CHAPTER 1

INTRODUCTION

Introduction

Health is a state of complete physical, mental and social well-being and not merely the absence of a disease or infirmity to lead a socially and economically productive life (World Health Organization, 1948). Geography considers health as a harmonious equilibrium between man and his environment. Medical geography, a sub-discipline of geography, examines the spatial distribution of health-related phenomena and the ways in which these phenomena interact and determine the status of human health in a community. The world patterns of health and disease of the past century are changing. The global burden of infectious diseases is anticipated to drop appreciably from 49% in 1990 to 22% in 2020, while the burden due to non-infectious diseases (especially cardiovascular diseases) is expected to rise drastically from just 36% to 57% during the same period (Mansourian, 2010). Out of all diseases, cardiovascular diseases 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.

Cardiovascular system, in humans, consists of the combined function of the heart, blood, and blood vessels to transport oxygen and nutrients to organs and tissues throughout the body and carry away waste products. The heart, which is the strongest muscle in the human body, is the engine of this system. The group of disorders of the heart and blood vessels are termed as cardiovascular diseases. Often, there are no symptoms of the underlying diseases of the cardiovascular system. A heart attack or stroke may be the first or the last warning of such diseases. Heart attacks and strokes are by and large acute and fatal events. Heart attacks are triggered by a blockage that obstructs blood from flowing to the heart. Strokes are caused by
disruption of the blood supply to the brain. This may result from either blockage (ischaemic stroke) or rupture of a blood vessel (haemorrhagic stroke).

The group of cardiovascular diseases includes the following types:

i. Coronary heart disease – It is the disease of the blood vessels supplying blood to the heart muscle. It is characterized by an inadequate supply of oxygen-rich blood to the heart because of the narrowing or blocking of a coronary artery. This happens when plaque, a substance made up of fat and cholesterol, builds up on the inner walls of the arteries that supply blood to the heart muscle.

ii. Cerebrovascular disease – It is the disease caused by disruption of the blood supply to the brain. It may occur due to either blockage or rupture of a blood vessel supplying blood to the brain.

iii. Peripheral arterial disease – This disease develops when there is narrowing of the arteries outside the heart, which supply blood to the arms and legs. The narrowing of blood vessels is caused by fatty deposits inside them.

iv. Rheumatic heart disease – It is a disease characterized by damage to the heart muscle and valves from rheumatic fever (a type of fever with inflammation and pain in the joints and muscles).

v. Congenital heart disease – It includes the malformations of heart structure existing right from birth.

vi. Deep vein thrombosis and pulmonary embolism - Thrombosis is the formation of a blood clot inside a blood vessel, obstructing the flow of blood through the circulatory system. Such blood clots formed in the leg veins can dislodge and move to the heart and lungs. Pulmonary embolism is the blockage of the main artery of the lung or one of its branches by such a clot that has travelled from elsewhere in the body through the bloodstream.

vii. Aortic aneurysm and dissection – It is the swelling and rupture of aorta, which is the principal artery of the body that carries oxygenated blood to most other arteries in the body.
viii. Other cardiovascular diseases – These include tumors of the heart, vascular tumors of the brain, disorders of heart muscle (cardiomyopathy), heart valve diseases, disorders of lining of the heart.

Heart diseases as such were not recognized in non-technological cultures, but the beating heart and its relationship to death have always been appreciated. Sudden deaths, now usually attributed to heart diseases, were recognized as early as the 5th century B.C. by the Greek scholar Hippocrates and were noted to be more common among the obese individuals. The role of disease in affecting the heart itself did not become apparent until the 17th century, when examination of the body after death became acceptable.

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). People in these nations are more exposed to risk factors leading to cardiovascular diseases and have less access to effective and equitable health care services (including prevention efforts and early detection services) which promptly respond to their needs. The nutritional transition and the concomitant rise in the prevalence of cardiovascular diseases in the developing countries will widen the mismatch between health care needs and resources, and the already scarce resources will be stretched ever more thinly (World Health Organization, 2003).

Howson et al. (1998) have identified the following regions of the world which are typically associated with certain types of cardiovascular diseases, depending upon the stage of their economic development:

(a.) Sub-Saharan Africa and the rural areas of South America and Asia – These regions are in the earliest stage of development and have higher prevalence of rheumatic heart disease (damage to heart muscle and valves from rheumatic fever), infections and nutritional deficiency-related disorders of the heart muscle.

(b.) China and some other Asian countries – In these countries, as the infectious disease burdens are reduced and nutrition improves, diseases
related to hypertension, such as haemorrhagic stroke (rupture of blood vessel supplying blood to the brain) and hypertensive heart disease become more prevalent. These areas are in the second stage of economic transition.

(c.) India and the former socialist countries including Russia – In these regions, as life expectancy continues to improve, high-fat diets, cigarette smoking and sedentary life-styles become more common. Non-communicable diseases then predominate, with the highest mortality caused by atherosclerosis (deposition of fats on the inner wall of an artery) leading to ischemic heart disease and atherothrombotic stroke (formation of a clot inside a blood vessel), especially at ages of less than 50 years. These regions are in the third stage of economic development.

(d.) Western Europe, North America (excluding Mexico), Australia, and New Zealand – These are the most developed regions of the world, where increased efforts to prevent, diagnose, and treat ischemic heart disease and stroke are able to delay the impact of these diseases to more advanced ages. Arteriosclerotic heart disease (thickening and hardening of artery walls) constitutes by far the most predominant form of cardiovascular diseases in these regions.

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. The problem of cardiovascular diseases in the country has assumed epidemic proportions, earning it the dubious sobriquet of being the ‘Heart Disease Capital of the World’ (The Tribune, 10th December, 2010). There are wide differences in the cardiovascular disease mortality in different parts of the country. The data of Sample Registration Survey (1998) reveal that the share of cardiovascular deaths out of total mortality is high in the states of Punjab (49.2%), Goa (41.8%), Tamil Nadu (35.7%) and Andhra Pradesh (31.4%) and low in the sub-Himalayan states of Meghalaya (10%), Nagaland (11%), Himachal Pradesh (12.3%) and Sikkim (16.4%). Gupta et al. (2006) have explained this variation in cardiovascular disease mortality in different states of India by the
difference in dietary consumption of fats, sugars, and green-leafy vegetables and the prevalence of obesity.

The above discussion reveals that 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, 1<sup>st</sup> May 2006). In 1985, the total number of outdoor patients suffering from cardiovascular diseases in government medical institutions of Punjab was 2.14 lakhs. The figure rose to approximately 3 lakhs in 1995 and then altogether doubled to 6 lakhs in 2005 (Directorate of Health and Family Welfare, Punjab). In 2007, the total number of registered deaths from all causes among indoor patients in various government medical institutions in the state was 10,017. The highest proportion (21%) of these deaths occurred due to diseases of the circulatory system. 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 traditional 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). The present research work has conducted a geographical analysis of cardiovascular diseases in the Bist Doab region, with a special focus on its rural areas.

**Statement of the Problem**

After Green Revolution in Punjab, the percentage of population Below Poverty Line in rural areas has declined from 28.21% in 1973-74 to 5.90% in 2004-05. The state has become economically prosperous. The per capita income has been increasing continuously and it has almost doubled from Rs. 25,631 in 1999-2000 to Rs. 50,558 in 2008-09. This has given rise to several modifications in the lifestyle of the people. Consequently, the burden of diseases created by affluence and prosperity is increasing in Punjab (Punjab
Human Development Report, 2004). People are adopting a sedentary way of life. There has been nearly twenty times increase in the total number of registered passenger vehicles, from just 2.18 lakhs in 1980-81 to 39.3 lakhs in 2007-08. Even the level of physical activity involved in agricultural operations has declined as a result of rapid farm mechanization. This is evident from the increase in number of tractors from around 1.18 lakh in 1980-81 to 4.85 lakh in 2007-08. At the same time, there is also a very high consumption of fats and alcohol. According to the data of 2002-2003, the per capita consumption of milk in Punjab is 890 gm/day which is highest among all states in India. The state ranks second in the country in per capita consumption of alcohol, after Kerala. In all, the Punjabi diet is very rich as compared to other parts of the country (The Times of India, 4th August 2008). All these factors have contributed to the rising incidence of cardiovascular diseases in Punjab and in recent years these diseases have distinctly emerged out as the single-leading cause of death in the state. Further, the cardiovascular disorders, generally associated with urban areas, are penetrating fast into the rural areas as well (Wander et al., 1994; Kaur and Bains, 2006). The Punjab Medical Council has observed that earlier, the heart related diseases were noticed less among rural population, but now more and more rural people are acquiring these diseases. Thus there is a need to investigate the geographical characteristics of this group of diseases and their associated risk factors particularly in rural areas. The present study makes an attempt to examine the geographical patterns and correlates of cardiovascular diseases and their associated health care provisions in the rural areas of the state’s Bist Doab region specifically.

The Bist Doab region is the most affluent of all the three traditional cultural regions of the state, the other two being Majha and Malwa. The per capita income of Bist Doab region is Rs. 32,190, which is much higher than that of Majha (Rs. 25,958) and Malwa (Rs. 30,500) (District Level Household Survey of Punjab, 2007-08). It clearly indicates that the people of Bist Doab region are comparatively richer and well off than the other two regions. Moreover, as much as 80% of people in the region are living in pucca houses as against 55% in Majha and 60% in Malwa. This again reflects that Bist Doab is the most prosperous cultural region of Punjab. The percentage of
population holding BPL (Below Poverty Line) cards is also very low in Bist Doab (10.9%) as compared to Majha (15.3%) and Malwa (16.7%). All these facts demonstrate that out of the three traditional regions of Punjab, the people of Bist Doab enjoy the highest degree of affluence. Therefore, this region offers an ideal case for studying the geographical patterns of cardiovascular diseases, which are essentially an outcome of a wealthy and affluent society.

**Review of Literature**

A systematic review of literature has been done to explore and interpret the existing body of research on the topic under study. The various studies pertaining to medical geography in general and cardiovascular diseases in particular have been reviewed under four broad headings:

(I) Evolution of Medical Geography

(II) Health and Disease:
   (a.) Environment and Health
   (b.) Changing Disease Patterns
   (c.) Infectious Diseases
   (d.) Non-infectious Diseases including Cardiovascular Diseases

(III) Health Care Provisions

(IV) Health and Disease in Punjab

*(I)* **Evolution of Medical Geography**

The foundation of medical geography was laid down by Hippocrates more than 2000 years ago. He has written the celebrated work ‘Airs, Waters and Places’ (5th century B.C.) in which he has explained the environmental causes of diseases while highlighting the interaction between culture and environment. Mayer (1990) has opined that his work is one of the most influential contributions to the development of historical medical-geographical thought. Barrett (2010) has traced the origins of the term ‘medical geography’ and found that it had two independent sources, one in France and the other in Germany. The French physicians used this term for the first time in later part of the 18th century and attempted to give substantive examples of this approach. In Germany the great three volume work ‘Versuch einer
allegemeinen medicinisch-praktischen Geographie’ (An Attempt at a General Medical Practical Cartography) of Leonhard Ludwig Finke written at the end of the 18th century was a magnificent contribution which surpassed the earlier attempts by French physicians in scope and concept. Rosen (1975) has considered this greatly recognized work to mark the beginning of modern history of medical geography.

The conceptual framework of medical geography has evolved a lot during the last two centuries. Akhtar and Izhar (2010) have comprehensively documented the shifts in focus of the sub-discipline during the second half of the 20th century. They have summarized that the focus of research during 1960s was on disease mapping and ecological explanations. In 1970s disease diffusion studies were undertaken along with location and accessibility analysis of health care provisions. During the next decade, emphasis was placed on research themes like health care planning model, health care behaviour, epidemiologic transition, geography of mental health and traditional medical systems. In 1990s, health implications of environment deterioration, climate change, development and urbanization were analyzed.

In the last two decades, scholars like Kearns and Joseph (1993), Jones and Moon (1993), Litva and Eyles (1995), Hall (2000), Cummins and Milligan (2000), Brown and Duncan (2002), Smith and Easterlow (2005), Massam and Basu (2010) and Brown and Moon (2012) have explored new themes and research directions in medical geography. Kearns and Joseph (1993) have argued that a re-examination of the interrelationships between the constructs of place and space is crucial to geography’s involvement in the broader endeavour of health research. This will include both an understanding of the ways in which space shapes the character of places and how the particularities of places resist or set in motion the spatial processes. Kearns (1993) has also observed that an engagement of medical geography with public health concerns and aspects of social theory will lead to a reformed medical geography, which will analyze issues such as the consequences of illness and health service provisions for both personal well-being and the collective experience of place by communities. In yet another work, the same author (1995) has surveyed the influence of post-modernism on medical
geography. Jones and Moon (1993) have examined the significance of themes of location and locality in medical geography. Litva and Eyles (1995) have presented a conceptual framework to illustrate how medical geography can generate theory. Hall (2000) has argued for the inclusion of the materiality of the body in a strengthened geography of health. This materiality must involve a re-interpretation of tangible body as a social entity, marked and imprinted by the temporality of social processes. Cummins and Milligan (2000) have also emphasized that new research in medical geography goes beyond spatial analysis to incorporate the influence of social and cultural dimensions on its work. They have further elaborated that transformation of the sub-discipline has taken place from a traditional 'medicalized' geography concerned with health care systems, disease ecology and mortality, to the one that now incorporates a much wider conception of health and well being, physical and mental health, and impairment. The need to develop a more critical perspective in geography of public health has been highlighted by Brown and Duncan (2002). The authors have stressed that such a perspective shall help to investigate the ways in which health has become a central motif for the organization of our lives within the late modern western society. Smith and Easterlow (2005) have described the way in which health itself is drawn into the structuring of society and space, resulting in health discrimination, illustrated in the processes of selective placement, entrapment and displacement of populations. Massam and Basu (2010) have emphasized that a focus on quality of life is a legitimate intellectual approach to understanding and explaining spatial patterns of health at all scales from local to the global. Such approach also represents a broad-based perspective on social organization that embraces policy making, civil society and issues of the state that focus on health care. Brown and Moon (2012) have outlined that the major opportunities for future geographical research on global health will be offered by geopolitics of infectious disease, chronic disease and health-related behaviour, inequality in health care, bioterrorism, food safety, health policy, medical tourism and health implications of global environmental change.
(II) Health and Disease

Several studies in different parts of the world have examined the interrelationship between environment and health, the changing patterns of diseases and the spread of various infectious as well as non-infectious diseases.

(a.) Environment and Health

The role of ecology and environment in determining the health of the masses has been analyzed by scholars like Joshi and Deshpande (1985), Learmonth (1985), Malkhazova and Alexeev (2010) and Collins (2010). Joshi and Deshpande (1985) have analyzed the distribution of some commonly prevalent diseases in South Asia, correlating their patterns with the prevalent bioclimatological framework. The authors have found that distribution of diseases throughout the South Asia follows a well defined pattern which is largely related to its ecological features. Learmonth (1985) has also studied the disease patterns in late colonial South Asia and concluded that regional differences in health and demographic trends may be considered in ecological terms as an evidence of differing stages of adjustment of equilibrium between groups of men and their environment. Malkhazova and Alexeev (2010) have analyzed the spreading of several diseases, the parasitic systems of which are parts of natural ecosystems. The authors concluded that on the global scale it is the geographical zonation of the environment that creates preconditions of the typical natural-endemic diseases. The number of the typical natural-endemic diseases closely connected to natural factors increases considerably from cold to hot belts and reaches its maximum in the sub-equatorial belt. Collins (2010) has examined the inter-relationships between environment, health, population displacement and sustainable development, by considering the case of cholera and dysentery in Mozambique. He has found that environmental changes, whether associated with population displacement or inappropriate development, can produce more favourable physical conditions for the occurrence of certain diseases, because such changes result in loss of protection from infections through
increased exposure to health risks and heightened biological and socio-economic susceptibility.

In India, many studies have been conducted on the aforesaid theme by geographers like Akhtar (1992), Singh (1992), Thulasimal and Sivangnamam (1997) and Hazra (2002). Akhtar (1992) has highlighted that environmental conditions are undoubtedly the causal factors affecting both health and disease, and have therefore been studied by a variety of disciplines. However, adopting a geographical approach is important to understand the spatial distribution of health and disease because it reveals wide variations at international, national, regional and local levels. The author has stated that these variations are due to socio-economic and cultural environments which are essentially man-made. Singh (1992) has evaluated the impact of environmental conditions on the health of residents of Bhopal city. The author has found that factors like high density of population and very low level of drainage facilities have degraded the environment and hence, the diseases like diarrhoea, typhoid and gastroenteritis are increasing in the low-lying high density areas. Thulasimal and Sivangnamam (1997) have studied the spatial variations of health status using disease occurrence and mortality patterns in Chengalpattu district of Tamilnadu. Hazra (2002) has examined the health profile of North-East India. She has found that the spatial patterns of health in North-East India show uniformity in case of communicable diseases which are influenced by ecological factors and diversity in case of diseases like cancer and AIDS which are affected by cultural factors. In yet another study (2002), the author has examined the health profile of Mizoram state and found that most of the diseases in the state are totally associated with the ecology and the natural habitat system, which reflects the overemphasis of the natural environment on lifestyle and cultural patterns.

The association between water quality and health has been examined by a number of geographers in different parts of the world (Low and Yusof, 2010 and Kloos, 2010), and in India (Das and Krishna, 2003; Sharma and Khan, 2003; Awasthi, 2009; and Kanchan, 2008). Low and Yusof (2010) have examined the various aspects connected with water quality and related health problems in Malaysia. The authors have placed an emphasis on a
review of current legislation governing the water quality programme and identification of the weakness in terms of implementation and violation of laws. Kloos (2010) has described the spatial and temporal distribution of the major contaminants found in large community wells in the Fresno/Clovis metropolitan area and has estimated their lifetime cancer risk. In India, Das and Krishna (2003) have examined the problems of water supply, water-logging and drainage conditions in Dakshindari slum area of South Dum Dum in Kolkata, to evaluate the relationship that exists between health and environmental parameters of the area. The findings reveal that 75% of slum dwellers go out of their area to get clean drinking water, so there is low incidence of water-borne diseases. However, they are more susceptible to cold, cough, respiratory diseases, skin problems, malaria, jaundice and typhoid. Sharma and Khan (2003) have conducted an analysis of water-borne diseases in Dausa district of Rajasthan. The authors have found that high concentration of fluorides in underground water has made people susceptible to dental and skeletal fluorosis. Awasthi (2009) has also investigated the impact of fluoride concentration on human health in Sonbhadra district of Uttar Pradesh. The author has observed that the water samples taken from dug wells are more contaminated as compared to the other sources like hand pumps and pucca wells. Kanchan (2008) studied the health implications of arsenic contamination of ground water in Murshidabad district of West Bengal and concluded that at a lower depth, the percentage of arsenic content in groundwater has increased rapidly in recent years due to excessive use of groundwater, which is adversely affecting the health of villagers.

Various scholars have also studied the health implications of air pollution (Chatterjee, 2001 and Meera et al., 2001), solid waste exposure (Aggarwal and Sanadhya, 2004; Singh, 2005) and insanitary conditions (Dwivedi, 2003 and Milkovic, Carbajo and Rubel, 2009). Chatterjee (2001) has brought out the impact of air pollution on the existing morbidity and mortality pattern in Delhi. The results show that almost 30% of Delhi’s population is suffering from respiratory disorders like asthma and chronic bronchitis, but there has been a decline in the number of reported cases in recent years due to the various measures taken to check air pollution. Meera
(2001) has highlighted the respiratory diseases caused by suspended particulate matter in Calcutta. The results have shown that about 34% population of the city is afflicted with diseases like rhinitis, allergy, bronchitis and asthma. Aggarwal and Sanadhya (2004) have examined the exposure processes and subsequent health risks to vulnerable communities around Bhalaswa landfill site of New Delhi. The findings have shown that closeness to site, housing quality, use of contaminated groundwater and direct contact with the site for livelihood are critical factors of exposure. The authors have found no strong distance decay relation in cumulative exposure levels; however those residing closest to the site and in low quality housing with low income levels have high levels of exposures and high vulnerability to health risks. Singh (2005) has also evaluated the effect of solid waste on human health in Varanasi district and concluded that traditional methods of municipal waste collection and disposal in India have become archaic, making the slum populations prone to communicable diseases like malaria, tuberculosis, diarrhoea and respiratory disorders. Dwivedi (2003) has evaluated the role of sanitation and safe environment in human development in an area. Milkovic, Carbajo and Rubel (2009) have studied the public health implications of magnitude and spatial distribution of canine faeces in Buenos Aires as canine faecal contamination contributes to environmental degradation and increases the exposure of humans to helminthic infections.

(b.) Changing Disease Patterns

Various studies have been conducted on the changing patterns of diseases in different parts of the world (Suh, 2001; Ganguly and Singh, 2002) and in India (Hazra, 1987; Sinha and Srivastava, 2001; Aparajita and Ramanakumar, 2005; and Kumari and Reddy, 2005). Suh (2001) has examined the cardiovascular disease mortality in Korea and has concluded that the overall mortality changes in Korea are consistent with the epidemiologic transition from the age of receding pandemics to the age of degenerative and man-made diseases. Ganguly and Singh (2002) have discussed the possible effects of global climatic change on the incidence of some communicable and non-communicable diseases. Using the data of World Health Organization on incidence of diseases, the authors have found
that in the recent past there has been resurgence of many vector-borne and water-borne diseases, and in the near future, there is likelihood of widespread occurrence of dengue, cholera and skin cancer.

As far as India is concerned, Hazra (1987) has regionalized the disease association for the state of West Bengal to single out the factors responsible for the changing trends of communicable and degenerative diseases during 1970 to 1990. Sinha and Srivastava (2001) have conducted an inter-state analysis of changing patterns of morbidity. The authors have pointed out that though there is substantial decrease in morbidity due to communicable diseases, they still contribute to more than half of the disease burden from all diseases. Aparajita and Ramanakumar (2005) have studied the burden of diseases in rural India by analyzing the cause of death. The authors have concluded that poverty and unhealthy environment-related causes are taking burdensome toll, mainly in the demographically backward states, notwithstanding the overall declining trend of infectious diseases. However, accidents and injuries and diseases of central nervous system are showing a significantly increasing trend. Kumari and Reddy (2005) have brought out the changes in disease pattern in Anantpur district of Andhra Pradesh. The authors have found that many diseases are widespread in the study area due to environmental pollution and lack of awareness about cleanliness in low income sections of society.

(c.) Infectious Diseases

The spatial processes of emergence, diffusion, spread and retreat of epidemics like typhoid fever, influenza and poliomyelitis in the developed countries of the world have been studied by scholars like Smallman-Raynor and Cliff (2001, 2002 and 2005) with Johnson (2002) and Trevelyan (2005). Smallman-Raynor and Cliff (2001) have examined the geographical transmission of typhoid fever in the makeshift encampments of U.S. military camps during the Spanish-American war of 1898. In another study with Johnson (2002), the same authors have investigated the geographical patterns and processes of diffusion of epidemic influenza in London and county boroughs of England and Wales during 1918-1919. In yet another
work, Trevelyan, Smallman-Raynor and Cliff (2005) have traced the spatial dynamics of poliomyelitis in United States, beginning with its epidemic emergence in 1910 to vaccine-induced retreat by 1971. Hazra (2004) has similarly explored the diffusion of SARS (Severe Acute Respiratory Syndrome), which is an atypical pneumonia, in various parts of the world in 2003. She has also examined the social and economic implications of the disease in the world community.

Another theme of interest that has attracted the attention of many scholars at international and national level is the study of HIV/AIDS. Scholars like Craddock (2000), Thomas (2007), Leisch (2010) and Mukhopadhyay and Dutt (2010) have worked on various dimensions of HIV/AIDS in different parts of world. Craddock (2000) has proposed a framework that combines a realistic approach to mapping vulnerability with post-structural approaches that focus more attention upon the role of social identities and cultural framings of HIV/AIDS. As an illustration of this framework, she has given the social, economic, political and cultural context of this disease in Malawi. Thomas (2007) has highlighted the significance of understanding the emotional well-being of people living with HIV/AIDS in developing countries. Drawing upon research undertaken in the Caprivi Region of Namibia, the author has examined the use of solicited text and photo diaries in enabling insight into the emotional impacts of this disease. The advantages and constraints of diary based approach have been analyzed, focusing on informant-directed research and the ethical considerations surrounding their use. Leisch (2010) has studied the spread of AIDS in Thailand with reference to highland and lowland districts of the Chiang Mai province. The author has found that with only societal changes and economic development in the lowland districts, combined with family planning in the highland districts, the province can go a long way in decreasing HIV infections and AIDS. Mukhopadhyay and Dutt (2010) have traced the diffusion of HIV in developing countries. They have described that from the original cores of the Central and West Africa, the disease has diffused not only all over the continent, but also to the other continents, including Asia. Future estimates reveal that the disease will continue to take more toll in the less developed countries. In
India, the incidence of HIV/AIDS has been studied by geographers like Choubey (2005) and Kharikar (2005). Choubey (2005) has pointed out that HIV/AIDS epidemic in the country has entered the third phase, where significant transmission is occurring through perinatal route. The epidemic is moving from high risk groups and urban centres to the general masses in rural hinterland with normal lifestyle. The disease has high prevalence in the states of Tamilnadu, Andhra Pradesh, Karnataka and Manipur. Kharikar (2005) has studied the demographic profile and awareness level of HIV/AIDS among migrants living in slums in Pune. He has also analyzed their risk taking behaviour and socio-economic impact of HIV/AIDS on their households. The findings reveal that young migrants are the most vulnerable group. The degree of awareness is low before acquiring HIV/AIDS and a huge social stigma is attached to the disease.

In India, several studies have been conducted on the incidence of other infectious diseases like cholera, diarrhoea, helminthic diseases, smallpox, hepatitis, leprosy, malaria and plague by geographers like Hyma and Ramesh (1976), Akhtar et al. (1977), Prasad (1985), Singh and Dutta (1981), De and Gollerkeri (1984), Kumar (1994), Sinha and De (1996) and Mukherjee (2003). Hyma and Ramesh (1976) have studied the geographic distribution and trends of cholera incidence in Tamilnadu during the period 1961-1974. The authors have also concluded that the disease appeared traditionally in areas having the confluence of rivers and streams, in wet paddy-growing areas and in river deltas and coastal tracts. Akhtar et al. (1977) have analyzed the resurgence of Malaria in India during 1965-1976. Prasad (1985) has also examined the incidence of Malaria in major urban centres of Andhra Pradesh over a time span of ten years, i.e. 1975-1984. The author has found that the disease prevalence is highest in coastal Andha Pradesh, especially in the two deltaic towns of Vijayawada and Guntur. These two towns are surrounded by a zone of intensive wet agriculture that has led to high malaria prevalence. The seasonal pattern also reveals that the months of high rainfall are followed by high disease incidence. Singh and Dutta (1981) have studied the patterns and correlates of smallpox in Patna during 1973-1975 and have concluded that the reasons for high concentration of the disease in some wards were the
contact with hospital patients and lack of inoculation. De and Gollerkeri (1984) have analyzed the distribution of morbidity of infectious hepatitis in Vadodra during the period 1977-1981. The authors have found that 60% of the patients are aged between 15 to 34 years and 71% of the suffering people are males. Kumar (1994) has given a detailed account of the history of plague in India and has highlighted the poor sanitary conditions, negligent role of local urban bodies and faulty health care system in India. Sinha and De (1996) have dealt with some of the epidemiological features, aetiological factors and spatial distribution of childhood leprosy cases in Vadodara district of Gujarat. The author have found that the overall incidence rates of childhood leprosy are low in Vadodra district as compared to the average for Gujarat state, however the spatial distribution pattern indicates considerable variation with certain pockets displaying high occurrence of child cases. Mukherjee (2003) has given an insight into the pattern of prevalence of acute diarrhoeal diseases in Meghalaya to understand their associated latent environmental factors. The author has found that in general, higher temperature, lower altitude and high density of population induced higher prevalence of diarrhoea. Late summer and early rainy season are the peak periods of incidence throughout the state.

(d.) Non-infectious Diseases including Cardiovascular Diseases

Many studies have been undertaken in different regions of the world on the spatial patterns and correlates of various non-communicable diseases and their associated risk factors. As far as cardiovascular diseases and their risk factors are concerned, apart from geographers, much work has also been done by scholars related to the fields of public health, social medicine, cardiology and epidemiology.

The first major attempt to study the epidemiology of cardiovascular diseases was made by the Framingham Heart Study carried out in the United States. This study has offered a deep understanding of the prevalence, incidence, prognosis, predisposing factors and determinants of cardiovascular diseases. It generated crucial findings such as the effects of tobacco use, unhealthy diet, physical inactivity, obesity, raised blood cholesterol, raised blood pressure and diabetes on cardiovascular diseases (Mendis, 2010).
Numerous other studies have been conducted in different parts of the world on the prevalence of this group of diseases. Scholars like Ingram and Gillum (1989), Lanska (1993), Hart et al. (1997) and Roth (2014) have studied the spatial patterns of cardiovascular diseases and their covariates. Ingram and Gillum (1989) have examined the regional and urbanization differentials in coronary heart disease in the United States among white males aged 35-74 years during 1968-1978 and 1979-1985. The authors have observed that many of the differentials of heart disease mortality found during 1968-1978 persisted during 1979-1985. The western parts of the country and fringe metropolitan areas recorded low death rates and the mortality rates continued to decline during the study period. Lanska (1993) has also observed a consistent pattern of marked geographic variation in stroke mortality within the United States with very high rates reported in the southeast Atlantic coastal plain and very low rates in the mountain census division. Hart et al. (1997) have studied the geographic variation in coronary heart disease in Scotland between 1984 and 1986 and has found significant variation at district level in risk factors which suggests that place locations may have a role in the distribution of coronary heart disease. Roth (2014) has examined the geographic distribution of cardiovascular health among women over the age of 65 years in USA. The results showed that the distribution of overall cardiovascular health and individual factors differed geographically and the patients had significant room for improvement in modifiable behaviours and cardiovascular risk factors.

Eng and Mercer (2000) have found seasonal variation in cardiovascular deaths in many countries, with the highest levels occurring during the coldest months of the year. Foster (1997), Ferrandiz et al. (2004), Calderon and Hunter (2009), Altura and Altura (2009) have examined the spatial association between cardiovascular disease prevalence and groundwater hardness. These studies have revealed that areas with hard water have lower incidence of cardiovascular diseases. Scholars like Hanigan (2005), Hu and Rao (2009) and Chen (2010) have examined the relationship of various cardiovascular diseases with air pollution and have ascertained a positive correlation between the two.
Some studies have questioned the spatial association between cardiovascular disease prevalence and the underlying patterns of their related risk factors. Lawlor et al. (2003) have analyzed the geographical variation in cardiovascular diseases and their risk factors among older British women. The authors have found that the spatial variations in prevalence of heart diseases among older women are not fully explained by variations in major risk factors. Subsequently, scholars like Howard et al. (2009) have advanced the hypothesis that geographic variations in risk factors contribute relatively little to the observed geographic variations in heart disease and stroke mortality. Diez Roux (2009) has pointed out that understanding the fundamental causes of geographic differences in cardiovascular diseases will require studying distal antecedents operating over the life course, which will most likely be social or environmental in nature. This will require understanding of the relevant social and environmental constructs, measuring them and empirically testing their effects.

Puska (2000) has pointed out that prevalence rates of cardiovascular diseases can be substantially reduced by introducing changes in people’s dietary habits. The author has reviewed the experience of Finland which made major changes in national nutrition policy during 1972 to 1997 and accordingly, drastic reduction was observed in national cardiovascular disease mortality. Djietror and Inungu (2008) have examined the changing spatial patterns of heart disease mortality across Michigan counties and have assessed the association between heart disease deaths and selected socio-economic risk factors among people aged 50 years and older. The regression analyses have shown that low level of education, unemployment rate, household income, poverty rate and lack of health insurance were each significantly associated with heart disease mortality. Hasan et al. (2009) have also examined the role of socio-economic indicators in the causation of coronary artery disease. A comparison of male cases with females reveals that majority of the male patients have a college degree, higher monthly income, semi or full professional occupations and are living in families with size of more than nine. Studies have also been conducted on geographical
accessibility and hierarchies of heart-related health care provisions (Hare and Barcus, 2007; Yiannakoulias et al., 2009).

The emerging epidemic of cardiovascular diseases in developing countries has been well documented by scholars like Reddy (1998, 2002, 2007) and Yusuf (1998) and Institute of Medicine, Washington D.C. (2010). All these studies have concluded that the developing countries are experiencing a sharp rise in burden of cardiovascular diseases because of demographic shifts with altered population age profiles, lifestyle changes due to recent urbanization, altered diets, tobacco use, diminished physical activity, delayed industrialization and overpowering globalization, probable effects of foetal under-nutrition on adult susceptibility to cardiovascular diseases and possible gene-environment interactions influencing ethnic diversity.

In India, many studies have been conducted on the prevalence of cardiovascular diseases and their associated risk factors by scholars like Rather (2002), Rastogi et al. (2004), Goyal and Yusuf (2006), Gupta et al. (2006) and Goenka et al. (2009). Rather (2002) has analyzed the incidence of heart diseases in urban population of Srinagar city. The study has revealed that the areas inhabited by rich families have higher incidence of cardiovascular diseases, since they consume meat more than standard requirement. Temporal trends show that the incidence of cardiovascular diseases has been increasing over time and seasonal patterns reflect that the disease incidence is high in winters. The cardiovascular mortality rate is higher for males in the age bracket of 14 to 60 years and for females of age 60 and above. Rastogi et al. (2004) have investigated the relationship between diet and ischemic heart disease risk among north Indians (New Delhi) and south Indians (Bangalore). The authors have found that diets rich in vegetables and cooked in mustard oil can contribute to lower the risk of this disease among Indians. Goyal and Yusuf (2006) have discussed the existing data on cardiovascular disease prevalence and its risk factors in the Indian subcontinent. Reviewing the recent evidences indicating that the burden of coronary heart disease in the Indian subcontinent can be largely explained on the basis of traditional risk factors, the authors have also challenged the
common perception that South Asian ethnicity per se is a strong independent risk factor for coronary heart disease. Gupta et al. (2006) have determined significance of various nutritional factors and other lifestyle variables in explaining the wide disparity in prevalence of cardiovascular diseases in different Indian states. The authors have noticed large disparities in cardiovascular disease mortality in different Indian states which can be epidemiologically explained by difference in dietary consumption of fats, milk, sugar and green-leafy vegetables and prevalence of obesity. Goenka et al. (2009) have described the trends and burden of cardiovascular diseases in India. The authors have also highlighted the adverse impact of increasing incidence of this group of diseases on Indian economy and have also suggested policy measures to prevent the rise of cardiovascular diseases in epidemic proportions. The increasing burden of cardiovascular diseases in rural areas of India has been documented by scholars like Gupta et al. (2003), Sharma et al. (2003), and Joshi et al. (2006). These studies have revealed that heart diseases occur at a younger age in rural subjects with primordial risk factors of faulty diet, tobacco consumption and sedentary lifestyle.

**Childhood obesity** is another significant research theme which has recently emerged in medical geography. Scholars like Ebbeling, Pawlak and Ludwig (2002), Procter et al. (2008), Kime (2008) and Evans (2010) have explored the various covariates of obesity among children. Ebbeling, Pawlak and Ludwig (2002) have described the problem of obesity among children as a public health crisis. Procter et al. (2008) have conducted a micro-level analysis of the relationships between childhood obesity and many variables of the obesogenic environment such as urbanization, access to local amenities, perceived local safety as well as dietary and physical activity behaviours in Leeds. The analysis has highlighted variation in these relationships across Leeds, thus identifying the populations at risk and providing health planners with additional information to tailor interventions and health policies to prevent childhood obesity. Kime (2008) has explored the importance of family environment as a contributory factor for childhood obesity. The author has found that ordering of eating highlights the importance of family setting which in turn influences the development of children’s eating behaviours. Evans
(2010) has argued that the obesity policies in United Kingdom must consider the temporality as well as spatiality of obesity and therefore, these policies should focus on children, anticipating their obesity as adults of the future.

Cancer is a disease whose incidence is increasing all over the world, but whose complex aetiology is not clearly understood. Scholars like Rigby and Gatrell (2000), Jacquez and Greiling (2003), Sheehan et al. (2004), Hsu et al. (2004), Gangbe et al. (2010) have examined the geographic variations in distributional patterns of various types of cancers in different parts of the world. The main aim of these studies is to explore if the geography of different types of cancers can help in the search for its explanatory causal factors. The scholars have attempted to examine the spatial association of different types of cancers with covariates like, socio-economic status and degree of urbanization; and probable underlying factors such as, air-borne toxins, food contaminants and exposure to pesticides. Akhtar (1983) has made a medico-geographical study of cancer distribution in India. The study highlights the most important typical cancer regions of India which have been associated with the physical, biological, socio-economic and cultural factors.

(III) Health Care Provisions

Scholars like Robson (2000), Brabyn and Skelly (2002), Guagliardo (2004), Jordan et al. (2004) and Morrissey et al. (2008) have examined the spatial variation and accessibility of health care provisions as well as the dynamics of hospital catchment areas in different geographical settings of the world. They have also suggested appropriate locations for various types of medical facilities in their respective study areas. Gish (2010) has highlighted the various obstacles in the successful spatial implementation of health care planning processes in developing countries. Bailly (2010) has stressed the need for formulating locationally specific policies in health services and integrating the economics of health services in regional policies. Oppong (2010) has found that the existing health care system in less developed countries is urban-biased and caters inadequately to rural areas. Stevenson (2010) has emphasized that community participation is important to assure sustainability of health care systems.
In India, the spatial organization, location patterns and spatial efficiency of health centres have been examined by scholars like Hodgson and Valadares (1983), Massam, Askew and Singh (1987), Sinha and Rajeshwari (1993), Akhtar and Khan (1993), Saravanabavan and Shanmuganandan (1996), Yadav and Prasad (2002) and Aggarwal (2003). They have studied the availability, functionality and hierarchical ordering of health centres in different states of India and the relationship of utilization of health care facilities with social structure. Choubey (2002), Mayer and Akbar (2007) and Garud et al. (2008) have analyzed the health care practices and behaviour among various tribal communities. Learmonth (1988) and Speziale (2010) have studied the revival of traditional systems of Unani and Ayurvedic medicine in India.

(IV) Health and Disease in Punjab

Only a few studies have been conducted in medical geography, focusing on the spatial aspects of health, disease and medical care in Punjab. Sandhu (1983) has examined the spatial patterns of incidence of tuberculosis in Patiala district and found that the occurrence and transmission of the disease was associated with environmental pollution, high density of population, low economic conditions, malnutrition, undernutrition and poor housing conditions. Singh and Bhullar (1982) have studied the patterns of corneal diseases in Punjab. The epidemiology of heart diseases and their associated risk factors in the rural areas of Punjab has been examined by scholars like Wander et al. (1994) and Kaur and Bains (2006). Wander et al. (1994) have conducted an epidemiological study to find out the prevalence of coronary heart disease and the influence of risk factors on its prevalence in Pohir village near Ludhiana. The authors find that the overall prevalence of coronary heart disease is 30.8/1000 and it is higher among females (37.7/1000) than males (25.6/1000). Only 38% of patients with this disease are aware of its prevalence and the knowledge about the risk factors is poor among people in general. Kaur and Bains (2006) have examined the risk factor profile of cardiovascular diseases in rural Punjabi male patients admitted to Hero DMC Heart Institute, Ludhiana. The findings reveal that the
etiology of cardiovascular diseases is multifactorial and no single factor is an absolute cause. 20% of the subjects were smokers, 56% were alcohol takers, 84% had sedentary lifestyle and 36% were overweight. Therefore, the authors conclude that suitable modifications in diet and lifestyle could significantly reduce the risk of cardiovascular diseases among rural male population of Punjab. There are some other studies related to the availability of health care provisions in Punjab. Singh (2006) has analyzed the disease ecology and health care system in Hoshiarpur district. Singh and Gill (2008) have critically examined the rural health infrastructure and services in Punjab from an economic perspective.

Apart from these, various reports published from time to time in different newspapers have highlighted the major health issues and diseases of the state. The main focus of these reports has been on the rising incidence of various types of cancers and mental illness in the cotton-belt of Malwa region, due to the high toxicity and chemical contamination of underground water (The Tribune, 4th October 2006; 1st August 2009; 26th March, 14th June, 13th October 2010). Some articles have also highlighted the increasing incidence of cardiovascular diseases in Punjab (The Tribune, 17th December 2003; 12th April 2004; 1st March 2010) due to the consumption of alcohol and rich diets coupled with sedentary lifestyle (The Tribune, 1st May 2006; The Times of India, 4th August 2008). A few reports have assessed the harmful health effects of garbage dumping in open areas (The Tribune, 10th September 2009) and disposal of dairy wastes in sewage system of populated areas (The Tribune, 26th June 2010).

Thus the foregoing review of literature shows that health and health-care have been studied from different perspectives by researchers belonging to pure medical sciences, epidemiology, social medicine, public health and geography. Health geographers in particular have studied how the geographic factors influence and determine the health conditions of human beings. With the growing importance of socio-ecological model of health, medical geography has evolved a lot in the recent past in terms of its emphasis and orientation. The research in the sub-discipline has been done on two
distinctive areas – disease ecology and health care services. Numerous macro and micro-level studies have been conducted in different geographical setups explaining the distributional patterns, temporal trends, spatial diffusion and geographical correlates of various infectious and non-infectious diseases, along with the availability, spatial and economic accessibility, utilization, hierarchical ordering and spatial efficiency of health care services. However, as far as particularly cardiovascular diseases are concerned, most of the studies have been undertaken from medical and epidemiological viewpoints and as such, not much work has been done by geographers in India in exploring their geographical characteristics and correlates and their associated health care provisions. There is a near absence of such studies on Punjab despite the fact that cardiovascular disorders are the leading cause of death in the state. The Punjab Human Development Report (2004) has pointed out that there is little information available on the prevalence of cardiovascular diseases in the state. It is only on the basis of anecdotal evidence, discussions with doctors and others associated with medicine, that the extent of affliction of these diseases is estimated in urban and rural areas of the state. Therefore, a very prominent research gap exists 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 has made a humble attempt 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 the selected Bist Doab region of the state.

**Objectives**

The objectives of the present research work are to:

1. Study the spatial patterns of mortality caused due to cardiovascular diseases in rural areas of Bist Doab and to identify the high-risk areas.
2. Examine the role of physical factors (particularly relief, seasonal variation in temperature and groundwater hardness) in determining the spatial patterns of cardiovascular diseases.
3. Analyze the role of socio-economic attributes (literacy, education level, occupation and income) in determining the geographic distribution of cardiovascular diseases.

4. Study the influence of behavioural characteristics (including tobacco use, alcohol consumption, diet, physical activity, awareness level) on the prevalence of cardiovascular diseases.

5. Study the spatial distribution of public and private medical facilities in rural areas of Bist Doab.

6. Find the geographical determinants of utilization (like distance, cost and income) of health-care provisions related to cardiovascular diseases.

7. Suggest policy inputs for improving rural-targeted health care system.

Research Questions

The present study addresses the following research questions:

1. How are cardiovascular deaths distributed in the rural Bist Doab?
2. What geographical factors affect the distribution of cardiovascular diseases?
3. What is the spatial distribution of health care provisions associated with the treatment of cardiovascular diseases in Bist Doab?
4. What is the role of socio-economic factors in the utilization of health care provisions related with cardiovascular diseases?

Hypotheses

The following hypotheses have been tested in this research work:

1. The eastern hilly and foothill areas of Bist Doab have lower cardiovascular disease mortality than rest of the region where the relief is plain.
2. The areas experiencing lowest winter temperature in the region record higher mortality from cardiovascular diseases.
3. Areas having hard groundwater have low disease mortality in the region.
4. Cardiovascular disease mortality is lower in areas having higher proportion of farming population.
5. The areas having high availability of liquor have high cardiovascular disease mortality.

The Study Area

The study is focused on the Bist Doab region (30°57′ N to 32°7′ N latitude and 75°4′ E to 76°38′ E longitude) of Punjab (Fig 1.1). It is a triangle-shaped natural region lying between 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 (Fig 1.2). As a result the eastern parts are hilly and undulating 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). The present study has been conducted for the rural areas of the region.

As far as health infrastructure is concerned, Bist Doab has a total of 625 sub centres, 391 subsidiary health centres, 110 primary health centres
and 68 community health centres. There are also 8 sub-divisional hospitals and 4 district hospitals. The region on the whole accounts for 23.2% of all the mortality and morbidity cases (indoor patients, outdoor patients and deaths caused among indoor patients) reported in the public medical institutions of Punjab.

Bist Doab has been selected as the study area due to the following reasons:

(a.) Bist Doab region has its own distinctive geographical identity in Punjab. It has varied physiography, giving rise to significant intra-regional variations in slope distribution which can have probable association with cardiovascular disease prevalence by influencing the extent of physical activity of the people.

(b.) As far as the seasonal temperatures are concerned, the lowest temperature in Punjab is recorded at Adampur (near Jalandhar), which falls almost in the centre of Bist Doab region. The seasonal variation in cardiovascular disease mortality can be most effectively studied in this region.

(c.) Unlike the other two regions of the state, Bist Doab relies heavily on groundwater sources for drinking and agricultural purposes. This is evident from the absence of any major canal network. Though the groundwater is sweet, it can vary markedly in its hardness (Ong et al., 2009). Kumar et al. (2006) has noted a huge variation in hardness and mineral contents of groundwater in Punjab. Hard water is associated with lower incidence of cardiovascular diseases. The present study has tried to explain the role of variable groundwater hardness in determining the spatial patterns of cardiovascular disease mortality in the region.

(d.) Further, the region has the highest literacy rate (77.3%) amongst all the three cultural regions of Punjab. Even the rural literacy rate of the region (74.8%) is much above the average for Punjab (64.4%). Thus the relationship between literacy rate and the incidence of cardiovascular diseases can be analyzed in a meaningful way because literacy affects the educational level, occupational structure and income of the people.
All the four districts of Bist Doab region reflect contrasting variation of cardiovascular disease mortality in Punjab, as revealed by data on number of cardiovascular deaths in public health institutions in the state in 2007. The district of Hoshiarpur has one of the highest mortality from cardiovascular diseases (18 deaths per lakh of population) in Punjab, while Jalandhar district has the lowest mortality (3 deaths per lakh of population) in the state. The figures for Kapurthala and S.B.S. Nagar districts are quite close to the state average (9 deaths per lakh of population).

Considering all these aspects, Bist Doab region offered an ideal case for undertaking the study.

**Data Sources and Methodology**

For the present research work, data have been collected from both primary as well as secondary sources. The objective-wise sources of data and methodology used are given below:

1. 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.

   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. Secondly, 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. Thirdly, an attempt was made to construct a regression model of cardiovascular mortality using cardiovascular risk index as an explanatory variable. Finally, the overall burden of cardiovascular diseases in the region was estimated by calculating the years of life lost due to the resultant
premature mortality. The economic loss incurred by these deaths was also assessed by considering the economically productive age group of 15 to 59 years.

2. To examine the role of physical factors (particularly, relief, seasonal variation in temperature and groundwater hardness) in determining the spatial patterns of cardiovascular diseases.

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 toposheet was downloaded from the website of University of Texas, USA. 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 village-wise Death Registers 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.

3. To analyze the role of socio-economic attributes (like literacy, education level, occupation and income) in determining the geographic distribution of cardiovascular diseases.

For this objective data has been 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 collected primary as well as secondary data was processed and analyzed in MS Excel software and the maps were prepared in ArcGIS 9.3 software. Various appropriate statistical diagrams like pie-chart, line graph and bar diagrams were also used for data representation.

4. To study the influence of behavioural characteristics (including, tobacco use, alcohol consumption, diet, physical activity, awareness level) on the prevalence of cardiovascular diseases.

The data for this objective was collected from the primary survey as mentioned above. The questions on behavioural aspects like consumption of tobacco, alcohol and dietary fats and oils were asked using the quantity/frequency approach, whereby enquiry was made regarding the overall frequency of consuming an item within the reference period and the usual quantity of the item consumed on a single occasion. Subsequently, averages were worked out from this data to find daily consumption of various items. 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). The collected primary data on behavioural risk factors of deceased in the sample was analyzed by calculating simple proportions and measures of central tendency like mean and mode. The results were represented through tables and bar diagrams and maps were prepared in ArcGIS.

5. To study the spatial distribution of public and private hospitals specializing in the treatment of cardiovascular diseases in Bist Doab.

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) in Bist
Doab 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.

6. To find the geographical determinants of utilization (like distance, cost and income) of health-care provisions related to cardiovascular diseases.

The data on utilization of health care provisions related to cardiovascular diseases was collected through interview schedule survey conducted in the study area, as mentioned in objective 3. The distance travelled from village to hospitals 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 data was represented through statistical diagrams like bar diagram and line chart. The information related to the 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.

**Period and Unit of Study**

The patterns of cardiovascular disease mortality and the associated health care provisions have been examined for the year 2009. Village has been taken as the basic unit of analysis because the data on cause of death for all cases is available in the form of village-wise death registers. Moreover,
village-level plotting of data in Bist Doab portrays the spatial variations in a precise manner and the geographical patterns thus obtained are quite close to reality. So the present study takes into account all the 3403 villages of the region. However, Community Development Blocks have also been used for explanations where data at village level was not available.

**Significance of the Study**

The present study 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.

**Limitation of the Study**

The temporal data on cardiovascular deaths is not available from the death registers of the study area. So the temporal variation in spatial patterns of cardiovascular mortality could not be examined.

**Organisation of the Material**

The present work has been organised into the following seven chapters:

Chapter 1- **Introduction**

This chapter 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 limitation of the research work and organisation of the material.
Chapter 2 - Spatial Patterns of Cardiovascular Mortality in Rural Bist Doab

In this chapter the spatial distribution and 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.

Chapter 3 - Physical Correlates of Cardiovascular Diseases

In this chapter 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 - Socio-economic Correlates of Cardiovascular Diseases

This chapter examines the socio-economic factors (mainly literacy, education level, occupation and income) affecting the geographical patterns of cardiovascular diseases in rural Bist Doab.

Chapter 5 - Behavioural Risk Factors of Cardiovascular Diseases

In this chapter 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 - Spatial Distribution and Utilization of Health Care Provisions

This chapter 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.

Chapter 7 - Summary, Conclusions and Recommendations

This chapter summarizes the main findings of the study, conclusions drawn from it and suggests recommendations for future rural-targeted health policies.