DETERMINANTS AND BURDEN OF ANEMIA IN INDIA

A dissertation submitted to the University of Hyderabad in partial fulfillment of the requirements for the award of

Master of Philosophy
In
Economics

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I **Shrishti Chamola**, hereby declare that the research embodied in the present dissertation entitled, **"Determinants and Burden of Anemia in India"** is an original research work and is free from plagiarism, carried out by me under the supervision of **Professor. S. Sandhya,** School of Economics, for the award of Master of Philosophy from University of Hyderabad**.** I also declare to the best of my knowledge that no part of this dissertation is earlier submitted for the award of any research degree or diploma in full or partial fulfillment in any other university. I hereby agree that my thesis can be deposited in Shodhganga/INFLIBNET.

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List of Abbreviations

ALE	Active Life Expectancy
BCC	Behaviour Change Communication
BMI	Body Mass Index
DALE	Disability Adjusted Life Expectancy
DALY	Disability Adjusted Life Years
DFLE	Disability Free Life Expectancy
GDP	Gross Domestic Product
HALE	Healthy Adjusted Life Expectancy
HYLL	Healthy Years of Life Lost
ICDS	Integrated Child Development Services
IDA	Iron Deficiency Anemia
IEC	Information, Education and Communication
IFA	Iron and Folic Acid Tablets
IHME	Institute of Health Metrics and Evaluation
NFHS	National Family Health Survey
NRHM	National Rural Health Mission
PYLL	Potential Years of Life Lost
QALE	Quality Adjusted Life Expectancy
QALY	Quality adjusted Life Years
WCD	Women and Child Development
YLD	Years of Life Lived with Disability
YLL	Years of Life Lost Due to Premature Death

Chapter I

Introduction

1.1Health and Productivity

A healthy mind and a healthy body is an important aspect of human development. A healthy person is an asset for the nation as well as the society. Education and Health are the pillars on which the future growth and development of a nation depends. India is a nation with a large percent of population with the maximum number of people falling in the age group of 15-59 years. We are at a position where we can avail the benefits of demographic dividend because the working population makes up the maximum percent of the population of India. If the people of our nation receive proper education and are healthy we can be sure of positive growth and development.

Healthy people are more productive because there is no barrier between their productivity and the performance of their work. As pointed out by David Bloom and David Canning in their study that a healthier population has a higher labor productivity. This happens because their workers are physically energetic and mentally robust. They do not fall ill frequently which results in lesser number of lost work days due to illness or taking leave for caring for other sick family members. People who are healthy are willing to work on their skills as they know they will live longer and can make use of the investments on skills they develop to reap benefits for themselves for a long time. Increased schooling promotes greater productivity which leads to higher income.

Good health also promotes school attendance and enhances cognitive function. When people have a long and healthy life they have to make sure that they have enough funds to cater to their needs after retirement therefore they save and this spurs the investment in a nation. With increase in investment there is more capital and incomes of the people increase. In recent times a lot of developing countries have shown a transition from high mortality and fertility to low mortality. When this transition takes place there is an initial increase in the number of dependent population in the form of young children but gradually they grow up and form the working population of a country. When this happens, income per capita of a nation rises eventually. But this is possible only when the government makes sure that the workforce is gainfully and productively employed *(David E Bloom, Feb 2000)*

There are many factors that influence the health of an individual some of them are genetic that are not under any ones control others are environmental, societal and yet others are the nutritional factors. Wholesome diet is of utmost importance if a person aspires to live a healthy life. Studies show that nutrition has a direct impact on the health of a person. Nutrition as defined by WHO is “the intake of food, considered in relation to the body’s dietary needs. Good nutrition – an adequate, well balanced diet combined with regular physical activity – is a cornerstone of good health. Poor nutrition can lead to reduced immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity.” A nutritious diet ensures a healthy body that is productive. More often than not a positive association is seen between health and productivity. A

study gives a four step conceptual linkage between nutritional status and productivity *(Popkin, November 1978)*

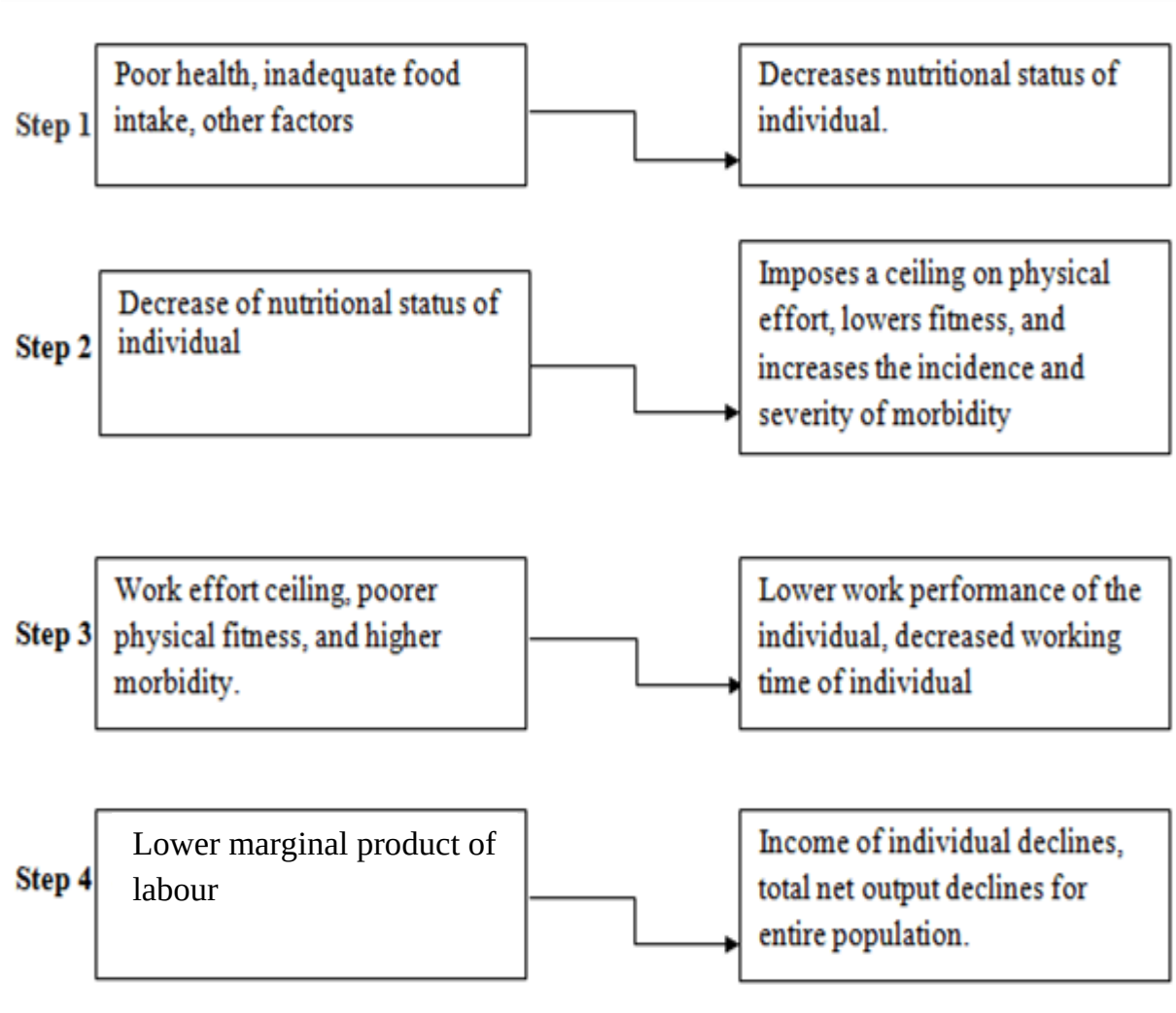


Figure1.1: Flow chart showing the linkages of nutritional gaps and its effect on productivity

This linkage depicts the process in which unmet food requirements can indirectly lead to a decline in the productivity of an individual as well as the whole nation.

1.2Background Information

Since the time of independence India has been trying to battle a lot of problems that are a hindrance to its growth and development. We have tried our hand at effective policy making as well as implementation in order to overcome issues like poverty, unemployment, skill development, sanitation, gender equality, education and many more. Out of these numerous issues one particular problem that still lingers on is the problem of food, nutrition and health. Food is a basic necessity of life and a nutritious diet is a prerequisite to a healthy body that can be put to effective use for any kind of economic activity. But India fails to achieve the minimum standards of health which are required for human body to function effectively. We

are aiming at reaping the benefits of demographic dividend but that cannot be possible without proper investment in human capital. Studies show that there is indeed a positive relationship between the development and growth of a nation and the health of the people of the nation.

David Bloom states that spending on health is one of the best investments around the world especially so incase of developing countries where the main source of production is physical labour these countries can benefit enormously from investments in healthcare and failing to tap into the benefits of a healthy population by ignore the health of population can result in losing out on a lot of benefits that are linked with investments in health like, returns on education, higher productivity of labour and higher incomes thereby fostering growth. (David E Bloom, Feb 2000)

Without proper investment in the development of health, education, skill and infrastructure realization of the demographic dividend will only remain a farfetched dream of India. The government of India spent around 1.5 percent of GDP on health in 2017-2018 only when the global average expenditure on healthcare stands at 6 percent of the GDP on healthcare. The funds allocated for the mitigation of nutritional deficiencies among the Indian population by the government was Rs 9,046 crore for the whole 2017 to 2020 period. The Ministry of Health and Family Welfare under the National Iron Plus Initiative allocated was 91950.29 lakhs for the years 2017-18 for combating the problem of anemia among women and children. But anemia still remains a chronic problem.

Rapid changes in the lifestyle of people due to globalization have lead to erratic routines. There is a massive shift in the eating patterns of people of India, people enjoy more of junk food in urban areas than nutritious and wholesome diet and in case of rural areas the food requirement is hardly met. Due to lack of proper diet a large population in India suffers from nutritional deficiencies, one such nutritional deficiency that is often ignored is anemia. Anemia is a disease that is either ignored due to lack of awareness or due to its mild nature which can lead to serious consequences later on.

Anemia is a condition where the oxygen- carrying capacity of red blood cells is insufficient for the body and the organs to perform the day to day functions. It is usually diagnosed by measuring the hemoglobin count in the body and on the basis of this count it is categorized into mild, moderate or severe anemia.

Anemia remains a leading problem among women of reproductive age and children in almost all developing and underdeveloped countries. The government of India has come up with various initiatives like;

- National iron plus initiative,
- Universal screening of pregnant women for anemia,
- Distribution of iron and folic acid after first trimester,
- Awareness programs through IEC&BCC,
- Providing people with insecticide nets and insecticide treated bed net to prevent spread of anemia through malaria

- TIRANGA scheme started in 2016 in Jharkhand under the integrated child development scheme where women were asked to prepare food of all three colours that are there in the Indian flag in order to combat malnutrition. Orange comprised of carrots, tomatoes that reduced vitamin deficiencies, white was for combating calcium deficiency and green for iron and zinc deficiency.

But still the statistics show only a partial improvement in the health condition of women and children as far as anemia is concerned.

The latest National Family Health Survey-4 (2015-16) shows that around 53percent women have anemia (37percent mild, 14percent moderate and 2percent severe) around 30-40 percent newborns suffer from anemia and low birth weight due to maternal anemia and malnutrition. Anemia though not a very severe disease can lead to reduced productivity in people suffering from it. Mild and moderate level of Anemia can lead to

- Low Concentration: unable to focus on a particular task which results in lowering a person's productivity.
- Fatigue: when a person is suffering from anemia, the body of that individual does not have enough hemoglobin in such a situation the organs and muscles as well as tissues do not receive adequate oxygen to function properly which makes a person tired and lethargic, leading to low productivity.
- Low Immunity: Studies have shown that iron deficiency anemia affects the immune system, making a person more susceptible to illness and infections which again hampers a person from performing tasks well and puts them at a risk of contracting infections.
- Confusion: Anemic people are often in a confused state of mind because of being tired; the heart has to work harder to help in proper functioning of the organs and therefore anemic people also suffer from confusion sometimes.
- Cognitive impairment among children: Anemia is also responsible for poor development of children, if adequate oxygen is not provided to the organs they do not develop properly leading to low mental and physical development of a child which further hampers a child's future growth. Low mental development will lead to poor performance in studies and other activities and this will eventually result in low paying job opportunities for the child.

In some severe cases anemia may lead to shortage of breath, rapid heart rate and enlargement of the heart leading to heart failure. Other problems that can be triggered by anemia are

Heart and lung complications: older people with severe anemia are usually at a risk of developing complications that affect their heart common problems include tachycardia and heart failure.

Pregnancy: Women who are pregnant and have severe anemia are at a risk of developing complications. Severe anemia may also lead to maternal mortality during child birth. They may also develop postnatal depression.

Therefore, even though Iron deficiency anemia rarely causes serious or long-term complications it is labeled as a 'silent killer'. Anemia leads to lower levels of productivity among sufferers. More often than not all symptoms of anemia are usually ignored until the situation gets out of hand. People with mild anemia usually develop coping mechanisms which makes living with this deficiency normal for them, for instance if a person feels tired they would sit down, take some rest and after a while continue with their work not realizing that if this pattern of feeling tired without any strenuous work is occurring repeatedly, then it surely is a cause of concern. In the long run this poses problem for the person as well as the economy because lower productivity directly impacts the development and growth of a nation if the workforce is not in the best of shape they will not deliver efficiently leading to loss to the nation.

1.3Relevance Of The Study

The fact that health is important to all individuals is a no brainer; it is only a healthy workforce that is of use to the economy. Healthy mind and body contribute positively towards the development of a nation. Therefore it is important to study the causes and the burden of diseases like anemia that hamper productivity and affect a huge population not just in underdeveloped and developing countries but also globally.

India has been trying to address the issue of anemia for long now and it still has not won the battle against it. The government has to attack the problem of nutritional deficiency from all directions if it wants to see India as a healthy nation with productive human capital.

The Global Nutrition Report 2017 aims at reducing the number of anemia cases by 50 percent by the year 2030. It is one of its major sustainable development goals and we are lagging behind in achieving the required target. Therefore, it is important to focus on this issue and address it properly.

Anemia is a not just a problem faced by the under developed and developing countries it is a global problem. It is one of the leading causes of disability around the world among people. In the 2017 Global burden of disease report iron deficiency anemia is one of the top ten factors causing disability among the people of India. As a nutritional deficiency it is easy to handle and address it by providing adequate amount of iron supplements to people especially women and children who are the worst sufferers. Anemia as a disease leads to a number of problems among individuals which is not very evident initially but wears a person down in terms of lowering their productivity and concentration level and can also lead to problem of an enlarged heart and eventually cause death when the disease reaches a very severe stage. A population that is low in terms of productivity cannot contribute efficiently in the growth and development of a nation. Therefore, it is necessary to first start with smaller insignificant diseases that affect a large number of people and then deal with major diseases that have huge burden on the nation.

1.4 Research Questions

1. What are the determinants of anemia among children, women and men in India?
2. What is the impact of anemia on the GDP of our nation in other words what is the burden of anemia?

1.5 Conceptual Framework

It is often observed that most of the underdeveloped and developing countries lack in the quality of health care. These countries are the ones where the quality of human capital is low because of lack of services in the areas of health and education. When the human capital of the nation is not of good quality then the productivity is also sub standard and not at par with developed countries. Proper education and health care facilities make sure that the people are well cared for and more productive, because they are in better health and educated they contribute positively to the growth and the output of the nation. It is empirically proven that good health and economic growth go hand in hand. Studies show that GDP can rise by 4 percent with just a 1 year increase in the life expectancy (*David Bloom, April 2003*)**.**

As put forth by Gary Becker *(Becker, April 1999)* in his theory of health capital, health is broadly defined as longevity and days free from any kind of illness in a given year. Health indirectly provides people with utility because it is in a way responsible for the income that an individual earns and their wealth. Health is demand one as a commodity for consumption and second as an investment. It is considered as consumption good because when person falls ill, those days of life are a source of disutility. It is considered as an investment because good health helps in making productive use of market and non market. This study takes its theoretical framework from the theory of human capital. Education and health are the most important aspects for development of human capital. Healthy people are a more productive resource for the nation, Gary Becker a leading American economist also said that health cannot be separated from human capital it is an inherent part of human capital. Everyone at the time of birth has a stock of health that depreciates with age and time. The stock of health that a person is born with can be increased by investing in health care activities like proper nutritious diet, exercise and regular health care checkups etc. He stated that education, training and health are the most important investments in human capital.

1.6 Research Objectives

1. To analyze the prevalence and morbidity pattern due to anemia across India among women, children and men.
2. To find out the factors responsible for the prevalence of anemia in India.
3. To find out the Disability Adjusted Life Years (DALYs) of people living with anemia and to calculate the burden of anemia on the GDP.

1.7 Review of Literature

According to the World Health Organization anemia is a condition in which the oxygen carrying capacity of red blood cells is not enough for carrying out the day to day functions of the body and the physiological needs Anemia is one of the most common blood disorders in the world with billions of people suffering from it. Anemia can be classified into three categories;

1. Mild anemia

2. Moderate anemia and

3. Severe anemia

This classification is based on the amount of hemoglobin present in the blood, in case of mild anemia in men hemoglobin lying in the range of 11-12.9 (g/dl) is considered anemic for females above 14years of age the range is 11-11.9(g/dl), and for children it varies according to the age but lies in the range of 10-11.9(g/dl). Men, women and children from the age of 5years to 14 years are considered moderately anemic when the hemoglobin lies in the range of 8-10.9(g/dl) children falling in the age group of 6-59months are considered moderately anemic when the hemoglobin is in the range of 7-9.9 (g/dl). Severe anemia is a situation where hemoglobin levels fall very low for men, women and children from the age of 5years to 14 years hemoglobin count below 8(g/dl) is considered to be severely anemic and for children in the age group of 6-59 months it is less than 7(g/dl). There can be many causes of anemia one of the major cause is deficiency of iron and vitamin B12. Anemia can also be caused because of inherited blood disorders like thalassemia or sickle cell anemia. Sometimes anemia happens because of other diseases like cancer, malaria or autoimmune diseases. This type of anemia is secondary in nature it is triggered because of the presence of some other disease. Women are more prone to being anemic because of factors like menstruation, pregnancy and lower intake of vitamins, meat and iron rich food etc in their diet.

While majority of the population in the world suffers from it there are very few people who actually take treatment for anemia this happens because the symptoms of anemia hardly make the presence of the disease visible, until the later stages where the person becomes severely anemic. The most significant symptoms of anemia are fatigue, loss of energy, insomnia, dizziness in advanced stages it can lead to loss of concentration, unusually rapid heart rate, and shortness of breath and sometimes enlarged heart or heart failure.

At present the percent of global population suffering from anemia is 24.8percent that is equal to 1.62 billion people. And half of the people who fall in the category of being anemic come from underdeveloped and developing countries. According to the global reports most of the cases of anemia are concentrated in parts of Africa, India, Pakistan, Afghanistan, Myanmar, Thailand, Saudi Arabia and Yemen. These nations have population of more than 40 percent that suffers from anemia. The report of 2017 also states that 51percent of women 22.7percent men and 58.4percent children living in India are anemic (NFHS-4) 2015-16. Indian women are not only suffering from the burden of Anemia but also from a double burden of obesity

one such study shows that more than half of the world's undernourished population lives in India and women make up for a huge number among them. *(Deepti Singh, 2011).*

A study on Bangladesh, a nation that has a population of 20percent- 39.9percent people who suffer from anemia suggested that the major causes of anemia among non pregnant married women of reproductive age were lack of education, usage of unhygienic toilets, non Muslim, rural living set up, breast feeding, amenorrheric. Underweight and older women were found to be more likely to develop anemia. *(Md. Golam Hossain, 2018)*

Another study on Tanzania a small country in the African continent found out that the cause of moderate to severe anemia among women of reproductive ages to be lack of proper education, pregnancy, rural residential areas, use of type of cooking fuel and sanitation facilities during pregnancy and low wealth status of the women and her family. They also gave suggestions of iron supplementation during pregnancy and proper use of antenatal care to prevent anemia among women. The variables that were indifferent to the analysis were age, marital status, number of children born in the last three years. There was little difference in the body mass index and use of tobacco also. *(Calistus Wilunda, 2013)*

Table1.1: Global anemia prevalence and number of individuals affected

Population Group	**Prevalence of Anemia**		**Population Affected**	
	Percent	95percent CI	Number(mn)	95percent CI
Preschool-age Children	47.4	45.7-49.1	293	283-303
School age Children	25.4	19.9-30.9	305	238-371
Pregnant Women	41.8	39.9-43.8	56	54-59
Non-Pregnant Women	30.2	28.7-31.6	468	446-491
Men	12.7	8.6-16.9	260	175-345
Elderly	23.9	18.3-29.4	164	126-202
Total Population	**24.8**	**22.9-26.7**	**1620**	**1500-1740**

Source: De Benoist B et al, Worldwide prevalence of anemia1993-2005. WHO (2008)

Anemia affects 1.62 billion people all over the world. This is equal to 24.8percent of the total world population. Children in the preschool are the most affected population and men are the least affected. In terms of whole number and figures non pregnant women are the most affected ones making up almost 468.4 million of affected women in the whole world.

This study focuses on the prevalence, factors and burden of anemia in India and its different states. A study on the prevalence and severity of anemia in India reported that anemia was more prevalent in rural India. Children in the age group of 6-30 months reported the lowest Hb levels. The major cause of iron deficiency was found to be a diet low in meat fish and

eggs. The study also found that only 14.6percent 6-35 month old children were consuming food rich in fish eggs and meat which are a rich source of iron and iron deficiency at that age leads to faulty neurological development that is not totally reversible. Apart from this it was also observed that there was an increasing prevalence of anemia with age. Females and males showed similar patterns in terms of Hb level till the age of 13 years. Men showed high prevalence of anemia after puberty and progressive increase of mild, moderate and severe anemia with age. Children below 10years of age were moderately anemic. After puberty almost 50percent of females were anemic and older women reported of moderate or severe anemia with age. *(Gerardo Alvarez-Uria, 2014).*Many studies also claimed that moderate and severe anemia prevalence was common even in well educated and high income group households. The other factors that this study recognized leading to anemia prevalence were low dietary intake, poor iron consumption (less than 20mg/day), poor folic acid intake (less than 70mg/day), chronic blood loss due to infections like malaria and hookworm. *(Kalaivani, 2009).*

There were more causes listed for the prevalence of anemia in some latest studies which showed that anemia is one of the leading causes of disability around the globe. The DALY's accounted for anemia globally is 68 million and it also increases the risk of child mortality and morbidity. The study also noted that delayed umbilical clamping (by 25 seconds to 5 minutes) results in increasing iron stores in newborn's (40-50 mg/kg of iron) which is important for brain development *(Cinta Moraleda, 2018)* .

One of the area specific study that focused on the prevalence and determinants of anemia among women in Andhra Pradesh found out that the factors responsible for high level of anemia among women was firstly, a diet low in iron and high in phytates, secondly, high level of malaria and other infectious diseases, thirdly frequent reproductive cycles. Other factors identified in the study done in Andhra Pradesh were that there was a strong relationship between low BMI and social status with anemia. *(Griffiths, 2003).* As far as children are concerned the major factor that determines the health of a child is the way in which the child is taken care of by the mother in the early days after birth a study in this regard was carried out by some researchers that studied the studied the relationship between Maternal education and the child health outcomes in Australia within the first 12 months the study found out that the children of women who had not completed school or had secondary school as their highest level of education had a 59 to 57percent increased chances of having infectious diseases or injury in the first year of life compared to children of women with a tertiary education. (Tamzyn M. Davey, 2015) .

Anemia is also linked with pregnancy; iron deficiency anemia adversely affects the maternal and fetal well being and is linked to higher mortality levels among women and children. Pregnant women with anemia experience breathing difficulties, fainting, tiredness, sleep difficulties, and palpitation. These women might develop prenatal infections and bleeding. Post partum cognitive impairment as well as behavioural changes among women is also reported. Anemia among mothers often leads to children being anemic. Low iron in a newborn born child can continue for as long as a year this results in iron deficiency anemia among new born. This iron deficiency should be treated as early as possible because children with low iron stores can have long term consequences of iron deficiency. New born children

and infants are at a risk of under developed cognitive, social, emotional and adaptive functions. This happens because iron is important for neural metabolism and functioning, the brain does not function properly due to changes in energy metabolism which hinders proper working of neurotransmitters and myelination.

Other studies have documented delays in both language and motor development, due to iron deficiency among children. If the mother is anemic then breast feeding also proves to be of no use for the child. It has been noted that as time passes the iron content in breast milk falls. Adequate supplementation is therefore needed for new born children that are born to anemic mothers. *(Noran M. Abu-Ouf, 2015).*One study focused on the groups most susceptible to nutritional deficiencies leading to anemia and stunting in low income countries. They reported that anemia and stunting lead to developmental difficulties, morbidity and mortality. Stunting was associated with age, sex, caste, diet and hunger. Anemia was on the other hand associated with age and consumption of untreated water which is a new variable affecting the prevalence of anemia. *(Lucas Gosdin, 2018).* A study carried out in Nepal found that there is a positive relationship between the prevalence of anemia and the sanitation practices of a region. They found out that open defecation led to a large number of people suffering from intestinal worms that resulted in people mainly children suffering from anemia. *(Diane Coffey, 2016).* So, there is a possibility of anemia being caused by not having clean drinking water and sanitation conditions.

Some studies analyzed the relationship between the economic development of a nation and the level of anemia. They found out that unlike the belief that some governments had that an increase in income will automatically result in reduction in the rate of anemia it was found out that even though there was an influence that development level had on anemia level but the relationship was not very strong. *(Linnemayr, 2009).*It was found that a 10percent increase in income is associated with a decline in anemia (0-59months) was only 2.8 percent (average African countries have a higher anemia rate) for women it was less proportional. It was noted that anemia level does not fall with income growth it requires sustained income growth to double national per capita in absolute of specific programmes to address anemia. Another study backed this issue stating that even high income settings where all requirements of nutrition were met even they were not enough to meet the needs of infants. As advised by the American Academy of Pediatrics the child should be breastfed and iron food should be started from the fourth month of the birth of the child. *(Cinta Moraleda, 2018).*

Iron deficiency as stated by a study causes serious disability or in extreme cases even death. Iron deficiency according to the study can affect the following outcomes; child mortality, maternal mortality, prenatal mortality, fitness and productivity and cognitive impairments. The total deaths attributable to iron deficiency anemia globally are 8, 41,000 and 35,057,000 DALYS that measures the years of life spent in less than full health. *(Stolfus, 2003).* Infants falling in the age group of 6-59 months in India that are anemic might have to intangible costs like life years lost due to early death and low quality of life of 8.3m DALYs and production losses of 24,001 million USD in 2013. These future costs were calculated by a research carried out by PLOS keeping in mind the consequences of iron deficiency anemia among children *(Rafael Plessow, 2015).*

1.7.1 Effect of anemia on the Productivity and its Economic Consequences

There have been many studies directed towards the analysis of the relationship between anemia and the productivity of human beings. Anemia is a disease that is not taken very seriously by people because it is difficult to detect its presence. There are hardly any people that refer to doctors for getting treated for anemia. This happens mainly because people do not realize the consequence of anemia they are unaware that insignificant diseases like that can hamper their productivity and lead to serious health consequences.

A study by Hass and Brownlie of Cornell University tried to address and explain this problem. They stated that there exists a cause and effect relationship between deficiency of iron and the physical work capacity by reviewing literature and conducting experimental study on animals and human beings. They found strong evidence in favor of iron deficiency causing reduction in aerobic work capacity which they explain as the oxygen uptake at a point at which the subject has reached the maximum level of exertion usually carried out on a treadmill or ergo meter or a field test (the Harvard Step Test). Results in both animals and humans show that Iron deficiency leads to reduced aerobic work capacity. Result for endurance capacity that is the threshold level for an individual to sustain a workload this proved the hypothesis right. These studies proved that iron deficiency leads to impairment in endurance. Same was the case with economic productivity also *(Jere D. Haas, 2001).*

Another study by *Basta et.al (1979*) shows that the productivity of rubber plantation workers who were given iron supplements was 17percent higher than the productivity of anemic workers who were given placebo.

(G.Psacharopoulos, 1998) Found that when the cognitive development of a person is improved by one standard deviation then the hourly earnings of that individual increase by 7 to 9 percent and similarly in Columbia an increase in one standard deviation of a person's ability was associated with a 5 to 7 percent increase in hourly wages. In developing countries as many as 6,00,000 women die each year due to complication in pregnancy and childbirth many problems are caused by anemia that is common among women that are pregnant. Mild anemia among females may lead to hemorrhage and severe anemia can lead to death. Anemia causes fatigue and also reduces physical stamina thereby stopping women from seeking proper medical care *(Jay Ross, 1998).* A pilot study conducted in Assam reaffirms the fact that anemia in pregnant females can lead to post partum hemorrhage. It was found that 35 percent of pregnant women had moderate and severe anemia. Women with severe anemia were more likely to suffer from PHH or giving birth to a child that had low birth weight and also perinatal death. *(Manisha Nair, 2016).*

Similarly, another study done in Rural Pakistan came up with the following results *(H. Alderman, 1996)* that a one standard deviation increase in wages resulted in an increase in wages from 10percent - 12percent (difference in results in due to different calculation technique used) . Effects of ability calculated slightly larger but not significant statistically.

Research done in Ghana *(Glewwe., 1996)* showed that 22 percent increase in earnings in the public sector and 33 percent increase in the private sector was attributable to just one standard deviation improvement in reading and mathematics score.

1.7.2 Burden of Anemia

The burden of a disease is studied by calculating the effect that the disease has on the life lived by the person suffering from the disease and its consequences. It is usually done with the help of some health gap measure listed below. Health gap measures compute the gap between the actual status of health of a person and the ideal status of health for that person.

The basic measures of population health which measure the health gaps were;

- Potential years of life lost(PYLL)
- Healthy years of life lost (HYLL)
- Quality adjusted life years(QALY)
- Disability adjusted life years(DALY)

According to the definition given by World Health Organization "One disability adjusted life year can be thought of as one lost year of 'healthy' life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between the current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability." DALY is the sum of years of potential life lost due to premature death, and the years of productive life lost due to disability.

DALY is used as an indicator to measure the burden of disease for over hundred diseases in eight regions for five age groups among both the genders. It is an established measure of burden of disease assessment and also of premature mortality. The DALY calculations can help in checking the cost effectiveness of health interventions. DALY as a measure of burden of disease is needed for setting up health services for various diseases that are contributing to the rising burden of disease, It also helps in supporting the research activities and helps in recognition of diseases that should be given top priority, we can also tap the target groups that are most affected by the diseases and allocate resources towards the betterment of health of the people. *(Murray, 1994).*

This study computes only the DALYs lost because anemia as a disease is one of the leading causes of disability around the world**.** India currently stands at the 103rd position out of 119 countries in the Global hunger index which is calculated by taking into account four aspects: undernourishment, stunting, child mortality and child wasting. According to the Global nutrition report India does not fare well in terms of its health status. India is 170th among 180 countries in terms of anemia among women, when a person is not in the best of his/ her health it becomes impossible for him/her to be productive. The loss of productivity results in lesser contribution to the development of the economy. In a study undertaken by a few researchers it was found that anemia resulted in 65.5 million YLD in 1990 and 68.4 million

YLD in 2010 globally. The percentage of anemic population decreased from 40.2percent to 32.9percent from 1990 to 2010.Females had a higher prevalence of anemia than men in all regions of the world and the leading causes of anemia were found to be iron deficiency, hookworms, sickle cell disorders and thalassemia *(Nicholas J. Kassebaum, 2014).*There have also been studies that have calculated the approximate loss due to disease burden and the effect of that burden on the economy; these studies also show that diseases lead to reduced productivity as well as lower wages for workers that are less productive. One study on the effects of anemia *(Jay Ross, 1998)*came to the conclusion hourly earnings of an individual with low cognitive skills will decrease by 4 percent if the standard deviation is decreased by half a standard deviation. They also claimed that a decline in half a standard deviation in IQ is enough proof to show the effect of iron deficiency anemia in childhood. The research also calculates a 4percent loss in productivity due to iron deficiency anemia as follows;

Cognitive loss 4percent x Wage Share in GDP (factor cost) x Gross Domestic Product per capita x Prevalence of anemia in children

By using the current prevalence of childhood anemia for estimating current productivity losses in adults, the study make an assumption that prevalence has remained the same for a long period of time. This method of computation would lead to an over or under estimate of impact of iron deficiency anemia on the current period *(S. Seshadri, 1989).*

A study done in Kenya showed that when iron supplements were given to school children they grew faster. These children were given 150 mg of iron supplementation for 3 months and for the control experiment children were given placebo for 3 months. The children consuming ferrous sulfate showed increase in height and weight. It was also reported that those children who were give iron supplements had a better appetite *(Lawless, Latham, Stephenson, Kinoti, & Pertet, 1994)*.

It is important to address the problem of anemia among children and women as soon as possible. Pregnant women who are anemic at the time of pregnancy often require special care and they are also charged additionally for the services that have to be given to them. Even though anemia does not lead to a lot of deaths the cost of morbidity has to be faced by the individual as well as the household and in case of maternal death the cost rises significantly both in terms of human cost as well as economic cost.

1.8 Gaps in Literature

A lot of studies have been done on the subject matter of anemia and also on the burden of diseases but a study focusing on the causes of anemia in India and the economic consequences in terms of Disability Adjusted Life Years has still not been done. There are very few studies that focus on the determinants of Anemia among Indian population and since anemia is a long standing problem that carries a heavy disability weight it is necessary to focus on tackling the problem effectively so that India can boast of a healthy and productive workforce that will be useful in the growth and development of the nation.

1.9 Chapterisation

The study is divided into six chapters; the first chapter gives an insight into the background of the study, the problem statement and also discusses the relevance and objectives of the study. The second chapter discusses the methodology that is adopted for carrying out the study it also talks about the data sources and variables used for analyzing the problem statements. The third chapter gives the analysis of the prevalence and morbidity pattern of anemia in India and the profile of the data used for the analysis. The fourth chapter determines the effect of socio-economic variables taken from the literature on the prevalence pattern of anemia. The fifth chapter gives a detailed account of the burden of anemia on the economy of India. The sixth chapter which is the last chapter discusses the conclusions that are drawn from the analysis and considers some policy suggestions.

Chapter II

Methodology

This study examines the extent of prevalence of anemia in India, the factors that influence the prevalence of anemia and calculates the burden of anemia. The accuracy and validity of any research can be judged only by the tools used and the results found. Therefore a systematic approach is adopted in order to achieve the objectives by using various analytical and descriptive techniques.

This chapter gives the details of the methodology followed for the analysis. It discusses the following sub topics;

- Study area
- Data sources
- Variables
- Research methods
- Hypothesis
- Plan of analysis
- Limitations of the study.

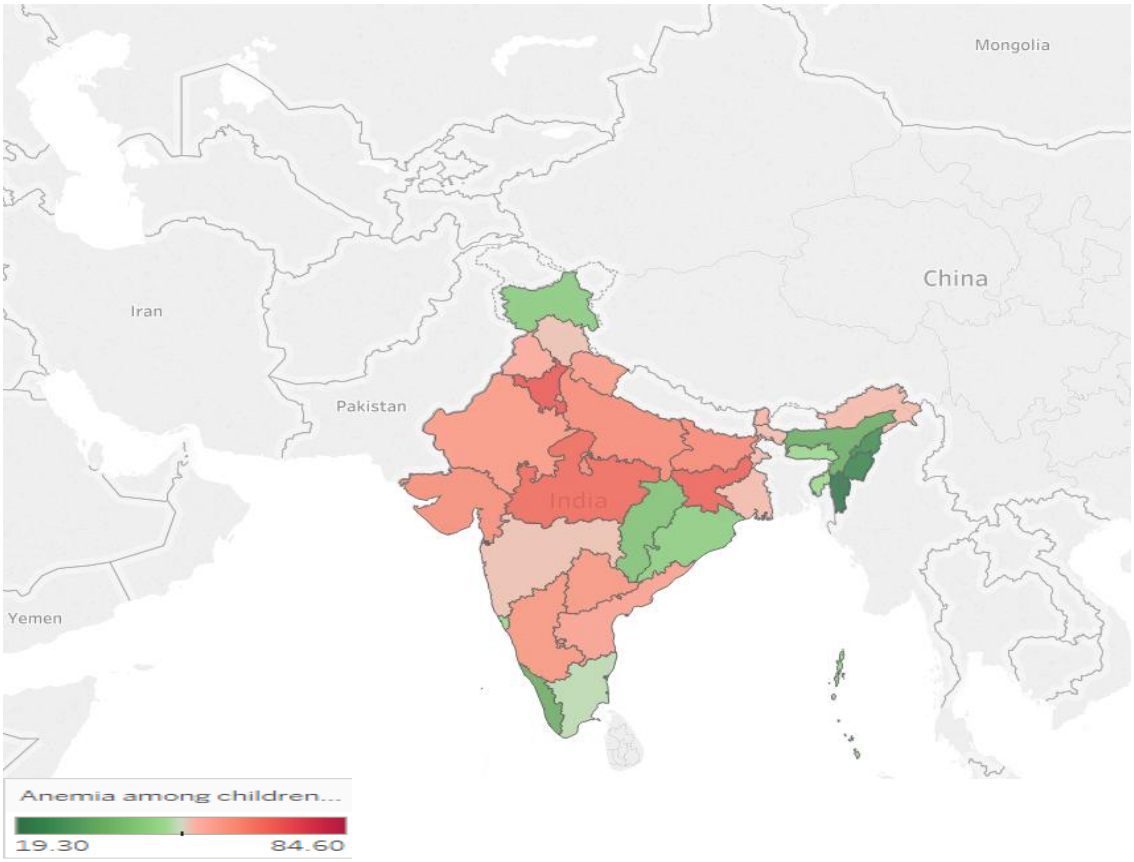
2.1 **Study Area**: The area in focus for the research is India. It is surrounded by Pakistan in the North West, china Nepal and Bhutan in the north and Myanmar in the south east. It is bounded by the huge Indian Ocean in the south. The Arabian Sea and the Bay of Bengal lie to its west and east respectively with the Himalayan ranges standing to the north of the nation.

2.1.1 Socio-demographic profile: India is a diverse nation with a population of 1,358,137,719 people and with more than half of its population falling in the category of below twenty-five years of age it is a hot market for reaping the benefits of demographic dividend. The country has variety of complex social and cultural patterns that effect individuals in their day to day life. It is important to study the socio demographic profile of any nation in order to have a deeper understanding of the economic and health outcomes.

2.1.2 Economic Profile: At present India is the third largest economy in the world according to purchasing power parity and one of the fastest growing economies too. The service sector of the Indian economy is the largest contributor in its GDP and the GDP per capita stands at $2,134 (nominal, 2018). In spite of all the growth and development that India has shown in the past few years there remain a number of pressing issues that are important before we focus on the development just in terms of GDP or PPP. The quality of health and education in Indian is a major cause of concern and any further development without addressing these two major issues will lead to disparities among the people who can afford it and the one's that cannot afford it.

2.1.3 The Status of Anemia in the Nation: According to the National Family Health Survey -4(2015-16) the percentage of females aged 15-49 years suffering from anemia was 53 children aged 6-59 months was 23percent and men aged 15 -49 years was 23percent .The survey showed a gloomy picture of the country in terms of tackling a relatively minor deficiency disease like anemia.

Figure2.1: Percentage of anemic children aged (6-59 months) in different states of India



Map showing the percentage of anemic among children aged 6-59 months in different states of India

2.2 Data Type and Sources:

The Data used in the research is taken from the National Family Health Survey -4 (2015-16), the Institute of Health Metrics and Evaluation(IHME), Sample registration system (2012-16), the Medical Certification of Cause Death report (2015) and the data on the per capita GDP of India was taken from the World Bank. National Family Health Survey-4 household level data was used for the analysis. The data has been collected under four different categories men, women, biomarker and the household. A sample of 628,900 households was selected for the survey all over India. 601509 occupied household were finally interviewed. The response rate of the households was 98 percent. The total numbers of women. Interviewed were 699,686 aged 15-49 years. The total numbers of men interviewed were 112,122 men aged 15-54 years.

Table 2.1 Number of Households, women, men and children according to the National Family Health Survey-4

	Total Number
Households	601509
Women	699686
Men	112122
Children	265653

2.3 Variables taken for the analysis from National Family Health Survey- 4

2.3.1 Anemia

National Family Health Survey-4 provides data on the hemoglobin level and the level of anemia among men, women and children. There are four categories in which the variable recording anemia level was divided - Mild, Moderate, Severe and Not anemic. For the ease of analysis all the three categories of anemia are taken as one single category "Anemia" and the other category is of people who are not anemic.

Table2.2: Percentage distribution of population with anemia.

	NFHS-3(2005-06)	NFHS-4(2015-16)
Children	70	58
Women	55	53
Men	24	23

Anemia is taken as dependent variable and the independent variables are socio-economic factors that are used to determine the prevalence of anemia.

2.3.2 Socio- economic Variables

Socio-economic variables describe the basic information about an individual and household. These variables are a combination of social and economic variables they comprise of details regarding the age, sex, educational attainment, wealth index, employment status and

residential area. Variables have been taken for all three categories - children, women and men separately.

a) Children

Table 2.3: Variables taken for children

Variables	Definition of the variables
Age of the child.	Age of the child in months as recorded at the time of the interview. Children below 6 months are excluded from the analysis as they show a higher level of hemoglobin count just after birth.
Type of residence	Place of residence is the place where the interview of the Child was carried out. It was classified as either urban or rural.
Sex	Female or a male
BMI	Computed using the height and weight measurements from the NFHS -4 dataset, by dividing the weight(in kilograms) of the child by the square of the height (in meters) of the child
Mother's Educational Attainment	Mother's highest educational level is a variable that gives information on the education of the mother. It is categorized as follows: No education, Primary, Secondary, and Higher.
Green leafy vegetables	The frequency of green leafy vegetables given to the child daily, once a week, occasionally or never was recorded because green leafy vegetables are rich in iron
Chicken, eggs, other meat	The frequency of chicken, eggs, other meat given to the child daily, once a week, occasionally or never was recorded because it is rich in iron.
Fish and shell fish	The frequency of fish and shell fish given to the child daily, once a week, occasionally or never was recorded because it is rich in iron
Beans , lentils pulses and peas	The frequency of beans , lentils pulses and peas given to the child daily, once a week, occasionally or never was recorded because it is rich in iron
Cheese, yogurt and milk	The frequency of cheese, yogurt and milk given to the child daily, once a week, occasionally or never was recorded because it is rich in iron
Wealth Index	The wealth index is a measure of living standard of a household. The wealth index is calculated using household's ownership of selected

	assets, such as television, type of water used, bicycle etc .This index is calculated using the principal components analysis. It is categorized into the following categories: poorest, poorer, middle, richer and richest for the purpose of comparison.
Mother's Anemia level	Measures whether the mother of the child is anemic or not anemic. Level of hemoglobin set for determining whether mother is anemic or not is 12.0g/dl. If Hemoglobin level falls below less than 12.0g/dl then the mother is said to be anemic.

b) Women

Table 2.4: Variables taken for women

Variables	Definition of the variables
Age	Records and groups the age of the respondent in groups of 5 years. It is calculated by using the century month code of the date of birth of the respondent and the century month code of the date of interview.
Type of residence	Place of residence is the place where the interview of the respondent was carried out. It was classified as either urban or rural. Urban areas (areas with over 1 million population), small cities (areas with population over 50,000), and all rural areas are assumed to be countryside.
Educational Attainment	It is the educational attainment of the respondent. categorized as follows: None, incomplete primary, complete primary, incomplete secondary, complete secondary, higher education
Currently pregnant	Records whether the respondent is Currently pregnant or not
Living children and currently pregnant	Records the total number of living children including current pregnancy. The categories are Zero number of children, 1- 3 numbers of children and more than 3 children.
Body Mass Index	It is calculated by dividing an individual's weight in kilograms by the square of their height in meters (Weight/Height^2). It is also known as the Quetelet's index.

Drugs for intestinal parasites during pregnancy	Records whether the respondent has taken drugs for intestinal parasites in last 6 months or not.
Iron and folic acid tablets	Records whether if the respondent has taken iron pills, sprinkles with iron or iron syrup within the past 7 days or not.
Wealth index	The wealth index is a measure of living standard of a household. It is calculated using household's ownership of selected assets, such as television, type of water used, bicycle etc .This index is calculated using the principal components analysis. The households are categorized into five wealth quintiles which are poorest, poorer, middle, richer and richest for comparison.

c) Men

Table 2.5: Variables taken for men

Variables	Definition of the variables
Age	Records and groups the age of the man in groups of 5 years. It is calculated by using the century month code of the date of birth of the respondent and the century month code of the date of interview.
Type of residence	Place of residence is the place where the interview of men was carried out. It was classified as either urban or rural. Urban areas (areas with over 1 million population), small cities (areas with population over 50,000), and all rural areas are assumed to be countryside.
Educational attainment	It is the educational attainment of the respondent. It is categorized as follows: None, incomplete primary, complete primary, incomplete secondary, complete secondary, higher education.
Wealth index	It measures the living standard of a household. It is computed using household's ownership of selected assets, such as television, type of water used, bicycle etc .This index is calculated using the principal components analysis. The households are categorized into five wealth quintiles which are poorest, poorer, middle, richer and richest for comparison.

Employment	Records whether or not the respondent works throughout the year, seasonally, or just occasionally.
BMI	It is calculated by dividing an individual's weight in kilograms by the square of their height in meters (Weight/Height^2). It is also known as the Quetelet's index.
Eats Green leafy vegetables	The frequency of green leafy vegetables taken by men categorized into daily, once a week, occasionally or never was recorded because green leafy vegetables are rich in iron
Eats Chicken, eggs, other meat	The frequency of chicken, eggs, other meat taken by men categorized into daily, once a week, occasionally or never was recorded because it is rich in iron.
Eats Cheese, yogurt and milk	The frequency of cheese, yogurt and milk taken by men categorized into daily, once a week, occasionally or never was recorded because it is rich in iron
Eats Fruits	The frequency of fruits taken by men categorized into daily, once a week, occasionally or never was recorded because it is rich in iron

2.3.3 Calculating Health Gaps

For calculating the health gaps (DALY) the following is the data

i. Life expectancy at the time of death taken from Sample registration System 2012-16
ii. Total number of deaths due to anemia in India taken from Institute of health metrics and evaluation
iii. Disability weight of anemia from the Global burden of disease report
iv. The total number of prevalent cases anemia to calculate the years of life lived with disability and the years of life lost due to premature death.

The data for the above variables was collected from various secondary sources like the Institute of Health Metrics and Evaluation, the sample registration system and the global burden of disease report.

The definitions for the above mentioned variables are as follows;

Table 2.6: Variables taken for calculating disability adjusted life years

Variable	Definition
Life expectancy at the time of death in years	It is a measure of the average time a living being is expected to live, based on the year of its birth, its current age and other demographic factors like gender. Life expectancy at the time of death is the average number of years that a person should have lived at the time of death.
Total number of Deaths due to the disease	It measures the total number of deaths that occur due to the disease and it is used in the calculation of years of life lost due to premature death.
Disability weights	It is a weight factor that reflects the severity of the disease on a scale from 0 to 1. Here 1 signifies perfect health and 0 signifies death. Years Lost due to Disability (YLD) are calculated by multiplying the prevalent cases and disability weight for the condition.
Number of prevalent cases	Number of prevalent cases is the actual number of cases alive, with the disease either during a period of time or at a point in time.

2.4Statistical Method

To look at the determinants of prevalence of anemia in India, Chi-square test has been used to find out the relationship between the dependent variable and each single independent variable. The null hypothesis is that there is no association between prevalence of anemia and the independent variables and the alternate hypothesis is that both prevalence of anemia and independent variables are associated. Further a Z test of column proportion has been applied to test the difference between the proportions of each independent variable that falls under the category of anemic population.

The formula for Z test is;

$$Z = \frac{P_1 - P_2}{\sqrt{P - Q(\frac{1}{n_1} + \frac{1}{n_2})}}$$

Where P_1 and P_2 are sample proportions of insured for different categories 1 and 2 or more of independent variable

P_1 = Population proportion, Q = 1-P

n_1= Total sample of anemic

n_2= Total sample of non anemic

The other objective of the research was to measure the burden of the disease using health gaps by calculating the Disability Adjusted Life Years (DALYs) using the World Health Organization methodology. The methodology for calculating the burden of the disease was as follows;

For calculating DALY we require years of life lost due to premature death and years of life lived with disability.

Years of life lost due to premature death (YLL): YLL are calculated by multiplying the total number of deaths from a particular disease and the standard life expectancy at the time of death. For YLL calculations the standard life expectancy for men and women of India from the sample registration system was taken for the year 2012-2016 and that has been used for the calculation of YLL. The combined life expectancy for men and women , life expectancy of men and life expectancy of women all three are used for age wise calculation and gender wise calculation of DALY.

$$YLL = N * L$$

Where, N = total number of deaths

L= standard life expectancy at age of death.

The standard life expectancies set by WHO are 80years for men and 82.5 years for women, but this was not used for the analysis we used the life expectancy for the population cohort of India given in the sample registration system.

Table 2.7: Standard life expectancy table for India

Age(in years)	Men	Women
0-1	67.4	70.2
1-5	69.1	72.2
5-10	65.5	68.9
10-15	60.8	64.1
15-20	56	59.3
20-25	51.2	54.6
25-30	46.6	49.9
30-35	42	45.2
35-40	37.5	40.6
40-45	33.1	35.9
45-50	28.8	31.4
50-55	24.7	26.9
55-60	20.8	22.9
60-65	17.3	18.9
65-70	14	15.3
70-75	11	12.1
75-80	8.4	9.3
80-85	6.1	6.7
85+	4.5	4.8

Source: Sample Registration System (2012-16).

Year of life lived with Disability (YLD) on the other hand measures the short term as well as the long term health loss due to suffering from an ailment by multiplying the prevalence of the disease by the disability weights.

YLD = P * DW

Where,

P= number of prevalent cases

DW=disability weights

In the case of anemia the disability weights are mild=0.004, moderate=0.052, severe=0.149, Cognitive impairment=0.031, for the purpose of calculation of disability weights for the whole population we took the average of the disability weights, which is equal to 0.0683.

After calculating the YLL and YLD we add both the values to get DALYs.

For calculating the burden of the disease we multiply the Gross Domestic Product per capita of a nation for different years by the total DALYs and get the burden of the disease in monetary terms.

2.5 Research Hypothesis

The expected results in the form of research questions that are found during the thorough review of literature are posed as;

1) What is the effect of Socio economic variables like age, type of residence, sex, wealth index etc on the prevalence of anemia on children, women and men?

2) What is the burden of anemia on the gross domestic product per capita of India?

2.6 Plan of Analysis

The dependent variable used is Anemia and the independent variables used are age, sex, type of place of residence, education, wealth index, these are chosen from the National Family Health Survey-4 a household level all India survey. Chi-square test has been used to find the association between dependent variable and independent variables. Z test has been used to test whether the difference between proportions of anemic people and the categories of the selected independent variable are significant or not. It gives the direction of the association. The data was analyzed by using IBM SPSS 20.0 and Microsoft excel. The computation of the health gaps was carried out using Microsoft Excel and used the World Health Organization methodology.

2.7 Limitations of the study

Like any other research this study too suffers from its own limitations some in the form of data and others in the form of methodology, all the possible limitations of the study are listed below;

1) The analysis is only of the National Family Health Survey-4(2015-16) data therefore; all limitations of the data are applicable to the research also, like age group beyond 49 for women and 54 for men are not taken into consideration while collecting data.

2) There might be other variables that affect the prevalence of anemia in India among people apart from the variables taken, which are not considered.

3) The disability adjusted life year calculations are related to age specific DALYs and any other method of DALY calculation might give different results neither age nor time discounting has been used to calculate DALYs. Only basic DALY has been computed.

Chapter III

Profile of the sample

This chapter gives details of anemic population of India taking into account all the socio demographic profile of the population. It analyzes the basic statistics of anemia percentage among the people of India.

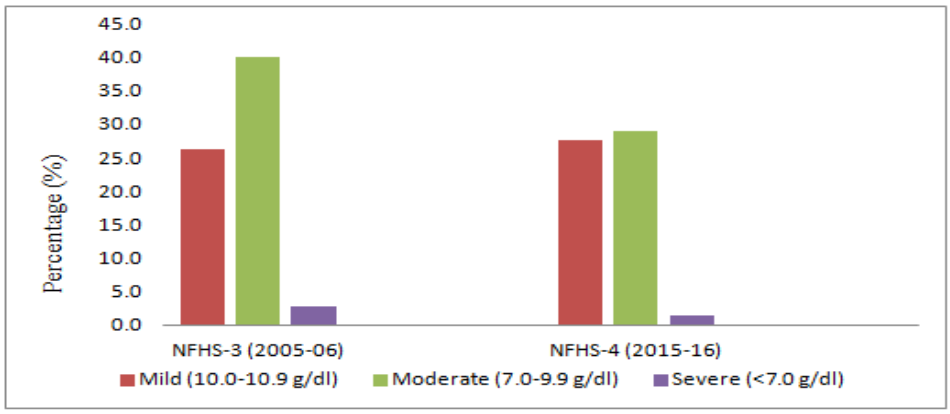
The NFHS-4 uses a stratified two stage sampling technique to collect data. A total of 601,509 households were successfully interviewed for hemoglobin testing with a response rate of 98percent. Consent for the test was taken from individuals and incase of minors and small children consent was taken from the parent or the guardians. Anemia testing was carried out by drawing blood either from the heel or finger .The blood was then collected in a microcuvette under the guidance of trained and experienced health investigators. Hemoglobin analysis was conducted using a battery operated HemoCue Hb 201+ analyzer and results were shared with the respondents there and then. Proper advice was given to men and women who had severe anemia.

The percentage of children, women and men suffering from anemia recorded were 58 percent, 53percent and 23 percent respectively.

3.1 Prevalence pattern of anemia among children in India

Anemia prevalence across India is high especially among children and women, according to studies carried out for understanding the factors that lead to such a high percentage of anemia in India it was noted that it is attributed to poor diet, poverty and lack of hygiene among individuals. The percentage of anemia according to gender and socio economic factors is shown with the help of graphs in this chapter.

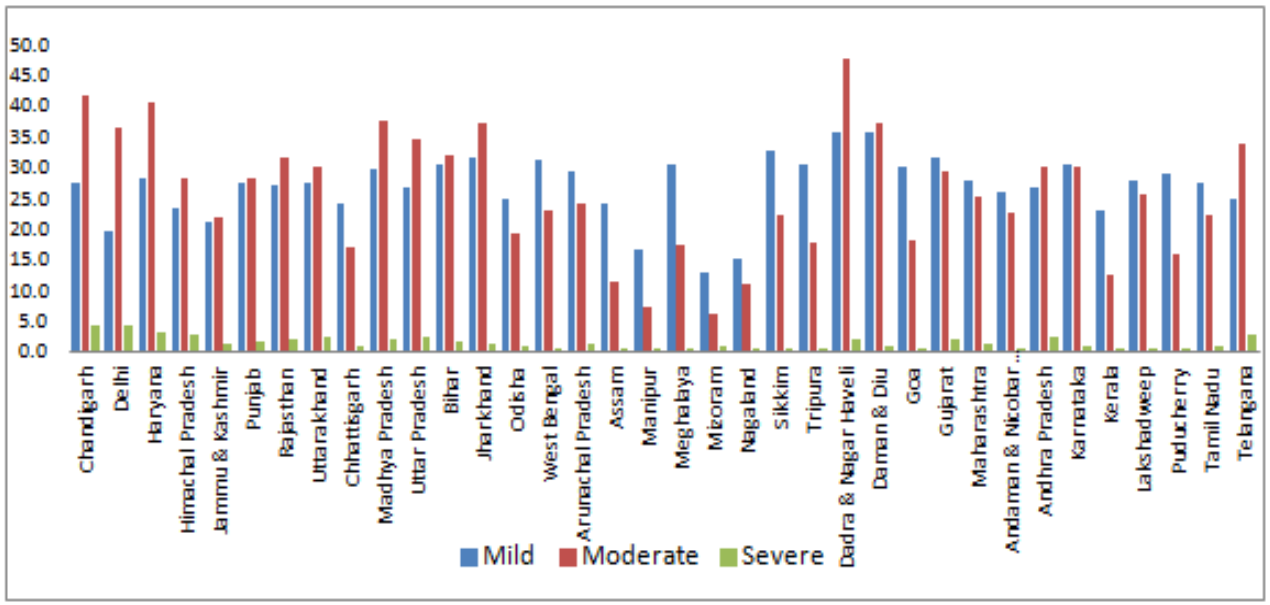
Figure 3.1: Change in the percentage of anemia among children all over India aged 6-59 months from NFHS-3 to NFHS-4.



Source: NFHS-4, 2015-16

The percentage of anemia among children in India has reduced from 70percent in 2005-06 to 58percent in 2015-16 but not very significantly there are still a large percentage of children who are moderately anemic and this comprises of around 29percent of children. The total percentage of children suffering from anemia is 58.4percent.

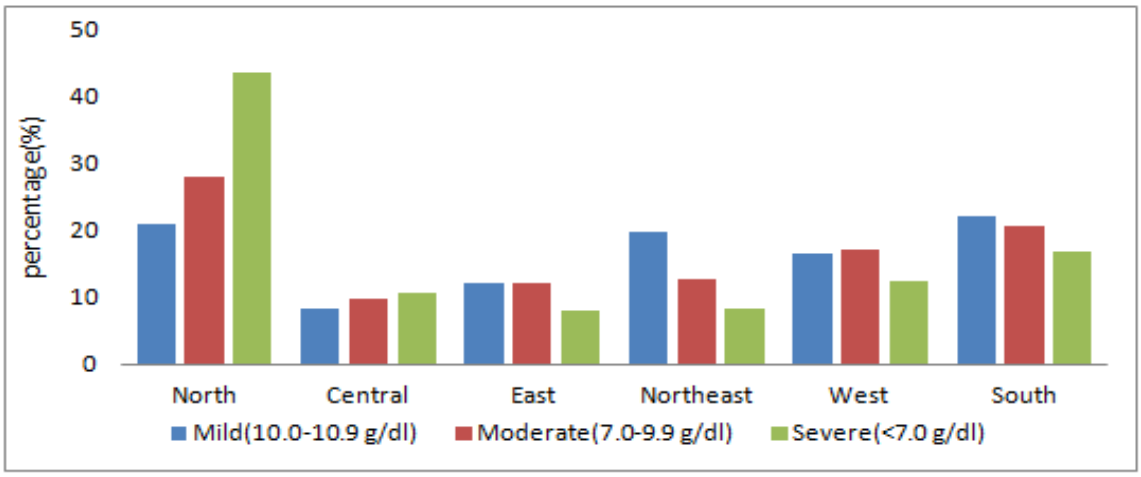
Figure 3.2: Percentage of anemia among children aged 6-59months among the states and union territories of India



Source: NFHS-4, 2015-16

Gujarat, Chandigarh, Haryana, Telangana, Madhya Pradesh and Jharkhand show a very high population of children suffering from moderate anemia. Among union territories Dadra Nagar and Haveli have the highest percentage of children suffering from any kind of anemia (84percent). Among the states Chandigarh reports the highest percentage of anemic children that is around 73percent.

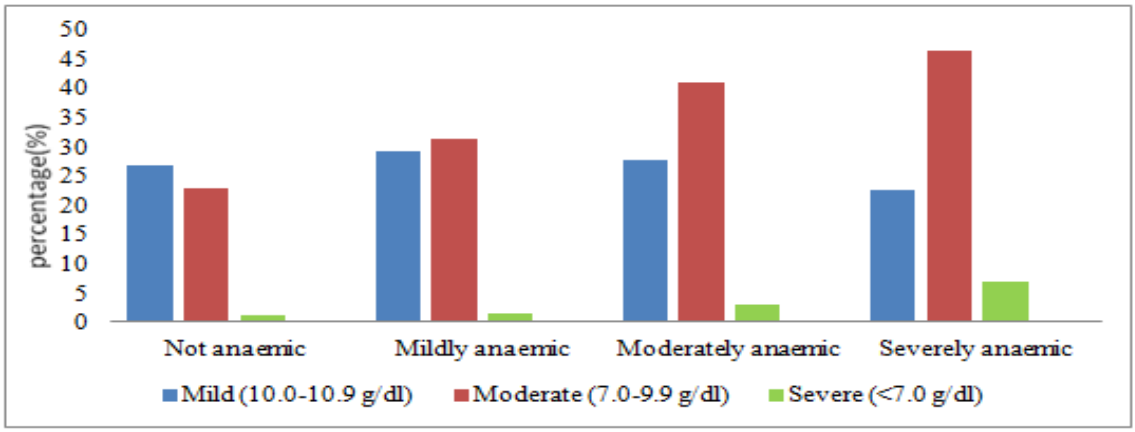
Figure 3.3: Percentage of anemia among children 6-59months of age across different regions of India



Source: NFHS-4, 2015-16

The Northern region has the maximum percentage of anemic children falling in all the three categories of anemia, the other two regions that have a high population of anemic children is southern and the western regions.

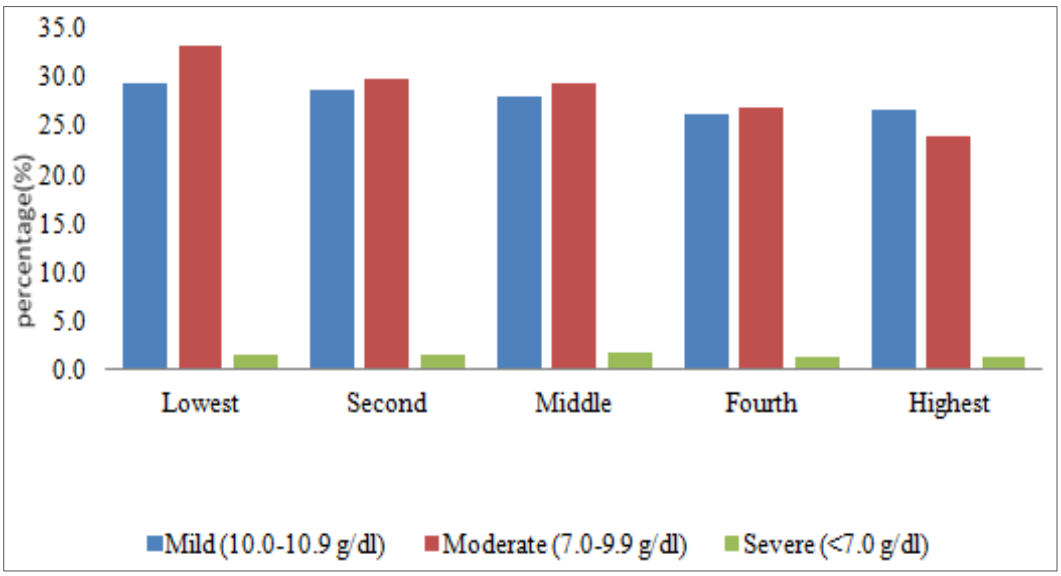
Figure 3.4: Percentage of anemia in children aged 6-59 months with respect to the anemia status of the mother



Source: NFHS-4, 2015-16

There is a higher chance of a child suffering from anemia if the mother of the child is anemic severely anemic women tend to deliver babies that are anemic which leads to incomplete development of the child. This hampers the overall development and future progress of the child not only in terms of his productivity but also, cognitive development and later on employability.

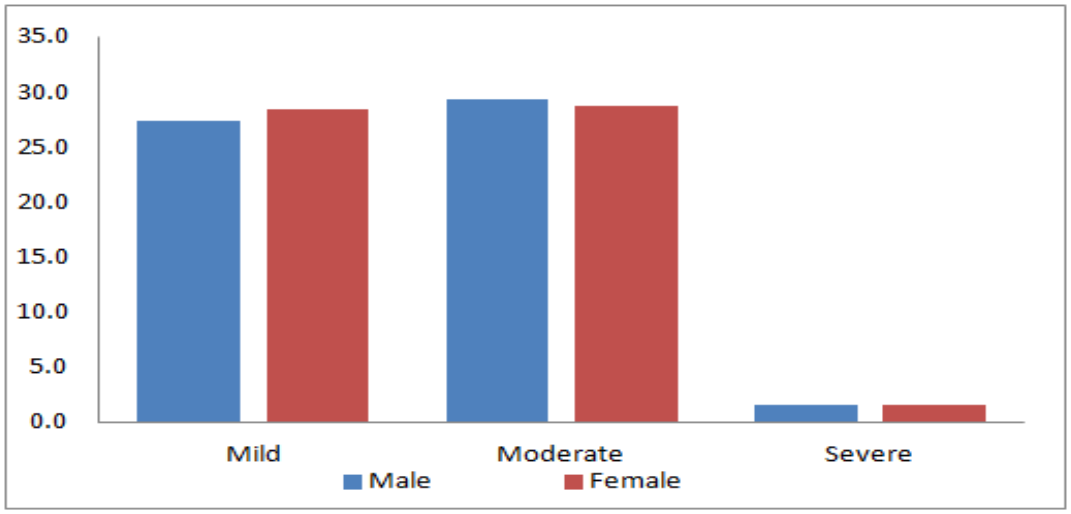
Figure 3.5: Percentage of anemia in children aged 6-59 months with respect to the wealth index of the household



Source: NFHS-4, 2015-16

The most important determinant of the kind of food and diet a person gets depends largely on the wealth status of the household. People that comprise of the highest wealth index have the least cases of anemia and the children coming from the lowest strata of the wealth index have the highest cases of severe, mild and moderate anemia.

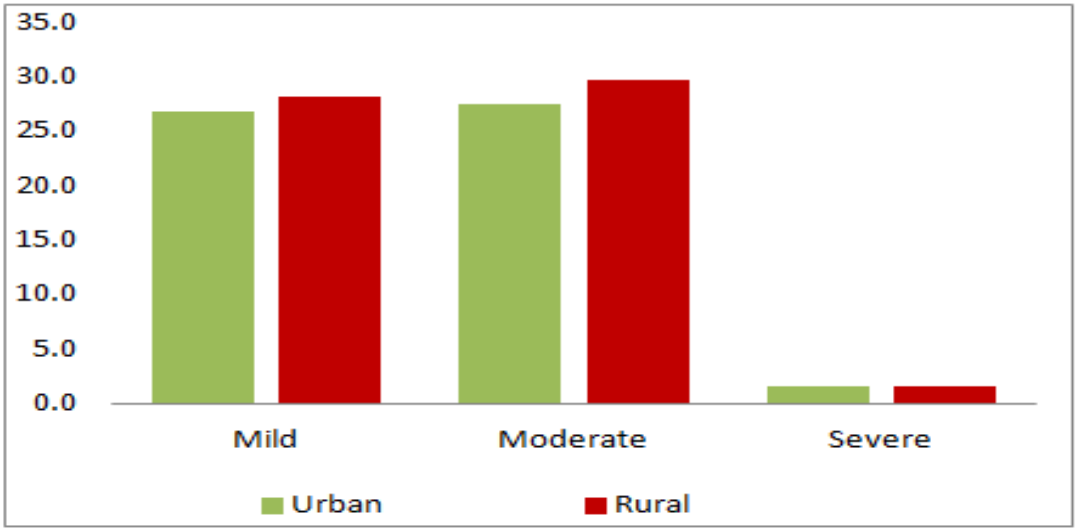
Figure 3.6: Difference in Anemia status between male and female children



Source: NFHS-4, 2015-16

Figure 3.6 shows the difference in anemia status between males and females falling in the age group of 6-59 months. The anemia status of both the genders is more or less same. Percentage of both mild and moderate anemia among children is high.

Figure 3.7 Difference in the anemia status among children in the urban and rural areas

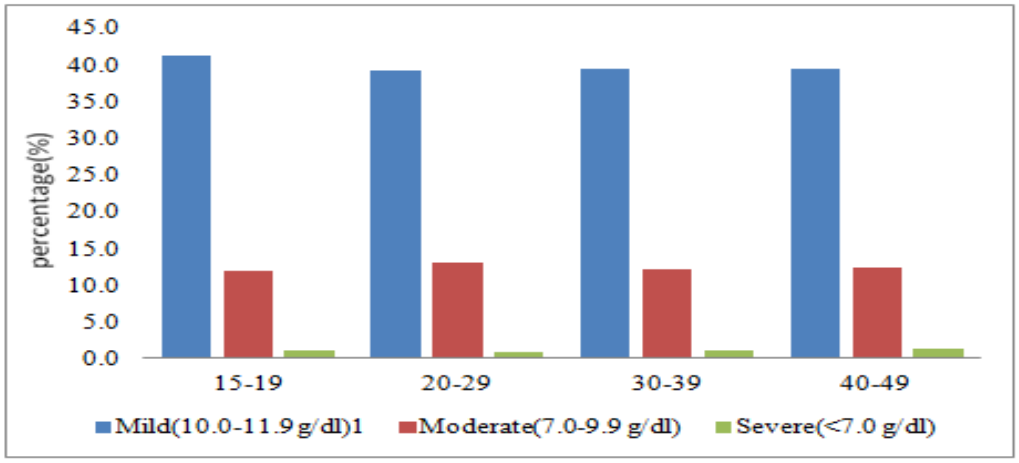


Source: NFHS-4, 2015-16

Figure 3.7 show that rural area has a higher percentage of anemic children in comparison with urban areas where the percentage of anemic children is less. Both mild and moderate anemia is high among children in both areas.

3.2 The percentage of anemic females in India

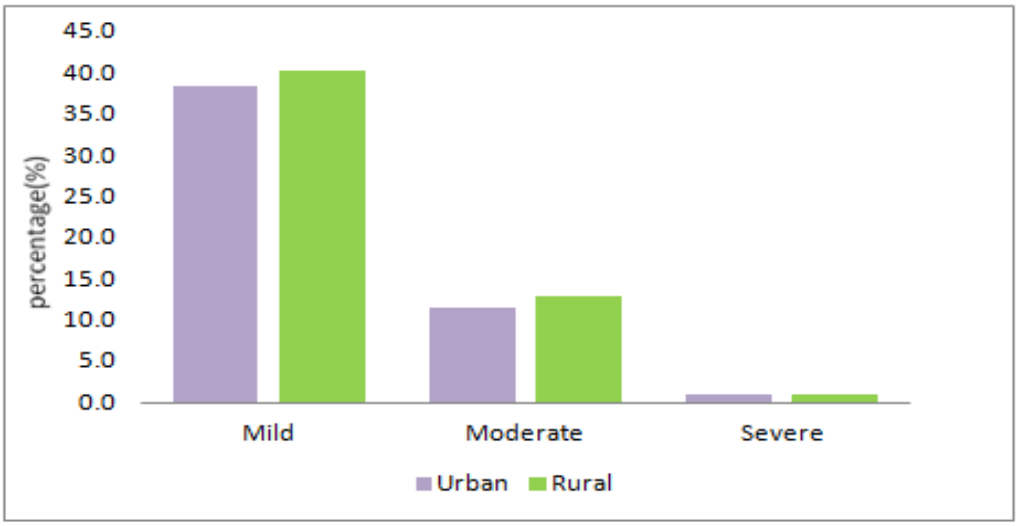
Figure3.8: Percentage of women age 15-49 with anemia



Source: NFHS-4, 2015-16

The level of mild, moderate and severe anemia among various age groups of women is almost the same throughout India the level of mild anemia is very high whereas there are very few people suffering from severe anemia.

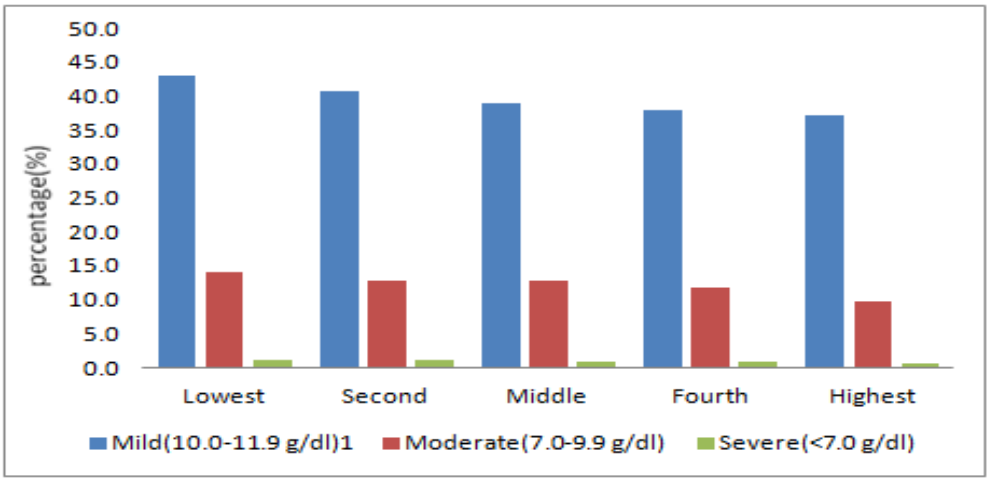
Figure 3.9: Percentage of Indian women with anemia in rural and urban areas



Source: NFHS-4, 2015-16

The percentage of rural women suffering from anemia is higher than the women in urban areas the percentage is close to 54.2percent as compared to 50.8percent in urban areas.

Figure 3.10: Percentage pattern of anemia among women according to the wealth index



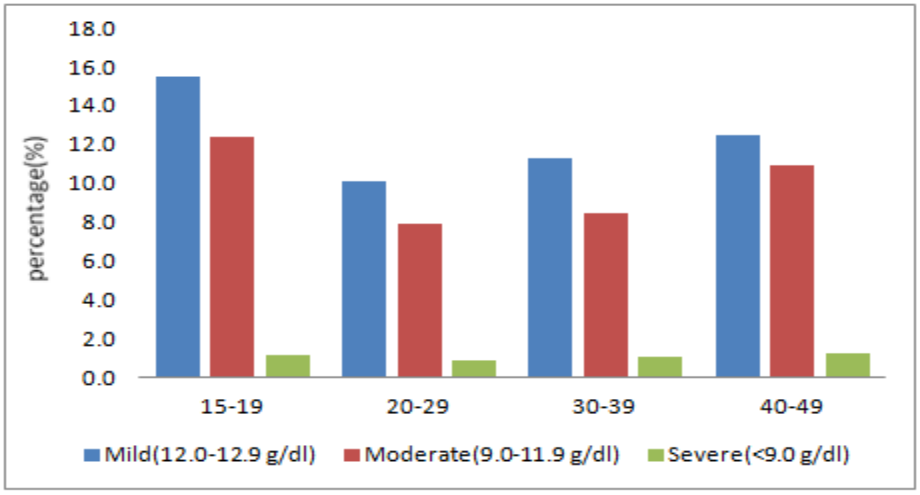
Source: NFHS-4, 2015-16

The women of the lowest wealth index make up for the highest number of people suffering from Anemia (Mild, Moderate and Severe).Mild anemia is prevalent across all five wealth indexes among females but gradually decreases with increase in the wealth index. Similar pattern is seen in case of moderate anemia, but severe anemia is more or less the same across all wealth indexes.

3.3 Percentage of anemic men in India

The percentage pattern of anemia for men is better compared to women and children of India but not very good. The following graphs give a clear picture of the percentage pattern of anemia among men in India .According to official statistics published by NFHS-4 around 24percent men are anemic in India.

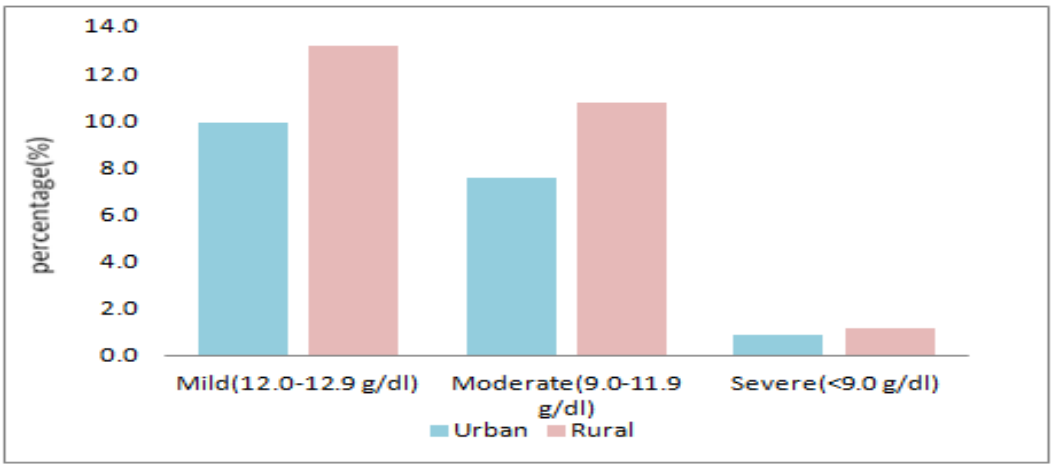
Figure 3.11: Percentage of anemia among men in the age group of 15-49



Source: NFHS-4, 2015-16

The age group affected most by anemia is 15-19 year old men and 40-49 year old men mainly because of either suffering from disease which leads to anemia or under nutrition .Moderate anemia remains high in all age groups more in younger men because of lack of proper diet in their growing years.

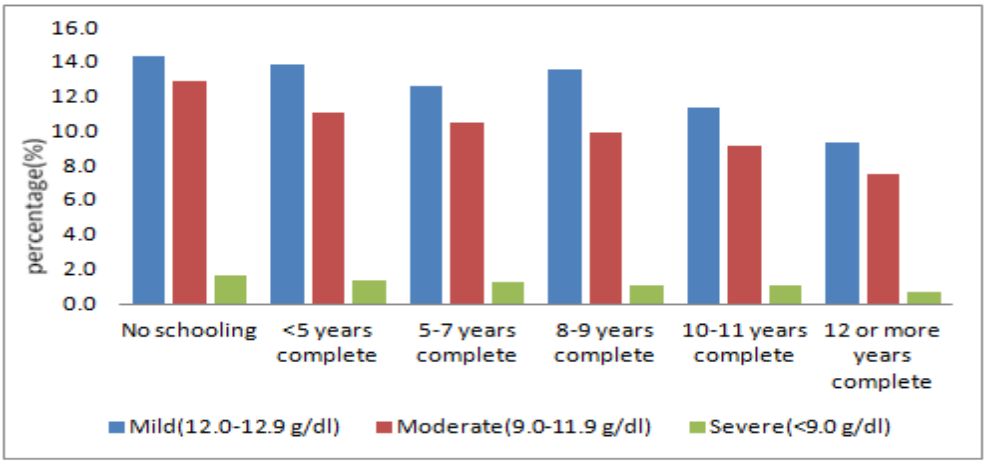
Figure 3.12: Anemia percentage according to residence among men



Source: NFHS-4, 2015-16

Rural men tend to be more anemic as compared to urban men and that trend continues among all categories of anemia mild, moderate as well as severe.

Figure 3.13: Percentage of anemia among men according to schooling level

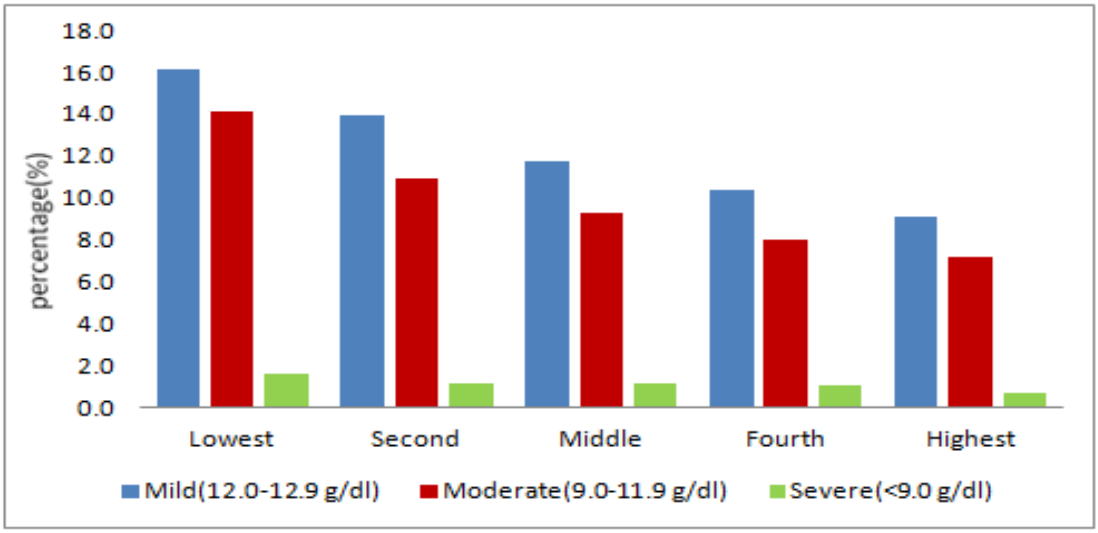


Source: NFHS-4, 2015-16

The figure shows that there is a difference among men who had some level of education than those who do not complete their education in terms of anemia prevalence.

This can be because of it is usually women who take care of activities related to preparation of food and men are not involved in the cooking or decisions regarding the food that should be prepared and consumed.

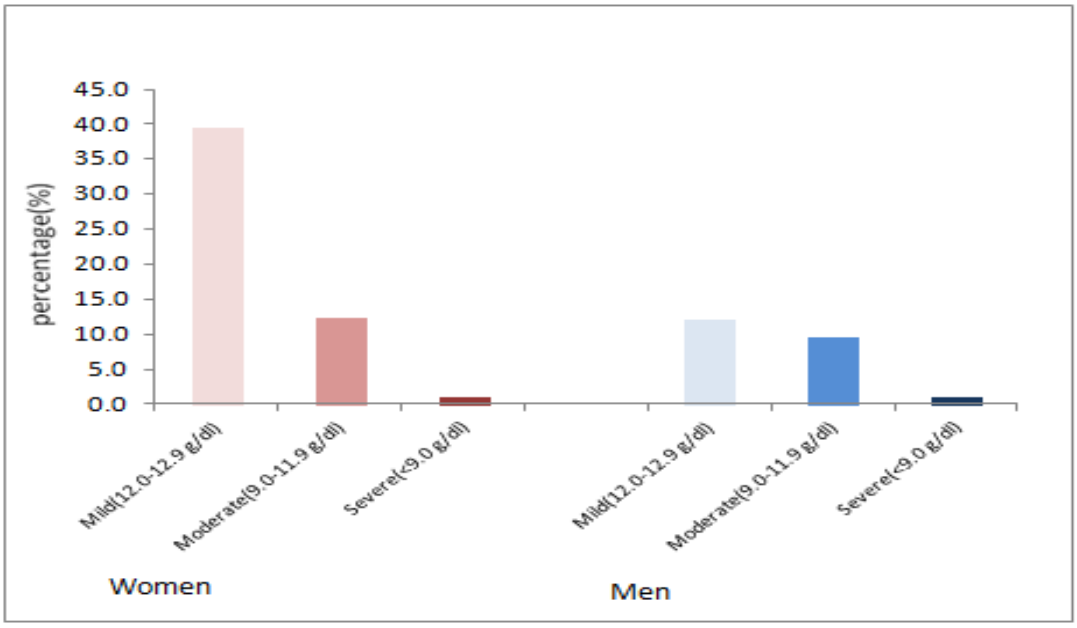
Figure 3.14: Anemia percentage among men as per the wealth index from lowest to the highest



Source: NFHS-4, 2015-16

The figure 3.14 shows that the poorest households comprise of the maximum percentage of anemic men and the percentage of anemia decreases as the wealth index increases.

Figure 3.15: Comparison of women and men anemia levels



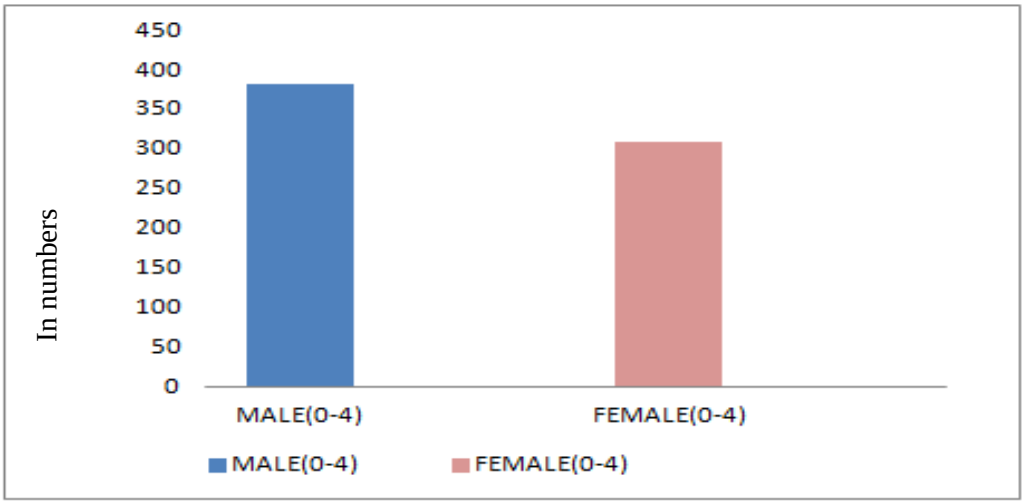
Source: NFHS-4, 2015-16

Women in India are more anemic as compared to men in all three categories of anemia that is probably because of the eating habits and religious connotations attached to eating meat and chicken that are food items that are rich in iron and proteins.

3.4 Deaths Due To Anemia according to Medical Certification for the Cause of Death Report (2015)

Deaths due to Anemia are not very prevalent it mainly causes disability among people but some anemia cases that lead to a person's death are recorded by the registrar general of India. Anemia leads to a weaker immune system and also problems related to the heart arise due to anemia therefore anemia is usually a secondary cause of death that plays the role of a catalyst in killing a person, primary cause may be heart disease or some other problem but mostly all patients suffering from any major ailment become victims of anemia. These statistics also account for hemoglobinopathies and hemolytic anemia.

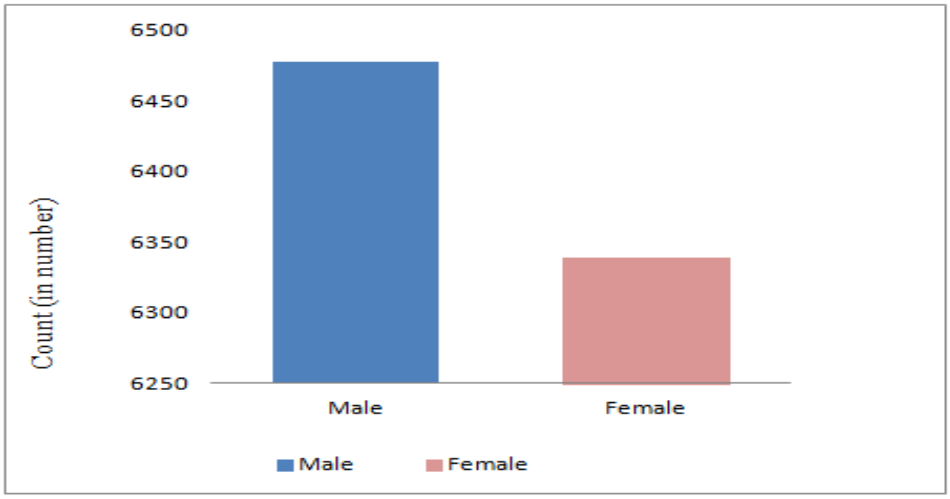
Figure 3.16: Deaths due to anemia among 0-4 years' old children in the year 2015



Source: MCCD, 2015

Death among children due to anemia was not very high. The medical certification for the cause of death report 2015 shows that death of a male child was more common due to anemia as compared to females.

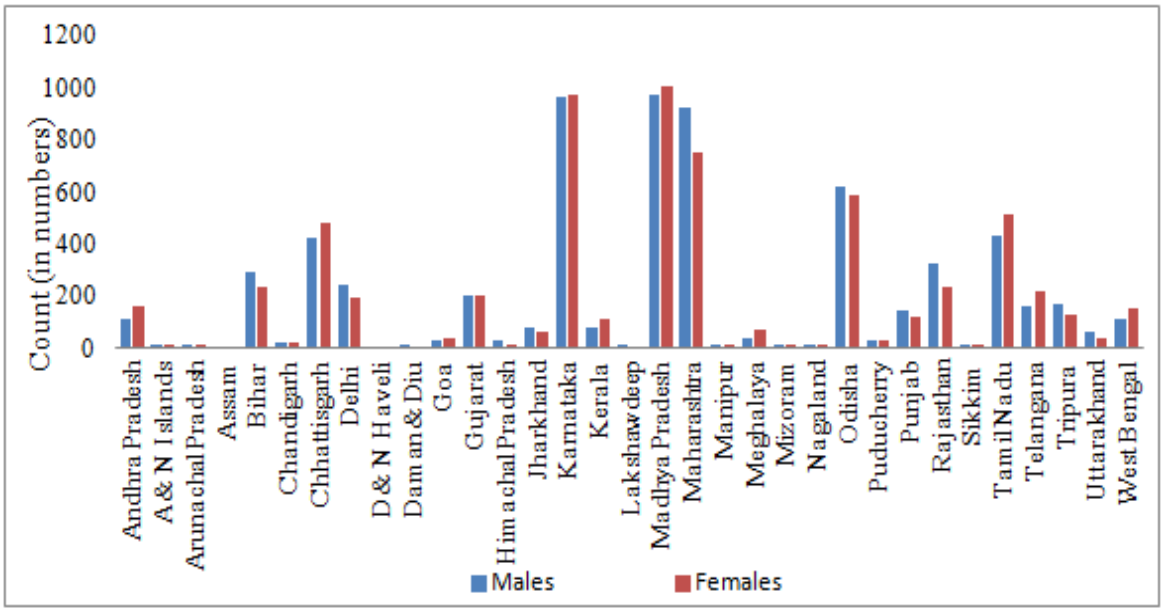
Figure3.17: Deaths due to anemia among men and women in India



Source: MCCD, 2015

Death due to anemia was more common among men rather than women even though there are a higher number of females that suffer from anemia in India.

Figure3.18: Deaths among men and women due to anemia in Indian states



Source: MCCD, 2015

The above figures show that there are not many deaths because of anemia, there are states like Madhya Pradesh, Karnataka, Maharashtra and Odisha that show high number of deaths due to anemia among men and women. The graph shows that anemia leads to death of more number of males than females.

This chapter gave an overview of the profile of the data. The percentage of anemia among different genders and age groups was depicted and it clearly shows that anemia in India is rampant and quite a high percentage of women and children are suffering from it.

Chapter IV

Determinants of prevalence of anemia in India

This chapter explains the variables that influence the prevalence of anemia among children, women and men in India. It explains in detail the possible reasons that cause people to suffer from anemia and how not just the nutritional deficiency but also the other socio economic variables that are a part of an individual's daily life influence the presence of anemia.

Extensive literature review suggests that adequate nutrition plays a detrimental role in a person's health but there are other factors that contribute too. For finding out the determinants that influence the prevalence of anemia for better anemia among children, women and men data was taken from NFHS -4.

The total sample of children was 265653 and the percentage of children suffering from anemia was around 58.4 percent as reported by NFHS-4. There are three categories of anemia mild, moderate and severe with varying degree of disability. The prevalence of severe anemia is very less but the other two categories affect a considerable number of children.

Some socio-economic variables are expected to determine the prevalence of anemia among children aged 6-59 months. Chi square test has been used to test the significant relationship between anemia and the independent variables and a Z- test of proportions has been applied to test the difference between the proportions of anemic children with two or more categories of the other independent variables.

4.1 Socio-Economic variables and their affect on anemic children.

The variables taken for children are age, type of residence, sex, mother's education, BMI, wealth index, the food that the mother gave to the child and the anemia level of the mother.

The null hypothesis and alternate hypothesis that follow for analyzing the relationship between these independent variable and Anemia is;

H_0: Prevalence of anemia among children is independent of age, sex, mother's education, type of residence, wealth index and the diet that the child takes.

H_1: Prevalence of anemia among children is dependent on age, sex, mother's education, type of residence, wealth index and the diet that the child takes.

The null and alternate hypothesis for determining whether the proportions of the variables taken for determining anemia level among children, women and men differ significantly or not are given with the description of the variable.

4.1.1 Age

Age is an important determinant of anemia among children. Young children are often less prone to being anemic but as they grow anemia prevalence starts increasing. It is hypothesized that children of age 0.5(6 months) to 2.5 (30 months) years to be anemic because children just after birth show a higher blood count and as they grow they become anemic due to multiple factors like lack of proper diet, no breast milk etc. Children who reach the age of 3 or 4 years have more options of getting a proper nutritious diet but small children are unable to get adequate amount of iron to keep them away from anemia. Moreover little kids are fussy eaters as compared to kids who fall in the category of 2.5 years to 5 years.

Table 4.1: Relationship between age of the child and anemia prevalence

Age of the child	Anemic	Not Anemic	Total	Proportion of anemic children	Z value
0.5 years- 2.5years	73683	36445	110128	0.669	82.14**
2.5years-5 years	43755	46367	90122	0.485	
Total	117438	82812	200250		

Pearson's chi square test value is 8062.022 and p value is <0.01

The chi square value of table 4.1 shows that there is significant relationship between age of a child and anemia prevalence. The chi square value is significant and the z value shows that the proportion of anemic children is slightly higher when they are younger than older.

4.1.2 Type of residence

The place where a person resides plays an important role in determining their health condition and lifestyle. More often than not the people living in rural areas are prone to higher levels of morbidity due to lack of hygiene and also poor availability of proper health care facilities. People living in rural areas are not too aware of the health problems and the kind of heath care facility that they should avail in order to be in better health. Therefore, it is hypothesized that children living in the rural areas will show a higher prevalence of anemia than the children living in urban areas because their parents won't be as informed as the parents that reside in urban areas.

Table4.2: Relationship between place of residence and anemia prevalence among children

Place of residence	Anemic	Not Anemic	Total	Proportion of anemic children	Z value
Urban	31348	24515	55863	0.561159	
Rural	86090	58297	144387	0.596245	15.70**
Total	117438	82812	200250		

Pearson's chi-square test is 204.455 and p value is <0.01.

The chi square value of the table 4.2 shows that there is a significant relationship between place of residence and anemia prevalence among children. The z value shows that the proportion of anemic children is slightly higher in rural areas as compared to urban areas.

4.1.3 Sex

Young children have low immunity and male children are more prone to infections and diseases when they are very young. Male children have a very delicate constitution and can be easily affected by infections and deficiencies when they are young. It is hypothesized that the females will be less anemic as compared to males.

Table 4.3: Relationship between sex of the child and anemia prevalence

Sex of child	Anemic	Not anemic	Total	Proportion of anemic children	Z value
Male	61160	43405	104565	0.584	-1.45
Female	56278	39407	95685	0.588	
Total	117438	82812	200250		

Pearson's chi-square test is 2.189 and p value is >0.10

The chi square value of the table 4.3 shows there is no significant relationship between the sex of a child and the prevalence of anemia. The z value also indicates that our expected hypothesis that male children will be more prone to being anemia is not proved statistically significant.

4.1.4 Mother's educational attainment

A small child is totally dependent on the mother for all basic needs and requirements; mothers play a significant role in the development of a child. If mothers are educated they will be in a better position to decide what is good for the child and what is not. Educational attainment makes sure that the mother is aware about the nutritional requirements of the child and gives him adequate food. It is hypothesized that a child born to a mother having no education to be more anemic in comparison to children being born to mothers who have completed their education. We have divided the educational attainment into three categories one is no education, the second one is incomplete primary to incomplete secondary education and the last one is complete secondary to higher education.

Table4.4: Relationship between mothers' educational attainment and anemia prevalence among children

Mothers' educational level	Anemic	Not Anemic	Total	Proportion of anemic children	Z value
Not educated	28173	17684	45857	0.614	39.19**
Educated	52422	49860	102282	0.512	
Total	80595	67544	148139		

Pearson's chi square test is 1479.626 and the p value is<0.01

The chi square test in table 4.4 shows that there is significant association between the educational attainment of the mother of a child and anemia prevalence. The chi square test is highly significant and it is clearly seen that children who are born to mothers who have no education are more anemic as compared to children who are born to mothers who have higher educational qualification.

4.1.5 Body Mass Index (BMI)

Body mass index measures the tissue mass in a person it helps in determining whether a person is underweight, normal, overweight or obese. It is calculated by dividing the weight (in kilograms) of a person by the square of their respective height (in meters). If the BMI come out to be under 18.5 a person is said to be underweight, if it is between 18.5—25 then it is normal and anything over and above 25 is considered overweight. People who are underweight have higher chances of suffering form nutritional deficiencies and therefore, it is hypothesized that the prevalence of anemia will be higher in children with BMI less than 18.5.

Table 4.5: Relationship between Body mass index and prevalence of anemia among children

BMI	Anemic	Not Anemic	Total	Proportion of anemic children	Z value
Below 18.5	112799	79731	192530	0.585	-6.52*
Above18.5	4632	3082	7714	0.601	
Total	117431	82813	200244		

Pearson's chi square test is 6.517 and the p value is <0.05.

The value of the chi square test in table 4.5 shows that there is significant association between the body mass index of a child and anemia prevalence. The chi square test is significant but the proportion of anemic children is more where the BMI is above 18.5 this proves that even though chi square is significant our hypothesis is not proved.

4.1.6 Wealth Index

Wealth index measures the relative standard of living of a household in comparison to the nation. The level of wealth index helps in determining the quality of life that a person is living. The richer the person the better is the quality of life that they experience and similarly people coming from the lower wealth index lead a lower quality of life thereby leading to situations where they are unable to fulfill their nutritional and health requirements. This situation puts them at the line of attack of various nutritional as well as health risks. It is hypothesized that anemia will be more prevalent in poorer households. We have divided the five categories of poorest, poorer, middle, richer and richest households into three categories namely, poor, middle and rich and comparison has been made between poor and middle, poor and rich in order to find out the effect of wealth index of a household on the anemia level of a child.

Table 4.6: Relationship between wealth index and prevalence of anemia among children

Wealth Index	Anemic	Not Anemic	Total	Proportion of Anemic Children	Z value
Poor	55240	35469	90709	0.608	20.26**
Middle	23704	16885	40589	0.584	
Rich	38493	30458	68951	0.558	
Total	117437	82812	200249		

Pearson's chi square value is 562.469 and the p value is <0.01.

The table 4.6 shows that there is significant relationship between the wealth index of a child's household and the anemia status of the child. The children belonging to poorer families have higher anemia prevalence as compared to children belonging to rich and middle level households.

4.1.7 Food intake

Food plays an important role in determining the nutrition that a person gets and the health of a person. Right diet can lead to a person being fit and healthy for a long time. Food items like meat and green vegetables are believed to carry rich iron content, thereby helping people in getting rid of iron deficiencies. A person should have at least 18micro grams of iron daily in their diet in order to make sure that they do not suffer from iron deficiency. It is hypothesized that children who eat meat, green leafy vegetables, fish, milk, yogurt and have pulses and lentils will have lesser chances of being anemic rather than children who do not have green vegetables and meat in their diet.

(a) Green leafy vegetables

Table 4.7(a): Relationship between children eating green leafy vegetables and the prevalence of anemia

Green leafy vegetables	Anemic	Not Anemic	Total	Proportion of anemic children	Z value
Yes	4542	3124	7666	0.592	-4.14*
No	15155	9466	24621	0.615	
Total	19697	12590	32287		

Pearson's chi square test is 13.373 and the p value is <0.05.

The table 4.7(a) shows that children who eat green leafy vegetables are less likely to be anemic and the chi square test also shows the relationship to be significant. The z value shows that the expectation that children having green leafy vegetables will be less likely to anemic is significant.

(b) Chicken or any other type of meat

Table 4.7(b): Relationship between children eating meat and chicken and the prevalence of anemia

Liver, heart and other organs	Anemic	Not Anemic	Total	Proportion of Anemic children	Z value
Yes	841	627	1468	0.572	-7.001*
No	18856	11962	30818	0.611	
Total	19697	12589	32286		

Pearson's chi-square test is 13.029 and the p value is <0.05.

The table 4.7(b) shows that children who eat meat and chicken are less likely to be anemic and the chi square test also shows the relationship to be significant. The z value shows that

the expectation that children having chicken and meat will be less likely to anemic is significant.

4.7 c) Fish and shell fish

Table 4.7(c): Relationship between children eating fish and shell fish and the prevalence of anemia

Fish and shell fish	Anemic	Not Anemic	Total	Proportion of Anemic children	Z value
Yes	672	503	1175	0.572	-7.112*
No	19025	12087	31112	0.615	
Total	19697	12590	32287		

Pearson's chi-square test is 8.505 and the p value is >0.05.

The table 4.7(c) shows that children who eat fish are less likely to be anemic. The chi square test shows the relationship to be insignificant. The z value shows that the expectation that children having fish and shell fish will be less likely to anemic is significant.

4.7 d) Beans, peas, lentils and nuts

Table 4.7(d): Relationship between children eating beans, peas, lentil nuts and the prevalence of anemia

Beans, peas, lentils and nuts	Anemic	Not Anemic	Total	Proportion of Anemic children	Z value
Yes	1953	1443	3396	0.575	-7.026**
No	17744	11146	28890	0.614	
Total	19697	12589	32286		

Pearson's chi-square test is 19.672 and the p value is <.01

The table 4.7(d) shows that children who eat beans, peas, lentils and nuts are less likely to be anemic and the chi square test also shows the relationship to be significant. The z value shows that the expectation that children having beans, peas, lentils and nuts will be less likely to anemic is highly significant.

4.7 e) Cheese, yogurt, other milk products

Table 4.7(e): Relationship between children eating cheese, yogurt, other milk products and the prevalence of anemia

Cheese, yogurt, other milk products	Anemic	Not Anemic	Total	Proportion of Anemic children	Z value
Yes	1395	1062	2457	0.567	-8.22**
No	18302	11528	29830	0.613	
Total	19697	12590	32287		

Pearson's chi-square test is 20.937and the p value is <.01

The table 4.7(e) shows that children who have cheese, yogurt, other milk products are less likely to be anemic and the chi square test also shows the relationship to be significant. The z value shows that the expectation that children having cheese, yogurt, and other milk products will be less likely to anemic is highly significant.

4.1.8 Mother's anemia level

Anemic mother's are at a higher risk of either dying while giving birth or giving birth to an anemic baby. There if high probability of a child being anemic if the mother is anemic. It is hypothesized that anemic mother's will deliver babies that are anemic.

Table 4.8: Relationship between mothers' anemia level and prevalence of anemia among children

Anemia level of mother	Anemic	Not anemic	Total	Proportion of Anemic children	Z value
Mothers' Anemic	66713	40906	107619	0.619	42.50**
Mothers' Not anemic	51625	46486	98111	0.526	
Total	118338	87392	205730		

Pearson's chi square test is 2004.300 and the p value is <0.01

The above table 4.8 shows that the mothers' who are anemic will deliver babies that are anemic. The chi square test shows that there is a significant relationship between mothers' anemia level and the child being anemic. The z test shows that the expectation of an anemic mother having an anemic child is statistically significant.

4.2 Socio-Economic variables and their affect on anemia prevalence among women.

The problem of anemia among females can be triggered because of various reasons. Females are more prone to being anemic as compared to men partly because of pregnancy related issues, menstruation, and lack of proper diet. The hypothesis for finding out the relationship between the prevalence of anemia among women and the independent variables is;

H_0: Prevalence of anemia among women is independent of Age, type of residence, educational attainment, currently pregnant, , drugs for intestinal parasites during pregnancy, Body mass index , taking iron pills, sprinkles or syrup and total number of living children as well as current pregnancy

H_1: Prevalence of anemia among women is dependent on Age, type of residence, educational attainment, currently pregnant, , currently pregnant, , drugs for intestinal parasites during pregnancy, Body mass index , taking iron pills, sprinkles or syrup and total number of living children as well as current pregnancy

4.2.1 Age

Age of women has been divided into two groups one group comprises of females above the age of 35 and the other one comprises of females below the age of 35. This categorization has been taken because most of the females go through pregnancy complications and hectic lifestyle in age group of 35 and below. Therefore it is hypothesized that females below 35 will be anemic.

Table 4.9: Relationship between Anemia among women and age

Age	Anemic	Not Anemic	Total	Proportion of anemic women	Z value
Below 35years	235289	207435	442724	0.531	1.37**
Above 35 years	125398	111293	236691	0.529	
Total	360687	318728	679415		

Pearson's chi-square value 122.589 and p value <0.05

The chi-square value shows that there is significant association between the age of women and the prevalence of anemia. Females falling below 35 years of age are more prone to being

anemic as compared to females falling in the age above 35 years. It is statistically proven through the Z test at 5 percent confidence level.

4.2.2 Place of residence.

The place of residence of a person is an important factor that determines their health condition and lifestyle. More often than not the people living in rural areas are prone to higher levels of morbidity due to lack of hygiene and also proper health care facilities. People living in rural areas are not very aware of the health problems and the kind of heath care facility that they should avail in order to be in better health. Therefore, it is hypothesized that people living in the rural areas will show a higher prevalence of anemia than the women living in urban areas.

Table 4.10: Relationship between place of residence and prevalence of anemia among women

Place of residence	Anemic	Not Anemic	Total	Proportion of anemic women	Z value
Urban	117176	113367	230543	0.508	
Rural	243511	205361	448872	0.542	28.22**
Total	360687	318728	679415		

Pearson's chi-square 761.781 and the p value is < .01

The table 4.10 shows that there is significant relationship between place of residence and anemia prevalence among women. The chi square value shows this relationship is highly significant and the z value shows that the proportion of anemic women is higher in rural areas as compared to urban areas.

4.2.3 Educational attainment

A person who is educated and aware of the diet to follow in order to remain healthy will have lesser chances of suffering from nutritional deficiencies like anemia. Education is important for making people understand the importance of proper diet if they aspire to lead a disease free life. It is hypothesized that women who have completed a certain level of education will be at a better position to ascertain the correct diet for themselves as compared to women that have no education at all and will be less prone to being anemic. We have divided the

educational attainment category into three parts and inter comparison is done in order to test our hypothesis.

Table 4.11: Relationship between Educational attainment and prevalence of anemia among women

Educational attainment	Anemic	Not anemic	Total	Proportion of anemic women	Z value
No education	105929	81783	187712	0.564	
Incomplete primary to incomplete secondary	184706	163262	347968	0.530	
Secondary and higher education	70051	73683	143734	0.487	-44.30
Total	360686	318728	679414		

Pearson's chi-square 2168.662 and p value <0.01

The table 4.11 shows that as educational attainment increases the level of anemia decline. The table shows a significant relationship between the educational attainment of women and prevalence of anemia among them. The z value indicates that the proportion of anemic women decreases as the level of education increases.

4.2.4 Wealth Index

Wealth index measures the relative standard of living of a household in comparison to the nation. The level of wealth index helps in determining the quality of life that a person is living. The richer the person the better is the quality of life that they experience and similarly people coming from the lower wealth index lead a lower quality of life thereby leading to situations where they are unable to fulfill their nutritional and health requirements. This situation puts them at the line of attack of various nutritional as well as health risks. Therefore, it is hypothesized anemia to be more prevalent in poorer households.

Table 4.12: Relationship between wealth index and prevalence of anemia among women

Wealth index	Anemic	Not anemic	Total	Proportion of anemic women	Z value
Poor	145581	110693	256274	0.568	52.91*
Middle	74867	65536	140403	0.533	
Rich	140238	142499	282737	0.496	
Total	360686	318728	679414		

Pearson's Chi square is 3357.903 and p value is <0.05

The above table 4.12 shows that the relationship between anemia and wealth index is significant the chi square test proves the fact that there is a negative relationship between wealth index and anemia prevalence the poorer the household the more are the chances of the women being anemic. The z value shows the proportion of poor women being anemic is higher.

4.2.5 Currently pregnant

Pregnant women are often required to take good care of their health because the baby gets nourishment through their diet only. Pregnant women are advised to take iron supplements so that the iron requirements of the mother and baby are fulfilled and they do not suffer from the deficiency of iron. Currently pregnant women are at a lower risk of being anemic because of eating healthy food as they have to cater to not only their nutritional requirements but also the requirement of the growing fetus too.

Table 4.13: Relationship between current pregnancy and prevalence of anemia among women

Currently pregnant	Anemic	Not anemic	Total	Proportion of Anemic women	Z value
No or unsure	345409	303686	649095	0.532	
Yes	15278	15042	30320	0.503	-23.28**
Total	360687	318728	679415		

Pearson's chi square 92.808 and p value <0.01

The table 4.13 shows that the proportion of pregnant females being anemic is not high as compared to females who are not pregnant. There is a significant relationship between the current pregnancy of a female and the level of anemia. It is evident from the data that the proportion of pregnant females being anemic is less as compared to females that are not pregnant.

4.2.6 Total number of children living and currently pregnant

The number of times a woman becomes pregnant and the gap between her pregnancies can sometimes be one of the leading causes of anemia. Women who have short time periods between two pregnancies are at a higher risk of being anemic, similarly women who have given birth to more number of children will be more prone to being anemic as deliveries often led to a lot of blood loss. It is hypothesized that females with higher number of pregnancies and more number of children are more anemic

Table4.14: Relationship between total number of children living as well as currently pregnant and prevalence of anemia among women

Total number of living children and currently pregnant	Anemic	Not Anemic	Total	Proportion of Anemic women	Z value
0	101831	93365	195196	0.522	
1to3	212262	186594	398856	0.532	
3+	46593	38768	85361	0.546	12.79**
Total	360686	318727	679413		

Pearson’s chi-square 295.005 and p value is <0.01.

The chi-square test shows that there is a significant relationship between the number of pregnancies as well as current pregnancy of a women and anemia. Table4.14 shows that as the number of children a female has borne increases her chances of being anemic also increase.

4.2.7 Taking iron tablets, sprinklers and syrups.

Women and expecting mothers are instructed to take iron supplements so that they can meet the daily iron requirements required for their own health as well as the health of the baby. People who have a poor diet and those who are pregnant need to take iron supplements so that they can avoid anemia which can have serious consequences if not taken care of. It is hypothesized that those women that are taking iron supplements are less likely to be anemic and the women who are unsure and are not taking iron supplements they are more susceptible to anemia.

Table4.15: Relationship between women taking iron tablets, sprinklers and syrups and prevalence of anemia among women

Taking iron tablets, sprinklers and syrups.	Anemic	Not Anemic	Total	Proportion of anemic women	Z value
No Don't Know	74134	56476	130610	0.57	
Yes	24344	20110	44454	0.55	-8.36**
Total	98478	76586	175064		

Pearson’s chi-square 54.996 and p value is <0.01

The table 4.15 shows that there is a significant relationship between taking iron tablets sprinklers, syrups and anemia level among women the z value also shows that women talking iron tablets are less likely to be anemic as compared to women who do not take intestinal drugs.

4.2.8 Dugs for intestinal parasites during pregnancy

Intestinal parasites live inside the human body mostly found in the gut. They take nourishment from the human body and reproduce inside the body of the host. These parasites suck the blood from the body of their host making them susceptible to conditions like anemia. Lack of proper hygiene, sanitation and clean drinking water often results in people suffering from intestinal parasites. It is hypothesized that women who have taken drugs for intestinal parasites will be less prone to suffering from anemia.

Table4.16: Relationship between women taking drugs for intestinal parasites and prevalence of anemia among women

Drugs for intestinal parasites during pregnancy	Anemic	Not Anemic	Total	Proportion of anemic women	Z value
Yes	17723	14624	32347	0.547	-7.51**
No/don't know	83596	64207	147803	0.565	
Total	101319	78831	180150		

Person's chi-square value is 33.760 and the p value is <0.01

The table 4.16 shows that there is a significant relationship between taking drugs for intestinal parasites and anemia level among women the z value also shows that women talking drugs for parasites are less likely to be anemic as compared to women who do not take intestinal drugs.

4.2.9 Body Mass Index

BMI measures the tissue mass in a person it helps in determining whether a person is underweight, normal, overweight or obese. It is calculated by dividing the weight (in kilograms) of a person by the square of their respective height (in meters). If the BMI come out to be under 18.5 a person is said to be underweight, if it is between 18.5—25 then it is normal and anything over and above 25 is considered overweight. People who are underweight have higher chances of suffering form nutritional deficiencies and therefore, it is hypothesized prevalence of anemia to be higher in people with BMI under 18.5.

Table 4.17: Relationship between the body mass index of women and prevalence of anemia among women

BMI	Anemic	Not anemic	Total	Proportion of anemic women	Z value
Below 18.5	23499	12419	35918	0.654	26.78**
Above18.5	64022	45597	109619	0.584	
Total	87521	58016	145537		

Pearson's chi square test 1014.887 and the p value is <0.01

The chi square test in table 4.17 shows that there is significant association between the body mass index of a women and anemia prevalence. The chi square test is highly significant and it is clearly seen that women with BMI below 18.5 are more likely to be anemic.

4.3 Socio-Economic variables and their affect on anemia prevalence among men

Men in India and around the world are the least affected population when it comes to anemia, but still getting an insight into the socio economic links that could be the possible reason for the prevalence of anemia among men would be beneficial for making anemia a rare deficiency among men.

The hypothesis for finding out the relationship between the prevalence of anemia among men and the independent variables is;

H_0: Prevalence of anemia among men is independent of Age, type of residence, educational attainment, Body mass index, wealth index and employment.

H_1: Prevalence of anemia among men is dependent on Age, type of residence, educational attainment, Body mass index, wealth index and employment.

4.3.1 Age

Age of men has been divided into two groups one group comprises of males above the age of 34 and the other one comprises of males below the age of 34 till 54. This categorization has been taken because most of the men go through puberty after the age of 13 or 15 their body requires more food but due to lack of adequate diet they are unable to fulfill their food requirements. It is hypothesized that men of age 15 -34 will be more anemic.

Table4. 18: Relationship between Age of men and anemia prevalence among men

Age	Anemic	Not anemic	Total	Proportion of Anemic men	Z value
15-34	1877	6335	8212	0.228	-0.99
35-54	1582	5102	6684	0.236	
Total	3459	11437	14896		

Pearson's chi-square test is 10.037 and p value is >0.1

The chi square value in table 4.18 shows that there is no significant relationship between age of a man and anemia prevalence among men. The chi square value shows this relationship is not significant and the z value shows that the proportion of anemic men is higher in the age group of 35-54.

4.3.2 Place of residence

The place where a person resides helps in determining their health condition and lifestyle. More often than not the people living in rural areas are prone to higher levels of morbidity due to lack of hygiene and also proper health care facilities. People living in rural areas are not very aware of the health problems and the kind of heath care facility that they should avail in order to be in better health. Therefore, it is hypothesized that men living in the rural areas will show a higher prevalence of anemia than the men living in urban areas.

Table 4.19: Relationship between place of residence and anemia prevalence among men

Place of residence	Anemic	Not anemic	Total	Proportion of Anemic men	Z value
Urban	1180	4982	6162	0.191	
Rural	2277	6456	8733	0.260	8.45**
Total	3457	11438	14895		

Pearson's chi-square test is 97.180 and p value is <0.01

The value of the chi square test in table 4.19 shows that there is significant relationship between place of residence and anemia prevalence among men. The chi square value shows

this relationship is highly significant and the z value shows that the proportion of anemic men is higher in rural areas as compared to urban areas.

4.3.3Educational attainment

A person who is educated and aware of the diet to follow in order to remain healthy will have lesser chances of suffering from nutritional deficiencies like anemia. Education plays an important role in making people understand the importance of proper diet if they aspire to lead a disease free life. It is hypothesized that men who have no education will be anemic and men who are educated will be less likely to be anemic. We have divided the educational attainment category into three sub groups and inter comparison is done in order to test our hypothesis.

Table 4.20: Relationship between Educational Attainment and anemia prevalence among men

Educational Attainment	Anemic	Not anemic	Total	Proportion of anemic men	Z value
No Education	634	1331	1965	0.322	11.71**
Incomplete primary to incomplete secondary	2047	6479	8526	0.240	
Complete secondary to higher	775	3629	4404	0.175	
Total	3456	11439	14895		

Pearson's chi-square test 196.944 and the p value is <0.01

The value of the chi square test in table 4.20 shows that as educational attainment increases the level of anemia declines. The table shows a significant relationship between the educational attainment of men and prevalence of anemia among them. The z value indicates that the proportion of anemic men decreases as the level of education increases.

4.3.4 Body mass index

BMI measures the tissue mass in a person it helps in determining whether a person is underweight, normal, overweight or obese. For calculating the BMI the weight (in kilograms) of a person has to be divided by the square of their respective height (in meters). If the BMI come out to be under 18.5 a person is said to be underweight, if it is between 18.5—25 then it is normal and anything over and above 25 is considered overweight. People who are underweight have higher chances of suffering form nutritional deficiencies and therefore, it is hypothesized prevalence of anemia to be higher in men with BMI under 18.5.

Table 4.21: Relationship between BMI and anemia prevalence among men

BMI	Anemic	Not anemic	Total	Proportion of anemic men	Z value
Less than 25	2921	8576	11497	0.254	9.19**
More than 25	531	2458	2989	0.177	
Total	3452	11034	14486		

Pearson's chi square test is 204.097 and the p value is < 0.01

The value of the chi square test in table 4.21 shows that there is significant association between the body mass index of men and anemia prevalence among them. The chi square test is highly significant and it is clearly seen that men with BMI below 18.5 are more likely to be anemic. The Z value shows the association to be highly significant.

4.3.5 Wealth Index

Wealth index measures the relative standard of living of a household in comparison to the nation. The level of wealth index helps in determining the quality of life that a person is living. The richer the person the better is the quality of life that they experience and similarly people coming from the lower wealth index lead a lower quality of life thereby leading to situations where they are unable to fulfill their nutritional and health requirements. This situation puts them at the line of attack of various nutritional as well as health risks. Therefore, it is hypothesized that anemia will be more prevalent in poorer households.

Table 4.22: Relationship between wealth index and anemia prevalence among men

Wealth index	Anemic	Not anemic	Total	Proportion of anemic men	Z value
Poor	1365	3354	4719	0.289	4.47**
Middle	676	2486	3162	0.213	
Rich	1416	5598	7014	0.201	
Total	3457	11438	14895		

Pearson's chi-square test is 183.35 and the p value is <0.01.

The value of the chi square test in the above table 4.22 shows that the relationship between anemia and wealth index is significant. The chi square test proves the fact that there is a negative relationship between wealth index and anemia prevalence the poorer the household the more are the chances of the man being anemic. The z value shows the proportion of poor men being anemic is higher.

4.3.6 Employment

Employment is closely related to a person's standard of living if a person is employed in a regular job it is evident that he will have a stable income. When he has regular income he will be able to cater to his daily food requirements and there is lesser possibility of him suffering from anemia as compared to a man who is unemployed or an occasional worker**.**

Table 4.23: Relationship between Employment and anemia prevalence among men

Employment	Anemic	Not anemic	Total	Proportion of anemic men	Z value
All year	2229	7673	9902	0.225	-5.99**
Seasonal/occasional	729	1887	2616	0.278	
Total	2958	9560	12518		

Pearson's chi-square test is 34.50 and the p value is <0.01.

The chi square test in the above table 4.23 shows that the relationship between anemia and employment of men is significant it proves the fact that if a man is employed for the whole year he is less likely to be anemic. The z value shows the proportion of men employed all year being anemic is lower.

4.3.7 Food intake

Food plays an important role in determining the nutrition that a person gets and the health of a person. Right diet can lead to a person being fit and healthy for a long time. Food items like meat, green vegetables, cheese and fruits are believed to carry rich iron content, thereby helping people in getting rid of iron deficiencies. A person should have at least 18micro grams to 28 micro grams of iron daily in their diet in order to make sure that they do not suffer from iron deficiency. It is hypothesized that men who eat meat, green leafy vegetables, cheese, yogurt and fruits have lesser chances of being anemic rather than men who do not have green vegetables and meat in their diet.

a) Frequency of eating Green leafy vegetables

Table 4.24(a): Relationship between Eating green leafy vegetables and anemia prevalence among men

Green leafy vegetables	Anemic	Not Anemic	Total	Proportion of anemic men	Z value
No	18	43	61	0.295	7.71**
Yes	3440	11395	14835	0.231	
Total	3458	11438	14896		

Pearson's chi-square test is 2.926 and the p value is >0.05

The value of the chi square test in table 4.23(a) shows that the relationship is not significant at 95percent significance level. The proportion of anemic men shows that men who eat green leafy vegetables are less likely to be anemic. The z value is proved to be significant so the null hypothesis for the z test is rejected.

b) Frequency of eating chicken or meat

Table 4.24(b): Relationship between eating meat and chicken and anemia prevalence among men

Frequency of eating chicken or meat	Anemic	Not Anemic	Total	Proportion of Anemic men	Z value
No	795	2615	3410	0.233	0.16
Yes	2662	8823	11485	0.231	
Total	3457	11438	14895		

Pearson's chi-square test is 6.646 and the p value is >0.05

The value of the chi square test in the table 4.23(b) does not show any significant difference between men who eat chicken and meat and those who do not. The z value shows that the hypothesis that men having chicken and meat are less anemic is not proved.

c) Frequency of eating milk, curd and cheese

Table 4.24(c): Relationship between eating milk, curd and cheese and anemia prevalence among men

Eats milk, curd and cheese	Anemic	Not anemic	Total	Proportion of anemic men	Z value
Yes	3264	10894	14158	0.23	
No	193	545	738	0.26	3.78**
Total	3457	11439	14896		

Pearson's chi-square test is 29.795 and the p value is <.001

The value of the chi square test in table 4.23(c) shows that the relationship is significant at 95percent significance level. The proportion of anemic men shows that men who eat milk, curd and cheese are less likely to be anemic. The z value is proved to be significant so the null hypothesis is rejected.

d) Frequency of eating fruits

Table 4.24(d): Relationship between eating fruits and anemia prevalence among men

Eats fruits	Anemic	Not Anemic	Total	Proportion of anemic men	Z value
Yes	3357	11221	14578	0.23	
No	101	218	319	0.31	10.53**
Total	3458	11439	14897		

Pearson's chi-square test is 52.563 and the p value is <.001

The value of the chi square test in table 4.23(d) shows that the relationship is significant at 95percent significance level. The proportion of anemic men shows that men who eat fruits are less likely to be anemic. The z value is proved to be significant so the null hypothesis is rejected.

4.4 Conclusions

It is evident that it is not just the food intake that determines the prevalence of anemia among children, women and men, but also many different socio economic factors. For children the factors that explained anemia prevalence among them were age, type of place of residence, body mass index, food intake, mother's anemia level and wealth index, for women age, type of place of residence, wealth index, body mass index, taking iron and folic tablets, current pregnancy , educational attainment and taking drugs for intestinal parasites were significant and lastly for men type of place of residence, body mass index, wealth index, employment , educational attainment and food intake were significant. It was observed that in all in all the rural population was more prone to being anemic than the urban. Men and women who have received proper education were less likely to be anemic. Wealth index which is a determinant of a standard of living of a person showed that people belonging to poor households were more likely to be anemic and people with a low body mass index were also anemic. More stress should be given to a balanced diet comprising of pulses, fruits and nuts because they have a significant impact on the hemoglobin levels these food are probably better absorbed by the body thereby resulting in lesser cases of anemia among people who have fruits, nuts and lentils in their diet.

Chapter V

Health gaps: Measuring the burden of anemia.

This chapter explains the concept of burden of disease and shows how anemia is continuously increasing the health burden of India which already is in a poor shape. We are well aware of the fact that efficiency of a person declines when they fall ill or get injured, this decline in efficiency affects their ability to be as productive as they could have been had they not fallen ill or met with an accident. This decline in productivity ultimately reflects in their work in the form of poor performance. An attempt to highlight the healthy life years that are lost of a person suffering from anemia is carried out by calculating basic DALYs. It is necessary to know about the Disability adjusted life years caused by a disease so that sound policies can be formulated and the problem can be handled at an early stage. By looking at the burden of a small nutritional deficiency like anemia we will know the lacunas in the policy that were created to tackle this problem and we can improve our policies and programmes so that India too can contribute positively towards achieving the global Sustainable Development Goals that aim at reducing global anemia prevalence by 50percent by 2030.

5.1 Burden of disease

Burden of disease is a measure that computes the loss in healthy life due to communicable diseases, non communicable diseases, injuries and risk factors. It was developed by the Harvard School of Public Health and the World Health Organization in 1990's. The burden of disease is calculated using summary measures of population health which can be divided into two broad categories i) Health Expectancies and ii) Health Gaps.

5.1.1Health expectancies:

Health expectancies are as defined as a measure of the years of life gained or improvement in the quality of life of an individual by undergoing treatment for the ailment that the person was suffering from. The following measures are used to understand health expectancies;

- Active life expectancy(ALE)
- Disability free life expectancy(DFLE)
- Disability adjusted life expectancy(DALE)
- Healthy adjusted life expectancy(HALE)
- Quality adjusted life expectancy(QALE)

5.1.2 Health gaps

A health gap measure is defined as a measure of lost years of full health in comparison with some 'ideal' health status or accepted standard. Full health here stands for a situation where an individual does not require any kind of assistance for day to day activities and does not suffer from any functional as well as mental limitations for performing daily tasks *(Doncho Donev, 2011).*

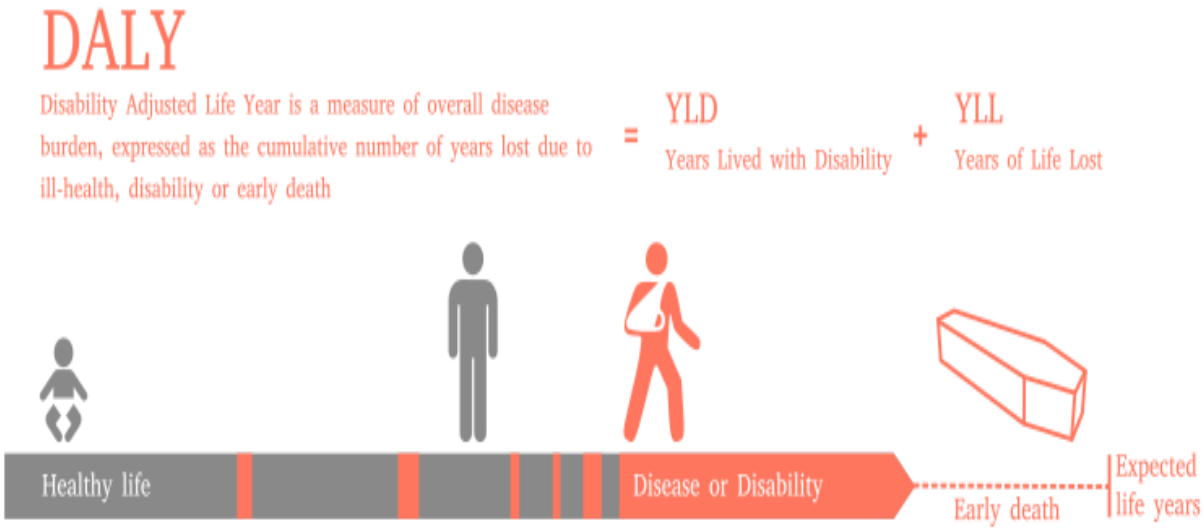
Following measures are used to know the health gaps;

- Potential years of life lost(PYLL)
- Healthy years of life lost (HYLL)
- Quality adjusted life years(QALY)
- Disability adjusted life years(DALY)

In this study DALYs is used to measure the health gaps.

5.2 Disability Adjusted Life Years (DALYs)

Disability adjusted life years (DALYs) is a measure of disease burden that is expressed as the total number of years that are lost due to sickness, disability or premature death. DALY is computed by adding the years of life lost due to premature death and the years of life lost due to disability .There are a number of people who lose out on the healthy life years because of being affected by diseases and this is precisely what DALY measures.



Source: World Health Organization

There are different ways of calculating disability adjusted life years. Some consider age weighting and time discounting to be important considerations for calculating DALYs; others calculate DALYs without age and time discounting. There are some others who just give importance to age discounting. We have calculated DALY without considering age or time discounting. We calculate DALYs on the basis of gender and age stratification, in order to find out the population that bears the maximum burden of anemia.

Disability weights

According to the World Health Organization, a disability weight is a weight factor that reflects the severity of the disease on a scale of 0 to 1, where 0 stands for perfect health and 1 denotes death. It was felt that diseases should be weighted according to the severity. For the global burden of disease study (2004), all types of diseases were grouped into seven classes of severity. They are given as follows *(Doncho Donev, 2011)*;

Table 5.1: Disability weights according to severity of the disease

Disability class	Severity weights	Conditions
I	0.00-0.02	Stunting due to malnutrition, schistosomiasis infection, long term scarring due to burns(less than 20% of the body)
II	0.02-0.12	Amputated finger, asthma case, edenutulism, mastectomy, severe anemia, stress incontinence, watery diarrhea.
III	0.12-0.24	Angina, HIV not progressed to AIDS , alcohol dependence, radius fracture in a stiff cast, infertility, erectile dysfunction, rheumatoid arthritis, low vision(<6/18,>3/60).
IV	0.24-0.36	Amputated arm, below the knee amputation, deafness, congestive heart failure, drug dependence , Parkinson disease, tuberculosis,
V	0.36-0.50	Bipolar affective disorder, rectovaginal fistula, mild mental retardation, neurological sequelae of malaria.
VI	0.50-0.70	AIDS case not on antiretroviral drugs, Alzheimer and other dementias, blindness, paraplegia, down syndrome.
VII	0.70-1.00	Active psychosis (schizophrenia), severe depression, severs migraine, quadriplegia, and terminal stage cancer.

Concept of Age weighting and time discounting

The earlier burden of disease studies used the concept of age weighting and time discounting for calculating the disability adjusted life years. The thought behind using age weighting was that a person who was of a younger age or an age group that was more likely to contribute to the economic growth of a nation by being a productive factor was given more weight in comparison to a person who was old and was not as productive as the younger individual. The value of years of life in childhood and old age were not given high weights because of their limited social roles and contribution to the society.

The concept of time discounting on the other hand states that one should count future gains and losses lesser in comparison to gains and losses that an individual incurs in the current period. It goes on to explain that a year of healthy life is preferable to an individual today than at some other time in future. Time discounting is a common practice in economics and the earlier global burden of disease studies also practiced it. For carrying out DALY calculation using age weights and time discounting the standardized formula is given as follows;

Standard age weighting formula:

$Cxe^{-\beta x}$

Where x = concerned age

e= age weighting factor

And C and β are constants set to 0.1658 and 0.04 respectively.

Standard time discounting formula:

$e^{-r(x-a)}$

Where, x is the concerned age

a= age to which the burden will be assigned

r= the discount rate

e= discount factor

This idea however, was met with a lot of backlash by a number of academicians, one of the studies listed the following problems associated with age weighting and time discounting (*Richardson*, 1999);

- It states that in the case of age weighting there is high possibility of the problem of double counting to occur. The study also points out to the fact that the weights that are given to the different age groups have to be properly validated and there has to be sound logic behind assigning a particular weight to an age group. This appears to be the case with published age weights.

- Time discounting on the other hand take the ethical attitudes distribution of benefits among people therefore it also proves to be a debatable issue in the calculation of burden of diseases.

- The study also suggests that Discounting and age weights should not be used in the calculation of the Burden of Disease. The most useful concept of the Burden of Disease may not imply weighting for age, time or for other elements which may be relevant in an economic evaluation of social value.

The newer studies on burden of diseases calculate DALYs with and without age weighting and time discounting till the time a more comprehensive measure and strong framework is not available to calculate DALYs.

5.3 Types of Anemia for which DALYs are calculated

In our study we are taking into account two major types of anemia one is caused due to nutritional deficiency and the other one is caused due to genetic defect. The first category of anemia is Iron deficiency anemia and the second category is Hemoglobinopathies and hemolytic anemia. Iron deficiency is caused due to lack of adequate iron in the diet of people and it is one of the leading causes of disability among the Indian population. Hemoglobinopathies and hemolytic anemia on the other hand is caused due to inherited genes. This class of anemia comprises of sickle cell anemia, thalassemia and other blood abnormalities which cause anemia.

An attempt to compare the burden of a genetic disease with a nutritional deficiency disease is made in order to see the burden of a condition that is well within our hands to overcome as compared to the other that has limited number of options available in terms of avoiding the disease and its burden. Iron deficiency being a nutritional deficiency can be easily avoided and a person can live a happy and healthy life after getting rid of the problem.

5.4 Measuring health gaps using DALYs for anemia

DALYs for iron deficiency anemia and hemolytic anemia have been calculated first on the basis of different age groups and then on the basis of gender. There are negligible deaths reported in case of iron deficiency anemia and it is a disease that usually results in disability among people. Therefore the Years of life lost due to disability is equal to the DALYs that the person loses, for Hemoglobinopathies and hemolytic anemia we calculate DALY using the standard formula of YLL+YLD= DALYs.

5.4.1 Age stratified DALY computation

DALY for anemia caused due to deficiency of iron

The total number of iron deficiency anemia cases needed for computing the years of life lived with disability

Table 5.2: Number of Prevalent cases of Iron deficiency anemia among people of India of different age groups

Year/Age	Under 5	5-14 years	15-49 years	50-69 years	70+ years
2007	41384190.61	75845437.62	191505721.9	43671860.47	11131592.67
2008	42434418.83	75697122.16	194929088.4	44818092.98	11616806.68
2009	43290757.46	75289604.75	198107408.6	45995803.62	12075504.22
2010	43659642.67	74687269.51	201035131.1	47211729.83	12489650.14
2011	43668331.36	73946562.42	203643423.5	48390721.01	12852268.56
2012	43629700.08	73005876.3	205983250.2	49481351.37	13164534.22
2013	43406535.71	71780193.57	208211610.9	50460829.59	13447539.96
2014	42649586.66	70272922.82	210303021.5	51311301.31	13694046.79
2015	41145846.32	68682581.62	212065556	52019653.51	13905368.71
2016	38925679.35	67177722.11	213409400.5	52567168.37	14091876.2
2017	36076603.27	65778157.92	214370882.6	52962000.62	14310049.27

Source: IHME

The table 5.2 shows that there is improvement in the number of cases of anemia among people falling in the age group of under 5 and 5-14 years, the age groups 15- 49 years , 50-60 years and 70+ years show a sustained increase in the number of cases of iron deficiency anemia over the years.

Table 5.3: Disability weights according to severity of anemia

Categories of anemia	Disability weights	
	2004 report	2010 report
Mild	0.00	0.004
Moderate	0.011	0.052
Severe	0.09	0.149

Combined disability weight of anemia as per latest guidelines= 0.0683.

In case of iron deficiency anemia the number of deaths is negligible most of deaths that occur are due to heart failure or some other primary cause. Iron deficiency anemia is rarely listed as the primary cause of death. Therefore, the years of life lost due to premature death will not be present as death does not occur due to iron deficiency anemia. So, the years of life lost due to disability are equally to the disability adjusted life years.

YLD=DALY

Table 5.4: Disability adjusted life years for different age groups in India

Year/Age group	Under 5	5-14 years	15-49 years	50-69 years	70+years
2007	2826540	5180243	13079841	2982788	760288
2008	2898271	5170113	13313657	3061076	793428
2009	2956759	5142280	13530736	3141513	824757
2010	2981954	5101141	13730699	3224561	853043
2011	2982547	5050550	13908846	3305086	877810
2012	2979909	4986301	14068656	3379576	899138
2013	2964666	4902587	14220853	3446475	918467
2014	2912967	4799641	14363696	3504562	935303
2015	2810261	4691020	14484077	3552942	949737
2016	2658624	4588238	14575862	3590338	962475
2017	2464032	4492648	14641531	3617305	977376

Figure 5.1: DALYs lost due to Iron deficiency anemia by different age groups in India

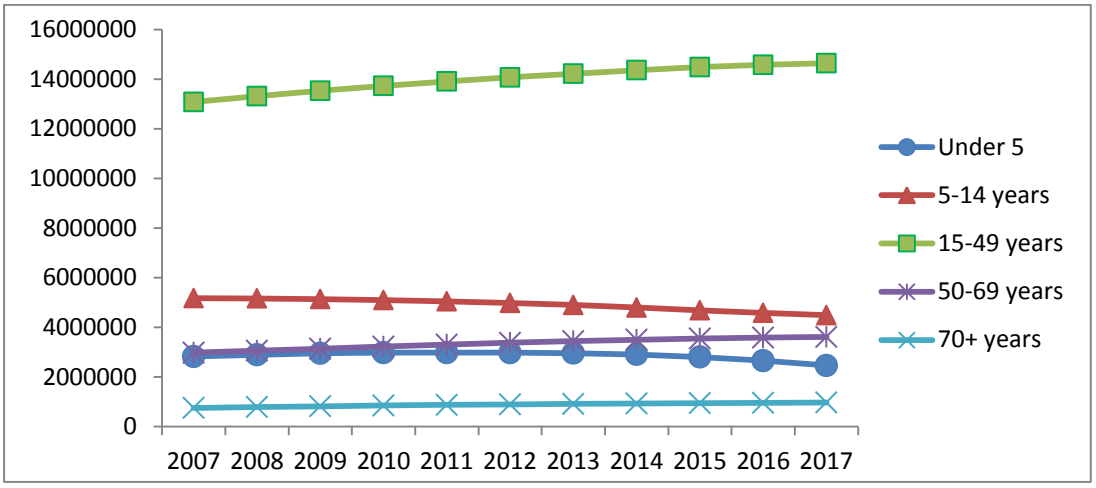


Figure 5.1 shows that the disability adjusted life years lost by the working age population in India is the maximum. The Under 5 years and 5-14 years population shows a declining trend which is a positive sign for future.

Hemoglobinopathies and Hemolytic Anemia

Hemoglobinopathies is a genetic defect that results in an abnormal structure of the hemoglobin molecule. These are inherited disorders and examples of these include sickle cell anemia, thalassemia and dyserythropoietic anemia. Hemolytic anemia on the other hand can be of two types intrinsic and extrinsic. Intrinsic is inherited and extrinsic is triggered by external stressors like toxins, medications etc. Our data includes number of cases of thalassemia, thalassemia traits, sickle cell anemia, and sickle cell anemia traits, G6DP deficiency and G6DP trait which are all inherited disorders that lead to anemia.

Death Due To Hemoglobinopathies and Hemolytic Anemia

Table 5.5: Deaths due to Hemoglobinopathies and hemolytic anemia among different age groups of India

Age groups/year	Under 5	5-14 years	15-49 years	50-69 years	70+ years
2008	1706	916	2742	684	184
2009	1637	899	2786	708	196
2010	1572	903	2816	736	206
2011	1559	876	2790	757	213
2012	1544	808	2630	787	222
2013	1516	772	2527	838	233
2014	1423	685	2447	880	242
2015	1368	563	2318	932	253
2016	1280	542	2357	975	262
2017	1184	531	2359	996	269

Source: IHME

The data of table 5.5 shows that there has been a decline in the number of deaths due to Hemoglobinopathies and hemolytic anemia for age groups 15- 49 years, 5-14 years and under 5 years. This could be because of improvement in medical facilities and better handling of genetic disorders related to anemia.

LIFE EXPECTANCY TABLE

Table 5.6: Standard life expectancy table for the Indian population cohort

Age Group	Life expectancy
Under 5	69.65
5-14 years	64.75
15-49 years	49.51
50-69 years	20.075
70+ years	7.85

SRS bulletin, 2012-2016

The standard life expectancy of the Indian population is calculated and published by the Sample Registration System (SRS). We used the standard life expectancy given by Sample Registration System for calculating the years of life lost due to premature death.

Years of Life Lost Due To Premature Death

Table 5.7: Years of life lost due to premature death

Year	Under 5	5-14 years	15-49 years	50-69 years	70+ years
2008	118800	59335	135762	13741	1444
2009	114034	58221	137933	14205	1535
2010	109468	58466	139430	14776	1619
2011	108611	56691	138156	15206	1668
2012	107559	52311	130209	15806	1746
2013	105590	49993	125122	16820	1831
2014	99104	44356	121150	17661	1904
2015	95309	36478	114756	18717	1985
2016	89144	35077	116702	19563	2060
2017	82496	34351	116786	20004	2110

The data of table 5.7 shows that years of life lost due to death have reduced for age groups under 5 years, 5-14 years and 15-49 years because the cases of death for these age groups fell down therefore the years of life lost due to premature death also reduced.

Calculating Years of Life Lived With Disability (YLD)

Number of Cases of Hemoglobinopathies and Hemolytic Anemia

Table 5.8: Number of cases of hemoglobinopathies and hemolytic anemia

Year	Under 5	5-14 years	15-49 years	50-69 years	70+ years
2008	46150236	91934838	220590214	48651910	13057555
2009	46192685	92566576	225028211	50325958	13634971
2010	46330282	93002578	229301825	52053611	14188537
2011	46650380	93333514	233415733	53813546	14718113
2012	47195377	93597807	237517900	55641876	15233672
2013	47791544	93657354	241749916	57515292	15758994
2014	48015777	93496538	246100438	59409350	16282803
2015	47689968	93353063	250345214	61301458	16800444
2016	46877473	93465972	254384055	63197483	17323367
2017	45594920	93851705	258232146	65061219	17930283

Source: IHME

The data of table 5.8 shows that the total number of cases of hemoglobinopathies and hemolytic anemia among different age groups. The age group that has witnessed a drop in the number of cases of hemoglobinopathies and hemolytic anemia is under 5 years; all other age groups have an increase in the number of cases of anemia.

Table 5.9: Disability weights

Categories of anemia	Disability weights	
	2004 report	2010 report
Mild	0.00	0.004
Moderate	0.011	0.052
Severe	0.09	0.149

Combined disability weight of anemia as per latest guidelines (2013) = 0.0683

Years of Life Lived With Disability (YLD)

Years of life lived with disability is the second component of disability adjusted life years and it measure the number of years of life lived without being in proper health or living with disability which stands for not being able to perform simple tasks without discomfort .

Table 5.10: Years of life lived with disability (YLD)

Year/Age group	Under 5	5-14 years	15-49 years	50-69 years	70+ years
2008	46150236	6279149	15066312	3322925	891831
2009	46192685	6322297	15369427	3437263	931269
2010	46330282	6352076	15661315	3555262	969077
2011	46650380	6374679	15942295	3675465	1005247
2012	47195377	6392730	16222473	3800340	1040460
2013	47791544	6396797	16511519	3928294	1076339
2014	48015777	6385814	16808660	4057659	1112115
2015	47689968	6376014	17098578	4186890	1147470
2016	46877473	6383726	17374431	4316388	1183186
2017	45594920	6410071	17637256	4443681	1224638

The data of table 5.10 shows that under five age group shows a decline in the number of years of life lived with disability which means that less number of cases of anemia among the

younger children is being reported. All other age groups have a steady increase in the years of life lived with disability due to hemoglobinopathies and hemolytic anemia.

Disability Adjusted Life Years

Table 5.11: Disability adjusted life years lost due to hemoglobinopathies and hemolytic anemia.

Year/Age groups	Under 5	5-14 years	15-49 years	50-69 years	70+ years
2008	3270861	6338484	15202074	3336667	893275
2009	3268995	6380518	15507359	3451468	932804
2010	3273826	6410542	15800745	3570037	970696
2011	3294832	6431371	16080451	3690671	1006915
2012	3331003	6445042	16352682	3816146	1042206
2013	3369753	6446791	16636641	3945114	1078170
2014	3378582	6430169	16929810	4075319	1114019
2015	3352534	6412492	17213334	4205606	1149455
2016	3290875	6418803	17491133	4335951	1185246
2017	3196629	6444423	17754042	4463685	1226748

The data of table 5.11 shows that the disability adjusted life years for the age group have declined over the course of ten years but for the rest of the age group DALY has increased continuously. The working age population that is 15-49 years has the maximum DALY. This shows that we do not have a very healthy workforce.

Burden Due To Iron Deficiency Anemia

Table: 5.12: Burden of iron deficiency anemia

Year	DALY	GDP Per capita(constant $)	Burden due to Iron Deficiency Anemia
2008	25236544	1196	30183436154
2009	25596045.07	1272	32554557396
2010	25891397	1361	35243462060
2011	26124839.26	1414	36937335355
2012	26313579.84	1472	38742479841
2013	26453048.27	1547	40932875040
2014	26516169.04	1642	43549959378
2015	26488038.12	1753	46437085353
2016	26375537.12	1875	49446410330
2017	26192892.48	1987	52033948677

The data of table 5.12 shows the burden that is attributable to iron deficiency anemia. The GDP per capita is in US $ at constant prices. The figures have been increasing continuously for all the years and it goes on to show that the population suffering from iron deficiency is continuously increasing. Even after running so many schemes the government of India is finding it difficult to wipe out iron deficiency which is one of the leading cases of anemia among people not only in India but also the world.

Figure5.2: Economic Burden of Iron Deficiency Anemia

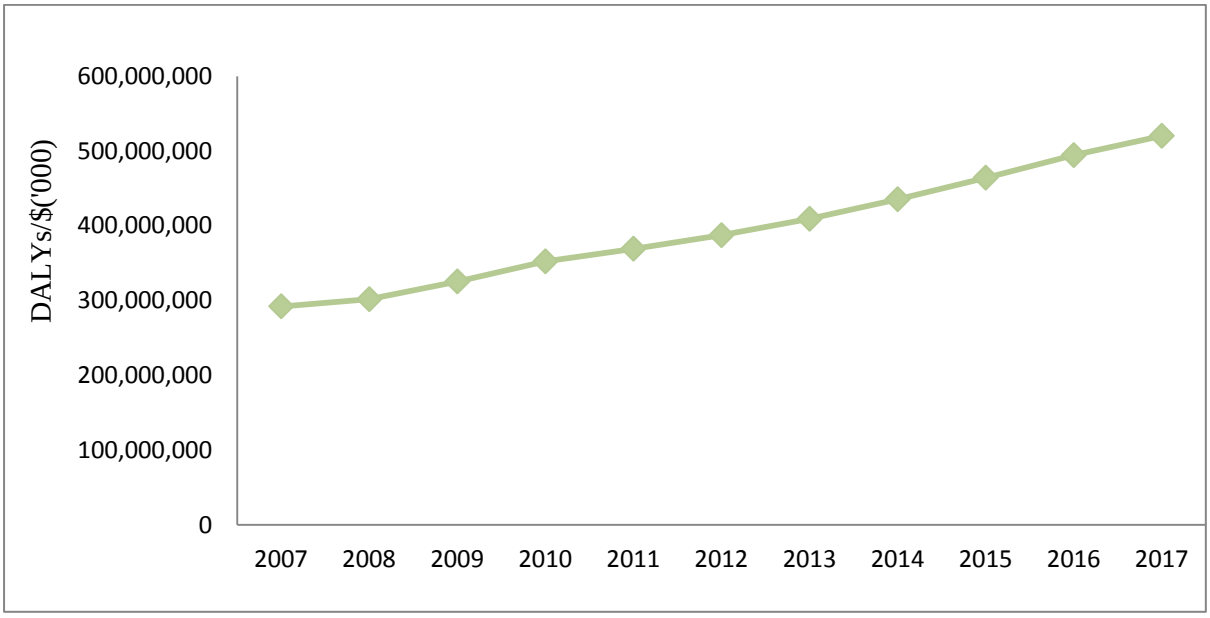


Figure 5.2 shows that the burden from Iron deficiency anemia is continuously increasing. It showed a decline in the year 2012 attributable to the effects of global financial crisis that resulted in reduction in the per capita GDP thereby resulting in a decline in the burden of iron deficiency anemia.

Burden Due To Hemoglobinopathies and Hemolytic Anemia

Table 5.13: Burden of hemoglobinopathies and hemolytic anemia

Year	DALY	GDP Per capita(constant $)	Burden due to Hemoglobinopathies and hemolytic Anemia
2008	28924266	1196	34594029228
2009	29428746	1272	37429212200
2010	29917951	1361	40724421420
2011	30397189	1414	42977916022
2012	30881064	1472	45467359287
2013	31372394	1547	48544965040
2014	31830218	1642	52277713503
2015	32239480	1753	56520135192
2016	32634144	1875	61179466383
2017	33004215	1987	65565100896

The data of table 5.13 shows the burden of anemia due to hemoglobinopathies and hemolytic anemia. The burden is continuously increasing and is even more than iron deficiency anemia. Hemoglobinopathies are inherited disorders that can be cured with medical advancements and improvement in health care facilities whereas iron deficiency on the other hand is a nutritional deficiency that can only be improved if adequate amount of iron is taken by every person in their diet the two problems are very different in terms of origin but contribute to burden in almost equal measures. Iron deficiency does not lead to any years of life lost due to premature death in that situation if we compare the years of life lived with disability iron

deficiency causes a lot of disability among people. Even though it is not greater than the YLD of hemoglobinopathies and hemolytic anemia it is quite a lot.

Comparison between the burden due to iron deficiency anemia and hemoglobinopathies and hemolytic anemia

Figure5.3: Comparison between the burden of iron deficiency anemia and hemoglobinopathies and hemolytic anemia

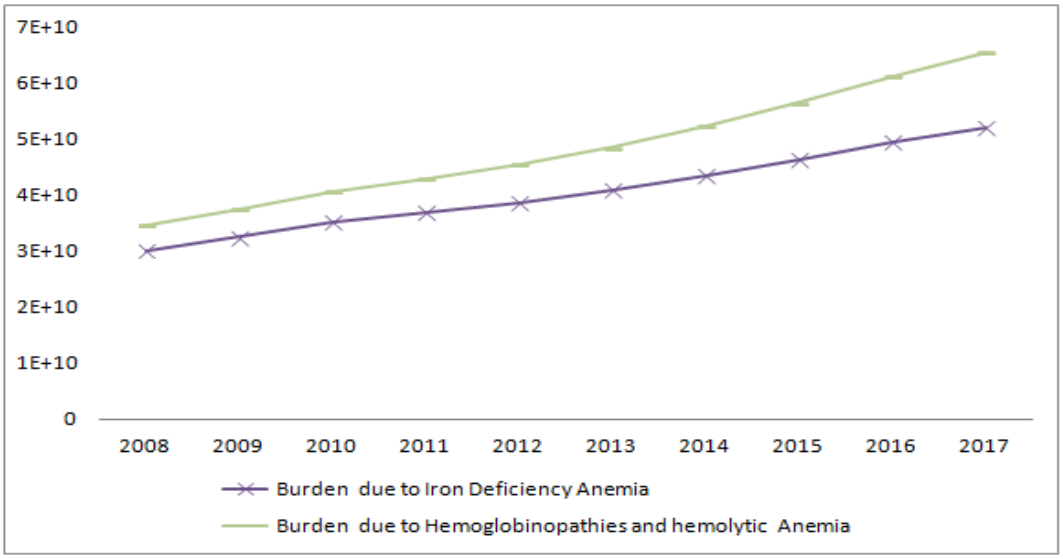


Figure 5.3 shows a comparison between the burden of iron deficiency anemia and hemoglobinopathies and hemolytic anemia. One is a nutritional deficiency while the other is a hereditary condition .Iron deficiency anemia causes a lot of disability among people which is evident from the graph.

5.4.2 Gender Wise DALY Calculation

It is important to calculate disability adjusted life years in terms of gender because it tells us which gender is most affected by anemia and what the extent of it is. It helps us in devising targeted policies so that the problem can be resolved. for instance if women are more affected by anemia and the disability adjusted life years lost are high for them we can see the reason for the rising numbers and make policies that cater to specific problems which will result in finding an appropriate solution to the challenges related to anemia.

Iron Deficiency Anemia - Women

Table 5.14: Disability adjusted life yeas lost by females of all age groups due to iron deficiency anemia

Year	Women all ages	5-14 years	15-49 years	50-69 years	70+ years
2008	15075926	2678296	8825177	1854778	498687
2009	15318600	2675999	8977458	1909714	520034
2010	15529379	2664177	9119130	1965334	539339
2011	15708180	2645907	9247221	2019112	555952
2012	15864547	2622074	9363557	2070642	569891
2013	15997260	2588973	9474164	2118332	582010
2014	16093621	2546321	9577728	2160636	591487
2015	16145196	2501697	9666591	2196645	598482
2016	16154721	2461217	9737353	2225717	604213
2017	16130170	2425206	9792004	2248201	611336

The data of table 5.14 shows that the disability adjusted life years lost by women in the age group 5-14 years have reduced, probably because of programmes launched by the government of India that focused on the nutrition given to children in the initial years. Rest of the age groups have shown an increase in the disability adjusted life years lost due to iron deficiency anemia among women in the last ten years.

Figure 5.4: DALYs lost by men due to iron deficiency anemia in different age groups

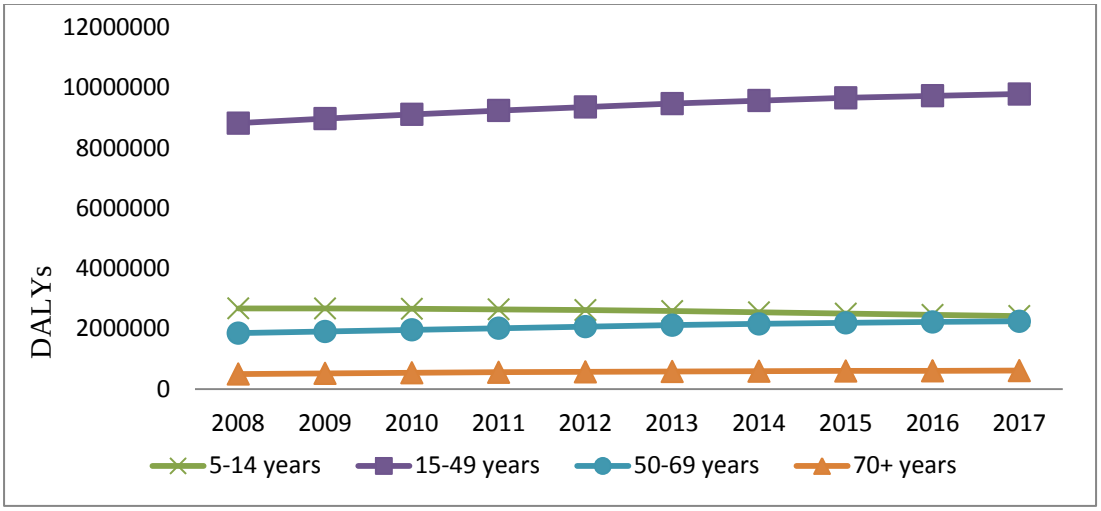


Figure 5.4 shows that the DALY lost by women due to iron deficiency anemia is highest in the working age population that is 15-49 years. A slight decline in witnessed in the age group of 5-14 years.

Iron Deficiency Anemia –Men

Table 5.15: Disability adjusted life yeas lost by men of all age groups due to iron deficiency anemia

Year	Men all ages	5-14 years	15-49 years	50-69 years	70+ years
2008	10160619	2491817	4488479	1206297	294740
2009	10277445	2466280	4553277	1231799	304722
2010	10362019	2436963	4611569	1259227	313704
2011	10416660	2404643	4661625	1285974	321857
2012	10449033	2364227	4705099	1308934	329247
2013	10455788	2313614	4746689	1328143	336457
2014	10422548	2253319	4785969	1343926	343816
2015	10342842	2189324	4817486	1356297	351254
2016	10220816	2127021	4838509	1364621	358261
2017	10062723	2067442	4849527	1369104	366039

The data of table 5.15 shows that the disability adjusted life years lost by men in the age group 5-14 years have reduced. Overall men of all ages have shown a decrease in the disability adjusted life years lost, probably because of programmes launched by the government of India that focused on the nutrition given to children in the initial years. Rest of the age groups have shown an increase in the disability adjusted life years lost due to iron deficiency anemia among men in the last ten years.

Figure 5.5: The DALYs lost by men due to iron deficiency anemia in different age groups

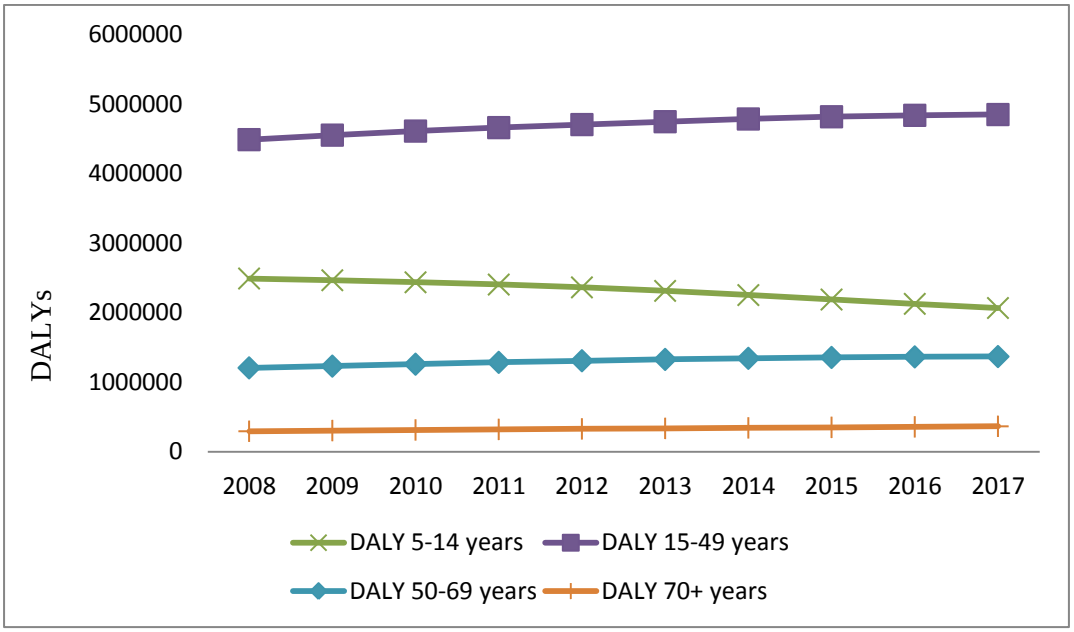


Figure5.5 shows that the DALY lost by the age group of 5-14 years old men is declining and for men in the age group 70+ years it is more or less the same. The maximum burden is on the working age group that is 15-49 years.

Comparison of DALYs lost due to iron deficiency anemia between men and women

Figure 5.6: Comparison of DALYs lost due to iron deficiency anemia between men and women

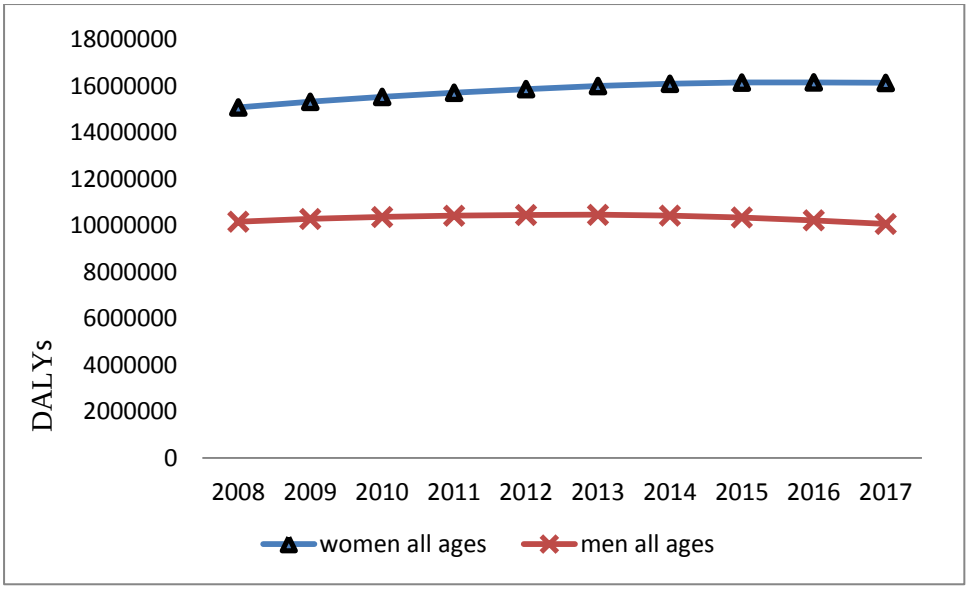
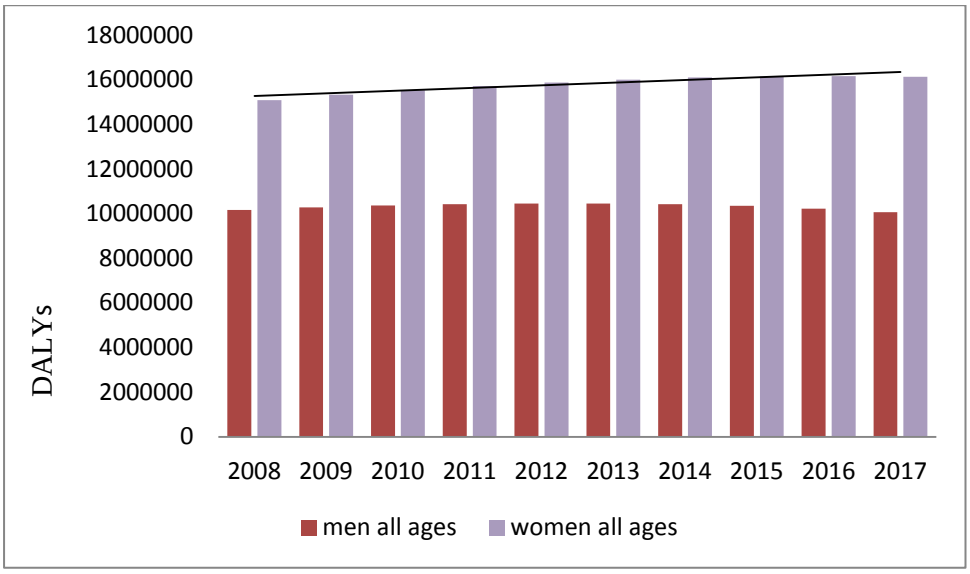


Figure 5.6 shows the difference in the disability adjusted life years lost by men and women. It is evident that women face more of the burden as compared to men in terms of iron deficiency anemia. This is problematic because anemic women usually delivery anemic children also. Therefore, a woman being anemic is more of a problem than a man being anemic.

Figure 5.7: Comparison of DALYs lost due to iron deficiency anemia between men and women



Hemoglobinopathies and Hemolytic Anemia

Hemoglobinopathies and Hemolytic Anemia – Women

Tables 5.16: Disability adjusted life yeas lost by women of all age groups due to hemolytic anemia

DALY	All ages	5-14 Years	15-49 Years	50-69Years	70+Years
2008	18412458	3954519	9616791	2140474	603317
2009	18772855	3989435	10323761	2219425	633349
2010	19108543	4013205	10026016	2299649	661505
2011	19423986	4027994	10206132	2380621	687607
2012	19741481	4038561	10381803	2465850	712833
2013	20065412	4040655	10565197	2554344	738140
2014	20366053	4031836	10754086	2643586	762482
2015	20635781	4023271	10936099	2732508	785631
2016	20892192	4027675	11113161	2821063	808772
2017	21131940	4043746	11280964	2907992	835636

The data of table 5.16 shows that the disability adjusted life years lost by women due to hemoglobinopathies and hemolytic anemia in all the age groups have increased leading to an increase in the burden of disease.

Figure 5.8: The disability adjusted life yeas lost by women in different age groups due to hemoglobinopathies and hemolytic anemia.

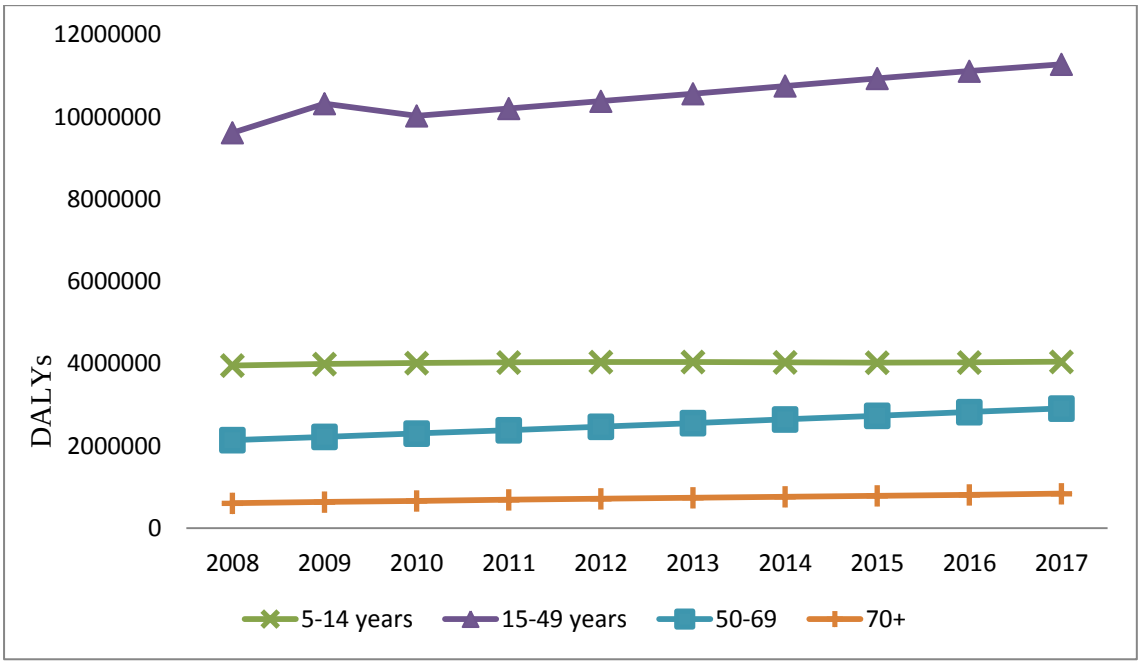


Figure 5.8 depicts that the age group that has the maximum burden is also the age group that contributes maximum to the gross domestic product of the nation. The burden of 5-14 years has shown a very slight decline where as the DALY lost by the age group of 50-69 years is showing an increasing trend, it shows that the elder females are reporting higher DALYs as compared to younger women.

Hemoglobinopathies and Hemolytic Anemia–Men

Table 5.17: Disability adjusted life yeas lost by men of all age groups due to hemolytic anemia

DALY	All age men	5-14 years	15-49 years	50-69years	70+years
2008	10723846	2383726	5569919	1196124	289946
2009	10865895	2390844	5662212	1231981	299444
2010	11017692	2397117	5758980	1270335	309182
2011	11181517	2403163	5858743	1309997	319299
2012	11345659	2406286	5956173	1350240	329362
2013	11512240	2405935	6057357	1390729	340020
2014	11664089	2398162	6162153	1431717	351528
2015	11800431	2389113	6264411	1473107	363816
2016	11935977	2391021	6364921	1514899	376465
2017	12061321	2400566	6460014	1555707	391103

The data of table 5.17 shows that the disability adjusted life yeas lost by men in the age group of 5-14 years has decreased in the year 2014 but again went up in the year 2017. All the other age groups have shown an increase in the DALYs lost due to hemoglobinopathies among men in India.

Figure 5.9: The disability adjusted life yeas lost by men in different age groups due to hemoglobinopathies and hemolytic anemia.

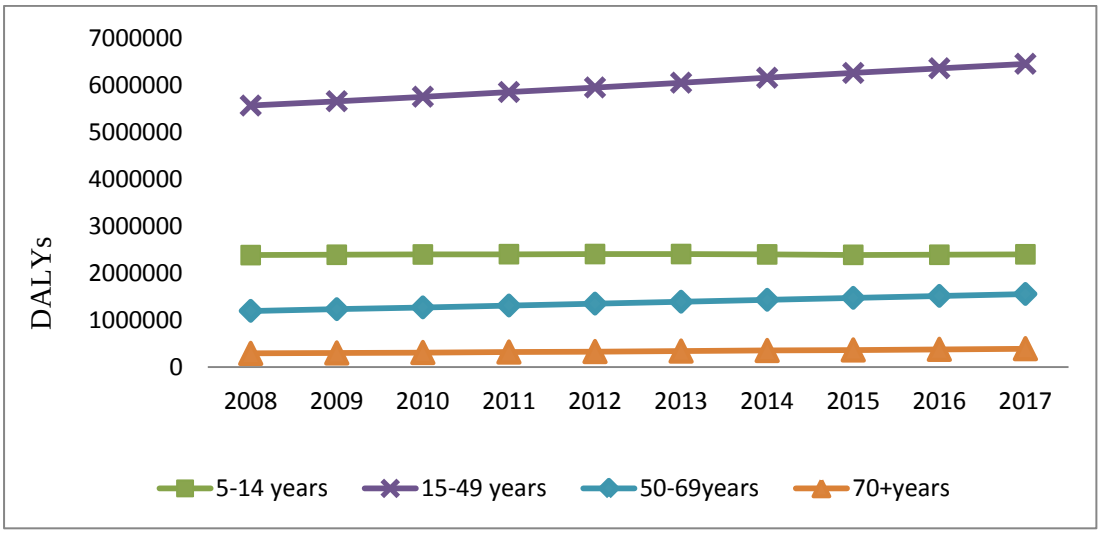


Figure 5.10: Comparison between DALYs lost due to hemolytic and hemoglobinopathies anemia among men and women

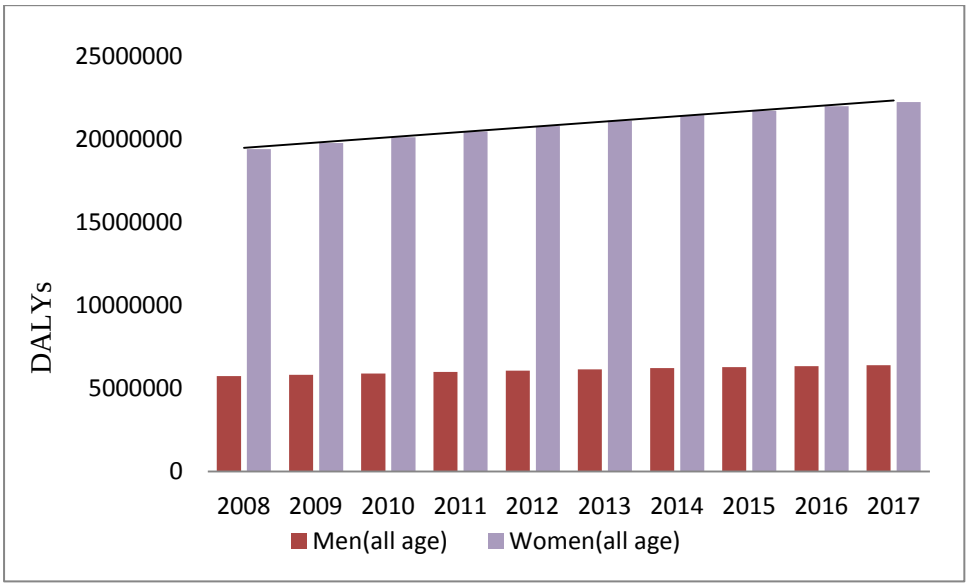


Figure 5.10 shows a comparison of DALY between men and women shows that there is the steady increase in the disability adjusted life years lost by women as compared to men who have witnessed a very slight rise in the Disability adjusted life years.

5.5 Conclusions

The analysis shows a few major things that we should give special attention to and focus on. The disability adjusted life years lost due to iron deficiency anemia for different age groups shows that the total DALYs lost for both men and women was 26192.89 per 1000 in the year 2017. The DALYs lost for hemolytic anemia by different age groups in the year 2017 was 34915.39 DALYs. Iron deficiency anemia falls in the category of nutritional deficiency diseases. Iron deficiency anemia resulted in 1.95 percent loss in the gross domestic product due to lost Disability adjusted life years in the year 2017 and hemoglobinopathies and hemolytic anemia resulted in a loss of 2.26 percent of the total GDP in 2017. In 2007 the loss in GDP was higher for iron deficiency anemia it was around 2.10 percent of the total GDP. The burden may not seem to be huge in terms of percentage of GDP but in absolute numbers it is quite high considering the population of India. Even though iron deficiency anemia is not a fatal disease it does result in approximately 20 percent of the total maternal mortality cases

and 50 percent of associated causes of maternal deaths. Anemia is also a risk factor for ischemic heart disease which results in 7.71 percent of the total DALYs lost in India.

When we calculate DALYs according to the gender it is clear that women have a higher DALY count as compared to men and they lose out on healthy life years more than men. As women are child bearers they should be doubly careful about their nutrition and health because bad health of women results in bad health of the next generation. Our focus should be on tackling the problem of iron deficiency anemia since it is a nutritional deficiency and requires lesser amount of effort and investment as compared to hemoglobinopathies or hemolytic anemia which are inherited diseases and difficult to treat. Iron deficiency anemia has a huge burden o the nation in terms of unhealthy and low productive labour which can be changed by little efforts on the part of government as well as people, people have to be sensitized about the consequences of small problems like anemia that result in lower productivity and ill health. People have be aware of their well being and take adequate measures to lead a healthy life because in the end if people do not make use of all the policies and methods that are devised to benefit them they are on no use.

Chapter VI

Conclusions and Policy Suggestions

This chapter brings out the conclusions that are drawn from the analysis using the National Family Health Survey-4 Data and the data from Institute of Health Metrics And Evaluation and lists some policy suggestions for dealing with the problem of anemia.

6.1 Conclusions and Policy Suggestions

Health of a country's population and people is a very important determinant of the productivity and growth of that nation. India has come a long way in terms of improving health care facilities and providing drugs to people. The health indicators like infant mortality and life expectancy have improved considerably but still there are a lot of problems that our country faces when we discuss the issue of health and health care. There is still lack of cost effective treatment options for people. Also there is high out of pocket expenditure 80.5 percent (approx) on health care in India, there is not enough insurance coverage among the Indian nationals (84.9 percent uninsured people in India) and likewise there are many issues in the healthcare sector.

Good health is closely related to the lifestyle and diet of the people. Without taking adequate food and a nutritious diet a person cannot remain healthy. If the person is not healthy then the productivity of that individual will go down. India currently stands at the 103rd position out of 119 countries in the Global hunger index which is calculated by taking into account four aspects: undernourishment, stunting, child mortality and child wasting. According to the Global nutrition report India does not fare well in terms of its health status. India is 170th among 180 countries in terms of anaemia among women, 114th among 132countries for stunting in children under five and 120th among 130 countries for wasting in children under five. Lack of nutrition also leads to development of anemia which is a nutritional deficiency of iron that results in lack of adequate oxygen in the body for proper functioning of the organs and the organ system.

Anemia is not only rampant among children in India it is also prevalent among women and men. Even though the population of men affected is not huge it still leads to lowering of productivity and the quality of work performed. The government of India under the National Iron plus initiative has allocated funds for tackling the problem of anemia among various sates as per the report by the Ministry Of Health And Family Welfare, Department Of Health And Family Welfare the amount allocated was 91950.29 lakhs for the years 2017-18, 22808.79 lakhs for the year 2016-17, 19411.12 lakhs for the year 2015-16 and 134170.20 lakhs for the year 2015-14. In spite of various initiatives by the Indian governments like the mid day meal scheme, National Rural Health Mission (NRHM), the situation has not improved much. There are other factors apart from just nutrition that play an important role in determining the health status of an individual. Socio economic factors also determine a person's health status; though these factors do not contribute directly to the health status of an individual they have an indirect effect on a person's health and anemia status.

The first objective of this research was to determine the socio economic factors that lead to the prevalence of anemia among children, women and men. The second objective was to determine the burden of anemia in India among men and women and among different age groups.

The major factors that determine the status of anemia among children are age, place of residence, education status of the mother of the child , BMI, wealth index and food intake , for women the factors are age, place of residence, educational status of the respondent, wealth index, current pregnancy, total number of living children, taking iron and pills and syrups, BMI and drugs for intestinal parasites and for men are place of residence, educational status of the man, BMI, Wealth index and for men the factors are food intake, because it is not only children and women that are affected but also men. An attempt has been made to compute and compare the burden of iron deficiency anemia which is a nutritional deficiency and hemoglobinopathies and hemolytic anemia which is a hereditary disease.

The various studies carried out in different areas of the world on anemia, maternal and child health show that not only is food an important determinant of anemia prevalence among

children, women and men but there are other socio economic factors like residential areas, wealth index, educational attainment that also play a crucial role in determining the prevalence of anemia among people. Studies also showed that anemia could lead to significant decline in the productivity of an individual.

The Data used in the research is taken from the National Family Health Survey -4 (2015-16), the Institute of Health Metrics and Evaluation(IHME), Sample registration system (2012-16), the Medical Certification of Cause Death report (2015) and the data on the per capita GDP of India was taken from the World Bank. A chi square test was applied to find out the relationship between anemia status of an individual and various independent variables. Then a proportions z test was applied to determine if the difference between the proportions of anemia across various categories of each independent variable is significant or not.

At present around 58 percent children, 53 percent women and 24 percent men suffering from anemia in India. It is evident from our study that there are many socio economic along with food intake that affects the prevalence of anemia among individuals.

The analysis for children, women and men was done separately the factors that explained anemia prevalence among children were age, type of residence, mother's education, BMI, wealth index and food intake. Children falling in the age group 0.5 years to 2.5 years are more likely to be anemic in comparison to children falling in the age group of 2.5 years to 5 years. The place where a child was living also influenced the prevalence of anemia among them children living in rural areas where more anemic in comparison to children living in urban areas. The body mass index was also an important determinant of anemia prevalence children falling in the category of BMI less than 18.5 which means children who were underweight were more anemic as compared to children who had BMI more than 18.5. Food intake also influenced the hemoglobin level among children green leafy vegetables, meat, chicken, lentils, peas, nuts beans, cheese, yogurt, and other milk products were food items

that were proved significant in determining the status of anemia among children. Mother's anemia level also proved to be significant if mother was anemic then there was a higher possibility of the child being anemic, mother's level of education was also a determinant of anemia prevalence among children mother's who had no education had a higher proportion of children who were anemic. And lastly wealth index was a significant determinant of anemia among children. Children of poorer households were more likely to be anemic.

The government should focus on providing good nutritious food to young children they should also make sure that education of women is not ignored because an educated mother stands a better chance of taking good care of her child. Better access to health care facilities in rural areas will help people in handling nutritional deficiencies like anemia faster.

The factors that proved significant for the determining the prevalence of anemia among women were age, type of residence, educational attainment, wealth index, current pregnancy, total number of living children, taking iron and pills and syrups, BMI and drugs for intestinal parasites.

Women falling in the age group of below 35 years were more prone to being anemic because most of the women go through pregnancies and menstruation during those years. Women living in rural areas were more likely to be anemic as compared to women living in urban areas because of lack of good living conditions and proper diet. Wealth index also proved to be a significant determinant of anemia among women. Poorer household had more anemic women and richer households had lesser proportion of women with anemia. Women with body mass index less than 18.5 were more anemic. Women who were taking iron and folic tablets during pregnancy were less likely to be anemic. Pregnant women usually take good care of their diet and women with less number of children ever born to them are less prone to being anemic child birth leads to a lot of blood loss for women. Women who received higher educational attainment were less prone to being anemic as compared to women who are not educated. Women who took drugs for intestinal parasites during pregnancy were less likely to be anemic as compared to women who did not take drugs for intestinal parasite.

Government should focus on education of women. They should also cater to the needs of pregnant women so that they do not become anemic just after giving birth. Proper distribution of iron tablets and nutritious food should be carried out.

The variables that proved significant for determining the prevalence of anemia among men were first the type of residence, educational attainment, BMI, Wealth index and food intake

A higher proportion of men living in rural areas were anemic. Men with a body mass index of less than 18.5 were more anemic. Men belonging to poorer households measured using the wealth indexes were more anemic. Men who were employed all year round were less likely to be anemic probably because they could maintain their standard of living and follow a proper nutrient rich diet. Educational attainment of men also proved to be significant men who had attained higher education were less likely to be anemic. The last determinant of anemia for men was food intake. Men who ate green leafy vegetables were less likely to be anemic. It was observed that in all in all the rural population was more prone to being anemic than the urban. Men and women who have received proper education were less likely to be anemic. Wealth index which is a determinant of a standard of living of a person showed that people belonging to poor households were more likely to be anemic and people with a low body mass index were also anemic.

The burden of anemia was computed using a health gap measure known as disability adjusted life years. A nutritional deficiency and a hereditary disease both of which lead to anemia were taken to see the burden of anemia on the gdp of India. The problem of Iron deficiency anemia that can be easily mitigated with the help of proper nutritious diet has a considerable amount of burden. Hemolytic anemia on the other hand is a hereditary disease therefore it would require more investment as compared to iron deficiency anemia for reducing the prevalence among the Indian population. The burden of iron deficiency, hemoglobinopathies and hemolytic anemia is huge many people falling in the working age group which is 15-49 years of age are victims of anemia and have to bear the burden of being anemic. The people suffering from these conditions are not as efficient as they could have been if they were free from anemia therefore the government should focus their policies on the younger age groups

and the working age groups for better productive human capital. The disability adjusted life years lost due to iron deficiency anemia for different age groups shows that the total DALYs

lost for both men and women was 26192.89 per 1000 in the year 2017. The DALYs lost for hemolytic anemia by different age groups in the year 2017 was 34915.39 DALYs.

Nutritional deficiencies make up for 3.23 percent of the total share of 43.94 percent of non communicable diseases share in DALYs. Share of disease burden from non communicable disease in the 2017 was 55.96 percent .Iron deficiency anemia falls in the category of nutritional deficiency diseases. Iron deficiency anemia resulted in 1.95 percent loss in the gross domestic product due to lost Disability adjusted life years in the year 2017 and hemoglobinopathies and hemolytic anemia resulted in a loss of 2.26 percent of the total GDP in 2017. In 2007 the loss in GDP was higher for iron deficiency anemia it was around 2.10 percent of the total GDP. The burden may not seem to be huge in terms of percentage of GDP but in absolute numbers it is quite high considering the population of India. Even though iron deficiency anemia is not a fatal disease it does result in approximately 20 percent of the total maternal mortality cases and 50 percent of associated causes of maternal deaths. Anemia is also a risk factor for ischemic heart disease which results in 7.71 percent of DALYs lost in India.

The funds allocated by the government for the iron plus initiative have reduced considerably but the fall in the percentage of anemia among women has not been that high. Anemia has reduced among children but non pregnant women that form the highest population of affected people from anemia 14.67 crore is still quite a lot. More focus should be given to states where anemia is rampant among people like Bihar and Chhattisgarh and proper allocation of funds should be done to deal with the problem of anemia and hidden hunger in an effective way.

We can expedite the process of bio fortified crops so that they reach the people as soon as possible that would be an effective way of dealing with malnutrition and iron deficiency. It is also important to raise awareness about the consequences of anemia which people often ignore. It is important for people to take good care of their health and go for regular checkups.

Ultimately even if government takes initiative to mitigate the problem but the people are not ready to comply the results are not going to be positive. We can also learn from success

stories of other countries where anemia was tackled by using their local belief system by a Canadian scientist named Christopher Charles who started the “lucky iron fish project” in Cambodia to fight the problem of anemia. It is just a question of taking the initiative of making India a “hidden hunger” free nation and working sincerely towards achieving that goal.

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