smoking history, fruits and vegetables consumption, physical activity level

and alcohol consumption). There were significant differences in control status only in relation to BMI categories and smoking status.

Table 4- 10. CVD Risk Factors of the Participants of the Dhulikhel Heart Study by Hypertension Control Status (N=99)

	Total (N=99)		Controlled		Not Controlled		p-values
	n	%	n	%	n	%	
BMI							0.029
Underweight (<18.5)	0	(0%)					
Normal (18.5-24.9)	35	(35.3)	18	(51.4)	17	(48.5)	
Overweight (25.0-29.9)	37	(37.3)	8	(21.6)	29	(78.3)	
Obese (≥30)	27	(27.2)	9	(33.3)	18	(66.6)	
Smoking							0.045
Never Smoker	54	(54.5)	24	(44.4)	30	(55.5)	
Former Smoker	28	(28.2)	9	(32.1)	19	(67.8)	
Current Smoker	17	(17.1)	2	(11.7)	15	(88.2)	
Fruits and Vegetable Consumption							0.420
< 5 servings of fruits and/or veg per day	45	(45.4)	14	(31.1)	31	(68.8)	
≥ 5 servings of fruits and/or veg per day	54	(54.5)	21	(38.8)	33	(61.1)	
Physical Activity							0.065
<600 MET-minutes/week	47	(47.4)	21	(44.6)	26	(55.3)	
≥ 600 MET-minutes/week	52	(52.5)	14	(26.9)	38	(73.0)	
Alcohol							0.177
None	69	(69.7)	29	(42.0)	40	(57.9)	
Low (<1 glass per week)	9	(9.0)	1	(11.1)	8	(88.8)	
Moderate (1-3 glass per week)	5	(5.0)	1	(20.0)	4	(80.0)	
High (3 or more glasses per week)	16	(16.1)	4	(25.0)	12	(75.0)	

¶ *Chi-squared test*

DISCUSSION

This is one of the first studies from Nepal to explore knowledge, awareness, treatment and control of hypertension. In this sub-urban population, we found that the level of knowledge, awareness, treatment and control of hypertension were low; and there were considerable differences, especially in knowledge across sex and ethnicity.

Knowledge on hypertension

This study adds an important perspective on the health literacy of the participants in relation to hypertension in Nepal. The finding that 43.1% of the participants were completely ignorant about risk factors of hypertension is very dismal. This is even more disturbing because the study site is a suburban town very near to the capital city of Nepal. It is thus fair to assume that the knowledge level would be even worse in rural areas, where the access to information is poorer and the educational achievement lower. Strong negative association of the knowledge of hypertension with male sex, Brahmin ethnicity and lower education level are concerning, although not unexpected in this setting. Low levels of female literacy, virtually non-existent community awareness programs on hypertension, and lack of regular screening programs are probably the major drivers behind the findings of our study.

Our findings are comparable to the result of another study from Nepal, which investigated the cardiovascular health knowledge, attitude and practice/behavior in an urban community of Nepal. They found that the participants had poor knowledge of heart diseases causes, with only 29.7% identifying hypertension as a risk factor.[12] Lack of knowledge about hypertension negatively influences patients' awareness and behaviors, and is a major obstacle in controlling the disease. In an underserved community in the US, Pandit et al (2009). reported that those with fewer years of schooling had less knowledge of the disease and its treatment; and were at greater risk for uncontrolled blood pressure.[32] Our finding of low levels of hypertension knowledge reinforces the urgent need to raise public awareness of hypertension at the national level.

Awareness of hypertension

The finding that more than half of the hypertensives were unaware of their hypertension status is consistent with findings from Nepal as well as from other developing countries.[3,4]

Higher level of awareness in older Nepalese also concur with other studies.[7,33,34] In cross-sectional studies, it is likely that the older age groups might have come into contact with health systems more often, leading to greater probability of being aware of their hypertension status. The findings related to higher awareness in females is also similar to most other studies.[34,35] In a systematic review of hypertension awareness, treatment and control in Africa, most studies revealed better awareness among women.[35] It is generally believed that the increased contact of women with the health system due to maternal and child health related issues leads to their greater awareness about their own health conditions as well.[34,36] Our findings also suggest that there might be distinct ethnic differences in awareness. The Brahmins and Newars, which generally represent more well-off ethnic groups in the community seem to have higher levels of awareness compared to others. Further in-depth studies exploring ethnic attributes that impact awareness to health conditions and health behaviors are required to understand this result. The lack of an association of education with hypertension in our study is in contrast to previous studies. Results from high-income as well as low and middle income countries have shown that higher education has a direct relationship with hypertension awareness.[34,37-40] We also didn't find a relationship with income status. In a population where most of the elderly are less educated or uneducated, it is likely that age confounds the relationship between education and awareness. Similarly, the association of income might be confounded by gender because the majority of the females belonged to the low income category in our study. The association seen with BMI, smoking history, and other CVD risk factors (diabetes, high total cholesterol HDL ratio and triglyceride levels) in univariate analysis might suggest the clustering of the co-morbid conditions with poor awareness level. However, these findings need to be interpreted with caution given the small sample size and lack of study power to elucidate conclusive findings.

Treatment and control of hypertension

The descriptive information on the treatment and control of hypertension in our study provides a unique perspective to the problem of hypertension in this population. The proportion of known hypertensives on treatment (64.6%) in this study is lower compared to the findings in a multi-country study (including high, middle and low income countries), which showed that about 77.7% of those aware of their hypertension status in low-income countries were on treatment.[3] The average rate was about 75% in another systematic review that included multiple low-income countries.[6] It is not clear why the rates are lower in our study population. One of the reasons might be the stigma against taking medications. Culturally, Nepalese are encouraged to avoid initiating taking medications unless they are symptomatic. Moreover, allopathic medications are viewed skeptically, especially when required to take for a long time. Further studies that investigate cultural dimensions of therapeutic aspects of hypertension will help establish the accurate relationship of culture and treatment pattern.

We learned that only about a third (35.3%) of those who were on treatment had their blood pressure controlled. This is consistent with most of the findings from other studies. The study from Vietnam showed a blood pressure control rate of 36.3%.[7] In the systematic review of studies from developed and developing countries, the control rate among participants on hypertension treatment was found to be about 32%. [6] However, our control rate is slightly lower than that of the findings from a multi-country study that showed an average control rate of 40.1% among the treated hypertensive patients from low-income countries.

When we take into account the fact that only about a third of all hypertensives get treated, these blood pressure control rates are unacceptably low. It is concerning that despite the availability of low-cost drugs for hypertension management, the treatment and overall control

rates are far from satisfactory. Treatment efforts are often hindered by patients' low perceived risks of hypertension, low health literacy, lack of motivation, and medication costs in low resource settings.[41,42] Despite the burden of CVD, and proven life-style modification and medication strategies for treating hypertension, Nepal does not have a clear national plan and strategy for hypertension prevention and management.[43,44,45,46,47] Few trained Nepalese health care providers are aware of international treatment guidelines, with a majority of the providers being unaware of standard approaches to hypertension management.[48] Although medication cost might not be a major issue in Nepal due to availability of low-cost generic drugs, lack of clear guidelines regarding medication use and low medication adherence pose significant barriers to the proper management of hypertension in Nepal.[41] Significant associations of high BMI and smoking status with hypertension control, as observed in this study also suggests that the approach to management of hypertension necessitates other behavioral interventions as well. These issues also emphasize the need of developing and implementing more comprehensive and culturally tailored approach that addresses the challenges of chronic disease management. As described in the concept of the Chronic Care Model[49], one of the most popular frameworks to address chronic diseases, management of chronic diseases entails a collaborative approach of following six core areas: Health systems (organization of care), clinical information systems, delivery system design, decision support, self-management support and community resources. [49-53]

We explored adherence to antihypertensive medications because poor adherence to antihypertensive therapy is estimated to contribute to the lack of blood pressure control in more than two-thirds of people living with hypertension.[21] It is known that adherence (to antihypertensives), hailed as the 'new frontier of quality improvement', is sub-optimal in resource-limited settings but the paucity of properly designed scientific studies have led to lack of clarity in factors associated with adherence. Although this study had a small sample

size and was underpowered for detecting associations between adherence levels and hypertension control, the findings suggest that adherence might be a major issue in this population as only about a third of the participants taking medications were highly adherent. Poor adherence to therapy is estimated to contribute to lack of blood pressure control in more than two-thirds of people living with hypertension.[54] Globally, approximately two-thirds of stroke, one-half of IHD, and approximately three-quarters of hypertensive disease were attributable to non-optimal blood pressure in the year 2000 and approximately two thirds of the burden of disease occurred in the developing world.[55]

Strengths and Limitations

To our knowledge, this is the first study from Nepal to explore the whole spectrum of knowledge, awareness, treatment and control of hypertension in such depth. The random sampling technique, standardized measurements, and extensive information on possible confounders are the major strengths of this study. This is also probably the first study from Nepal that has explored adherence to antihypertensives in a population-based sample.

Our study has several limitations. First, this study is not representative of Nepal and generalizability is limited. So, we will not be able to distinguish the finer variations that might be present between the study population and other Nepalese, mainly belonging to other ethnic groups, geographic and development regions that are not represented in the study. Dhulikhel is a small town having a large tertiary level health service provider, Dhulikhel Hospital. Almost one third of the staff of Dhulikhel Hospital are inhabitants of Dhulikhel. This might make the study indicators overly positive compared to the Nepalese population of similar socio-demographic level in other settings.

Although blood pressure measurement in a single setting tend to overestimate the prevalence, we believe that this is not a problem in this study because the blood pressure was measured at

home\, and not in a clinical setting by a health provider. Given the practical challenges, it is common to rely on the blood pressure measurement on only one day in large epidemiological studies.

While assessing knowledge on hypertension, we did not used a standardized questionnaire. Additionally, the study did not include qualitative data collection techniques to get an in-depth understanding of hypertension knowledge. As in any cross-sectional study, we were not able to establish the temporality and causality in relation to the determinants of hypertension awareness, treatment and control. Due to the small sample size, we were not sufficiently powered to detect any associations of magnitude below an odds ratio of 1.9. The study also did not have adequate power to draw definitive conclusions on significant determinants of hypertension treatment and blood pressure control.

Conclusion

Despite limitations, this study provides a comprehensive understanding of awareness, treatment and control of hypertension in this suburban Nepalese population; and gives valuable insight into the knowledge of hypertension in this community. We found that the general awareness, treatment and control of hypertension was poor and the knowledge on hypertension was very low. These results provide a glimpse of the dismal picture of hypertension prevention and management in Nepal, which might be true for many other low-income settings as well. Our ability to follow up these study participants for further data collection will help determine additional poorly understood relationships of various correlates of hypertension in this Nepalese community.

REFERENCES FOR CHAPTER 4

1. Rapsomaniki E, Timmis A, George J, et al. Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1·25 million people. *Lancet* 2014; **383**(9932): 1899-911.
2. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; **380**(9859): 2224-60.
3. Chow CK, Teo KK, Rangarajan S, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. *JAMA* 2013; **310**(9): 959-68.
4. Vaidya A, Pokharel PK, Karki P, Nagesh S. Exploring the iceberg of hypertension: a community based study in an eastern Nepal town. *Kathmandu Univ Med J (KUMJ)* 2007; **5**(3): 349-59.
5. Aryal K, Neupane S, Mehata S, et al. Non Communicable Diseases Risk Factors: STEPS Survey Nepal 2013. Kathmandu: Nepal Health Research Council, 2014.
6. Pereira M, Lunet N, Azevedo A, Barros H. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens* 2009; **27**(5): 963-75.
7. Son PT, Quang NN, Viet NL, et al. Prevalence, awareness, treatment and control of hypertension in Vietnam-results from a national survey. *J Hum Hypertens* 2012; **26**(4): 268-80.
8. Hyman DJ, Pavlik VN. Characteristics of patients with uncontrolled hypertension in the United States. *N Engl J Med* 2001; **345**(7): 479-86.
9. Basu S, Millett C. Social epidemiology of hypertension in middle-income countries: determinants of prevalence, diagnosis, treatment, and control in the WHO SAGE study. *Hypertension* 2013; **62**(1): 18-26.
10. Ashfaq T, Anjum Q, Siddiqui H, Shaikh S, Vohra EA. Awareness of hypertension among patients attending primary health care centre and outpatient department of tertiary care hospital of Karachi. *J Pak Med Assoc* 2007; **57**(8): 396-9.
11. Morenoff JD, House JS, Hansen BB, Williams DR, Kaplan GA, Hunte HE. Understanding social disparities in hypertension prevalence, awareness, treatment, and control: the role of neighborhood context. *Soc Sci Med* 2007; **65**(9): 1853-66.

12. Vaidya A, Aryal UR, Krettek A. Cardiovascular health knowledge, attitude and practice/behaviour in an urbanising community of Nepal: a population-based cross-sectional study from Jhaukhel-Duwakot Health Demographic Surveillance Site. *BMJ Open* 2013; **3**(10): e002976.
13. Vaidya A, Krettek A. Physical activity level and its sociodemographic correlates in a peri-urban Nepalese population: a cross-sectional study from the Jhaukhel-Duwakot health demographic surveillance site. *Int J Behav Nutr Phys Act* 2014; **11**(1): 39.
14. Nepal Demographic and Health Survey 2011. Kathmandu, Nepal: Ministry of Health and Population, New ERA, and ICF International, Calverton, Maryland. , 2012.
15. Consultation WE. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; **363**(9403): 157-63.
16. The Asia-Pacific Perspective: Redefining Obesity and Its Treatment. Melbourne, Australia: World Health Organization Western Pacific Region, International Association for the Study of Obesity, & International Obesity Task Force., 2000.
17. WHO STEPS Surveillance Manual: The WHO STEPwise Approach to Chronic Disease Risk Factor Surveillance. Geneva, Switzerland: World Health Organization, 2005.
18. Global Physical Activity Questionnaire (GPAQ). Analysis guide. Geneva, Switzerland: World Health Organization.
19. Global Recommendations on Physical Activity for Health. Geneva, Switzerland: World Health Organization, 2010.
20. Joint FAO/WHO Workshop on Fruit and Vegetables for Health: Report of a Joint FAO/WHO Workshop,. Kobe, Japan: FAO and WHO, 2004.
21. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension* 2003; **42**(6): 1206-52.
22. Association AD. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2010; **33 Suppl 1**: S62-9.
23. Expert Panel on Detection Ea, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA* 2001; **285**(19): 2486-97.
24. Millán J, Pintó X, Muñoz A, et al. Lipoprotein ratios: Physiological significance and clinical usefulness in cardiovascular prevention. *Vasc Health Risk Manag* 2009; **5**: 757-65.

25. Genest J, Frohlich J, Fodor G, McPherson R, Dyslipidemias WGoHaO. Recommendations for the management of dyslipidemia and the prevention of cardiovascular disease: summary of the 2003 update. *CMAJ* 2003; **169**(9): 921-4.
26. Holme I, Aastveit AH, Jungner I, Walldius G. Relationships between lipoprotein components and risk of myocardial infarction: age, gender and short versus longer follow-up periods in the Apolipoprotein MOrtality RISk study (AMORIS). *J Intern Med* 2008; **264**(1): 30-8.
27. Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. *J Clin Hypertens (Greenwich)* 2008; **10**(5): 348-54.
28. Krousel-Wood M, Islam T, Webber LS, Re RN, Morisky DE, Muntner P. New medication adherence scale versus pharmacy fill rates in seniors with hypertension. *Am J Manag Care* 2009; **15**(1): 59-66.
29. Morisky DE, DiMatteo MR. Improving the measurement of self-reported medication nonadherence: response to authors. *J Clin Epidemiol* 2011; **64**(3): 255-7; discussion 8-63.
30. Daniel W. Biostatistics: A foundation for analysis in the health sciences. 7 ed. New York: John Wiley and Sons.
31. Daniel W. Daniel WW (1999). Biostatistics: A foundation for analysis in the health sciences. 7th edition. New York. John Wiley and Sons. 7 ed. New York: John Wiley and Sons; 1999.
32. Pandit AU, Tang JW, Bailey SC, et al. Education, literacy, and health: Mediating effects on hypertension knowledge and control. *Patient Educ Couns* 2009; **75**(3): 381-5.
33. Duboz P, Boëtsch G, Gueye L, Macia E. Hypertension prevalence, awareness, treatment and control in Dakar (Senegal). *J Hum Hypertens* 2014; **28**(8): 489-93.
34. Damasceno A, Azevedo A, Silva-Matos C, Prista A, Diogo D, Lunet N. Hypertension prevalence, awareness, treatment, and control in mozambique: urban/rural gap during epidemiological transition. *Hypertension* 2009; **54**(1): 77-83.
35. Kayima J, Wanyenze RK, Katamba A, Leontsini E, Nuwaha F. Hypertension awareness, treatment and control in Africa: a systematic review. *BMC Cardiovasc Disord* 2013; **13**: 54.
36. Wamala JF, Karyabakabo Z, Ndungutse D, Guwatudde D. Prevalence factors associated with hypertension in Rukungiri district, Uganda--a community-based study. *Afr Health Sci* 2009; **9**(3): 153-60.

37. Gupta PC, Gupta R, Pednekar MS. Hypertension prevalence and blood pressure trends in 88 653 subjects in Mumbai, India. J Hum Hypertens. England; 2004: 907-10.
38. Muntner P, Gu D, Wu X, et al. Factors associated with hypertension awareness, treatment, and control in a representative sample of the chinese population. *Hypertension* 2004; **43**(3): 578-85.
39. Colhoun HM, Hemingway H, Poulter NR. Socio-economic status and blood pressure: an overview analysis. *J Hum Hypertens* 1998; **12**(2): 91-110.
40. Esteghamati A, Abbasi M, Alikhani S, et al. Prevalence, awareness, treatment, and risk factors associated with hypertension in the Iranian population: the national survey of risk factors for noncommunicable diseases of Iran. *Am J Hypertens* 2008; **21**(6): 620-6.
41. Walsh JM, Sundaram V, McDonald K, Owens DK, Goldstein MK. Implementing effective hypertension quality improvement strategies: barriers and potential solutions. *J Clin Hypertens (Greenwich)* 2008; **10**(4): 311-6.
42. Ogedegbe G. Barriers to optimal hypertension control. *J Clin Hypertens (Greenwich)* 2008; **10**(8): 644-6.
43. Turnbull F, Collaboration BPLTT. Effects of different blood-pressure-lowering regimens on major cardiovascular events: results of prospectively-designed overviews of randomised trials. *Lancet* 2003; **362**(9395): 1527-35.
44. Turnbull F, Neal B, Algert C, et al. Effects of different blood pressure-lowering regimens on major cardiovascular events in individuals with and without diabetes mellitus: results of prospectively designed overviews of randomized trials. *Arch Intern Med* 2005; **165**(12): 1410-9.
45. Dickinson HO, Mason JM, Nicolson DJ, et al. Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. *J Hypertens* 2006; **24**(2): 215-33.
46. Sacks FM, Svetkey LP, Vollmer WM, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001; **344**(1): 3-10.
47. Adrogué HJ, Madias NE. Sodium and potassium in the pathogenesis of hypertension. *N Engl J Med* 2007; **356**(19): 1966-78.
48. Dhital S, Karki A. Dealing with the burden of hypertension in Nepal: current status, challenges and health system issues. *Regional Health Forum* 2013; **17**(1): 44-5.
49. Wagner EH. Chronic disease management: what will it take to improve care for chronic illness? *Eff Clin Pract* 1998; **1**(1): 2-4.

50. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. *JAMA* 2002; **288**(15): 1909-14.
51. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. *Health Aff (Millwood)* 2001; **20**(6): 64-78.
52. Wagner EH, Austin BT, Von Korff M. Organizing care for patients with chronic illness. *Milbank Q* 1996; **74**(4): 511-44.
53. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. *JAMA* 2002; **288**(14): 1775-9.
54. The sixth report of the joint national committee on prevention, detection, evaluation and treatment of high blood pressure. Bethesda, MD: National High Blood Pressure Education Program, National Heart, Lung and Blood Institute. National Institutes of Health 1997.
55. Lawes CM, Vander Hoorn S, Law MR, Elliott P, MacMahon S, Rodgers A. Blood pressure and the global burden of disease 2000. Part II: estimates of attributable burden. *J Hypertens* 2006; **24**(3): 423-30.

CHAPTER 5

CONCLUSION AND IMPLICATIONS FOR FUTURE RESEARCH

In this cross-sectional study, we enrolled 1073 participants from randomly selected households of Dhulikhel municipality, in central Nepal. Through a household-level data collection including an in-depth questionnaire, anthropometric measurements and laboratory analysis of blood samples, we determined the prevalence and associated cardiovascular diseases (CVD) risk factors, a CVD risk profile and detailed aspects of hypertension including knowledge, awareness, treatment and control.

Prevalence of CVD risk factors may be higher than previously estimated and males are at higher risk: The findings demonstrated that conventional risk factors (current smoker, overweight or obese, less than recommended physical activity, less than recommended consumption of fruits and vegetables and hypertension) were highly prevalent in this population. Only 10.0% males and 13.7% females had none of the conventional risk factors. Males were found to have significantly higher adverse CVD risk profiles compared to females. Smoking rates were nearly double among males compared to females in both current and former smoking categories. Hypertension was twice as common in males (37.4%) compared to females (20.8%).

These findings provide evidence that the prevalence of CVD risk factors in this population is remarkably higher than national estimates and suggest that such high prevalence might be true for other urban and sub-urban communities in Nepal. Poor CVD risk profile in older age groups is a consistent finding in studies worldwide. However, this study shows major

concerns with regard to the presence of CVD risk factors even in young adults. Almost 90% of the participants below 25 years had at least one CVD risk factor. This study also highlights the differential prevalence of risk factors between males and females. Except for ethnicity, sex and age, other socio-demographic parameters didn't show significant relationships with CVD risk profile of the participants.

Diabetes prevalence is alarmingly high: We found that the prevalence of diabetes (35.5%) and pre-diabetes (41.4%) in this study, measured using the HbA1C cut-offs, was almost ten times higher than the recent national survey in Nepal. Although it can be argued that the high prevalence of overweight or obesity and almost 40% participants with less than recommended level of physical activity might be the major drivers of diabetes in this population, it is still difficult to fully explain the observed level of diabetes prevalence. This might well be one of the highest reported diabetes prevalence so far in the South Asian region. It should also be noted that our study measured HbA1C for diagnosing diabetes, leading to the detection of cases that might have been missed through blood glucose tests only. It is known that HbA1C is likely to be influenced by presence of conditions that lead to rapid red cell turnover (e.g., hemolytic or iron deficiency anemias) and hemoglobinopathies (depending on the assay employed). [1-3] However, it is unlikely that the present study population has high prevalence of these conditions. We realize that the possibility of racial differences in HbA1C is not fully explored nor understood in the South Asian population, which may limit the interpretation of our findings.

Hypertension is an important CVD risk factor in this population and Newari ethnicity may be independently associated with it: Almost a third of the study participants were hypertensive. A number of factors can be attributed to the high prevalence of hypertension in this population. High prevalence of overweight and obesity, less physical activity and high

smoking rates, all of which have proven relationships with hypertension risk... However, the role of dietary salt intake as well as ethnicity is poorly understood. Apart from male sex, older age and high BMI, our results strongly suggest that Newari ethnicity might be independently associated with hypertension. In a multivariate model controlling for other socio-demographic factors and conventional risk factors, Newars had five times higher odds of having hypertension compared to Brahmins. The association persisted even after controlling for blood sugar and lipid levels. We were not able to control for salt intake in this study. But, it is unlikely that differential consumption of salt (even if it were present) might fully explain such large risk differences.

Male sex, older age, low physical activity, being unemployed, and Newar ethnicity were significant predictors of hypertension in this population. The average AUC of the prediction model for internal validation was 0.808 (95% CI: 0.769-0.847). In resource-limited settings like Nepal, where laboratory tests are not easily available for large scale screening, we believe that utilizing easily obtainable socio-demographic and other CVD risk variables may prove to be useful for screening programs, hypertension prevalence prediction and also for policy-decisions. We were not able to externally validate the prediction model, which thus limits its generalizability.

Knowledge, awareness, treatment and control of hypertension are low: The knowledge related to hypertension was low in this population. Almost 43.1% of the participants were not able to mention even a single risk factor of hypertension. In the multivariate model, females had lower knowledge compared to males. Among different ethnic groups, Newars were most likely to have knowledge of hypertension when compared with Brahmins. Education was strongly associated with hypertension knowledge. Compared to those with no formal

education, those with less than high school high school graduates were nearly 3 and 9 times more likely to cite at least one risk factor of hypertension, respectively.

We found that, a total of 43.6% of the hypertensive participants were aware that they had high blood pressure. In a multivariate analysis, we did not find significant association between any socio-demographic factor (except with ethnicity) and awareness of hypertension. Out of those who were aware of their hypertension status, 76.1% of were currently on treatment. However, only 35.3% of those on treatment had their blood pressure under control (SBP<140mm Hg and DBP <90mmg Hg). Only about a third of the participants on treatment were compliant with taking their antihypertensive medications. These findings suggest that medication adherence might be a major issue in this population although the analysis was limited by small sample size.

Strengths and Limitations

This study provides new insights into the prevalence of CVD risk factors and an in-depth information on hypertension and its risk factors in the context of Nepal. The random sampling technique, standardized measurements and extensive information on potential confounders are the major strengths of this study. It is one of the first studies in Nepal to explore this issue in such depth within a population, and provides a unique opportunity to explore the differences that might occur within some population sub-groups.

This study further confirms that hypertension is a major CVD risk factor in the community and also impacts younger age groups. If the alarming prevalence remains unabated, it will lead to catastrophic health outcomes as well as serious social and economic consequences in the future. To our knowledge, this is the first study to provide strong evidence on the ethnic

differences of hypertension in a Nepalese community. For an ethnically diverse country like Nepal, developing generic prevention programs might prove to be too simplistic and less effective. Hence, our finding has important implications in terms of future research as well as development of culturally tailored prevention and management programs. This is also the first reported hypertension prevalence prediction model generated from a Nepalese study population. We expect that this will serve as a basis for future advanced prediction modelling to facilitate evidence-based policy, program development, and implementation.

The finding related to high diabetes prevalence in this population necessitates further research to confirm it and explore possible causes. Future studies should also test the validity and the reference level of HbA1C for the Nepalese population. This is also an important message to researchers and policy makers that, extrapolation of findings from other studies, especially those that may not reflect our settings, might grossly under or overestimate key problems.

The findings related to low levels of knowledge of hypertension in this study also emphasizes the immense task ahead in educating the public on CVD risk factors. This is of paramount importance in the communities where a large proportion of the population are illiterate. The low level of awareness, treatment and control of hypertension in our study corroborates with other similar findings from developing countries and underscores the need of unique implementation innovations at every level from primordial to secondary level prevention.

Our study has several limitations as well. As a cross-sectional study, the study has inherent limitations in inferring causal associations. We were not able to investigate laboratory parameters in all the participants and thus didn’t have a large enough sample size to test associations related to diabetes and lipid abnormalities. The lack of data on urinary sodium excretion was also a major limitation of the study. Thus, we were not able to determine the relationship of sodium consumption with blood pressure in this population and were not able

to control for sodium consumption. Future studies should include biochemical parameters so that the effect size of each of the conventional and presumed risk factors can be discerned more precisely. Moreover, if a relationship between dietary pattern and salt consumption can be determined, we might be able to deduce salt consumption information from the extensive dietary data collected in the study.

The study was conducted in the hilly town of Dhulikhel, which may not be representative of all of Nepal. Thus we cannot generalize these findings to the country-wide population. The generalizability is limited mainly because of ethnic, socio- cultural and geographic variation of the country that is not well-represented in the study. Dhulikhel is a small town with a large tertiary level health service provider, Dhulikhel Hospital. Almost one third of the staff of Dhulikhel Hospital are the inhabitants of Dhulikhel and have reasonably better access to health care compared to the rest of the population in Nepal. This might make the study indicators overly positive compared to the Nepalese population of similar socio-demographic level in other settings.

Although blood pressure measurement in a single setting may tend to overestimate the prevalence, we believe that may not be a problem because the measurement taken at home, and not in a clinical setting by a health provider. Given the practical challenges, it is common to rely on the blood pressure measurement on only one day in large epidemiological studies.

The hypertension knowledge assessment was based on a single question about risk factor of hypertension. We did not collect qualitative data to get an in-depth understanding of knowledge on hypertension. In the hypertension awareness study, we were not sufficiently powered to detect any association of magnitude below 1.9 OR. The study was also

underpowered to draw definitive conclusions on determinants of hypertension treatment and control.

The Way Forward

This study provides great opportunity for advancing our understanding of CVD epidemiology in Nepal and possibly in other low-income settings. Our ability to follow up the study participants longitudinally provides an unparalleled opportunity to examine the trend of CVD risk factors, incidence of CVD events and clearer insights into the associations and interplay of different conventional and presumptive risk factors with CVD events. The research team is already working to institute standardized clinical examinations and follow up of the participants so that CVD events and other relevant clinical information are timely ascertained.

Most importantly, this study provides a perfect opportunity to develop and test innovative implementation approaches to the prevention and, where appropriate, management of CVD risk factors, which are important to reduce the morbidity and mortality associated with CVD. It also serves as an excellent platform to adapt, implement and evaluate proven approaches of chronic disease management like the Chronic Care Model.[4-8]

The strength of Dhulikhel Hospital in its ability to engage with the community will be an important asset in ensuring that the findings of this study are widely communicated to the local stakeholders, including the District Health Office and community organizations that are involved in promoting healthy behaviors. The findings will also be communicated to the health care providers in Dhulikhel Hospital and to other local health care providers so that they can be made aware of the risk factors widely prevalent but previously unnoticed in this population.

The study report will also be presented in the national level forums, particularly in the Ministry of Health and meetings of related professional societies for the sharing of findings that will lead to clinical, public health as well as policy level discourses. The Ministry of Health in Nepal has been working to integrate management of chronic diseases at all levels of health care. Recent publication of the Multisectoral Action Plan for the Prevention and Control of Non Communicable Diseases (2014-2020) has set ambitious goals and targets to prevent and manage CVD as well.[9] However, there is not yet a proper program in place that addresses mass screening and awareness campaigns of CVD. Inadequate research to fully understand the epidemiology of CVD in different sub-population within Nepal, is another constraint to develop culturally tailored programs. The findings of this study will be helpful to highlight the fact that the return to investment would be very high in the awareness and screening programs that help prevent most of the CVD and their complications through very cheap, effective interventions, if started early. Our findings also emphasize the need of getting in-depth information on CVD epidemiology in different population settings. Furthermore, the setting of Dhulikhel in the context of ongoing Dhulikhel Heart Study will also be an ideal 'test site' for a number of implementation approaches for the prevention and management of CVD.

We believe that this work will serve as a testimony to the fact that even in resource-limited settings, committed institutions and cooperative communities can collaborate to successfully implement large-scale epidemiological research. We believe that this will motivate other public health professionals to pursue career in the field of CVD, which, despite the magnitude of its burden, is still a lost priority in most low-income settings.

REFERENCES FOR CHAPTER 5

1. Wisdom K, Fryzek JP, Havstad SL, Anderson RM, Dreiling MC, Tilley BC. Comparison of laboratory test frequency and test results between African-Americans and Caucasians with diabetes: opportunity for improvement. Findings from a large urban health maintenance organization. *Diabetes Care* 1997; **20**(6): 971-7.
2. Bry L, Chen PC, Sacks DB. Effects of hemoglobin variants and chemically modified derivatives on assays for glycohemoglobin. *Clin Chem* 2001; **47**(2): 153-63.
3. WHO. Use of glycated haemoglobin (HbA1c) in the diagnosis of diabetes mellitus. *Diabetes Res Clin Pract* 2011; **93**: 299-308.
4. Wagner EH. Chronic disease management: what will it take to improve care for chronic illness? *Eff Clin Pract* 1998; **1**(1): 2-4.
5. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. *JAMA* 2002; **288**(15): 1909-14.
6. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. *Health Aff (Millwood)* 2001; **20**(6): 64-78.
7. Wagner EH, Austin BT, Von Korff M. Organizing care for patients with chronic illness. *Milbank Q* 1996; **74**(4): 511-44.
8. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. *JAMA* 2002; **288**(14): 1775-9.
9. Multisectoral Action Plan for the Prevention and Control of Non Communicable Diseases (2014-2020). Kathmandu: Government of Nepal, World Health Organization Country Office for Nepal, 2015.

APPENDIX 1

DHULIKHEL HEART STUDY
HOUSEHOLD QUESTIONNAIRE

Interviewer code: ___ ___

GEOGRAPHICAL INFORMATION
District: KAVREPALANCHWOK **Municipality:** DHULIKHEL **Ward no**: __ __
Tole name: _____ Household number: __ __ __ __ __ __ __

RESPONDENT INFORMATION
1. Name of the respondent: _____ _____
2. Name of Household Head: _____ _____
3. Interview Language: (a) Nepal __ (b) Newari __
4. Date of interview: __ __ / __ __ / __ __ __ __ Interview start time: __ __ | __ __

4.1 Total number of visits: (a.) First time __ (b) Second time __ (c) Third time _

RESULT OF INTERVIEW
(a) Started __ (b) Absent at time of visit __ [Next visit date __/__/____}
(c) Absent for extended time __ (d) Postponed __ [Next visit date __/__/____] (e) Refused __

CONSENT (Enumerator reads the consent sheet, makes sure the participants understand}
(a) Agree __ (b) Disagree __ → The interview ends

HOUSEHOLD INFORMATION
5. Number family members in the household
(a) Less than 18 years __ __(b) 18 years or above __ __ (c) Total __ __ Phone number __ __ __ __ __ __ __

6. Details of the household members

Sn	Name	Relationship with head of household	Sex	Date of birth	Age	Physical disability (Y/N)	Fall ill in last 6 months (Y/N)	If yes, name the illness	How long the illness last	Visited doctor (Y/N)	Visited shamans (Y/N)

(Write 'Self ' in the relationship if the respondent is the head of the household)

MIGRATION
7.1. Are there any members of your household who lived here in the past 10 years but who has since moved away (at least six months ago)? (a) Yes __ (b) No __ → Go to 8
7.2 How many family members have migrated? __ __
7.3. Detail information of the migrants

Sn	Name of the migrant	Relation to the head of the household	Sex	Age when migrated (if age less than 1 year write 00)	Main reason	Country of migration	Name of the city in case of Nepal and India

7.4 Does your household receive remittances? (a) Yes __ (b) No __ → Go to 8

7.5 What are the remittance primarily spent on?
(a) Daily consumption___ (b) Education ___ (c) Health ___ (d) Household asset __
(e) Saving __ (f) Repay loan ___ (g) Other (Specify) _____

MORTALITY

8.1 Has anyone in your family died in the last year? (a) Yes __ (b) No __ → Go to 9

8.2 Detail information of the deceased member (Be sensitive)

SN	Name of the deceased	Sex	Date when died (DD/MM/YYYY)	Completed age when died	Cause of death	If does not know the reason, write the symptoms before dying

ENVIRONMENT

9 What type of fuel does your household mainly use for cooking?
(a) Electricity __ (b) LPG __ (c) Natural gas __ (d) Biogas __ (e) Kerosene __
(f) Coal, lignite __ (g) Wood __ (h) Straw__ (i) Crop __ (j) Animal dung __

10 Do you use improved stove to cook? (a) Yes __ (b) No __

11 Is cooking usually done in the house, in separate building or outdoors? (Outside the house)
(a) In the house __ (b) Separate building __ (c) Outdoors __

12 What type of toilet does your household have?
(a) Flushed to piped sewerage __ (b) Flush to septic tank __ (c) Flush to pit latrine __
(d) Flush to somewhere else __ (e) Flush, unknown__ (f) Ventilated improved pit latrine
(g) Pit latrine with slab __ (h) Pit latrine without slab __ (i) Composting toilet __
(j) Bucket toilet __ (k) No facility/ bush/ field __

13 Do you share this toilet with other household? (a) Yes __ (b) No __

14 What is the main source of drinking water?
(a) Piped into dwelling __ (b) Piped to yard __ (c) Public tap __ (d) Tube well __
(e) Protected dug well __ (f) Unprotected dug well __ (g) Rain water ___ (h) Tanker __
(i) Protected spring __ (j) Unprotected spring __ (k) Surface water__ (l) Bottle __

15 Do you treat drinking water? (a) Yes __ (b) No __ → Go to 17

16 If yes, how do you treat drinking water?
(a) Boil __ (b) Add bleach/chlorine __ (c) Strain through cloth __ (d) Water filter __
(e) Solar disinfection __ (f) Let it stand and settle __ (g) Don't know __

SOCIO ECONOMIC STATUS

17. What type of family do you live with? (a) Nuclear __ (b) Joint __

18 Does any member of this household own following? (Y/N)
(a) A watch __ (b) A bicycle/rickshaw __ (c) A motor cycle/scooter __
(d) A three wheel tampo __ (e) A car/truck __ (f) A tractor __

19 Does any member of this household own any agricultural land? (a) Yes __ (b) No __ → Go to 21

20. How much of Agriculture land do members of this household own? __ __ (unit _____)

21. Does this household own any livestock, herds, other farm animals or poultry? (a) Yes __ (b) No __ → Go to 23

22. If yes, how many of following livestock do you own?
(a) Buffalo __ (b) Cow __ (c) Goats __ (d) Sheep __ (e) Chicken __ (f) Ducks__ (g) Pigs __

23. Does any member or this household have a bank account/cooperative/or other savings account ?
(a) Yes __ (b) No __

24. What is the head of house's income per month (NRs)?
(a) No income __ (b) Less than 5000 __ (c) 5001-10000 __ (d) 10001-20000 __
(e) 20001-30000 __ (f) 30001-40000 __ (g) 40001-50000 __ (h) 50001-60000 __
(i) 60001-70000 __ (j) 70001-100000 __ (k) more than 100000 __
(l) Do not know __ (m) Refused __

HOUSEHOLD OBSERVATION

25. Main material for the floor
(a) Earth/ sand __ (b) Dung __ (c) Wood planks __ (d) Cement __ (e) Wood __ (f) Carpet_
(h) Venyl or asphalt strips __ (i) Ceramic tiles __ (h) Palm/bamboo __ (h) Others(Specify) _____

26. Main Material on the Roo
(a) No roof __ (b) thatch/palm leaf __ (c) rustic mat __ (d) palm/bamboo __
(e) Woodplanks __ (f) Cardboard __ (g) Ceramic tiles __ (h) Cement __
(i) Galvanized sheet __ (j) Others (Specify) _____

27. Main Material on the external wall
(a) No walls __ (b) Mud/Sand __ (c) Bamboo with mud __ (d) Stone with mud __
(e) Ply wood __ (f) Cardboard __ (g) Cement __ (h) Stone with cement __
(i) Bricks __ (j) Cement blocks __ (k) Wood planks/ Shinles __ (l) Others (Specify) _____

28. How many rooms does the house has? (Do not count the toilet and the rented rooms) __ __

29. How many rooms in the house are used for sleeping? __ __

APPENDIX 2

DHULIKHEL HEART STUDY
Personal questionnaire

Interviewer code : __ __

A. ELIGIBILITY CRITERIA

1. Are you resident of Dhulikhel ? (a) Yes ___ (b) No ___
2. Have you been living in Dhulikhel for past 6 months? (a) Yes ___ (b) No ___
3. Are you 18 years or above (a) Yes ___ (b) No ___
4. (If female), are you currently pregnant? (a) Yes ___ (b) No ___
5. Does participant appear to be cognitively able to conduct the interview?
6. (Enumerator will observe the condition of the respondent) (a) Yes ___ (Specify) _____(b) No ___

CONSENT

(a) Agree ___ (b) Disagree ___ → Interview ends
Interview start time…….. Date of interview (DD/MM/YYYY)……

B. PARTICIPANT'S INTERVIEW

1. Ward number: __ __ 2. Tole Name _____ 3. Household number __ __ __ __ __ __
4. Family number: __ __ 5. Serial Number of the person from form1 __ __
6. Identification Number: __ __ __ __ __ __ __ __ __ *(DH-ward no.-household no.-family no.-personal serial no in the family.)*

C. DEMOGRAPHIC CHARACTERISTICS

1. What is your full name ? _____ _____
2. Sex (Observe): (a) Male __ (b) Female __ (c) Third gender __
3. What is your mobile number? __ __ __ __ __ __ __ __ __ __
4. What is your email address? (If not available write NA) _____@ _____. com
5. What is your age? (Completed years) __ __ years
6. What is your birth date ? __ __ / __ __ / __ __ __ __
7. What is your citizenship number? __ __ __ __ __ __ __ __
8. What is your ethnic group?
   (a) Brahmin __ (b) Chettri/Thakuri/Sanyasi __ (c) Newar __
   (d) Magar/Tamang/Rai/Limbu __ (e) Sherpa/Bhote ___ (f) Kami/Damai/Sarki/Gaaine/Baadi __
9. What is your mother tongue? (a) Nepai __ (b) Newari __
10. What is your marital status?
    (a) Never married __ (b) Currently married __ (c) Separated __
    (d) Widowed __ (e) Cohabiting__ (f) Refused__
11. What was your age when you got married? __ __ years
12. What was age of your spouse when you got married? __ __ years
13. What is your religion?
    (a) Hindu __ (b) Buddhist __ (c) Muslim __ (d) Kirat __ (e) Christian
14. What is the highest grade or year of school you have ever completed, including college? ___ __ years
15. For How long did you have Vocational Training? __ __ months
16. Which one best describes the kind of work you have done most of your life?
    (a) Professional ___ (b) Clerical __ (c) Sales and services __ (d) Skilled manual __
    (e) Unskilled manual __ (f) Agriculture __ (g) Student __ (h) Housewife __
    (i) Military / Police __
17. Which of the following describes your main status over the past 12 months?
    (a) Government employee __ (b) Non-government employee __ (c) Self-employed __
    (d) Non-paid __ (e) Home maker __ (f) Unemployed __ (g) Student __
18. Talking about the past year, what was your average earning? _____ (per day / per month / per year)
19. Give me the name and contact number of three people with who you expect to be in close contact in future

SN	Name	Relation	Phone number	Email ID
__	_____	_____	_____	_____
__	_____	_____	_____	_____
__	_____	_____	_____	_____

D. WOMEN EMPOWERMENT

20. Does the wife own property under her own name? (a) Yes __ (b) No __
21. Does the wife have her own bank account? (a) Yes __ (b) No __

E. SMOKING

Now I will ask you some smoking related questions, okay?

22. Have you ever used tobacco such as cigarettes, bidi, pipe, cigars, khaini, surti, jarda paan, hukka, chilim, tamakhu? (a) Yes __ (b) No __
23. At what age did you start tobacco use? __ __ years

24. Have you used tobacco in the last month? (a) Yes __ (b) No __
25. At what age did you stop tobacco use? ____ years
26. Have you ever smoked cigarettes? (a) Yes __ (b) No __
27. How many days do you smoke in a typical month? __ __ days
28. The day when you smoke, on an average how many cigarettes do you smoke?.....(number of cigarettes smoked per day)
29. Do you usually smoke filter cigarettes or non-filter cigarettes? ((Show Card; Picture Number)
    filter cigarettes have filter i.e. a small sponge at the end of the cigarettes)
    (a) Filter cigarettes __ (b) Non-filter cigarettes __ (c) Don't know __
30. Have you ever smoked bidi? (Asking about only bidi) (a) Yes __ (b) No __
31. How many days do you smoke in a typical month? _____days
32. The day when you smoke, on an average how many cigarettes do you smoke? ___
33. Have you ever smoked pipe or cigar? (a) Yes __ (b) No __
34. How many days do you smoke in a typical month? __ __ days
35. The day when you smoke, on an average how many cigarettes do you smoke? ___

Smoking quit

36. Have you ever tried to quit smoking? (a) Yes ___ (b) No ___
37. How many times did you try to quit smoking? __ __
38. What was the longest duration you didn't smoke after you attempted quitting? __ __
39. Would you be interested in quitting smoking if we could help you with quitting? (a) Yes __ (b) No __
40. Have you ever used khaini, surti, jarda paan? (Asking about only khaini, surti jarda paan) (a) Yes __ (b) No __
41. How many days do you use in a typical month? ____ days /weeks/months/year
42. The day when you use Khaini Surti, Jarda, Paan, on an average how many amount of these do you use? ____
43. Have you ever smoked hukka, chilim or tamakhu? (asking about only hukka, chilim, tamakhu) (a) Yes __ (b) No__
44. How many days do you smoke in a typical month? ___ days/weeks/months/year
45. The day when you smoke, on an average how many cigarettes do you smoke? ___

Second hand smoking

46. Does anyone living with you smoke cigarettes,/bidi/cigar/pipe/hukka/ chilim when you are present?
    (a) Yes __ (b) No __
47. During past 7 days, on how many days did someone in your home smoke when you were present? ____
48. During past 7 days, on how many days did someone smoked in close areas in your workplace such as building, work area or specific office when you were present? _____

F. ALCOHOL DRINKING

49. Do you ever drunk any alcoholic drink such as beer, wine, jaad, chhyang, tongba, ningaar, raksi, soltyang, whiskey, brandy, rum, vodka, sherry, champagne? (a) Yes __ (b) No __ (c) Refused __
50. At what age did you start drinking alcoholic drink? ___ years
51. Do you ever drink beer? (Currently or in the past, ask only of beer) (a) Yes __ (b) No __
52. How many days do you drink beer in a typical month? __ __(Week/ Month)
53. The days when you drink, how many bottles (650 ml) of beer do you normally drink in one day? _____ml
54. What is the maximum number of drinks in one occasion you had in the past month? _____
55. Do you ever drink jaad, chhyang, tongba or nigaar? (a) Yes __ (b) No __ (9) Refused
56. How many days do you drink jaad, chhyang, tongba or nigaar in a typical month? _____ (Week/ Month)
57. The days when you drink, how many glassess of jaad, chhyang, tongba or ningaar do you normally drink in one day? (Show picture of glasses and write in ml from the booklet) _____ml
58. What is the maximum number of drinks in one occassion you had in the past month? (Show picture of glasses and write in ml from the booklet) _____ml
59. Do you ever drink wine, sheery or champagne? (a) Yes (b) No__ (c) Refused
60. How many days do you drink wine in a typical month? …… (Week/ Month)
61. The days when you drink, how many glasses of or champagne do you normally drink in one day? (Show picture of glasses - picture number 28) _____ml
62. What is the maximum number of drinks in one occasion you had in the past month? (Show picture of glasses -picture number 28) _____ml
63. Do you ever drink raksi, aila or soltyang (hard liquor)? (a) Yes __ (b) No __ (c) Refused__
64. How many days do you drink raksi, aila or soltyang in a typical month? ___(Week/ Month)
65. The days when you drink, how many glasses of rakshi, aila or soltyang do you normally drink in one day? ? (Show picture of glasses -picture number 28_____ml
66. What is the maximum number of drinks in one occasion you had in the past month? Show picture of glasses -picture number 28) _____ml
67. Do you ever drink whisky, scotch, brandy, rum or vodka? (a) Yes __ (b) No __ (c) Refused
68. How many days do you drink whisky, scotch, brandy, rum or vodka in a typical month? ____(Week/ Month)
69. The days when you drink, how many glasses of whisky, scotch, brandy, rum or vodka do you normally drink in one day? ___ml
70. What is the maximum number of drinks in one occasion you had in the past month? ____ ml
71. In the past five years, has your alcohol intake increased, decreased or remained the same?
    (a) No__ (b) Increased intake __ (c) Decreased intake __
72. If you do not drink alcohol now, did you ever drink alcohol regularly? (for former drinker)(a) Yes __ (b) No __
73. At what age did you start drinking? ____ years
74. At what age did you stop drinking alcohol regularly? ___years

75. How many drinks per week did you usually drink? ____
76. What is the maximum number of drinks that you ever had on one occasion? ____

F. MEDICAL HISTORY

Cardiovascular health

(Now I am going to ask you about diseases or procedures that you may have had in the past. If you do not know the answer, just say 'don't know')

77. Has your doctor ever told you had a myocardial infarction or heart attack? (a) Yes __ (b) No __ (c) Don't know__
78. Where was it diagnosed? (Name of the hospital/ nursing home/ clinic) _____
79. Were you hospitalized for your myocardial infarction or heart attack? (a) Yes __ (b) No __ (c) Don't know__
80. Has your doctor ever told you that you had congestive heart failure? (a) Yes __ (b) No __ (c) Don't know__
81. Where was it diagnosed? (Name of the hospital/ nursing home/ clinic) _____
82. Were you hospitalized for your congestive heart failure? (a) Yes __ (b) No __ (c) Don't know__
83. Has your doctor ever told you that you had rheumatic heart or valve problems? (a) Yes __ (b) No __ (c) Don't know__
84. Has your doctor ever told you that you had atrial fibrillation? (a) Yes __ (b) No __ (c) Don't know__
85. Has your doctor ever told you that you had deep venous thrombosis or blood clots in your leg? Yes __ (b) No __ (c) Don't know__
86. Has your doctor ever told you that you had pulmonary embolus or blood clots in your lungs (fokso ma ragat jameko)? a) Yes __ (b) No __ (c) Don't know__
87. Has your doctor ever told you that you had other heart or circulatory problems? a) Yes __ (b) No __ (c) Don't
88. Please specify which heart or circulatory problems you had _____
89. Have you ever had cardiac bypass surgery? (a) Yes __ (b) No __ (c) Don't know __
90. Have you ever had any other heart surgery? (a) Yes __ (b) No __ (c) Don't know __
91. Have you ever had surgery on the blood vessels in your neck (carotid arteries)? (a) Yes __ (b) No __ (c) Don't know __
92. What side did you have the surgery on ? (a) Right __ (b) Left __ (c) Both __
93. Have you ever had surgery on the blood vessels in your legs? (a) Yes __ (b) No __ (c) Don't know __
94. What side did you have the surgery on? (a) Right __ (b) Left __ (c) Both __
95. Have you ever had a repair of an aortic aneurysm ? (a) Right __ (b) Left __ (c) Both __
96. Have you ever had a pacemaker implant ? (a) Yes __ (b) No __ (c) Don't know __
97. Have you ever had an angioplasty of the coronary arteries, which is a dilation of the arteries of the heart with a balloon? (a) Yes __ (b) No __ (c) Don't know __
98. Have you ever had angioplasty of the lower extremity arteries, which is a dilation of the arteries of the leg with a balloon? (a) Yes __ (b) No __ (c) Don't know __

Rose Angina

87. Have you ever had a pain or discomfort in your chest ? (a) Yes __(b) No __
88. Do you get it when you walk uphill or hurry? (a) Yes __ (b) No __
89. Do you get it when you walk at an ordinary pace on the level? (a) Yes __ (b) No __
90. What do you do if you get it while you are walking? (Probe) (a) Stop or slow down, or continue at same pace after taking nitroglycerine __ (b) Continue at same pace __
91. If you stand still, what happens to it ? (Probe) (a) Relieved __ (b) Not relieved __
92. How soon is it relieved? (a) 10 minutes or less __ (b) More than 10 minutes __
93. Where do you get this pain or discomfort? (Write the code of the region) (a) A __ (b) B__ (c) C __ (d) D __ (e) E __ (f) F __
94. Have you ever had a severe pain across the front of your chest lasting for half an hour or more? (a) Yes __ (b) No __
95. If you answered yes, did you see a doctor because of this pain? (a) Yes __ (b) No __
96. If you saw a doctor, what did your doctor say it was? (a) Angina __ (b) Heart Attack __
97. Have you ever had to sleep on 2 or more pillows to help you breathe? (a) Yes __ (b) No __
98. Have you ever had been awakened at night by trouble breathing? (a) Yes __ (b) No __
99. Have you ever had swelling of your feet or ankles? (Excluding during pregnancy)? (a) Yes __ (b) No __
100. If you answered yes, did it tend to come on during the day and go down overnight? (a) Yes __ (b) No __
101. Do you get pain in either leg on walking? (a) Yes __ (b) No __
102. Do you get this pain in your calf or calves? (a) Yes __ (b) No __
103. Do you get it when you walk uphill or hurry? (a) Yes __ (b) No __ (c) Never hurry or walk uphill __
104. Do you get it when you walk at an ordinary pace on the level? (a) Yes __ (b) No __
105. Does this pain ever disappear while you are walking? (a) Yes __ (b) No __
106. What do you do if you get it while you are walking? (a) stop or slow down __ (b) Continue at same pace __
107. If you stand still, what happens to it? (a) Relieved __ (b) Not relieved __
108. Have you ever had pneumonia? (a) Yes __ (b) No __ (c) Do not know __
109. Have you ever had emphysema (fokso fulne)? (a) Yes __ (b) No __ (c) Do not know __
110. Have you ever had asthma? (a) Yes __ (b) No __ (c) Do not know __
111. Have you ever had chronic bronchitis? (a) Yes __ (b) No __ (c) Do not know __
112. Are you troubled by shortness of breath when hurrying on level or walking up a slight hill? (a) Yes __ (b) No __ (c) Do not know __
113. Do you have to walk slower than people of your age on the level because of breathlessness? (a) Yes __(b) No __
114. Do you ever have to stop for breath when walking at your own pace on the level? (a) Yes __ (b) No __

115. Do you ever have to stop for breath after walking about 100 yards or 91 meters (or after a few minutes) on the level? (a) Yes __ (b) No __
116. Have you ever had Chronic Obstructive Pulmonary Disease (COPD)? (a) Yes __(b) No __ (c) Don't know

Stroke related questions

117. Have you ever had sudden painless weakness on one side of your body?
(a) Yes __ (b) No __ (c) Do not know __
118. Have you ever had sudden numbness or a dead feeling on one side of your body?
(a) Yes __ (b) No __ (c) Do not know __
119. Have you ever had sudden painless loss of vision in one or both eyes?
(a) Yes __ (b) No __ (c) Do not know __
120. Have you ever suddenly lost the ability to understand what people are saying?
(a) Yes __ (b) No __ (c) Do not know __
121. Have you ever suddenly lost the ability to express yourself verbally or in writing?
(a) Yes __ (b) No __ (c) Do not know __

High blood pressure

122. Have you ever had your Blood Pressure checked? (a) Yes __ (b) No __ (c) Do not know __
123. If yes, why did you have your blood pressure checked?
a) I had some symptoms, which I thought were related to high blood pressure__
b) Blood pressure was checked as a part of a regular check up__
c)Because there was an opportunity for a free check up __
d) My family advised me __
e) My friends/relatives advised me __
f) It was checked while I had gone in for some other health problems __
124. Were you ever diagnosed or told by a doctor/health official that you had high blood pressure or hypertension?
(a) Yes __ (b) No __ (c) Do not know __
125. If yes, when was it diagnosed? _____
126. Are you currently receiving any of the following advice for hypertension by a doctor or other health worker?
(a) Special prescribed diet ___ (b) Advice or treatment to lose weight __
(c) Advice or treatment to stop smoking __ (d) Advice to start to do more exercise __
(e) Have you ever seen a traditional healer for hypertension? __
(f) Are you currently taking any herbal or traditional remedy for your hypertension?
127. Were you advised to start medicine to reduce high blood pressure? (a) Yes __ (b) No __
128. When were you first advised to take medicine for High Blood Pressure? __ __/ __ __ / __ __ __ __
129. If yes, Did you start taking medicine for high blood pressure? (a) Yes __ (b) No __
130. If not started to take medicines, what is the main reason that you decided not to start your medicine? (Do not read the list to the respondent and do not prompt. Check all that he/she mentions)
a. My doctor advised me to stop the medicine because I didn't need them any longer. __
b. I did not know (I was not told) that I had to continue the medicine. __
c. I could not afford (the medicine). __
d. I got side effects (from the medicine). __
e. The medicine didn't control my blood pressure and so I decided to stop taking them. __
f. I was afraid that I might be dependent on the medicines and would need to take it life-long. __
g. I did not have any symptoms of the disease and hence did not feel like I needed the medicine. __
h. I do not believe that the medicine will help to control my high blood pressure. __
i. My friends or family members suggested stopping the medicine. __
j. I started alternative medicines (e.g., herbal, homeopathy, etc) and decided to stop the medicine. __
k. I started alternative approaches like yoga, regular exercise, etc. and thus decided to stop the medicines.
l. The medicines were not easily available. __
m. I was too sick to continue taking medicine and there was nobody to help me with that. __
n. The number of medicines and timing was too confusing__
o. The regimens were changed very frequently which really upset me. __
p. I lost trust on my health care provider and thus stopped the medicine. __

131. Now I am going to read a list of reasons that may have played a part in your stopping to take your high blood pressure medicine. Which of the following are related to your decision to stop taking your medicine?
a. I could not afford (the medicine). __
b. I got side effects (from the medicine). __
c. The medicine didn't control my blood pressure and so I decided to stop taking them. __
d. I was afraid that I might be dependent on the medicines and would need to take it life-long. __
e. I did not have any symptoms of the disease and hence did not feel like I needed the medicine. __
f. My friends or family members suggested stopping the medicine. __
g. I started alternative medicines (e.g., herbal, homeopathy, yoga, regular exercise etc) and decided to stop the medicine. __
h. The number of medicines and timing was too confusing __
i. Is there any other reason for which you stopped medicine? __
j. What alternative medicine did you start?
(a) Herbal __ (b) Homeopathy __ (c) Yoga __ (d) Ayurvedic __ (e) Regular exercise __

Morisky Medication Adherence Scale (Eight Item) for hypertension

132. Do you sometimes forget to take your [hypertension] pills? __
133. People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past two weeks, were there any days when you did not take your [hypertension] medicine? __
134. Have you ever cut back or stopped taking your medication without telling your doctor, because you felt worse when you took it? __
135. When you travel or leave home, do you sometimes forget to bring along your [hypertension] medication? __
136. Did you take your [hypertension] medicine yesterday? __
137. When you feel like your [hypertension] is under control, do you sometimes stop taking your medicine? __
138. Taking medication everyday is a real inconvenience for some people. Do you ever feel hassled about sticking to your [hypertension] treatment plan? __
139. How often do you have difficulty remembering to take all your blood pressure medication? __
140. If forget to take medicine, what is the main reason that you miss taking your medicines? _____
    a. I simply forget. __
    b. I did not know (I was not told) that I had to take medicine regularly. __
    c. It is too expensive to take it regularly. __
    d. I get side effects (from the medicine) if I take regularly. __
    e. I am afraid that if I take it regularly I might be dependent on the medicine and would need to take life.__
    f. I do not have any symptoms of the disease and hence do not feel like I need to take it every day. I take it only when I get symptoms (like headache, dizziness) __
    g. I do not believe that the medicine will help to control my disease. So, I don't mind taking it irregularly. __
    h. My friends or family members suggested not to take it regularly. __
    i. I started alternative medicines (e.g., herbal, homeopathy, etc) and decided to be irregular with the medicine. __
    j. I started alternative approaches like yoga, regular exercise, etc. and thus decided to be irregular with the medicine.
    k. The medicines are not easily available. __
    l. I am too sick to remember taking the medicine regularly and there is nobody to help me with it. __
    m. The number of medicines and timing is too confusing. __
    n. The regimens were changed very frequently which really upset me. __
    o. I lost trust on my health care provider and thus miss taking the medicine. __

141. Now I am going to read a list of reasons that may have played a part in your missing your medications. Which of the following are related to missing your medicine? Reasons
    a. It is too expensive to take it regularly.
    ___
    b. I get side effects (from the medicine) if I take regularly.
    ___
    c. I am afraid that if I take it regularly I might be dependent on the medicine and would need to take life
    _
    d. I do not have any symptoms of the disease and hence do not feel like I need to take it every day
    __
    e. My friends or family members suggested not to take it regularly
    __
    f. I started alternative medicines (e.g., herbal, homeopathy, etc) and decided to be irregular with the medicine__
142. What alternative medicine did you start?
    (a) Herbal __ (b) Homeopathy __ (c) Yoga __ (d) Ayurveda __ (e) Regular exercise __

Knowledge on high blood pressure (*Now I am going to ask you some questions about high blood pressure*)

143. Please tell me what you think are the reasons we develop high blood pressure. (Do not read the list to the respondent and do not prompt. Check all that he/she mentions)
    (a) From family (heredity) __ (b) Unknown reasons __ (c) High salt intake __
    (d) Smoking __ (e) Excess alcohol consumption __ (f) High fat diet __
    (g) Obesity __ (h) Lack of exercise __ (i) Stress __ (j) Don't know __
144. Please tell me what you think might happen if our blood pressure is not properly controlled?
    (a) Stroke __ (b) Heart Disease __ (c) Kidney problem __ (d) Eye problem __(e) Diabetes __(f) Don't know _
145. Please tell me what you think are the ways we can control our blood pressure.
    (a) Reduce salt intake __ (b) Reduce weight __ (c) Exercise regularly __
    (e) Reduce intake of fatty food __ (f) Start medicine __ (g) Stop smoking __
    (h) Stop/Reduce alcohol consumption __(i) Follow up for check up every three months__ (j) Don't know __
146. Which of the following is the most desirable blood pressure reading?
    (a) 130/90 __ (b) 180/110 __ (c) 140/80 __ (d) 120/80 __ (e) Lower than 120/80 __ (f) Don't know __
147. The main cause of high blood pressure is:
    (a) Stress __ (b) Obesity __ (c) Unknown __ (d) Aging __ (e) Don't know __

148. A person with high blood pressure has:
(a) High cholesterol __ (b) High risk of heart attack and stroke __ (c) Nervous condition __ (e) Don't know __
149. High blood pressure medication is usually prescribed to be taken under:
(a) under stressful situation __ (b) as a lifelong way to manage high blood pressure __
(c) When activities require physical exertion __ (d) whenever a patient feels bad (e) Don't know__
150. Which of the following is more likely to contribute to your high blood pressure?
(a) Physical Activity__(b) Salt/sodium intake __ (c) High cholesterol level __ (d) Icecream __(e)Don't know __
151. Major risk factors other than high blood pressure for heart disease and stroke is
(a) High cholesterol __(b) Smoking __ (c) Family history of heart disease __ (d) All of above __ (e) Don't know
152. Has your doctor ever told you that you had diabetes (chini-rog/ sugar)? (a) Yes __ (b) No __
If yes, when was it diagnosed? __ __ / __ __/__ __ __ __
153. Are you currently receiving any of the following treatments/advice for diabetes prescribed by a doctor or other health worker?

Treatment or Advices

154. What advices have you received?
(a) Insulin injection __ (b) Drugs (medication) that you have taken in the past two weeks___
(c) Special prescribed diet __ (d) Advice or treatment to lose weight __
(e) Advice or treatment to stop smoking_ (f)Advice to start or do more exercise __
155. Have you ever seen a traditional healer for diabetes or raised blood sugar? __
156. Are you currently taking any herbal or traditional remedy for your diabetes? __
157. When the medicines were first prescribed? __ __ __ __ / __ __ / __ __
158. Have you been taking the medicines regularly? (a) Yes __ (b) No __ (c) Refused __
159. If you have not been taking medicines regularly, how often do you miss the doses?
(a) Daily __ (b) Every 2 to 3 days __ (c) Once a week __ (d) Every 15 days __
160. What are the main reasons for not taking the medicines? (list top 3)
1 _____ 2 _____ 3_____

FOOD FREQUENCY

161. How many times do you usually eat in a day? (Times of eating) __
162. Do you regularly take any vitamin supplementation? (Vitamin supplement) (a) Yes __ (b) No __
163. If yes, which vitamins do you take? _____
164. How many months ago did you start taking vitamin supplementation? _____ Months
165. Do you take calcium supplementation? (a) Yes __ (b) No __
166. How many months ago did you start taking calcium supplementation? _____ Months
167. Do you take iron supplementation? (a) Yes __ (b) No __
168. How many months ago did you start taking iron supplementation? ____ Months
169. Do you take fish oil or omega-3 supplementation? (a) Yes __(b) No __
170. How many month ago did you start taking fish oil or omega-3 supplementation? ____ Months
171. Do you usually add table salt to food or fruit before eating? (Add table salt) (a) Yes __ (b) No __
172. Do you usually add sugar to your tea or coffee? (Add sugar) (a) Yes __(b) No __
173. Do you use artificial sugar instead of sugar? (Artificial sweetener) (a) Yes __ (b) No __
174. Have you changed your eating pattern/food due to any disease? (a) Yes __ (b) No __
175. If yes, Name the disease _____ _____ _____
176. How many times in a week do you eat out of home? (in a restaurant or hotel? ____
177. Do you usually eat animal fats with meat? (eat boso) (a) Yes __ (b) No __

178. Last year, what did you eat and how often (Show portion size picture)

	Unit					Portion size				
Frequency of eatin	**Never**	**Day**	**Week**	**Month**	**Year**	**A**	**B**	**C**	**D**	**None**
Rice	0	1	2	3	4	1	2	3	4	0
Beaten rice	0	1	2	3	4	1	2	3	4	0
Wheat	0	1	2	3	4	1	2	3	4	0
Choumin	0	1	2	3	4	1	2	3	4	0
pasta macaroni spaghetti	0	1	2	3	4	1	2	3	4	0
Sooji	0	1	2	3	4	1	2	3	4	0
atta roti	0	1	2	3	4	1	2	3	4	0
bhuteko maize	0	1	2	3	4	1	2	3	4	0
white bread	0	1	2	3	4	1	2	3	4	0
brown bread	0	1	2	3	4	1	2	3	4	0
kodo fapar bajra	0	1	2	3	4	1	2	3	4	0
whole pulse	0	1	2	3	4	1	2	3	4	0
Washed pulse	0	1	2	3	4	1	2	3	4	0
Sprout	0	1	2	3	4	1	2	3	4	0
Cheakpeas dry peas beans	0	1	2	3	4	1	2	3	4	0
Soyabean	0	1	2	3	4	1	2	3	4	0
Broccoli Cauliflower	0	1	2	3	4	1	2	3	4	0
cabbage kohlrabi	0	1	2	3	4	1	2	3	4	0
Pumpkin	0	1	2	3	4	1	2	3	4	0
Potato	0	1	2	3	4	1	2	3	4	0
Greenveg	0	1	2	3	4	1	2	3	4	0
Radish Turnip	0	1	2	3	4	1	2	3	4	0
Parwal	0	1	2	3	4	1	2	3	4	0
Green Beans Peas	0	1	2	3	4	1	2	3	4	0
Karela	0	1	2	3	4	1	2	3	4	0
Egg Plant	0	1	2	3	4	1	2	3	4	0
Tomato	0	1	2	3	4	1	2	3	4	0
Lauka	0	1	2	3	4	1	2	3	4	0
Schoos	0	1	2	3	4	1	2	3	4	0
lady's finger	0	1	2	3	4	1	2	3	4	0
Ghiraula	0	1	2	3	4	1	2	3	4	0
Rukhkatahar	0	1	2	3	4	1	2	3	4	0
YAM	0	1	2	3	4	1	2	3	4	0
Sweet Potato	0	1	2	3	4	1	2	3	4	0
Taamaa	0	1	2	3	4	1	2	3	4	0
Gundruk	0	1	2	3	4	1	2	3	4	0
Mushroom	0	1	2	3	4	1	2	3	4	0
Garlic	0	1	2	3	4	1	2	3	4	0
onion_shallot	0	1	2	3	4	1	2	3	4	0
Carrot	0	1	2	3	4	1	2	3	4	0
Cucumber	0	1	2	3	4	1	2	3	4	0
Orange	0	1	2	3	4	1	2	3	4	0
grape_fruti	0	1	2	3	4	1	2	3	4	0
pine_apple_freq	0	1	2	3	4	1	2	3	4	0
jujube_aaru	0	1	2	3	4	1	2	3	4	0
apple_pear	0	1	2	3	4	1	2	3	4	0
Guava	0	1	2	3	4	1	2	3	4	0
Alubakhada	0	1	2	3	4	1	2	3	4	0
Lychee	0	1	2	3	4	1	2	3	4	0
Grapes	0	1	2	3	4	1	2	3	4	0
Lemon	0	1	2	3	4	1	2	3	4	0
Banana	0	1	2	3	4	1	2	3	4	0
Mango	0	1	2	3	4	1	2	3	4	0
Pomegranate	0	1	2	3	4	1	2	3	4	0
Watermelon	0	1	2	3	4	1	2	3	4	0

Papaya	0	1	2	3	4	1	2	3	4	0
Mutton	0	1	2	3	4	1	2	3	4	0
chicken_with_skin	0	1	2	3	4	1	2	3	4	0
chicken_without_skin	0	1	2	3	4	1	2	3	4	0
chicken_mo_mo	0	1	2	3	4	1	2	3	4	0
Sausage	0	1	2	3	4	1	2	3	4	0
Buff	0	1	2	3	4	1	2	3	4	0
buff_mo_mo	0	1	2	3	4	1	2	3	4	0
buff_sausage	0	1	2	3	4	1	2	3	4	0
Pork	0	1	2	3	4	1	2	3	4	0
pork_mo_mo	0	1	2	3	4	1	2	3	4	0
fried_fish	0	1	2	3	4	1	2	3	4	0
nonfried_fish	0	1	2	3	4	1	2	3	4	0
Egg	0	1	2	3	4	1	2	3	4	0
whole_milk	0	1	2	3	4	1	2	3	4	0
low_fat_milk	0	1	2	3	4	1	2	3	4	0
Yogurt	0	1	2	3	4	1	2	3	4	0
milk_tea	0	1	2	3	4	1	2	3	4	0
black_tea	0	1	2	3	4	1	2	3	4	0
milk_coffee	0	1	2	3	4	1	2	3	4	0
black_coffee	0	1	2	3	4	1	2	3	4	0
coke_pepsi_mountain_dew	0	1	2	3	4	1	2	3	4	0
fanta_sprite	0	1	2	3	4	1	2	3	4	0
fruit_juice	0	1	2	3	4	1	2	3	4	0
canned_juice	0	1	2	3	4	1	2	3	4	0
Paneer	0	1	2	3	4	1	2	3	4	0
Pizza	0	1	2	3	4	1	2	3	4	0
Cheese	0	1	2	3	4	1	2	3	4	0
Biscuit	0	1	2	3	4	1	2	3	4	0
Noodles	0	1	2	3	4	1	2	3	4	0
canned_food	0	1	2	3	4	1	2	3	4	0
Peanut	0	1	2	3	4	1	2	3	4	0
Cashew	0	1	2	3	4	1	2	3	4	0
Almonds	0	1	2	3	4	1	2	3	4	0
Walnut	0	1	2	3	4	1	2	3	4	0
Pistachio	0	1	2	3	4	1	2	3	4	0
Dried fruit	0	1	2	3	4	1	2	3	4	0
Bhujiya	0	1	2	3	4	1	2	3	4	0
veg_burger	0	1	2	3	4	1	2	3	4	0
chicken_burger	0	1	2	3	4	1	2	3	4	0
Potato chips	0	1	2	3	4	1	2	3	4	0
Donought	0	1	2	3	4	1	2	3	4	0
ice_cream	0	1	2	3	4	1	2	3	4	0
Chocolate	0	1	2	3	4	1	2	3	4	0
Sweets	0	1	2	3	4	1	2	3	4	0
Malpa	0	1	2	3	4	1	2	3	4	0
Swaari	0	1	2	3	4	1	2	3	4	0
Pakauda	0	1	2	3	4	1	2	3	4	0
french_fries	0	1	2	3	4	1	2	3	4	0
mustard_oil	0	1	2	3	4	1	2	3	4	0
sunflower_oil	0	1	2	3	4	1	2	3	4	0
soyabean_oil	0	1	2	3	4	1	2	3	4	0
Butter	0	1	2	3	4	1	2	3	4	0
Ghee	0	1	2	3	4	1	2	3	4	0
Sugar	0	1	2	3	4	1	2	3	4	0
Jaggary	0	1	2	3	4	1	2	3	4	0
Jam	0	1	2	3	4	1	2	3	4	0
Pickels	0	1	2	3	4	1	2	3	4	0

PHYSICAL ACTIVITY

(*In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.****)***

Activity at work

179. Does your work involve vigorous-intensity activity that causes large increase in breathing or heart rate like carrying or lifting heavy loads, digging or construction work, etc.. for at least 10 minutes continuously?
    (a) Yes _ (b) No
180. If Yes, In a typical week, on how many days do you do vigorous- intensity activities as part of your work? (no.of days) _____ (days/ month/year)
181. How much time do you spend doing vigorous-intensity activities at work on a typical day?_____ (minutes/ hour)
182. In a typical year, how many months are you involved in this activity? _____ months
183. Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously? (a) Yes __ (b) No __
184. In a typical week, on how many days do you do moderate- intensity activities as part of your work?
    ___ (days/month/year)
185. How much time do you spend doing moderate-intensity activities at work on a typical day? ___ (mins/ hour)
186. In a typical year, how many months are you involved in this activity? _____

Travel to and from places

(The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship)

187. Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?
    (a) Yes __ (b) No __
188. If yes, 10. In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places? _____ (days/ month/year)
189. How much time do you spend walking or bicycling for travel on a typical day? ___ (minutes/ hour)

Recreational activities

190. Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [running or football,] for at least 10 minutes continuously? (a) Yes __ (b) No __
191. If yes,13. In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities? (number of days) _____ (days/ month/year)
192. How much time do you spend during vigorous-intensity sports, fitness or recreational activities on a typical day? ___ (minutes/ hour)
193. In a typical year, how many months do you do vigorous-intensity sports, fitness or recreational activities?
    ____ months
194. Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate such as brisk walking,(cycling, swimming, volleyball)for at least 10 minutes continuously? (a) Yes __ (b) No __
195. If yes, 17 In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities? (Number of days) _____ (days/ month/year)
196. 18 How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day? ___ (minutes/ hour)
197. In a typical year, how many months do you do moderate-intensity sports, fitness or recreational activities?
    ____ months

Sedentary behavior

198. 20 How much time do you usually spend sitting or reclining on a typical day? ___ (minutes/ hour)

SF8

199. Overall, how would you rate your health in the past 4 weeks?
    (a) excellent__ (b) Very good__ (c) good__ (d) fair __ (e)poor __ (f) Very poor__
200. During the past 4 weeks, how much did physical health problems limit your usual physical activities (such as walking or climbing stairs)?
    (a) Not at all__ (b) Very little__ (c) Somewhat__ (d) Quite a lot__ (e)Could not do physical activites __
201. During the past 4 weeks, how much difficulty did you have doing your daily work, both at home and away from home, because of your physical health? (give options)
    (a) Not at all__ (b) Very little__ (c) Somewhat__ (d) Quite a lot__ (e)Could not do physical activites __
202. How much bodily pain have you had in the past 4 weeks?
    (a) None __ (b) Very mild__ (c) Mild__(d) Moderate__ (e) Severe__ (f) Very severe
203. During the past 4 weeks, how much energy did you have?
    (a) Very much __ (b) Quite a lot __ (c) Some __ (d) A little__ (e) None __
204. During the past 4 weeks, how much did your physical health or emotional problems limit your usual social activities with family or friends?
    (a) Not at all__ (b) Very little__ (c) Somewhat__ (d) Quite a lot__ (e)Could not do physical activites __

205. During the past 4 weeks, how much have you been bothered by emotional problems (such as feeling anxious, depressed or irritable)?

(a) Not at all__ (b) Very little__ (c) Somewhat__ (d) Quite a lot__ (e)Could not do physical activites __

206. During the past 4 weeks, how much did personal or emotional problems keep you from doing your usual work, school or other daily activities?

(a) Not at all__ (b) Very little__ (c) Somewhat__ (d) Quite a lot__ (e)Could not do physical activites __

PHYSICAL FUNCTION

Physical Functions	I can do	I can do with help or assistance	I cannot do	Refused/ Unknown
208. Do you have difficulty walking 1 kilometer?	1	2	0	9
209. Do you have difficulty walking inside your home?	1	2	0	9
210. Do you have difficulty getting out of a bed or chair?	1	2	0	9
211. Do you have difficulty walking up 10 steps?	1	2	0	9
212. Because of health or physical problems, do you have any difficulty or are you unable to…..				
a…do heavy housework like scrubbing floors or washing windows, or yard	1	2	0	9
b….do light housework, for example:- wiping table, clear dish, dusting, brooming etc	1	2	0	9
c… shop for personal items like toothepaste, soap, brush etc?	1	2	0	9
d….eat including feeding yourself?	1	2	0	9
e….dress yourself	1	2	0	9
f….bathe or shower?	1	2	0	9
g….use the toilet including walking to the toilet?	1	2	0	9
h….lifting or carrying something about 5 kg?	1	2	0	9
i…reaching out (stretch upper arm) ?	1	2	0	9
j….gripping with your hands?	1	2	0	9

DEPRESSION

213. Below is the list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the past week)

Labels	Rarely (less than 1 day)	Some (1-2 days)	Occasionally (3-4 days)
a. I was bothered by things that usually don't bother me.	0	1	2
b. I did not feel like eating; my appetite was poor.	0	1	2
c. I felt that I could not shake off the blues even with help from my family or friends.	0	1	2
d. I felt I was just as good as other people.	0	1	2
e. I had trouble keeping my mind on what I was doing.	0	1	2
f. I felt depressed.	0	1	2
g. I felt that everything I did was an effort.	0	1	2
h. I felt hopeful about the future.	0	1	2
i. I thought my life had been a failure.	0	1	2
j. I felt fearful.	0	1	2
k. My sleep was restless.	0	1	2
l. I was happy.	0	1	2
m. I talked less than usual.	0	1	2
n. I felt lonely.	0	1	2
o. People were unfriendly.	0	1	2
p. I enjoyed life.	0	1	2
q. I had crying spells.	0	1	2
r. I felt sad.	0	1	2
s. I felt that people dislike me.	0	1	2
t. I could not get "going."	0	1	2

STRESS

Many people experience ongoing problems in their everyday lives. Please tell us whether any of the following has been a problem for you:

214. Do you have serious ongoing health problem (yourself)? (a) Yes __ (b) No __ (c) Refused __
215. Has this been a problem for six months or more? (a) Yes __ (b) No __ (c) Refused __
216. Would you say this problem has been: (a) Not very stressful __ (b) Moderately stressful __ (c) Very stressful_
217. Does someone close to you have serious ongoing health problem? (a) Yes __ (b) No __ (c) Refused __
218. Has this been a problem for six months or more? (a) Yes __ (b) No __ (c) Refused __
219. Would you say this problem has been (a) Not very stressful __ (b) Moderately stressful __ (c) Very stressful_
220. Do you have ongoing difficulties with your job or ability to work ? (a) Yes __ (b) No __ (c) Refused __
221. Has this been a problem for six months or more? (a) Yes __ (b) No __
222. Would you say this problem has been (a) Not very stressful __ (b) Moderately stressful __ (c) Very stressful_
223. Do you have ongoing financial strain? (a) Yes __ (b) No __ (c) Refused __
224. Has this been a problem for six months or more? (a) Yes __ (b) No __ (c) Refused __
225. Would you say this problem has been(a) Not very stressful __ (b) Moderately stressful __ (c) Very stressful_
226. Do you have ongoing difficulties in a relationship with someone close to you? (a) Yes __ (b) No__(c) Refused
227. Has this been a problem for six months or more? (a) Yes __ (b) No __ (c) Refused __
228. Would you say this problem has been (a) Not very stressful __ (b) Moderately stressful __ (c) Very stressful_

MMSE

229. What is the year ? _____
230. What is the date (yyyyy-mm-dd) ?__ __ __ __ / __ __ / __ __
231. What is the day ? _____
232. What is the month? _____
233. Where are we? Name of the country (a) Nepal __ (b) Don't know __
234. Zone (a) Bagmati __ (b) Don't know __
235. District (a) Kavrepalanchwok __ (b) Don't know__
236. Municipality/Village Development Committee (a) Dhulikhel __ (b) Don't know__
237. Tole : _____

(I am going to name 3 objects. There will be 1 second interval to name each object. Please repeat the names of the objects after I have said them: (Give one point for each correct answer. Then repeat them until the participant learns all three.) (Y/N)

238. Repeat the names: (a) Ball __ (b) Car __ (c) Comb __ (d) Times taken to say all 3 objects ___
239. Please spell this word backwards: "DHU-LI-KHE-LA" ___
240. I had named 3 objects to you. Can you please repeat the names of the three objects?
    (a) Ball __ (b) Car __ (c) Comb __ (d) Times taken to say all 3 objects ___
241. I am going to show two objects to you. Can you please name them? (a) Pen __ (b) Other __
242. Can you name it please? (notebook) (a) Notebook __ (b) Other __
243. Please repeat the following: "No ifs, ands or buts" (a) Repeat __ (b) Can not repeat __
244. I am going to give you a three stage command. Please follow it. Here is the command:
245. Take a paper in your hand (a) Yes __ (b) No __
246. Fold it in half (a) Yes __ (b) No __
247. Put it on the floor (a) Yes __ (b) No __
248. There is a command written here. Please read it and obey the following: "Close your eyes."
    (a) Closed eyes __ (b) Did not close eyes __ (c) Can not read__
249. *Please write a sentence. (Give one point if the sentence has a subject and a verb and can be understood. Spelling mistakes are permissible)*
    (a) can write a sentence__ (b) cannot write a sentence__ (c) cannot write (illiterate) __
250. Show a picture of pentagon. Please copy the design given below (Give one point if the design has two figures with five sides and five and angles each and shows a four sided intersection.).
    (a) Correct design__ (b) Incorrect design __ (c) Refused __
251. Digit Span Substitution task

    Place the task sheet before the participant and pointing to the task say: Look at these boxes across the top of the page. On the top of each box are number one through nine. On the bottom part of each box there is a symbol. Each symbol is paired with a number. Point to the four rows of the boxes. Down here are boxes with numbers on the top, but the bottom part is blank. I want you to put the correct symbol in each box like this. Fill in the first three sample boxes. Now I want you to fill in all boxes up to this line. After demonstration and practice is complete, point to the first box following the sample items and say. When I tell you to begin, start here and fill in the boxes in these four rows. Do them in order and don't skip any, please try to work as quickly as possible. Let's begin. If the participant has difficulty completing the ten sample items or does not grasp the task, help him complete the sample items. If the participant still has difficulty, discontinue the task. If participants do the task, stop the participants after 90 seconds. Say that's good. This complete this set of tasks

252. Test result- test items
    (a) Done __ (b) unable to do -physical disability__ (c) unable to do - vision/hearing__ (d) Refused__
253. Number of Symbols Correctly Coded: ____
254. Number of symbols incorrectly Coded: ____

DIGIT SPAN TEST

Digit Span Test Forward

255. I am going to say some numbers. Listen carefully, and when I am through say right after me. For example, if I say 7-1-9, what would you say? If the participant succeeds, say- That's right. If the participants, fails the example, say - No, you would say 7-1-9. I said 9-1-9, so to say it forwards you would say 7-1-9. Now try these numbers. Remember, you are to say them forwards, 3-4-8. Whether the participant succeeds or fails with the second example (3-4-8), proceeds to item 1. Give no help to second example or any of the items. Only discontinue test if the participant has failed both trials of same span length eg 5a and 5b

Item	Pass	Fail	Does not know number	Refused
1a. 1—7	1	0	2	9
1b. 6—3	1	0	2	9
2a. 5--8—2	1	0	2	9
2b. 6--9—4	1	0	2	9
3a. 6--4--3—9	1	0	2	9
3b. 7--2--8—6	1	0	2	9
4a. 4-2-7-3-1	1	0	2	9
4b. 7-5-8-3-6	1	0	2	9
5a. 6-1-9-4-7-3	1	0	2	9
5b. 3-9-2-4-8-7	1	0	2	9
6a. 5-9-1-7-4-2-8	1	0	2	9
6b. 4-1-7-9-3-8-6	1	0	2	9
7a. 5-8-1-9-2-6-4-7	1	0	2	9
7b. 3-8-2-9-5-1-7-4	1	0	2	9
8a. 2-7-5-8-6-2-5-8-4	1	0	2	9
8b. 7-1-3-9-4-2-5-6-8	1	0	2	9

Digit Span Test Backward

256. (Proceed this step as the Digit span Test Forward has been done but here the only one different step is that the say the digits as it is mentioned below and the respondent will say from the backward. For eg: if you say 1-2 then the respondent has to say 2-1.

Item	Pass	Fail	Does not know number	Refused
1a. 2--6	1	0	2	9
1b. 5--7	1	0	2	9
2a. 6—2—9	1	0	2	9
2b. 4—1—5	1	0	2	9
3a. 3-2-7-9	1	0	2	9
3b. 4-9-6-8	1	0	2	9
4a. 1-5-2-8-6	1	0	2	9
4b. 6-1-8-4-3	1	0	2	9
5a. 5-3-9-4-1-8	1	0	2	9
5b. 7-2-4-8-5-5	1	0	2	9
6a. 8-1-2-9-3-6-5	1	0	2	9
6b. 4-7-3-9-1-2-8	1	0	2	9
7a. 1-4-3-7-6-2-5-8	1	0	2	9
7b. 7-2-8-1-9-6-4-3	1	0	2	9

HEALTH KNOWLEDGE, ATTITUDE AND BEHAVIOR

257. What does birth control pill not do?
(a) Prevent unplanned pregnancy__ (b) Regulate a women's menstrual cycle__
(c) Prevent STD and HIV transmission (d) Planned for number of children you want __
(e) Don't know__ (f) Refused __

258. Which of the following is not the way that HIV is transmitted?
(a) Sexual contact or intercourse __ (b) Injection drug use __
(c) Pregnancy__ (d) Planned for number of children you want __
(e) Don't know__ (f) Refused __

259. Which is not the risk factor of diabetes?
(a) Family member has diabetes __ (b) Being overweight __ (c) Eating too many sweets __ (d) Walking everyday __ (e) Don't know__ (f) Refused __

260. 16_4 Which of the following is not the way to get diarrhea?
(a) Contact from friend __ (b) Untreated water __ (c) Food __
(d) Washing hands __ (e) Don't know__ (f) Refused __

261. On the past 30 days, do you hear or see a health related (family planning, HIV, diarrhea, etc) public service announcement on? (a) Radio __ (b) TV __ (c) Newspaper __

262. How many times in the past six months have you been hospitalized? _____
263. How many times in the past six months have you personally visited a doctor or a nurse for a health issue? ___

GEOGRAPHICAL ASSESIBILITY

264. What is the nearest health center, Dhulikhel Hospital or a different one? (a) Dhulikhel hospital __ (b) PHCC__
265. How do you normally travel to nearest health center? (a) On foot __ (b) Bicycle __ (c) Mortor __
266. How long does it take you to travel to the health center in minutes for your typical mode of transport? ___
267. How do you normally travel to Dhulikhel hospital? a) On foot __ (b) Bicycle __ (c) Mortor __
268. How long does it take you to travel to Dhulikhel Hospital in minutes for your typical mode of transport? ___

SOCIAL NETWORK

269. In the past month, how many times have you visited a family members and a friend's house? _____
270. Do you participate in an organization or cooperative in your community? For instance, a water committee, women's group, forest group, or NGO. (a) Yes __ (b) No __

HEALTH INSURANCE

Let me give you some brief information about health insurance. Health insurance is a product that you can purchase for yourself or someone in your family that will reduce the payments you would make to the doctor and/or health center/hospital when it is visited. The insurance covers some but not all illnesses and payments associated with treatment. Which services are covered depends on the insurance plan.

271. Have you heard of health insurance before today? (a) Yes __ (b) No __

Possible costs of insurance include a:-Premium: This is a set amount of money you have to pay every month. Even if you do not get sick or go to the health center/hospital during that month you will still have to pay the fee regularly and you will not get your money back. A family premium covers five members in your family of your choosing. If you have more than five members, not all five people can be covered and the insurance cannot switch between insured and uninsured members. Copayment: Some health insurance plans will require the member to pay part of their own fees in addition to the monthly premium.

272. Who is covered by the health insurance? Mark all that apply. (If whole family is selected, proceed to the next question)
(a) Whole family __ (b) head of the household __ (c) Husband __ (d) Wife __ (e) Father __
(f) Mother __ (g) Son __ (h) Daughter __ (i) Grand father (j) Grand mother__
(k) Brother __ (l) Sister __

Dhulikhel Hospital is considering establishing the Dhulikhel Hospital Health Insurance Program. They are interested in learning how many people would participate in such a program. We will describe this program and ask whether you would be willing to pay the required fees to participate in this program. For this health insurance plan it covers your family, up to 5 selected individuals. In addition to paying the premium, every time that you or your dependent gets a basic drug, you would have to pay a 20% co-payment. Please mention the bid amount that you just asked

273. Would you be willing to pay [fill in randomly chosen bid amount: (……Rupee) a month for family (five person) premium health insurance with a 20% co-payment that covered the following health-related treatments and/or services that are currently available at Dhulikhel Hospital? (Y/N)
(a) Emergency service __ (b) Laboratory __ (c) Radiology__ (d) In-patient __
(e) Dental __ (f) Physioterapy __ (g) ICU __ (h) Surgery __
(i) Dialysis __ (j) CCU __
(k) Medication (except dermatological, some orthopedic medication like bandage or arm splint etc),__

This is a follow up question to f3 and should be asked casually. If the respondent answered yes to their given bid value, they should be asked if they would pay the next higher bid amount. Or if the respondent answered no to their given bid value, they should be asked to pay the next lower bid amount. Here are the bid amounts: 1, 10, 50, 100, 150, 200, 300, 400, 500, 700, 900, and 1200. For example: The respondent was asked if they would pay 50 Nrs for the insurance, they said yes. You would ask if they would pay 100 Nrs for the insurance (the next higher amount). The respondent was asked if they would pay 300 Nrs for the insurance, they said no. You would ask if they would pay 200 Nrs for the insurance (the next lower amount). Please mention the second bid amount

274. What if you were instead asked pay _____ Nrs for the insurance. Would you buy the health insurance?
275. If you had to select only five people in your family to insure, who would, they be (relationship with household head)?
(a) _____ (b) _____(c) _____ (d) _____ (e) _____

276. Please tell us how important to you that the following services be covered by the health insurance? Tell us how important to you that the following

Services	extremely important	somewhat important	not that important	not at all important
1. Prescription Drugs	4	3	2	1
2. Laboratory Tests	4	3	2	1
3. Hospital Stays	4	3	2	1
4. Surgery Expenses	4	3	2	1
5. X-Rays	4	3	2	1
6. Doctor Fees	4	3	2	1
7. Hospital Fees	4	3	2	1

277. Please tell us how important to you that the following illness/health issues be covered by the health insurance?

Health Issues	extremely important	somewhat important	not that important	not at all important
1. . Prenatal Care	4	3	2	1
2. Uterine Prolapse	4	3	2	1
3. Child Delivery	4	3	2	1
4. Heart Problem	4	3	2	1
5. Eye problem	4	3	2	1
6.Asthma/Breathing problem	4	3	2	1
7. Diabetes	4	3	2	1
8. Flu/ Fever	4	3	2	1
9. Dental problem	4	3	2	1

278. Were you hospitalized in Dhulikhel hospital for any health problem in the past year? (a) Yes __ (b) No__
279. Do you have the Hospital Card? (a) Yes __ (b) No __
280. Card number(Hospital ID) _____

WOMEN'S HEALTH

Now I would like to ask you about all the menstruation, pregnancies and hormonal contraceptive use during your life

281. At what age did you begin having your menstruation period? _____
282. Have you ever been pregnant? (a) Yes ____ (b) No ____
283. If yes, How many pregnancies have you had (Please include miscarriage) ? _____
284. How many children that you have been given birth to ? _____
285. How many children that you have given birth to are alive? _____
286. How old were you when you were pregnant for the first time?_____ years

Now I would like to talk about family planning- the various was or methods that a couple can use to delay or avoid a pregnancy.

287. Have you ever used contraceptive oral pills? (a) Yes _____ (b) No _____
288. At what age, did you first used pills?(in years) _____ years
289. What is the brand name of the pills that you used?
(a) Nilocon White ___ (b) Sunaulo Gulab __ (c) Feminyl __ (d) Femicon __ (e) OK pills __
290. How long did you use each of the pills (count all period even if you discontinued in between)? (If less than 1 month, write 00. Please note down the months, if years, weeks or days are mentioned then convert it into months)
(a) Nilocon White ___ (b) Sunaulo Gulab __ (c) Feminyl __ (d) Femicon __ (e) OK pills __
291. Did you ever use injectable (sangini 3 monthly injection) ? (a) Yes ___ (b) No ____
292. At what age, did you first use injectables? _____ years
293. How long did you use injectables _____
294. Have you ever used implants (Norplant)? (a) Yes ___ (b) No ___
295. At what age, did you start using implants (in years) ? _____
296. How long did you use implants (in months, if less than a month wirte 00) ?.....
297. Have you ever used IUD? Yes ___ (b) No ___
298. At what age, did you start using IUD? _____years
299. How long did you use IUD (count all period even if you discontinued in between)? _____months
300. Are you still having your menstrual period?
(a) No __ (b) Yes, regularly ___ (c) Yes, as usual ___ (d) Refused ___
301. How old were you when your periods stopped completely / Irregular? _____
302. Have you ever used Hormone Replacement Therapy (menopause medicine) when you suffered from hot flashes and sweating at night? (a) Yes ___ (b) No ___
303. How old were you when you first used HRT? _____
304. Are you still using HRT? (a) Yes ___ (b) No ___
305. How old were you when you stopped using HRT? _____

MEDICINE INTAKE HISTORY

306. Are you taking any medicine in the last 15 days? (a) Yes _____ (b) No _____
307. If yes, please bring me all the medicines or packages.
308. Which of them are prescribed by doctor or health worker?

S.N	Name of the medicine	Yes/ No	Dose	Dose unit	Frequency (per day)	Reason for taking	When started taking medicine
1	Atenolol						
2	Aforpaital						
3	Aspirin						
4	Clopidogrel						
5	Digoxin						
6	Ennlapril						
7	Frusemide						
8	Glibenclamide						
9	Hydrochlorothiazide						
10	Glipizide						
11	Hydrochlorliazide						
12	Insulin						
13	Losartan						
14	Metformin						
15	Metoprolol						
16	Ramipril						
17	Spironolactone						
18	Telmisartan						

309. What side effects you had, if any?
(a) Depressin __ (b) Dizziness __ (c) Dry cough __ (d) Headache __ (e) Impotence __
(f) Nausea __ (g) Vomiting __ (h) Vomiting __ (i) No side effects __
310. In the past 15 days, did you take any herbal, ayurvedic medicine or homemade medicine?
(a) Yes__ (b) No __
311. If yes, what are they ?

S.N	Name of the medicine	Dose	Dose unit	Frequency (per day)	Reason for taking	When started taking medicine (yyyy/mm/dd)

312. What side effects you had, if any?
(a) Depressin __ (b) Dizziness __ (c) Dry cough __ (d) Headache __ (e) Impotence __
313. (f) Nausea __ (g) Vomiting __ (h) Vomiting __ (i) No side effects __

MEASUREMENT

Now we are going to take some measurements

314. Blood Pressure (three measurements)
Systolic blood pressure (1st) __ Systolic blood pressure (2nd) __ Systolic blood pressure (3rd) __
Diastolic blood pressure (1st) __ Diastolic blood pressure (2nd) __ Diastolic blood pressure (3rd) __
Pulse (1st) Pulse (2nd) ___ Pulse (3rd) ___

315. Anthropometry
(a) Height :____ cm (b) Weight :___ pounds (c)Waist :___ cm (d) Hip: ___ cm
(e) Neck to middle finger: ___ cm

316. Interview end time: _____

Thank you.
This is the end of the interview.