SUMMARY

Introduction

The World Health Organization (2011) uses the term cardiovascular diseases (CVDs) to describe ‘the diseases of the heart, vascular diseases of the brain and diseases of blood vessels’. These diseases include coronary artery (heart) disease, hypertension, congestive heart failure, congenital heart failure, congenital cardiovascular defects and cerebrovascular disease. Cardiovascular diseases are responsible for over 17.3 million deaths per year and are the world’s number one cause of death (WHO, 2011; Murphy et al., 2012). CVD was responsible for less than 10% of all global deaths at the beginning of the 20th century (Thomas et al., 2006), but by 2005 it rose to 30% and is expected to further rise to 37% by 2030 (WHO, 2011). About 80% of these deaths were in low- and middle-income countries (Gaziano et al., 2010; Taylor, 2010; Gupta et al., 2011; WHO, 2011; Murphy et al., 2012). Among the cardiovascular diseases coronary heart disease (CHD) and stroke are the first and second most common causes of death worldwide (Husseini et al., 2009). Cardiovascular disease in developing countries is spreading epidemically, related to aging population, changing lifestyle (due to industrialization and urbanization) and nutrition transition (Reddy and Yusuf, 1998; Kuulasmaa et al., 2000; Unal et al., 2004; Reddy et al., 2005). Yusuf et al. (2001) categorized the epidemiological transition in the world into four stages. India is now at the third stage of this transition.

Epidemiologists in India and international agencies such as the world health organization (WHO) have been sounding an alarm on the rapidly rising burden of CVD for the past 15 years. It is estimated that by 2020, CVD will be the largest cause of disability and death in India, with 2.6 million Indians predicted to die due to CVD (Mohan et al., 2008; Goenka et al., 2009; Taylor, 2010; Boparai et al., 2011). The prevalence of hypertension varies around the world with the lowest prevalence in rural India (3.4% in men and 6.8% in women) and the highest prevalence in Poland (68.9% in men and 72.5% in women) (Kearney et al., 2005). Determination of the relative roles of genes and environment in the etiology of high blood pressure is very important.
In India, the burden of cardiovascular diseases has increased many folds in recent times due to increase of westernized diets, life styles and the increasing mean age of populations. The risk factors for cardiovascular disease seem to cut across all cultural patterns and geographic regions in India. Many studies have found that the aggregation of these risk factors due to genetics is greater than environmental origin. Therefore, it is essential to understand how blood pressure is influenced by familial factors (both genetic and environmental) and how these contribute to the risk for cardiovascular diseases.

Objectives

The major objectives of the study are (i) to examine the prevalence of pre-hypertension, hypertension and to provide overall essential baseline data for cardiovascular diseases among the study population (ii) to identify better anthropometric, physiometric and socio-economic lifestyle indicators to predict cardiovascular diseases and their basic relationship and impact on the occurrence of the disease (iii) to describe the genetic heritability and familial household contribution to the phenotypic variation for cardiovascular risk factors especially for SBP and DBP.

Materials and Methods

Target Population: The total objectives were examined in the Ramadasia community. This community was recognized as socially, educationally and economically backward class in Punjab, which was also recognized as scheduled caste population (under article 341(1) (2) of the constitution of India). The Ramadasia communities had traditionally been relegated to the most menial labour with negligible possibility of upward mobility and also subject to social disadvantages and exclusion in comparison to the wider community. Therefore, socio-economic status of the families was rated as far below than average Indian social structure. The selection of this scheduled caste community from state of Punjab for this study is due to the fact that this huge population has never been examined before. The other reasons for chosen this backward community is the familial structure of the population. Mostly, they were living in joint family with atleast two generations and sharing common household environment, socio-economic, health and genetics. The composition of household consists of father, mother, grandfather and
grandmother, a group of brother and their wives and their sons and unmarried daughter. Most of the women came in the family after marriage and shared household of their husbands (Badaruddoza and Brar, 2006; Byard et al., 1989).

**Sampling Design**: This study used a stratified multistage cluster random sampling design. The present sample is supposed to represent Ramadasia scheduled caste population of ages 7 years and above including three generation i.e. grandparental, parental and offspring generation. The present survey had special emphasis on parental and offspring generation. The survey was oversampled to produce reliable estimates for these generations especially parental and offspring generations. Sampling was done in four stages. The detailed has been discussed in the thesis. Sampling was done in four stages. In first stage strata were selected, the four districts (primary sampling units) out of total 22 districts of Punjab were selected. Second stage involved sample size determination and cluster formation through power analysis. Third stage involved proforma designing. The questionnaire was grossly divided in three parts socio-economic lifestyle variables (age, sex, family status, education level, occupation, income, food habit, physical activity, exercise, smoking and alcohol ), physiometric measurements (SBP, DBP, MBP, pulse rate and pulse pressure) and anthropometric measurements (height, weight, waist circumference, hip circumference, arm circumference, calf circumference, biceps skinfold, triceps skinfold, WHR and BMI). In the fourth stage data collection was done on house to house basis. Only those families having at least two generations were included. The total number of selected clusters, numbers of household are 61 and 600 respectively and the total number of samples studied after exclusion criteria were 1827, including 911 males and 916 females. As our study is familial in nature our whole samples were divided into three generations offspring (639), parents (954) and grandparents (234) generations. Detail calculation of sample size determination through power analysis has been in the thesis.

**Measurements**: All the measurements of anthropometric, physiometric and informations of socio-economic life style variables have been done on each subject through standard technique and protocol. The details have been given in the thesis.
Analysis: All the data were analyzed through different statistical methods such as descriptive, correlation, linear regression, multiple regressions, $R^2$ (coefficient of determination), stepwise regression, logistic regression, wald chi square statistics, student’s t-test, odds ratio, sensitivity, specificity, Youden’s index, principal component factor analysis have been done using SPSS (v.17.0) Statistical Package for Social Sciences.

Results and Discussion

Prevalence: The results of the present study indicated that prevalence of pre-hypertension with normal BMI has been found to be maximum in male offspring generation (20%) which is followed by male parental (19%) and grandparental (7.45%) generations. The prevalence of hypertension with normal BMI has been found maximum in male grandparental generation (34%) which is followed by male parental (5.69%) and male offspring (1.59%) generation. The highest prevalence of pre-hypertension and hypertension with normal BMI were found in female offspring (13%) and male grandparental (20.71%) generations. Therefore, individuals with normal BMI have significantly higher risk to develop cardiovascular risk in male and female offspring and male grandparental generations as compared to overweight and obesity. However, obese individuals have developed hypertension in male and female parental and female grandparental generations. As the present study in generation based, it posed a difficulty in comparison of present results with a previous investigation on relative risk of hypertension. Nevertheless, this study agrees with findings of other previous investigations that have showed that risk of hypertension increased with increasing BMI. However, this is not the case especially in younger generation or offspring generations.

When the subjects were classified into normal, overweight and obese categories with criteria based on waist circumference (adopted from Yalcin et al., 2005) then different picture has been found. The prevalence of pre-hypertension and hypertension with overweight and obese subjects have been found maximum in male and female parental generations; male and female grandparental generations. Whereas, subjects with normal waist circumference range have maximum prevalence of pre-hypertension and
Summary

hypertension in only male offspring generation. The results of female offspring generation are inconsistent. Waist circumference was the most important anthropometric indicator in men and women for prediction of cardiovascular diseases. This highlights the importance of android obesity in blood pressures. The present study has also observed a progressive increase in the prevalence of elevated blood pressure with increasing of overweight and obesity based waist circumference criteria. Also according to WHR measurement cut-off points, the prevalence of pre-hypertension and hypertension have been found maximum with overweight and obese subjects in male and female parental generations and male and female grandparental generations. The maximum prevalence of pre-hypertension and hypertension has been observed with normal range of WHR in male offspring generation.

The results of present study revealed that waist circumference and WHR were slightly better predictors as compared to BMI to understand the relationship between obesity and cardiovascular risk development. Although, BMI is widely used as measure of fatness in epidemiological studies because this index is highly correlated with body fat. In the present study, based on BMI it can be concluded that general obesity is quite prevalent in all generations. However, prevalence of central obesity, as observed by waist circumference is higher than general obesity in most of the generations (female offspring, male and female parental and grandparental generations). This may be partly related to the nature of the diet and sedentary lifestyle. This has been also reported in many recent studies (Ketel et al., 2007; Sarkar et al., 2009; Badaruddoza et al., 2011).

However, subjects with higher education level such as graduate/ post graduate/ professional had very low prevalence of hypertension. This showed education has relation with the prevalence of hypertension in every generation. In this study, low education level or illiteracy was significantly related to CVD in males and females. However, occupation did not show any relation with the prevalence of CVD. The prevalence of pre-hypertension and hypertension have shown to be maximum in lower middle class for male offspring, male and female parental generations and male grandparental generation. In many Indian study (Rastogi et al., 2004; Jeemon and
Reddy, 2010) showed significantly higher CVD risk among low socio-economic group compared to high socio-economic group.

As the epidemiological transition is taking place in India with the background of economic globalization, therefore, CVD risk factors among Indian poor and middle class is rapidly increasing. Thus, the impact of globalization changed behavioral pattern of middle and poor class people in India. Therefore, higher level of tobacco and alcohol use, obesity, overweight and hypertension are associated with lower levels of education and income in India (Gupta, 2006; Reddy et al., 2007).

The results obtained from the present study in respect of food habits was that vegetarians exhibit higher blood pressure (pre-hypertension and hypertension) among female offspring generation (10.34% for pre-hypertension; 1.92% for hypertension), female parental generation (15.92% for pre-hypertension; 13.59% for hypertension) and female grandparental generation (17.14% for pre-hypertension; 46.43% for hypertension). Non-vegetarians exhibit higher blood pressure among male offspring generation (13.49% for pre-hypertension; 2.12% for hypertension); male parental generation (26.88% for pre-hypertension; 13.21% for hypertension) and male grandparental generation (7.44% for pre-hypertension; 31.91% for hypertension). It is interesting to note that most of the males with pre-hypertension and hypertension were non-vegetarian and they preferably consumed red meat, soft and hard beverages and processed and fast foods with high fats. But, most of the females with pre-hypertension and hypertension are vegetarians.

The present analysis addressed the association of physical activity and CVD risk factors among three generations. No physical activity or exercises were associated with significantly increased risk of CVD, independent of sex and generations. The apparent protective effect with moderate intensity of exercise and physically active lifestyle on CVD has been observed in all generations.

The present study has revealed a substantially high rate of non-smokers (90.48% in general) in this community in all generations among men and women. Therefore, no specific relationship between this behavioral risk factor and CVD has been found. This
is also due to the fact that the Sikh religion does not permit to smoke in men and women. However, the picture of alcohol consumption is different. It was found that 94% of male offspring, 51% of male parents and 48% of male grandparents were non-alcoholics and had never drunk in their lifetime, whereas, 6% of male offspring, 49% of male parents and 52% of male grandparents consumed alcohol at regular or at some point of time. All the females in every generation did not smoke or consume alcohol. These findings clearly indicate that respondents with lower socio-economic background had a higher rate of prevalence of alcohol consumption except in the case of offspring generation due to lower age group and financial constraints. This finding was consistent with the observations in India and other countries also (Sugathan et al., 2008; Kaur et al., 2011).

Correlation: In the context of simple Karl Pearson’s Product moment correlation between anthropometric, socio-economic lifestyle variables with SBP, DBP and MBP among all the generations have shown significant independent relationship of these variables. The data clearly showed that almost all anthropometric traits except WHR and the level of education and stress (physical/psychological/psychosocial) among both males and females have been found to be significantly correlated with SBP, DBP and MBP. All anthropometric variables for both male and female parents, occupation, income and alcohol for only male parents have been found to be significantly correlated with SBP, DBP and MBP. However, strength of correlation has been different for different anthropometric and socio-economic lifestyle factors within different generations. Hence, the study also suggested the especially BMI and waist circumference would be simple and significant indicator for the management of moderate or high risk of cardiovascular diseases and regular health care system in the present community.

Regression Analysis: As regards of blood pressure indices many interesting results with respect to regression analysis have emerged. Across blood pressure phenotypes for all three generations; offspring, parental and grandparental, almost all anthropometric and socio-economic lifestyle variables were atleast moderately related to blood pressures on the basis of univariate regression analysis. In the linear regression analysis,
it has been observed that the main independent contributory risk factors to the total variation of SBP and DBP were as such: age (33% and 20% for SBP and DBP, respectively), waist circumference (32% and 13% for SBP and DBP, respectively), stress (18% for SBP), income (18% for SBP), occupation (14% for SBP) in male offspring generation. However, any of the socio-economic lifestyle variables has no significant contribution to DBP. The contribution of hip circumference (12.8% and 4.8% for SBP and DBP, respectively), weight (10.9% and 5.9% for SBP and DBP, respectively) and education (3.3% and 4.4% for SBP and DBP, respectively) were significant in female offspring generation. The main independent contributions in male parental generations were by pulse rate (8% for SBP), skinfold thickness (6% for DBP), income (4.2% for SBP) and alcohol (71% for DBP). The main independent contributions in female parental generation were for pulse pressure (72% for SBP), waist circumference (7% for DBP). The main contributions in male grandparents were found for pulse pressure (66% for SBP), age (14% for DBP), alcohol (27% for SBP) and exercise (17% for DBP). The main contributions for female grandparent were by pulse pressure (83% and 20% for SBP and DBP, respectively). No socioeconomic variable had significant contribution in male parental and grandparental generations.

The study showed that different predictors have different contribution in different generations. It is difficult to find out a single significant contributory predictor in all generations. Therefore, such type of study would generate valuable information on the nature-nurture interaction involved in the chronic diseases like cardiovascular diseases.

**Multiple Regression Analysis:** However, when blood pressures were regressed on the different sets of variables using multiple regression analysis, then fewer variables were found to be statistically significant at 5% level. This suggested that some of the variables among anthropometric and socio-economic lifestyle factors are primary in nature (significant multivariate correlates) while others are secondary (non-significant multivariate correlates) in different generations.

It is also interesting to note that in multivariate system, cumulative contribution of the maximum total variance ($R^2$) for anthropometric variables were 86% and 33% for SBP and DBP respectively among female grandparental generation and lowest contributions
(R²) were 50% and 14% for SBP and DBP among female offspring. For socio-economic lifestyle factors the similar results were as follows; 30% and 15% for SBP and DBP among female parental and male offspring generations, respectively and lowest contributions 4% and 1% for SBP and DBP among female offspring and female parental generation respectively. However, in offspring generations, the cumulative contribution of anthropometric risk factors to the total variations is 56.9% and 50% for SBP and 22.9% and 13.9% for DBP in male and female offspring, respectively. The similar observation of socioeconomic lifestyle variables were 29% and 3.8% for SBP and 14.6% and 4.3% for DBP in male and female offspring, respectively. The data suggested that a stronger and greater impact of anthropometric and socioeconomic lifestyle variables on SBP as compared to DBP.

**Stepwise Regression Model:** All alternative regression models such as five and eight models for all possible subsets among anthropometric and socio-economic lifestyle factors have been used for greater explanatory power for the association of CVD. The selection of predictor variables in the models have been chosen with respect to largest correlation with the criterion variables such as SBP and DBP. The first predictor variables were selected based on the highest partial correlation followed by second, third and other predictor variables based on the respective highest partial correlation in the forward selection. The final model contains all of the independent variables that meet the inclusion criteria. The model used are as such: model 1- age; model 2- age+ BMI; model 3-age+ BMI+ WC; model 4- age+ BMI+ WC+ WHR; model 5- age+ BMI+ WC+ WHR+ pulse rate for anthropometric predictors and for socio-economic lifestyle predictors; model 1- occupation, model 2- occupation+ income; model 3-occupation+ income+ education, model4-occupation+ income+ education+ food habits; model 5- occupation+ income+ education+ food habits+ physical activity; model 6-occupation+ income+ education+ food habits+ physical activity+ exercise; model 7-occupation+ income+ education+ food habits+ physical activity+ exercise+ smoking; model 8- occupation+ income+ education+ food habits+ physical activity+ exercise+ smoking+ alcohol. The R is the measure of correlation between observed value and predicted value of the criterion value (SBP and DBP) whereas, R square (R²) is the square of the measure of correlation and indicates the portion of variance in the criterion
value (SBP and DBP) which is accounted by the respective model. Overall statistical significance of a regression model is checked by F-test statistics.

The significance indicates only that the model is not useless. It may or may not be sufficiently good fit. The complement of ‘goodness of fit’ is denoted by also $R^2$. The larger the $R^2$, the better is the fit. $R^2$ is also used to compare one model with another. Using stepwise multiple regression analysis, the present study has shown that almost all anthropometric models (1-5) and socio-economic lifestyle models (1-6 for females and 1-8 for males) have significant and pronounced influences on SBP and DBP. The regression coefficients of all models were significant at $p<0.001$.

**Logistic Regression Analysis:** On binary logistic regression analysis, the magnitude and nature of significant association between pre-hypertension/hypertension with anthropometric and socioeconomic lifestyle variables were different in different generations. Logistic regression is useful for the present situation in which the study is able to classify subjects based on values of a set of predictor variables such as anthropometric and socio-economic lifestyle factors. In the present study the risk of developing pre-hypertension was highest among both the male and female parental generations with respect to WHR (1.5 times) and among female grandparents with respect to sedentary/active lifestyle (2.2 times) as compared to other anthropometric and socio-economic lifestyle risk factors. Similarly risk of developing hypertension was maximum with respect to WHR (9.9 times higher for male parents and 4.4 times higher for female parents) among parental generation and for socio-economic lifestyle factors, exercise (2.14 times) and education (2.84 times) have greater impact among male offspring and female offspring generations, respectively as compared to other variables. However, overall it was observed that BMI, WHR and waist circumference have almost equal association with development of pre-hypertension and hypertension. For socio-economic lifestyle variables greater influence was found for exercise, education, food habit and physical activity (sedentary/active).

**Principal Component Factor Analysis:** The current study focused on one of the major objective, to determine significant cardiovascular risk factors through principal component factor analysis (PCFA) among three generations. The study performed
PCFA with orthogonal rotation to reduce 12 inter-correlated variables into groups of independent factors. The factors have been identified as 2 for male grandparents, 3 for male offspring, female parents and female grandparents each, 4 for male parents and 5 for female offspring. This data reduction method identified these factors that explained 72%, 84%, 79%, 69%, 70% and 73% for male and female offspring, male and female parents and male and female grandparents respectively, of the variations in original quantitative traits. The factor 1 accounting for the largest portion of variations was strongly loaded with factors related to obesity (BMI, waist circumference, WHR and thickness of skinfolds) among all generations with both sexes, which has been known to be an independent predictor for cardiovascular morbidity and mortality. The second largest components, factor 2 and factor 3 for almost all generations reflected traits of blood pressure phenotypes loaded, however, in male offspring generation it was observed that factor 2 was loaded with blood pressure phenotypes as well as obesity. Therefore, in the present study factor analysis has been applied to investigate the clustering of variables that are thought to be important components of CVD. Hence, the analysis yielded only two clusters of factors such as obesity and elevated blood pressure with pulse pressure and pulse rate which is also not unusual in the literature. The majority of the studies have reported to these factors (Badaruddoza et al., 2010; Badaruddoza et al., 2011; Kaur et al., 2012).

The present model suggested that clustering of variables in obesity and blood pressure was a result of multiple factors in which centripetal fat and blood pressure (SBP and DBP) played key roles. Moreover, all the loaded risk variables (anthropometric and physiometric) are modifiable in nature. Therefore, it seems reasonable to argue that early prevention and proper intervention strategies to promote healthy lifestyle to reduce the burden of CVD in this population.

**Remark:** This study not only confirmed but also extended prior work by developing a cumulative risk scale from factor scores. Till today, such a cumulative and extensive scale has not been used in any Indian studies with individuals of three generations. These findings and study highlight the importance of global approach for assessing the risk and need for studies that elucidate how these different cardiovascular risk factors
interact with each other over the time to create clinical disease. The findings also added depth to the negligible amount of literature of factor analysis of cardiovascular risk in any Indian ethnic population.

**Familial Correlation:** Results from this study of extended nuclear families in a scheduled caste community in Punjab clearly demonstrated familial aggregation of CVD risk factors. The brother-sister, father-offspring (male/female), mother-offspring (male/female) correlations were all greater than spouse correlations (brother-sister: 34% for SBP, 31% for DBP, 38% for BMI; father-male offspring: 31% for SBP, 30% for DBP, 21% for BMI; father-female offspring: 21% for SBP, 20% for DBP, 15% for BMI; mother-male offspring: 17% for SBP, 15% for DBP, 23% for BMI; female offspring: 20% for SBP, 18% for DBP, 29% for BMI; spouse: 4% for SBP, 5% for DBP, 9% for BMI). These observations have suggested that individuals who share genes tend to be more alike in aggregation of CVD risk factors. The magnitude of these correlations is similar to many previous studies in India and abroad (Knuiman *et al*., 1996; Badaruddoza and Sawhney, 2009; Kumar and Badaruddoza, 2010; Badaruddoza and Patharia, 2012; Badaruddoza and Kaur, 2012). The magnitudes of these correlations for SBP, DBP and BMI have been found to be lower in grandparent-offspring. Therefore, the higher estimates of correlations among parent-offspring generations and siblings suggested the genetic closeness and those same family environmental factors determine the variations of blood pressure phenotypes. But the correlation between siblings was even larger than correlation between parent-offspring and others.

The findings of familial aggregation of blood pressures especially in offspring generations in present population indicated the need for further investigation into genetic determinants of blood pressure through epidemiologic familial studies. The magnitude of familial effect for SBP is more consistent than DBP. However, familial correlation estimates of SBP were less than those reported from previous studies (Byard *et al*., 1989; Gu *et al*., 1998; Rice *et al*., 2000; Badaruddoza and Sawhney, 2009).

**Heritability:** The present study has also examined the cause of familial aggregation of blood pressure and genetic and environmental influences on blood pressure. Familial aggregation of blood pressure is largely due to genes rather than familial environment.
Heritability explained by the genetic variation in blood pressure. Therefore, the present study has a great potential for the study of quantitative genetic variations within and between the generations. The estimates of heritabilities through variance-component approach produced a wide range of heritabilities (10%-98.7%) for selected anthropometric and physiometric phenotypes between different combinations of the three generations. However, the general trend of heritability patterns observed in the present study is in agreement with the findings of different previous studies (Rice et al., 2000; Arya et al., 2002; Badaruddoza and Kumar, 2009)

However, direct comparison of our result with other studies would be difficult because heritability represented that portion of total phenotypic variations which is attributable to the genetic variations. This would differ from population to population which also differs in distribution of different socio-economic risk factors for all respective traits. Since, generation effects were significant in most of the phenotypes, the magnitude of heritability in inter-generation difference were also more prominent in the present study group. The observed higher heritability of these traits may be attributable to the cohabitation of the majority of subjects leading to similar type of nutrition and environmental effects. The pattern of heritability of parental generation was consistent for all the phenotypes.

**Sensitivity, Specificity and Likelihood Ratio:** The present study has attempted to evaluate comparative three anthropometric indicators (BMI, waist circumference and WHR) and five socio-economic lifestyle factors (food habits, physical activity, exercise, smoking and alcohol) to identify the most distinctive indicators for pre-hypertension and hypertension for a specific community in Punjab. No such study has been performed in this region based on sensitivity, specificity and likelihood ratio with three generations. Therefore, with the lack of data on this subject unfortunately, the present study was unable to be compared with other studies.

Among male parental generation the waist circumference and WHR for pre-hypertension; WHR and exercise for hypertension and waist circumference and BMI for pre-hypertension and hypertension among female parental generation were better indicators to assess CVD risk factors. High sensitivity suggested that waist
circumference and BMI performed well in female parental generations. The present findings were consistent with several other studies in India, other south Asian and western countries (Hsieh and Muto, 2006; Chehrei et al., 2007; Schneider et al., 2007; Mellati et al., 2009; Gupta and Kapoor, 2012).

The results of the analysis of present data suggested waist circumference for almost all the generations with average high sensitivity upto 97% and 99% for female parents generation in the prediction of pre-hypertension and hypertension. BMI and WHR may be considered with respect to sensitivity in the second level of best predictor for both pre-hypertension and hypertension. If we compare positive likelihood ratio of the three generations with respect to all the indicators then it was observed that LR+ value of BMI have been consistently higher among all the generations as compared to waist circumference and WHR. Therefore, it has suggested that combination of waist circumference and BMI would be the better predictors to assess CVD risk. Several studies have analyzed the association between CVD risk factors and other anthropometric factors based upon sensitivity, specificity and likelihood ratio analysis. Most of the studies (Mellati et al., 2009; Gupta and Kapoor, 2012) including present one, support the idea that waist circumference and BMI are the best anthropometric index of CVD risk factors compared to other indicators. However, due to different reported cut-off values across different ethnic population groups, future research and study would be required until reaching an internationally acceptable simple and appropriate measure that could be easily and efficiently used in the clinical and epidemiological research. However, the results presented here support the use of combined association of waist circumference and BMI for the prediction of CVD risk.

Remark: The thesis included at least 70 tables and 70 graphical presentations. It has also presented wide range of results, discussion and review which is supported by exhaustive references from 1942 to 2012. Many interesting results have been discussed in the thesis.