Summary and Conclusions

Cardiovascular diseases are the group of disorders of the heart and blood vessels. Out of all diseases, cardiovascular ailments are the world’s largest killers that claim 17.1 million lives every year, representing 29% of all global deaths (World Health Organization, 2010). It is estimated that by 2030, almost 23.6 million people will die from cardiovascular diseases and these are projected to remain the single leading cause of death. The incidence of cardiovascular diseases varies greatly from one area to another, depending upon the variations in physical, socio-economic, behavioural and institutional factors. About 82% of the deaths caused by cardiovascular diseases occur in low- and middle-income countries (World Health Organization, 2010).

The World Health Report (2002) has projected cardiovascular diseases to be the largest cause of death and disability in India by 2020, which will account for 42% of the total mortality from all causes. Within the country, the economically advanced state of Punjab has the highest proportion (approximately 50%) of cardiovascular deaths out of the total mortality. The incidence of cardiovascular diseases has been increasing rapidly in the state over the last few decades. The population of the state is being exposed to greater risk of cardiovascular diseases due to the intake of rich diet, high cholesterol level and sedentary lifestyle (The Tribune, 1st May 2006).

In 2007, cardiovascular deaths formed the biggest share (21%) of the total 10,017 deaths registered from all causes among indoor patients in various government medical institutions in the state. The combined incidence of cardiovascular morbidity and mortality (number of outdoor patients, indoor patients and deaths caused among indoor patients) in 2007 shows that the Bist Doab region of the state has much higher incidence rate (33 cases per thousand of population) along with Majha (35 cases per thousand of population), than the Malwa region (26 cases per thousand of population). A
very prominent research gap existed in the literature dealing with the geographical aspects of cardiovascular diseases and their associated health care provisions in Punjab or its different regions. Hence the present study attempted to fill this gap to some extent by studying the spatial patterns and correlates of cardiovascular diseases and their associated health care provisions from a geographical perspective in Bist Doab region of the state, which is the most affluent of all the three traditional cultural regions of the state.

The objectives of the present research work were to: (i.) study the spatial patterns of mortality caused due to cardiovascular diseases in rural areas of Bist Doab and to identify the high-risk areas; (ii.) examine the role of physical factors (particularly relief, seasonal variation in temperature and groundwater hardness) in determining the spatial patterns of cardiovascular diseases; (iii.) analyze the role of socio-economic attributes (literacy, education level, occupation and income) in determining the geographic distribution of cardiovascular diseases; (iv.) study the influence of behavioural characteristics (including tobacco use, alcohol consumption, diet, physical activity, awareness level) on the prevalence of cardiovascular diseases; (v.) study the spatial distribution of public and private medical facilities in rural areas of Bist Doab; (vi.) find the geographical determinants of utilization (like distance, cost and income) of health-care provisions related to cardiovascular diseases; and (vii.) suggest policy inputs for improving rural-targeted health care system. The research questions addressed in this study were: (i.) how are cardiovascular deaths distributed in the rural Bist Doab; (ii.) what geographical factors affect the distribution of cardiovascular diseases; (iii.) what is the spatial distribution of health care provisions associated with the treatment of cardiovascular diseases in Bist Doab; and (iv.) what is the role of socio-economic factors in the utilization of health care provisions related with cardiovascular diseases?

The following five hypotheses have been tested in this research work: (i.) the eastern hilly and foothill areas of Bist Doab have lower cardiovascular disease mortality than rest of the region where the relief is plain; (ii.) the areas
experiencing lowest winter temperature in the region record higher mortality from cardiovascular diseases; (iii.) the areas having hard groundwater have low disease mortality in the region; (iv.) cardiovascular disease mortality is lower in areas having higher proportion of farming population; and (v.) the areas having higher availability of liquor have higher cardiovascular disease mortality.

The study area is a triangle-shaped natural region lying between the Beas and Satluj rivers. The former bounds it in the west and the latter in the south. The eastern boundary of the region is marked by the Shiwaliks, while the rest of the region has an almost flat surface. The region shares 17.6% (8844 sq. km.) of state’s total geographical area and is one of the three traditional cultural regions of the state, the other two being Majha and Malwa. The climate of the region is of continental monsoon type. The soils are mostly fertile and alluvial in origin. According to 2001 census, the population of Bist Doab is 4,770,477 which accounts for 19.64% of Punjab’s total population. Out of this 71.58% people live in rural areas. The literacy rate of the region is 77.33% and 67.5% of the population is engaged in non-agricultural activities. Administratively, the region consists of four districts namely, Jalandhar, Hoshiarpur, Kapurthala and S.B.S. Nagar, which encompass 30 Community Development Blocks. National Highway No. 1 (Grand Trunk Road) passes through Jalandhar and Kapurthala districts. The region has a total of 3403 villages, 35 towns and 2 cities (Jalandhar and Hoshiarpur) and this study has been conducted for the rural areas of the region.

The present study is quite significant because it is the first endeavour of its kind aimed to understand the dynamics of cardiovascular diseases in the Bist Doab region from a geographical standpoint. The study attempts to bridge the gap in the literature of medical geography on health and disease in Punjab. It facilitates the identification of risk-prone areas in terms of cardiovascular disease mortality. The findings of the study are useful for formulating location-specific policies in health services. The measures suggested by the study can be incorporated in the district health plans chalked out under the supervision of National Rural Health Mission.
The research work has been organised into seven chapters. Chapter 1 provides introduction to the topic, review of literature, statement of the problem, research questions, objectives, hypotheses, geographical setting of the study area, data sources and methodology, period and unit of study, significance and limitations of the research work and organisation of the material. In Chapter 2, the spatial patterns of cardiovascular disease mortality in rural areas of Bist Doab has been examined and areas with high intensity of disease prevalence have been identified. In Chapter 3, the role of physical factors particularly relief, seasons and groundwater hardness has been analyzed in determining the spatial patterns of cardiovascular diseases in rural Bist Doab. Chapter 4 examines the socio-economic factors (literacy, education level, occupation and income) affecting the geographical patterns of cardiovascular diseases in rural Bist Doab. In Chapter 5, the relationship between behavioural risk factors (tobacco use, alcohol consumption, diet, physical activity, awareness level) and the prevalence of cardiovascular diseases has been analyzed. Chapter 6 examines the spatial distribution of public as well as private medical facilities in Bist Doab and the determinants of utilization of health-care provisions associated with the treatment of cardiovascular diseases. The last chapter (Chapter 7) summarizes the main findings of the study, conclusions drawn from it and suggests recommendations for future rural-targeted health policies.

In order to study the spatial patterns of mortality caused due to cardiovascular diseases in rural areas of Bist Doab and to identify the high-risk areas (Chapter 2), data have been collected from both primary as well as secondary sources. The village-wise data on the cause of death, month of death, age and sex of the deceased was noted down for all the reported cases from Death Registers of 2009 available in the Office of Registrar (Births and Deaths) in all the four district headquarters of Bist Doab. Initially, an exploratory study of age and gender differentials and spatial patterns of cardiovascular mortality was conducted at village level. The observed patterns were quantified through a spatial clustering technique to identify the areas of high occurrence of cardiovascular deaths. The mortality rates were then aggregated at block-level for further analysis. A composite cardiovascular risk
index was computed at block level by normalizing and aggregating five variables, i.e. alcohol vends, milch animals, health services, terrain slope and industrial density. A regression model of cardiovascular mortality was constructed using cardiovascular risk index as an explanatory variable. The overall burden of cardiovascular diseases in the region was estimated by calculating the years of life lost (YLL) due to the resultant premature mortality. The economic loss incurred due to these deaths was also assessed through the potentially productive years of life lost (PPYLL) by considering the economically productive age group of 15 to 59 years.

The findings of this chapter revealed that in 2009 out of the total 24,573 deaths from all causes occurring in rural areas of Bist Doab region, nearly 28% (6,796 deaths) were caused due to cardiovascular disorders. Approximately 65% of the persons who died from cardiovascular diseases were males, while the rest 35% were females. Thus, the male population of the study region has much higher rate of cardiovascular mortality than the females, and most of the male cardiovascular deaths occur below the age of 60 years. In females this peak is noticed in comparatively older age groups. The consumption of traditional high fat diet, heavy intake of alcohol and tobacco, coupled with sedentary lifestyle results in an early onset of these diseases, particularly in male population of the region. It has also been found that the incidence of cardiovascular mortality portrays clearly discernible micro-level spatial patterns in the study area. These patterns can be effectively attributed to the underlying physical, socio-economic and cultural peculiarities of the region. The eastern parts of the region with uneven terrain have low rate of cardiovascular mortality, because the people of this area have physically demanding lifestyles and consequent low prevalence of obesity. The central flat plain of the study region has relatively much higher incidence of cardiovascular deaths, particularly in areas close to the urban centres. This high rate is due to the adoption of urban way of life by rural population, sedentary and affluent lifestyle, physically inactive work environment and high levels of air pollution. The rural areas along major highways, especially those situated in close proximity to industrial complexes also have high mortality from cardiovascular diseases. It seems that
cardiovascular diseases are radiating out of urban centres, expanding along
the main arteries of transportation and trickling down into the rural areas. The
flood plain belts of both Beas and Satluj rivers with widespread alcohol
consumption also experience very high incidence of cardiovascular deaths. In
addition to this, cardiovascular mortality is also high around Adampur, which
experiences coldest winter temperatures in the region. The results of
regression model show that the composite cardiovascular risk index devised
in this work has been successful in explaining 35% of the variation in
cardiovascular mortality observed at block level.

The Years of Life Lost (YLL) metric was used to quantify the potential
loss from premature cardiovascular deaths in terms of time (years). In 2009, a
total of 83,322 years of potential life were lost due to cardiovascular mortality
in rural Bist Doab. Out of these, 56,752 years belonged to males while the
rest (26,570 years) were of females. On an average 25.7 years were lost per
thousand of population in the region. This figure was 33.3 in case of males
and 17.3 in case of females. It clearly shows that the burden of cardiovascular
diseases on male population is twice as much as on female population. Most
of the areas with high cardiovascular risk score have high burden of
cardiovascular mortality. The economic value of the potentially productive
years of life lost (PPYLL) due to cardiovascular diseases in rural Bist Doab
was more than Rs. 2 billion in the year 2009. Thus the premature
cardiovascular mortality is causing huge productivity loss to the economy of
the study region.

In order to examine the role of physical correlates (relief, seasonal
variation in temperature and groundwater hardness) of cardiovascular
diseases (Chapter 3), the study area was divided into four physiographic units
based on the variation in altitude. The topographical sheet of the region
prepared by Defense Mapping Agency Topographic Center, Washington, D.C.
(U.S.A.) was used. This map was used because it displayed the attributes of
whole Bist Doab on one sheet, as opposed to the Survey of India maps which
portray the study region in great detail, spread over several sheets. A contour
map of Bist Doab was prepared from the downloaded sheet on a contour
interval of 50 metres. The data on cardiovascular mortality for the year 2009 was noted down from the village-wise Death Registers of the study area and the mortality figures were aggregated for each physiographic unit. The method of visual comparison was used to explore the relationship between cardiovascular mortality and underlying physiography of the region. Subsequently, Robinson’s method of slope analysis was applied to calculate average slope in degrees. Karl Pearson’s coefficient of correlation was calculated to estimate the association between average slope and proportional cardiovascular mortality rate at the block level. The data and information on temperature conditions of the study area were acquired from the website of India Meteorological Department, the Meteorological Observatory of Air Force Station at Adampur (Jalandhar district) and various newspaper reports. The month-wise deaths caused due to cardiovascular and non-cardiovascular diseases were noted down for the year 2009 from Death Registers of all villages of Bist Doab and were aggregated and plotted month-wise for the entire region using multiple-line graph. The map of climatic zones of the study area was prepared from the corresponding larger map of Punjab state, obtained from the Department of Soil and Water Conservation, Punjab. The method of visual comparison was used to investigate the potential influence of climatic conditions on the spatial patterns of cardiovascular mortality in the study area. The groundwater calcium hardness data was obtained from the website of Central Ground Water Board, India for the year 2005. The calcium content (mg/l) was noted down for 27 observation wells in the study area. Based on the variation in calcium content, the groundwater was classified into five categories of varying hardness. The point data of the observation wells was used to generate a continuous surface using Regularized Spline Interpolation technique in ArcGIS 9.3 software. This technique estimates and interpolates values using a mathematical function, by extruding the sample points to the height of their magnitude and bending a sheet of rubber that passes exactly through the input points, resulting in a smooth surface with minimal overall surface curvature. The method of visual comparison was employed to observe the relationship between groundwater hardness and cardiovascular mortality in different parts of the study area.
The results showed that physical environment plays an important role in determining the spatial patterns of cardiovascular mortality in Bist Doab. As mentioned above, the eastern hilly areas of the region have low incidence of cardiovascular mortality due to physically active lifestyle of the native population and the consequent low prevalence of obesity. The flat upland plain and the flood plain have high rates of cardiovascular mortality due to sedentary lifestyle, rich dietary intake and high level of air pollution. In order to analyse the effect of slope and uneven terrain on the incidence of cardiovascular mortality, Karl Pearson’s coefficient of correlation was calculated for the block level data of proportional cardiovascular mortality rate and average slope. The value of correlation coefficient worked out to be -0.4 (with p<0.05), which clearly proves that there is negative association, though not strong, between the two variables. So the areas with higher degrees of average slope have lower incidence of cardiovascular mortality and vice versa in the Bist Doab. Thus the hypothesis that ‘the eastern hilly and foothill areas of Bist Doab have lower cardiovascular disease mortality than rest of the region where the relief is plain’ stands validated. Therefore, physiography has an important role to play in determining cardiovascular health of the people in the study region.

The incidence of cardiovascular mortality displays a characteristic rhythm with respect to the seasons. The peak summer and peak winter season experience the highest number of deaths caused due to cardiovascular ailments. Climatic stress has been found to be an important factor in determining the spatial distribution of cardiovascular mortality. It has been found that the areas in central parts of the region (Jalandhar and Kapurthala districts), experiencing extreme climatic conditions have recorded high mortality from cardiovascular diseases, whereas the areas with comparatively less extreme temperature conditions have registered lower rates of cardiovascular mortality. Therefore the hypothesis that ‘the areas experiencing lowest winter temperature in the region record higher mortality from cardiovascular diseases’ is proved. The seasonal variation in temperature exerts a strong influence on the spatial distribution of cardiovascular mortality in the Bist Doab.
In terms of groundwater hardness, the results of spline interpolation technique show that the eastern parts of Bist Doab region have hard underground water. Comparisons with cardiovascular mortality patterns show that these areas are associated with low cardiovascular mortality. The general trend of hardness goes on decreasing towards the western side of the study area. The areas in central and west-central parts have soft underground water. The rates of mortality from cardiovascular diseases are high in these parts of the region. So it has been found that soft water areas have higher cardiovascular mortality rates, while the areas having hard underground water experience lower cardiovascular mortality. This finding is in line with the proposed hypothesis that ‘the areas having hard groundwater have low disease mortality in the region’.

In the next two chapters, analysis of the role of socio-economic attributes (literacy, education level, occupation and income) and behavioural characteristics (tobacco use, alcohol consumption, diet, physical activity, awareness level) in determining the geographic distribution of cardiovascular diseases was conducted. The data were collected from both primary as well secondary sources. For collecting primary data, a sample size of 1.5% (100 cases) was selected out of the total 6796 cardiovascular deaths recorded in 2009. A detailed interview schedule was prepared and administered on the family members of the selected 100 deceased persons. The questions pertained to the socio-economic and behavioral aspects of the persons who died from cardiovascular diseases. The sampling design was divided in two stages. At the first stage around 20 villages were sampled from all the major hot spot clusters of villages recording high cardiovascular mortality using proportionate sampling. Bigger the hot spot, higher was the number of villages in sample. At the second stage snowball sampling was used to choose five deaths from each selected village with the help of the concerned village officials. The village-level secondary data on literacy and occupation was collected from Punjab Primary Census Abstract, 2001 and the same data aggregated at block-level was noted down from Block at a Glance publication of Economic and Statistical Department, Punjab. The secondary data on location of alcohol vends in rural Bist Doab was obtained from Punjab Excise
and Taxation Department for the year 2006-07. The average figures for liquor quota, sale, consumption and revenue generated from alcohol trade in Punjab as a whole, were noted down from Punjab State Excise Policy documents and newspaper reports of various years. The data on obesity for overall Punjabi population was obtained from National Family Health Survey (2005-06).

As far as socio-economic factors (Chapter 4) are concerned, striking contrasts have been found in spatial patterns of rural literacy within the region. In general the literacy rate is high in the north-eastern parts of the study area and it decreases gradually towards the south and west. The areas having high literacy rate have reported low rates of cardiovascular mortality and vice versa. The Karl Pearson’s coefficient of correlation between literacy rate and proportional cardiovascular mortality rate at block level is -0.301 (significant at p<0.10). Although this correlation is not strong enough, but still it reflects inverse association between cardiovascular mortality and literacy level in the study region. The primary survey data revealed that only 3/5th of the deceased persons in sample had received some sort of formal education, while the rest of them had not attended school at all. Only 7% of the sample had done formal study or training course equivalent to 12th grade or above, which reflects that the persons dying from cardiovascular diseases had low level of education in general. Further the educational status of women who died from cardiovascular diseases was very low in comparison to the men in the selected sample. The low level of educational qualification is a major hindrance to the spread of health literacy about cardiovascular diseases among the rural people of Bist Doab. Moreover, the level of education has been found to have direct influence on the economic and behavioural characteristics of the deceased persons. The coefficient of correlation between the years of formal education and per capita household income of the deceased persons in the sample is 0.43 (significant with p<0.000008). It shows that the level of education of the sampled population directly affects their financial well-being, which in turn implies that the major chunk of people who are less educated or not educated at all, are on the lower side of economic status too. It has also been found that the prevalence of behavioural risk factors is higher among the male persons with lower
educational status and the risk decreases with increase in education. Thus, the people with higher level of education have reduced risk of dying from a cardiovascular ailment and they have a comparatively longer life-span than the less educated ones.

In terms of occupation, no relationship was found between proportion of agricultural workers and cardiovascular mortality rate. Thus the hypothesis that ‘cardiovascular disease mortality is lower in areas having higher proportion of farming population’ is disproved. In the selected sample, only male persons were engaged in some kind of economic activity and a large majority of them were engaged in medium and low status jobs. The males employed in occupations with higher status had lower prevalence of major cardiovascular risk factors. They had higher mean age at death than the people engaged in low status jobs. All females in sample were housewives and their average BMI was higher than all occupational categories of males. The monthly income profile of the sampled population reflected that more than 1/3rd of the deceased persons had no income from any economic source and another 1/3rd of the sampled population earned less than Rs. 5000 per month. Thus a major chunk of persons who died from cardiovascular diseases had very low levels of income and the incidence of cardiovascular deaths decreased with an increase in income, pointing towards the comparatively healthier lifestyles of the people having higher economic status. In addition to this, nearly 2/3rd of the males in the sample were responsible for earning more than half of their respective household incomes before their death. So the deaths caused due to cardiovascular diseases also incurred huge economic burden on the family of the deceased. Therefore, it has been found that in rural Bist Doab, the social and economic status of people is notably affecting their cardiovascular health.

The behavioural risk factors, namely tobacco smoking, alcohol consumption, diet, physical activity and awareness, studied in Chapter 5, have also been found to play a very critical role in the development of cardiovascular diseases and the associated resultant mortality. In the sampled cases of cardiovascular mortality, tobacco smoking and alcohol
consumption was found to be prevalent only among the males. More than 1/5\textsuperscript{th} of the men smoked tobacco. The average number of bidis and cigarettes consumed by smokers was 23.62 per day. Tobacco smokers died from cardiovascular diseases at a much younger age than the non-smokers. The educational level and per capita monthly household income of smokers was also low. Most of these males were engaged in elementary occupations, craft and related trades. Bidis were found to be more popular than cigarettes and a very high tendency of concurrent use of tobacco and alcohol has been found. Over the past few years, a massive increase has been witnessed in alcohol consumption in the whole state and excise revenue from liquor trade has become a major source of income for the state government. There are nearly 1539 alcohol vends in Bist Doab, out of which 839 are situated in rural areas. These rural vends have a high concentration in south-central parts of the region. A weak and insignificant correlation ($r=0.17$, insignificant at 95% level) has been found between alcohol available in proof litres per male from licensed vends and proportionate cardiovascular mortality, primarily because illegal alcohol production also has a big role in determining the rate of cardiovascular mortality in the study region. So the hypothesis that ‘the areas having high availability of liquor have high cardiovascular disease mortality’ has been disproved. As many as 68% of the males in sample consumed alcohol out of which more than half were heavy consumers. Another important finding of the analysis is that the average age at death was highest for moderate and light drinkers, probably due to the protective effect of moderate alcohol consumption on cardiovascular system. The heavy consumers of alcohol were comparatively less educated and had lower per capita monthly household income. The mean BMI of heavy alcohol users was higher than moderate consumers and abstainers.

As far as diet of the sampled population is concerned, it was found to be high in fats and oils. The mean consumption of milk was slightly higher in males than females, but the females scored over males in consuming butter and desi ghee. The most popular oils used for cooking were mustard oil, followed by desi ghee and vanaspati oil. The mean per capita total fat consumed by the sampled persons was 44.31 gm/day, which was much
higher than the recommended maximum limit of 29 gm/day. Approximately 68% of the sampled persons consumed non-vegetarian food as well. The combined prevalence rate of overweight and obesity among the sampled deceased persons was 55%, which reflected their low level of physical activity. Women were found to be more obese than men. Working men mostly preferred cycling or walking to commute to workplace. The general awareness of risk factors of cardiovascular diseases in households of deceased persons was of average level. The most frequently stated risk factors were hypertension and diabetes.

In order to study the spatial distribution of public and private medical facilities in Bist Doab (Chapter 6), the data on the location of government medical institutions (sub-centres, subsidiary health centres, rural hospitals, primary health centres, community health centres, sub-divisional hospitals, district hospitals), private practitioners (degree holders and registered medical practitioners) was obtained from the Department of Health and Family Welfare for the year 2010. The number of health institutions (sub-centres, subsidiary health centres, primary health centres and community health centres) per 1 lakh population was calculated. The resulting figures were plotted on blockwise maps in ArcGIS 9.3 software. The data on ambulances available in Bist Doab was taken from the website of Punjab Health Systems Corporation for the year 2011. The road map of Bist Doab was obtained from Punjab Administrative Atlas (2011). Line density analysis was performed in ArcGIS to find the density of major roads in the study area. While calculating the density, weights were assigned to the roads according to their importance and the final output map displayed weighted density of major roads in the study area.

It has been found that the availability of government and private health care institutions is high in the southern parts of the study area, particularly in the western half of district Nawanshahar and adjoining eastern half of district Jalandhar. On the other hand, the physically disadvantaged areas like the uneven hilly terrain of Shiwaliks and the flood plains of rivers Beas and Satluj have very low level of availability of health care services. It has been found that 2/3rd blocks do not have any CHC in rural areas. The study region has a
good availability of ambulance service for transferring the emergency cases of cardiovascular diseases, however the density of major roads is very low along the eastern border of the region (due to undulating hilly area) and the extreme western margins of the study area. These areas of low density of major roads have lower level of geographic accessibility to health care institutions, in comparison to the central parts of the region through which the National Highway No. 1 (Grand Trunk Road) also traverses.

For finding the geographical determinants of utilization (distance, cost and income) of health-care provisions related to cardiovascular diseases, the data was collected through the above mentioned interview schedule survey conducted in the study area. The distance travelled from village to hospitals and the travel time for seeking medication was calculated on the basis of the information provided by the family members of the sampled deceased persons. Apart from this, primary data was also collected on the monthly expenditure on medicines of the sampled persons, duration of medication, details of surgery performed and cost of surgery. The share of household income spent on medication of the sampled deceased persons was calculated. The information related to government programmes on cardiovascular health care was obtained from the websites of Ministry of Health and Family Welfare (India) and Department of Health and Family Welfare, Punjab.

The findings of utilization of health care services showed that only 64% of the sampled deceased persons took medicines for the treatment of cardiovascular diseases. The average distance travelled by the sampled persons for seeking medication for cardiovascular diseases was 22 km. Almost 15% of the persons who were prescribed medication, had to spend more than half of their total monthly household income on buying medicines for their treatment. The mean duration for which the deceased took medication was 5.36 years and 71% of them died within 6 years of medication. In addition to this, $1/10^{th}$ of the total deceased in the sample underwent some kind of surgery for the treatment of their cardiovascular disorders. The households of these persons had to spend large amount of
money (Rs. 2.5 to 10 lakh) for the operations. These operations were performed for heart bypass surgery, blocked arteries (angioplasty) and stroke, apart from angiography tests. The destinations preferred by them for these operations were Oxford Hospital, Jalandhar; Tagore Hospital, Jalandhar; Dayanand Medical College and Hospital, Ludhiana; Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh and SGL Kashmir Singh Hospital, Jalandhar. Almost all (except one) of these institutions are in private sector. Therefore, the private sector plays a very big role in providing specialized cardiovascular health care services to the people of the study area and the cost of surgical treatment of cardiovascular diseases is very high.

**Recommendations**

The spatial patterns identified in this research work provide very useful basis for formulating area-specific health policies to curtail the further ascent of cardiovascular diseases in the Bist Doab. The present research therefore recommends as follows:

- The rural areas of central plains especially around Jalandhar, Nakodar and Phagwara require immediate attention of health care authorities for reducing cardiovascular mortality.
- The villages lying along river Beas, near the towns of Dasuya, Tanda, Begowal, Bholath, Dhillwan and Kapurthala need focussed health programmes to control the very high incidence of cardiovascular mortality.
- In view of the huge economic loss being caused due to potentially productive years of life lost on account of premature cardiovascular deaths, targeted cardiovascular health measures should be taken.
- The central parts of study region (particularly around Adampur) experiencing extreme temperature conditions should be provided additional health care resources (like mobile dispensaries and emergency services) during peak winter and summer months, so that the concerned population gets easy and quick medical aid for cardiovascular problems.
• There is an imperative need to motivate people to undertake increased level of physical activity, particularly in the central plain areas of Bist Doab. The village panchayats should consider the development of common lands into parks for morning/evening walks and other recreational activities. Sports should be promoted among young as well as adult population to encourage an active lifestyle.

• It is recommended that calcium supplements in the dietary regime of the people should be introduced for controlling the high rates of cardiovascular mortality, particularly in blocks of Jalandhar and Kapurthala districts.

• Efforts are needed for achieving universal literacy rate through various programmes of the government. This recommendation is supported by the finding that people with higher level of literacy and education have reduced risk of dying from cardiovascular ailments and they have comparatively longer life-span than the less educated ones.

• Cases of best practices adopted by certain administrative officials in the region should be rewarded and encouraged for emulation in other parts. For instance, the efforts of Nawanshahar (district S.B.S. Nagar) administration for discouraging and controlling the heavy consumption of alcohol can be replicated in other areas. No individual should be allowed to purchase alcohol in bulk, except if a license has been procured from the competent authority of the Excise and Taxation department.

- The alcohol vends should not sell liquor to anyone without recording the age proof of the buyer. Sale of alcohol to young persons should be strictly banned.

- The state excise policy should gradually scale down the liquor quotas to constrain the abundant supply of alcoholic beverages, particularly in southern parts of Bist Doab.

- Alcohol vends should be relocated away from the settled parts of the villages. The Excise and Taxation Department should also positively consider the requests
of all village panchayats that demand shutting down or relocation of vends.

- Strict measures should be taken for controlling illegal liquor trade, smuggling and illicit brewing of alcohol in the flood plain areas of Beas and Satluj.

• The trade of cigarettes and bidis should be banned. Health campaigns should be launched in rural areas to promote smoking cessation among the addicts. These programmes should also focus on preventing weight gain that accompanies smoking cessation, in order to reduce the incidence of cardiovascular diseases in smoking quitters.

• Specific dietary intervention programs to reduce the consumption of fats and oils should be introduced in the region, as it is traditionally known for high intake of fats and milk products. Most importantly, such intervention programs must be introduced at school level to foster healthy eating habits right from childhood.

• The public sector hospitals should be upgraded and restructured to provide cardiovascular treatment at affordable prices to the rural population of Bist Doab. New hospitals with specialized facilities should be established to reduce distance travelled by cardiovascular patients for seeking medical treatment, as for example in the least equipped Nadala and Shahkot blocks. The problem of complete absence of rural Community Health Centres in 2/3\textsuperscript{rd} of the blocks of the region should be addressed on priority.

• The density of motorable roads should be increased in hilly eastern parts of Bist Doab (particularly in district Hoshiarpur) to improve accessibility to health care services.

• The expansion and scaling up of National Programme for prevention and control of Cancer, Diabetes, Cardiovascular diseases and Stroke (NPCDCS) should be prioritized in the hot spot areas of cardiovascular mortality identified in this research work (particularly district Jalandhar).

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