Selected Micronutrient Status of Ethnic People in Chittagong Hill Tracts

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Dedication

Every challenging work needs self efforts as well as guidance of elders specially those who are very close to our heart.

My humble effort I dedicate this thesis to my supportive, invariably encouraging and unconditionally loving

Parents
Specially my
Father
Whose affection, love, encouragement and prayers make me able to complete my tasks

Date 21th January, 2016

Certificate

This is to certify that the thesis entitled “Selected Micronutrient Status of Ethnic People in Chittagong Hill Tracts” has been completed sincerely and satisfactorily by Sadia Sartaz, registration no 031, session 2010-2011, enrolled in University of Dhaka, Dhaka-1000, Bangladesh, for the degree of Master of Philosophy (MPhil) in Nutrition and Food Science, is an original record and was supervised by me and can be submitted to the examination committee for evaluation.

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Abstract

This study investigated serum vitamin A and E, copper, zinc, iron, serum ferritin and haemoglobin levels of ethnic people living in Chittagong Hill Tracts (CHTs). It also addressed their sociodemographic condition, dietary practice, nutrition knowledge and morbidity.

It is a cross sectional study conducted among the ethnic people of Bandorban, Rangamati and Khagrachori. Blood samples were collected from 171 female of reproductive age from 156 households.

Vitamin A and E were analyzed by HPLC. Atomic Absorption Spectrophotometryr was used to analyze serum Zn, Cu, and Fe concentrations. Serum Ferritin level was estimated by Pathozyme Ferritin kits. Cyanmethemoglobin method was employed to measure the blood haemoglobin level. IBM SPSS 21 software package was used for statistical analysis.

The study population was classed into *Lactating* and *Non pregnant non lactating woman* (NPNL). In lactating women, serum vitamin A and E, Zn, Cu and Fe concentrations were 1.3±0.5µmol/L, 5±3.5 µmol/L, 26.2±6.2µmol/L, 19.8±6.2µmol/L and 22.48±8.7 µmol/L respectively, while in NPNL women, concentrations of these micronutrients were 1.6±0.5µmol/L, 6 ±3.4 µmol/L, 25.6±6.3µmol/L, 20.98±7.02µmol/L and 21.5±9.09 µmol/L respectively. With exception of vitamin A, E and Cu, the values for Zn and Fe were apparently observed a little higher in the lactating mother than the NPNL women, the difference was insignificant (p= 0.1- 0.4). Expect vitamin A, the difference was significant (p=0.00). Concentrations of serum ferrtin and haemoglobin in lactating women were 35.5±29.4 µg/L and 9±2.5 g/dl; in NPNL women were 42.4±37.51 µg/L and 8.5 ± 2.3 g/dl respectively. Though these have apparent difference but it was not significant (p = 0.06-0.08).

The micronutrients and biochemical indices were also evaluated by their reference cutoff values. In female, cutoff points for serum vitamin A & E, Zn, Cu and Fe are 0.7µmol/L, 12 µmol/L, 10.1µmol/L, 11µmol/L and 11µmol/L respectively, and for serum ferritin and blood hemoglobin are 15µg/L and 12 g/dl respectively. It was noted that majority of the lactating and NPNL women have the micronutrients and ferritin levels at or above the reference cutoff point, but the hemoglobin and vitamin E was found below the reference cutoff point. Dietary intake of vitamin A, Zn and Cu content were observed to be equivalent or nearer to the RDA, but iron and vitamin E intake was less than the RDA. It was found that dietary intake of micronutrients, except iron have positive association with the serum micronutrient values. Inadequate dietary intakes of vitamin E negatively influenced serum vitamin E concentrations.

In sociodemographic assessment, it was observed that majority of ethnic people were literate (~70%), mostly involved in household chores (78%) and few were in agriculture and job (8%), have good income (~ tk. 19000), household food security (~86%), nutrition knowledge (~83%), and drink water mostly (81%) from tube well. It was further seen that the study population have good lifestyle with better micronutrients and ferritin levels. The ethnic people have much better zinc and vitamin A status as compared to the national micronutrient status.

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ACRONYMS

CHTs	Chittagong Hill Tracts
NGO	Non Government Organization
BRAC	Bangladesh Rural Advancement Committee
BNPS	Bangladesh Nari Progati Sangha
ALRD	Association for Land Reform and Development
BELA	Bangladesh Environmental Lawyers Association
SEHD	Society for Environment and Human Development
IDF	Integrated Development Foundation
IPAF	Indigenous Peoples Assistance Facility
CIPRAD	Centre for Indigenous Peoples Research and Development
CAF	Community Advancement Forum
EED	Evangelischer Entwicklungsdienst
IWGIA	International Work Group for Indigenous
UNDP	United Nations Development Programme (UNDP),
UNICEF	United Nations Children's Fund
FAO	Food and Agriculture Organization of the United Nations (FAO)
ADB	Asian Development Bank
UN	United Nations
EU	European Union
DANIDA	Danish International Development Agency
JBIC	Japan Bank for International Cooperation
WHO	World Health Organization
UNESCO	United Nations Educational, Scientific and Cultural Organization
NORAD	Norwegian Agency for Development Cooperation
SIDA	Swedish International Development Authority
CIDA	Canadian International Development Agency
AusAID	Australian Government's Overseas Aid Program
HNP	Health Nutrition and Population
NCD	Non-communicable diseases
CCDB	Christian Commission for Development in Bangladesh
THNPP	Tribal Health, Nutrition and Population Plan
MOCHTA	Ministry of Chittagong Hill Tracts Affairs
WFP	World Food Programme
FWAs	Family Welfare Assistants
UNAIDS	Joint United Nations Programme on HIV and AIDS
ESLSPP	Ensuring Sustainable Livelihood Security of Poor People
HF	Humanitarian Foundation
CANDL	Community Action on Natural Resource Management for Decent Living
AUK	Adibashi Unnayan Kendra
GRAUS	Gram Unnayon Sangathon
MROCHET	Mrochaw Chen Chap Eungra Tia

Limitation of this research

Although the research has reached its aims, there was a limitation of fund constrains.

Section A:

Sociodemography, food security, nutrition knowledge, dietary habit and nutritional status of ethnic people living in Chittagong Hill Tracts

Chapter 1: Introduction

1.1 Overview

Bangladesh has been culturally enriched by the colourful lifestyle of different ethnic people. Chittagong Hill Tracts (CHTs) is one of the regions of Bangladesh, which is teeming with more number of ethnic minorities than the majority Bengalis unlike other parts of Bangladesh. CHTs comprises of Bandarban, Khagrachari and Rangamati with 53% ethnic minorities. Distinctive historical background, lifestyle, employment pattern, social infrastructure, culture, religions, diversified food habits and physical appearance make them different from mainland population. Previously the hilly ethnic people of Chittagong Hill Tracts were poor, underprivileged, neglected, food insecured, deprived from basic needs, health services and job opportunities. They were Jhum cultivators and maintainted lower socio-economic standards. Their situation has been improved over the last few years regarding access and utilization of basic social services such as education, health, nutrition, water and sanitation services, gender equity, new job prospective, cultivation of alternative crop varieties, and implementation of modern agricultural techniques. A series of national and international organizations, and government of Bangladesh are implementing various development projects for the acceleration of socio-economic development process of ethnic groups in the three hill tracts districts. First section of this research focuses on the socio-demography, food security, dietary habit and nutritional status of ethnic people living in the CHTs and finds the influence of socio-economic and socio-demographic status on food security, dietary nutrient intakes and nutritional status of these ethnic people.

1.2 Background

1.2.1 Ethnic people

Ethnic/tribal community or ethnicity is defined as: Ethnic group associated with or belonging to a particular race or group of people who have a culture that is different from the mainstream culture of a country.

An ethnic group or ethnicity is a socially defined category of people who identify with each other based on common ancestral, social, cultural or national experience. Membership of an ethnic group tends to be defined by a shared cultural heritage, ancestry, origin or myth, history, homeland, language and/or dialect, ideology, symbolic systems such as religion, mythology and ritual, cuisine, dressing style, physical appearance etc.[1]

Ethnic people in independent countries have social, cultural and economic conditions distinguish them from other sections of the national community and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations.[2]

“Tribal community means such a group of people who are more or less organized in a region having a cultural unity and whose members feel that they are included in the same cultural unit”.[3]

Ethnic groups of Bangladesh

Numerous different ethnic groups live in Bangladesh for centuries. Smaller groups of ethnic communities in Bangladesh covering about 2% of the total population live in different pockets of the hilly zones and some in plain lands of the country.[4]

Ethnic communities of Bangladesh live in the southeastern, north-western, north-central and north-eastern regions. These regions include the Chittagong Hill Tracts, Sylhet Division, Rajshahi Division and Mymensingh District.[5] According to the primary census report of 2011, total ethnic population group of Bangladesh is 27. The total population of ethnic people

in Bangladesh was estimated to be over 2 million in 2010.[1] Bawm, Buna, Chakma, Garo, Hajong, Horizon, Khami, Khasi, Khyang, Koch, Lushai, Mahat, Manipuri, Marma, Mro, Mrong, Munda, Oraon, Paharia, Pankho, Rajbansi, Urua, Sak, Santal, Tanchangya, Tipra and Rakhaine are the ethnic groups of Bangladesh.[6-7]

The proportion of the ethnic population in the 64 districts varies from less than 1% in majority of the districts to 56% in Rangamati, 48.9% in Kagrachari and 48% in Bandarban in the Chittagong Hill Tracts (CHTs).[14] The majority of the ethnic population live in rural areas. Most tribal people are of SinoTibetan descent and had distinctive Mongoloid features. They speak Tibeto-Burman languages.[8]

The largest tribe of Bangladesh is Chakma consisting of 4, 44,748 people, while the Marma, the second largest ethnic group is comprised of 2, 02,974 person.[2] Most of the ethnic groups are the followers of Buddhism. Some are Hindus and Christian.

Their historical background, economic activities, social structure, religious beliefs and festivals make them unique.

1.2.2 Chittagong Hill Tracts

The Chittagong Hill Tracts (CHTs) is the only extensive hill area in Bangladesh and it is located in the southern eastern part of Bangladesh. The area of the Chittagong Hill Tracts is about 13,184 sq km constituting ten per cent of the total land area of Bangladesh, of which 92% is highland, 2% medium highland, 1% medium lowland and 5% homestead and water bodies. Administratively, the CHTs comprise three hill districts: Banadarban, Khagrachari and Rangamati. The districts are comprised seven main valleys formed by the Feni, Karnafuli, Chengi, Myani, Kassalong, Sangu and Matamuhuri rivers. It is surrounded by the Indian states of Tripura on the north and Mizoram on the east, Myanmar and Cox's Bazar on the south and east and Chittagong district on the west.[9]

The CHTs has a low population density, 100 people per sq km, compared to the national average of 800. Annual population growth rate is 1.6% per year in CHTs.[11]

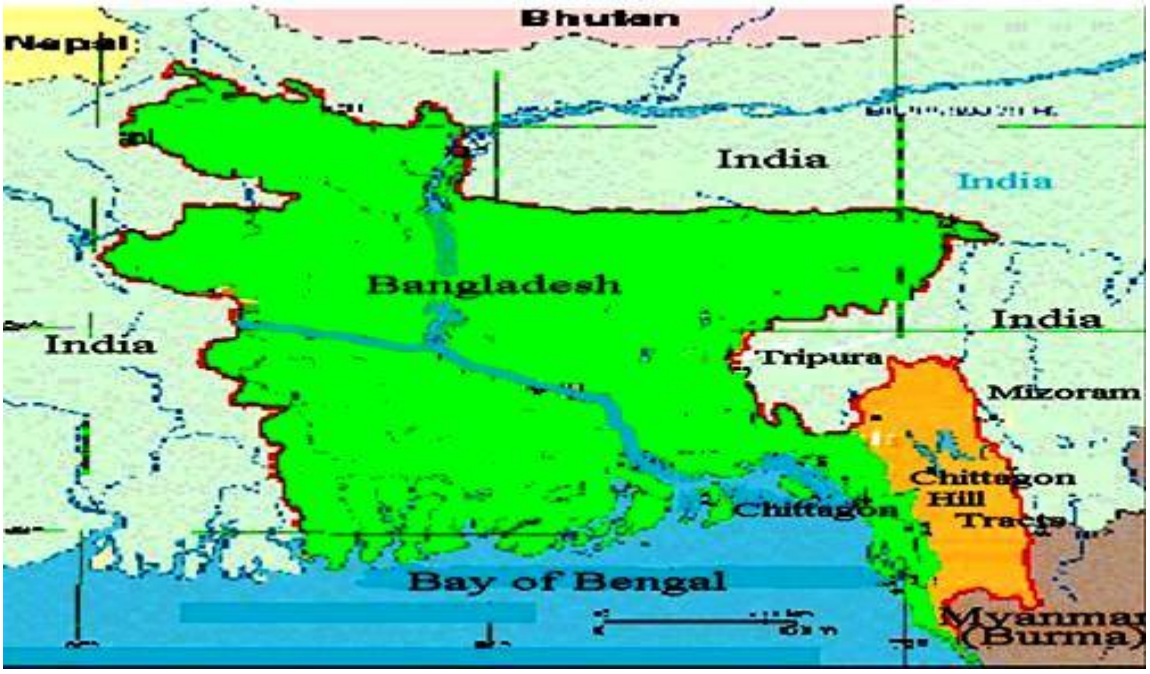

Figure 1.2.2.a: Bangladesh featuring boarders of Chittagong Hill Tracts

Ethnic communities in CHTs

The Chittagong Hill Tracts is the most diversified region in Bangladesh in respect of ethnicity and culture. The CHTs is the homeland of several ethnic groups. All of them have their individual language and culture. According to 2011 census, the population of CHTs is 15, 98,291, out of which, 845,541 are ethnic people comprising 53% of total population.[10] There are 11 ethnic groups living in the CHTs. The eleven ethnic multi-lingual minorities are: Bawm, Chak, Chakma, Khyang, Khumi, Lushai, Marma, Mro, Pangkhua, Tangchangya, and Tripura. The highest population belongs to the Chakma (43.35%) followed by the Marma (25.77%) and the Tripura (13.58%) (Das, P. K., 2009).[19] These ethnic people differ markedly from the Bengali majority with respect to social system, practices, heritage, religious practices, languages, physical appearance, traditional dress, diversified food consumption, festivals and farming methods.[17]

Almost all the ethnic communities of the CHTs are believed to have had their original homeland in Arakan and they migrated to their present habitat at different times in the past centuries.[18]

The ethnic communities of Bangladesh have their distinctive ways of living, but those who are living in CHTs, are distinctive than the others. They have their own living culture, and they live more closely to the natural contact for their livelihood and housing than the other ethnic communities in other regions of Bangladesh. The distinct features of major ethnic groups are discussed below:

Chakma: Most of the Chakmas live in the Rangamati district. The Chakmas generally live in an agrarian self-reliant society. They do all their day to day work by themselves from agriculture to weaving clothes.

Marma: The Marmas sometimes referred to as Moghs lives mostly in and around Bandarban. They also belong to the Mongoloid group. They are engaged in shifting cultivation which is locally called jhum farming.

Tripura: The Tripuras or Tipra live in the most part of the CHTs in a scattered manner. The name ‘Tipra’ originated from the word ‘Top’ which means ‘river’ and ‘Pra’ which means the confluence. Together ‘Topra’ means the people who used to live in confluence of rivers. Their way of life is different in many ways from others. These differences are apparent in their socio religious festivals.

Tanchangya: The Tanchangyas are the original faction of the Chakmas. They migrated from Arakan in 1881 during the period of Chief Dharam Baksh Khan and took up their abode on hill tops.

Bawm: The Bawm tribesmen live in Bandarban. The word Bawm is believed to have originated from ‘Kem Jau’ – which means ‘united nation’. The Bawms mainly depend on fruit gardening.

Mro: The Murongs’ who came over from Arakan to Burma a few hundred years ago concentrate in and around the Bandarban district of the CHTs. The Murongs depend on Jhum cultivation. They eat wild animals such as dogs, tigers, pigs, goats, deer, cow, poultry birds etc. They live on the hilltops in houses erected on ‘machangs’ platforms.[20]

Table 1.2.2.a: Distribution of ethnic population in the CHTs region[20]

Ethnic group	Total population	% of total
Chakma	239417	43.4
Marma	142334	25.8
Tripura	75000	13.6
Tangchangya	50000	9.1
Bawm	8000	1.5
Murong (Mro)	25000	4.5
Khumi	1241	0.2
Chhak	2500	0.5
Pankhoa	4000	0.7
Khyang	3734	0.7
Lushai	1098	0.2

Figure 1.2.2.b: Life style of ethnic people in Chittagong Hill Tracts

Districts of Chittagong Hill Tracts

Bandarban

Bandarban was originally a sub-division of Chittagong Hill Tracts district. It was upgraded to a district on October, 1981. Bandarban district is full of hills and forests. The total area of the district is 4479.01 sq.km of which 2653.54 sq.km. is under forest. Bandarban district is bordered by Rangamati district to the north, Arakan (a state of Myanmar) and Naf River to the south, Indian border and Rangamati district to the east, Chittagong and Cox's bazaar districts to the west. According to 2011 population and housing census total population of Bandarban districts was 3,88,335, among them 2,03,350 were male and 1,84,985 were

female. The annual growth rate of Bandarban districts was 2.64%. Bandarban is the lowest densely populated district in Bangladesh where 85 persons lives in per sq km.[13] Marma, Murong, Tripura, Bawm, Tanchanga Chakma, Chak, Khyang, Khumi, Lushei and the Pankho are main ethnic groups of this district.[11] The majority of ethnic people of Bandarban district are Marma.

Khagrachori

Khagrachhari was formerly a sub-division of Chittagong Hill Tracts. It was previously the headquarters of Ramgarh sub-division and became a sub-division in 1970 and was upgraded to a district in 1983. It is bounded on the north by India, on the east by Rangamati district, on the south by Chittagong and Rangamati districts and on the west by India and Chittagong.

The area of Khagrachori is 2749.16 Sq. km. There are three municipalities in Khagrachori named Khagrachhari, Ramgor and Matiranga. The number of sub district in Khagrachori district is nine, named- Khagrachhari, Mohalchori, Manikchori, Panchori, Luxmichori, Dighinala, Matiranga, Ramgor and Merung.

Khagrachhari is a valley. It has three rivers namely Chengi, Kasalong and Maini. Chengi is the longest river in Khagrachhari. Most of the land of Khagrachhari are hilly areas.[16] The total population of Khagrachari district is 6, 13,917, of which male are 3, 13,793 and female are 3, 00,124.[11-12] The sex ratio is 105:100. Demographically here 52% are tribal population and 48% are non tribal people. Among the total population there are Bengalees and three major tribes namely Chakma, Marma and Tripura. Ethnicity-wise population distributions of Khagrachori are Chakma-1,460,45; Tripura-67,342, Marma-55,844, non tribal community 2,48,559 and others 673 (census, 2001). The density of population is 225 per square kilometre and annual growth rate is 1.08.[13]

Rangamati

Rangamati became a sub-division of former Chittagong Hill Tracts District in 1891. It was upgraded to a district in 1983.[12] Rangamati Hill District lies to the south-east of Bangladesh. The total area of the district is 6,116.11 sq. km. (2361.44 sq. miles), of which 4768.49 sq. km. is forest. There are ten Upazilas in the district. The district is bounded to the north by Tripura, east by Mizoram, south by the Bandarban district and west by Khagrachhari and Chittagong district. The area covers vast forest land, wide range of hills and alluvial valley bottoms.

According to the population census 2011, the total population of the district is 5, 95,979 of which male 3, 01,376 and female 2, 82,903. The population growth rate is 1.58 and population density per sq. km is 97.

Many types of ethnic people live here; such as Chakma, Marma, Tripura, Tanchangya, Lushai, Khyang, Pankhoa, Kuki etc. According to population census 2011, of the total population of Rangamati; 3, 56,153 were ethnic people. Among them 2, 60,445 were Chakma, 51,235 were Marma, 27,052 were Tanchangya and 17,421 belong to other ethnic groups.[15]

1.2.3 Earlier socio-economic status

Over many years, the ethnic people are living in three districts of Chittagong Hill Tracts had suffered from a lot of political, economic and social problems.

Socioeconomy of ethnic people

Barkat et al (2009)[20] characterized the ethnic people of Chittagong Hill Tracts of Bangladesh as one of the most vulnerable because of its income and employment opportunities, poverty, housing, health, water, sanitation, education and inter community confidence. Dhamai (2006)[21] commented that the main problems of the ethnic people were land dispossession (through development and forestry projects), limited access to education and other social services and discrimination from the part of the non-ethnic peoples.

Economic problems

The opportunities for diversity of occupations were very limited as CHTs is a hilly area. The cultivation and agriculture depended mainly on the primitive techniques and technologies. A survey of 400 households in the CHTs area, (Dutta, 2000:34)[22] identified the main occupations of these ethnic people were agriculture (64%), followed by agriculture labor (12.5%), business (8.5%), service/professions (7.8%), fishing (4.8%) and tenant farmer (2.5%). The main forms of cultivation were the thousand year old Jhum and burn cultivation which were the main source of sustenance for these ethnic people. Unfortunately over the time these old cultivation techniques in hills made the lands infertile, imbalanced the ecology and created huge environmental damages such as landslips, which increased the siltation of the nearby lakes and subsequently caused floods. Because of the growth of population and infertility of land these people were forced to change their occupations.

There were many industries that contributing to the economy of the CHTs but the control of these industries were completely in the hands of the bangalis because the entrepreneurship status among the ethnic people of the CHTs were poor.[23] In the research conducted by the Asian Development Bank (2001) it was found that: "ethnic people face huge barriers in entering non-agricultural trades, which were largely controlled by a few family based alliances (water transport, bamboo/ timber trades, trucks). Only in traditional textiles and bamboo crafts were there ethnic entrepreneurs, who were slowly entering construction industries. But all large contracts (roads) go to outsiders that generate employment. The pubic licensing for trade and transport largely favours the outsiders and the public servants, not local people". These were the reasons for which it was commonly said that the most horrible poverty conditions prevail among the ethnic people of Chittagong Hill Tracts and most of these people can be classified either poor or the extreme poor.[23] According to Mullah, Parveen and Ahsanullah (2007; 53)[24]: "As a poor country Bangladesh has a low level of monthly income. Most of her people live under the poverty line. The tribal (population) undergoes a worse case."

Land dispossession and migration

Issues related to land ownership were complex among the ethnic population as most lands falls under the category of traditional customary property (55%). Only 21% ethnic people had land property categorized as "registered ownership".[32] Land dispossessions was one of the main problems of the ethnic people of the CHTs in Bangladesh. In most of the cases lands of these people were taken away without their consent. In many cases this dispossession was done in the name of development. In 1960 the then Pakistan government built the Kaptai

hydroelectric project on the river Karnafuli and as a result the lands of ethnic people were flooded and they had to migrate to other places including Myanmar and India (Dhamai, 2006).[21] Later the government had taken land from these ethnic people several times in the name of creating reserve forests and protecting areas, building national parks and ecosystem. According to the Amnesty International Report of 2000, the tribal people of the CHTs established the people's solidarity association in 1972, which created conflicts and resulted in the death of more than 8,500 people including civilians (IDMC, 2009).[26] In 1979, the Government of Bangladesh started to settle the Bangalis from the plain lands to the CHTs area. These settlers forcefully occupied the lands of the ethnic people in the CHTs (Dhamai, 2006).[21] These ethnic people had experienced a horrible legacy of violence, rape, loot, murder, arson, abduction and forcible conversion, sacrilege of religion, forcible occupation change, dispossession of land and property as well as gross violation of human rights for more than two decades. (Dhamai, 2006).[21] Thousands of ethnic people in the CHTs were ousted from their own hearth and home. Of them about 70 thousand ethnic people of the CHTs took shelter in India as refugees and a large number in the deep forest of remote areas within the country.

Educational facilities

The situation of education was also vulnerable in the CHTs region of Bangladesh. As these ethnic people mainly lived in relatively remote areas of the country, they lacked the basic infrastructure needed and in many cases, they were neglected from the mainstream support of the government.[23] According to Mullah, Parveen and Ahsanullah (2007; 51)[24]: "Despite considerable improvement in the spread of education in Bangladesh, level of educational attainment is still very low amongst the ethnic people, with a strong differential persisting between males and females." It was found that the literacy rate in the CHTs was lower than the national literacy rate and seven out of every ten women in the CHTs were illiterate.[23] The children's literacy rate of Chakma was 36.20%, Marma 26.60%, Mro 2.90% and Tripura was 18.50%. According to Mullah, Parveen and Ahsanullah (2007; 53)[24]: "Although the number of primary schools is adequate, they are not well managed. They really suffer from lack of number of teachers, let alone good teachers. The school facilities are shanty and the communications to the schools are not good. The presence of teachers in their respective schools depends upon their sweet will since they may draw their salaries without being there. For the schools are often far from their homes, teachers usually do not go to school except for the day when they have to draw their salaries."

Another problem of education was the language. The most important limitation of the education system was that these ethnic children had to study in Bengla (the national language) which is not their mother tongue.[21] In many cases, the ethnic children face learning difficulties and thus get dropped out.[21,23] Barakat (2009; 119)[20] commented that "The ethnic children in the CHTs are in a disadvantageous position as they have to start school with a different language". In their research, Barakat et al (2009)[20] found that: "As reported by the respondents, the other reasons for discontinuation are the following: children are not welcome at school, medium of instruction not understandable, helping parents, insecurity, and lack of interest of children." Chowdhury and Hossain (2010)[27] found that conflict had a negative impact on the schooling of the household members.

Health facilities

Though in Bangladesh many health and welfare services were provided by both governmental agencies and the NGOs, in hill areas these services were not that much available like those in

the plain areas. Barakat et al (2009; 122)[20] commented that: "In many areas they don't avail the service due to lack of knowledge of it. And, in many other areas, service providers don't visit their houses, or they can't approach service providers due to geographical obstacles in spite of having sufficient knowledge of it. In other areas, service providers and services are not available." Sultana (2011)[28] identified the following main health problems prevailing in the CHTs: a. the poor health status is an underlying factor for its very low participation in economic development. b. There are government health care centres and private clinics but in many cases these are inaccessible as the transports are irregular and costly. That is why, in many cases these people depend on the traditional healers. c. The most common diseases are malaria, diarrhoea, acute respiratory tracts infections, malnutrition and poor pregnancy. d. Infant mortality is higher than the national figure. In 2007 the child mortality rate for the nation was 52 in every 1000, whereas in the CHTs this was 61 in every 1000. The main reason for this is the lack of knowledge. e. Waterborne diseases, basic sanitation and hygiene remain as the most common problems in the CHTs. In their research Barakat et al (2009)[20] found that the main causes for not taking help of the health service providers are they 'don't know where to go' and 'facility/provider is too far".

Discrimination and violation of human rights

Bangladesh obtained her independence in the year 1971. The constitution of Bangladesh published in 1972, disregarded the 'multi-ethnic make-up' of the country and mentioned only 'Bengali nation' and as a result, it failed to recognize the ethnic peoples in the country (Mohsin, 2003; 23)[29].

The ethnic people of the CHTs had faced discrimination in different aspects of their lives. They were not given a chance to get involved in the many development decisions even those are related to them.[21] This discrimination was mainly practiced by the Bengalis. In many cases, the cultures of the ethnic people were considered as second rated. The opportunities given by Government of Bangladesh in case of employment in governmental jobs and admission into government institutions of these ethnic people were not properly operated. Discrimination was also practiced in giving them business licenses. As a result the economic condition of these people always remains vulnerable. As mentioned earlier, there was no constitutional recognition of the ethnic people in Bangladesh; these people get a lower status.[30] The ethnic children were deprived of education, health care, nutrition and other basic needs. They become the victims of double discrimination - as children and as ethnic minorities. The numbers of drug addicted children were large. Drug smugglers used to sell them these drugs. These children became the victims of torture, rape and other sexual abuses by the security forces and the settlers from the plain lands.

Food insecurity

Most of the ethnic people in the CHTs were not secured throughout the year in relation to food availability; Ashar (June-July) and Sravan (July-August) being the worst months. The harvests are often damaged by extreme weather conditions and pests (rats, boars etc). Excessive rains and flooding during the monsoon often results in localized crop losses and it was predicted that the ongoing rat infestation would result in further reductions in harvests and seed stocks, and in some cases had already led to 85% reduction in yield of the annual harvest.[32] Depending on the severity of the food shortages, households adopt a range of coping strategies. Spending may be diverted from education, clothing and medicines towards food purchases. Family members engage in day labour for wages in towns and neighbouring Jhum fields, with labourers earning approximately USD 1.7 per day. The households changed their eating patterns, taken smaller meals less regularly, and moved from nutritious foods such

as rice, to less nutritious forest foods, some of which are unfit for consumption. The sales of livestock and borrowing from various sometimes exploitive sources support households during particularly poor harvest years. Dutta (2000)[22] indicated that, 77.25% ethnic households were food insecured.[31]

1.2.4 Developmental programmes implemented by organizations for the ethnic people

NGOs and institutions

Most of the larger NGOs based in the plain regions also operate in the CHTs. This includes Bangladesh Rural Advancement Committee (BRAC: credit, primary education), ASHA (especially microcredit), Manusher Jonno Foundation (MJF: human rights, primary education, livelihood), Podokkhep (specially micro-credit), Community Development Centre (CODEC: human development), Al-Rabita (specially health), Bangladesh Nari Progati Sangha (BNPS: women's rights), Association for Land Reform and Development (ALRD: land rights), Bangladesh Environmental Lawyers Association (BELA: environment), Society for Environment and Human Development (SEHD: environment and ethnic rights) among others. In addition the micro credit institutions, Grameen Bank and Integrated Development Foundation (IDF) also operate in this region.

Local organizations

Indigenous Peoples Assistance Facility (IPAF), Centre for Indigenous Peoples Research and Development (CIPRAD) and Community Advancement Forum (CAF) are some local organizations working for the development of ethnic peoples in the CHTs. These local NGOs were represented by an elected body of NGOs known as the Hill Tracts NGO Forum. Some of these NGOs have partnerships with national organizations (e.g. with ALRD, BNPS, BRAC, MJF, SEHD) and some international organizations (e.g. Evangelischer Entwicklungsdienst-EED/Church Development Service), Christian Aid, the International Work Group for Indigenous Affairs (IWGIA) and Tebtebba Foundation. In addition, some of the local NGOs have partnerships with the United Nations Development Programme (UNDP), the United Nations Children's Fund (UNICEF), the Food and Agriculture Organization of the United Nations (FAO) and ADB among others. Also there are people's organizations, community based organizations and mass organizations of ethnic peoples. One such leading organization is the Movement for the Protection of Forest and Land Rights in the CHTs which plays a major role in advocacy on forest and land rights of ethnic people at the regional and national levels.

International organizations

UN agencies

No United Nations agency is known to have solely targeted ethnic peoples in its work in Bangladesh, but a number of them have focused involvement of ethnic peoples, particularly in the CHTs region. For example, a UNDP led project in the CHTs is supported by funds from the UN along with funds from bilateral development agencies (e.g. European Union (EU), Danish International Development Agency (DANIDA), and Japan Bank for International Cooperation (JBIC). This is a post conflict project including capacity building, confidence building, socio-economic development, primary education and health care etc. Similarly UNICEF has a programme in partnership with the CHTs Development Board. The World Health Organization (WHO), UNESCO, FAO and UNICEF have programmes in different parts of the country, some of which include ethnic peoples in CHTs.

Bilateral international development agencies

Among the leading bilateral development agencies supporting projects for ethnic peoples in the CHTs is the European Commission, JBIC, Department for International Development of Kingdom of Great Britain and Northern Ireland (DFID) - through MJF, Norwegian Agency for Development Cooperation (NORAD), Swedish International Development Authority (SIDA) Canadian International Development Agency (CIDA), DANIDA and the Australian Government's Overseas Aid Program (AusAID). DANIDA is a major donor for Chittagong Hill Tracts Development Facility (CHTDF) - US$4.5 million for agriculture and food security in the CHTs. AusAID is funding 100 scholarships for the CHTs ethnic students' tertiary-level education in Australia. It is a five-year programme, and so far 70 CHTs ethnic scholars have been sent to Australia.

International financial institutions

To date the ADB is the main international financial institution involved in development activities that directly or indirectly target ethnic peoples through its regional interventions in the Chittagong Hill Tracts (CHTs). There also are the ADB-led Second Primary Education Programme (PEDPII) and the World Bank's Tribal Health Plan.

- **ADB's CHT Rural Development Project**

In 1997 development activities were initiated in Chittagong Hill Tracts region named Chittagong Hill Tracts Rural Development Project (CHTRDP). The project was designed to contribute to a reduction in the incidence of absolute poverty in the CHTs and to provide a confidence building environment. It was meant to develop basic physical infrastructure, including construction of 55 km of sub district roads (against a target of 75 km) and 197 km of union roads (against a target of 350 km). Community development and microfinance components were introduced with a view to provide opportunities for expanding income and employment generating activities including for irrigation, agriculture, drinking water and other village development activities.

- **ADB's CHT Rural Development Project**

Technical assistance has been approved by ADB for the Second Chittagong Hill Tracts Rural Development Project. The project is to be based on lessons learned from its predecessor (CHTRDP) and will have similar components including, (i) institutional strengthening of CHTs-specific institutions to undertake their mandated roles; (ii) capacity-building, organizational structure and participatory processes for rural development and community empowerment; and (iii) rural infrastructure including improved rural access and small-scale water resource interventions (typically irrigation systems, village water supply and watershed management).

- **The ADB-led Second Primary Education Development Programme**

The overall goal of this programme was poverty reduction through universal primary education to contribute to sustainable socio-economic development and equity as envisaged in the Millennium Development Goals (MDGs). A specific objective was to provide quality primary education to all eligible children in Bangladesh under a sector wide approach programme. In the context of ethnic peoples in the CHTs, the programme is to take all necessary and appropriate actions to enhance inclusive education, including: appointment of specialized staff; development of curricula and materials, with consideration for cultural and ethnic diversity and gender and disability issues and development of a strategy and action plan for access to primary education for children from ethnic communities and areas in accordance with relevant ADB policies.[37]

- **The World Bank's Health Nutrition and Population Sector Reform Programme**

The US$4.3 billion Health Nutrition and Population (HNP) Sector Programme for Bangladesh is to increase availability and use of user centered, effective, efficient, equitable, affordable and accessible quality health care services. The project comprises: (i) supporting delivery of essential services (ESD); (ii) supporting development of policies and strategies for emerging challenges, and possibly for implementation which includes Asian Development Bank, Australian Agency for International Development, Canadian International Development Agency, Department for International Development, European Commission, the World Bank, Japan International Cooperation Agency, Norwegian Agency for Development Cooperation, Swedish International Development Cooperation Agency and United Nations Children's Fund. In the Later stage with a focus on reducing injuries and implementing improvements in emergency services and preventing and controlling major non-communicable diseases (NCD); (iii) urban health service development. A Tribal HNP Plan (THNPP) focuses on meeting the

specific health needs of ethnic people and was developed after detailed consultations with NGOs and other stakeholders.

International NGOs

There are perhaps no international NGOs (INGOs) that work solely with ethnic peoples in Bangladesh. However, some INGOs have programmes and projects that are intended to benefit, among others, member of ethnic peoples. These include the following: *Médecins Sans Frontières* (MSF) Holland (runs health clinics in CHTs), OXFAM International (on rights, development and disaster management), Action AID (rights, development), Christian AID (culture and education), NETZ Germany (Partnership for development and rights: rights and development), Miserior (rights and development), Save the Children (United Kingdom, education and children's rights), Save the Children Sweden (education and children's rights), Save the Children Denmark (education and children's rights), CCDB (Christian Commission for Development in Bangladesh: rights and development), EED (capacity-building), IWGIA (indigenous rights) and Tebtebba Foundation.[35,36,38,40]

National and international Organizations

The Ministry of Chittagong Hill Tracts Affairs of Bangladesh

MOCHTA ensures political, social, educational and economic rights of the people living in the Chittagong Hills Tracts (CHT) region through preparation and implementation of welfare oriented programmes.

- Implemented developmental work for the betterment of economic, education, culture, social activities, language, and religious ethnic activities of the tribal and non tribal people of Chittagong Hill Tracts in 2008.
- Monitors work of NGO activities in Chittagong Hill Tracts.[33]

Projects undertaken by the Ministry of Chittagong Hill Tracts Affairs of Bangladesh:

- To improve the quality of life of the people of the CHTs Region- Installation of tube wells and construction of water reservoir and irrigation infrastructure, supply of safe drinking water and development of fish resources in the Hill districts, improvement of quality of health services and development of agriculture sector through Chittagong Hills Tracts Development Board, District Council, Khagrachari; District Council, Bandarban; District Council, Rangamati and Chittagong Hills Tracts Regional Council.
- To protect the basic demands and rights of the children of the CHTs- Construction and renovation of school buildings, to provide children health services and distribution of nutritious biscuits among the children, provide training to pregnant women and mothers of 1- 3 years old children about basic health and mental development related issues to develop children's mental faculties through Chittagong Hills Tracts Development Board and Chittagong Hill Tracts Regional Council.
- To preserve the language and culture of different tribes of the CHTs- Provide assistance for celebration of special days and festivals by different tribes and development of education, religion and social welfare related institutions in the remote areas through Chittagong Hill Tracts Development Board, District Council, Rangamati, District Council, Bandarban and District Council, Khagrachari.
- To develop the infrastructure of the CHTs and expansion of economic programmes- Construction and development of rural infrastructures (roads, bridges, culvert etc.), distribution of different agricultural inputs (power tiller, pump, spraymachine, seed etc.) among the farmers of Hill areas, establishment of small scale and cottage industries in order to remove unemployment through Chittagong Hills Tracts Development Board, District Council, Rangamati; District Council,Khagrachari; District Council, Bandarban; Chittagong Hills Tracts Development Board;Chittagong Hill Tracts Regional Council and District Council, Rangamati.
- To ensure participation of the local people in the development of technology- Provide technical education and training to young men and women through Chittagong Hills Tracts Development Board and District Council, Bandarban.[33]

Tribal/Ethnic Health Population and Nutrition Plan for the Health, Population and Nutrition Sector Development Program (HPNSDP)

The Government has made provisions for a Tribal Health, Nutrition and Population Plan (THNPP), under HNPSP, which recognizes the specific social, cultural, economic and special factors to be taken into account for HNP service delivery in tribal areas (tribal areas are defined as those having (over) 25 % tribal population, and includes the CHTs).[41]

UNDP in Bangladesh

UNDP works closely with the Ministry of Chittagong Hill Tracts Affairs (MoCHTA), the CHT Regional Council (RC), the three Hill District Councils (HDCs), the traditional institutions of the three Circle Chiefs, International, National and CHTs based NGOs, Civil Society Organizations, local leaders and representatives from local community based organizations.

- Hill District Councils are now successfully managing the delivery of health services in the CHTs. In 2014, the health services comprised of over 850 community health service workers and 16 mobile medical teams. Since the commencement of the project, 2.5 million patients have been treated and over 2,800 safe births ensured.
- More than 20,000 children in the CHTs have gained access to education through 315 schools managed by the Hill District Councils. Mother tongue based pre-primary multi lingual education tools have been rolled out across 7 ethnic communities in the region, reducing language barriers faced in school. In 2014, 95% of all project supported students who sat the primary education certificate examination passed.
- Mother tongue based multi-lingual education remains central to growing enrolment and reduced dropout rates amongst primary schools in the Hill Tracts. In 2014 the facility, through the Hill District Councils, built on previous efforts with the successful roll out of pre-primary multi-lingual education materials to 7 ethnic communities across the region.
- Advocacy efforts have contributed to the commitment by government to transfer 1,500 tribal police officers to be stationed in their home districts. Over 280 police officers have been transferred to date. Furthermore, 600 community police forums have been reactivated and 610 local police personnel trained on the CHTs context.[40]

Chittagong Hill Tracts Development Facility

- Capacity of CHTs institutions strengthened through provision of technical support in participation in planning and implementation of multi-sectoral development projects.
- Remote communities across the CHTs empowered through formation of 3,257 Para (local communities) development committees and 1,686 Para nari development groups (Women's Groups), and provision of micro-grants for community projects.
- A model for community-based health services in remote areas developed through a network of 1,000 community health service workers, backed by 16 Mobile Health Teams with 80 satellite clinics across 15 Upazilas (lowest tier of government).
- 300 schools supported in remote areas, benefiting over 20,000 children. School management committees supported in school building, renovation and improved management of schools. Quality of education strengthened by recruitment and training of 700 teachers; and multilingual mother tongue education methods and materials developed in 11 local languages.[32]

UNICEF and WFP

UNICEF and WFP also support community-based health initiatives in the CHTs. UNICEF, through the Integrated Community Development Project (ICDP) has supported the Government in establishing a network of Para Centres in selected communities throughout the CHTs. These are community-based facilities run by para workers. ICDP uses the para centre as a base from which to offer a range of community development activities, organized by the para workers. It focuses primarily on educational activities and early childhood development, but also supports awareness raising and promotional activities for health, water and sanitation.

UNFPA

UNFPA provides technical support to the Mother and Child Welfare Centres (MCWCs) in each district, prioritizing antenatal care (ANC) and postnatal care (PNC), safe delivery and emergency obstetric care (EOC). At the community level, UNFPA is providing Skilled birth attendants training to Family Welfare Assistants (FWAs) and Health Assistants (HAs). With this training they are able to provide 'safe delivery' at home and are able to support and provide midwifery training to Family Welfare Visitors (FWVs). UNFPA also supports family planning services to distribute contraceptives and provide counselling for long term methods of contraception.

WHO

WHO does not work directly in the CHTs, but works with Government Ministries and other stakeholders at the national level to improve health management systems and good governance in the health sector. WHO provide technical support to immunization and involved in active and passive surveillance of communicable disease in the CHTs.

UNAIDS

UNAIDS also does not work directly in the CHTs, but supports campaigns nationally to raise awareness on HIV and AIDS.[42]

BRAC

BRAC (Bangladesh Rural Advancement Committee) is a local non-government organization involved in poverty alleviation and social mobilization. BRAC expanded its health program in Rangamati, Khagrachari and Bandarban in 1998 together with economic development and education programmes to serve the most disadvantage people in this area to provide quality health care. Initially BRAC started its essential health care (EHC) packaged including malaria control in limited geographic areas and gradually scaled it up to 25 sub districts by 2004. It pays particular attention to the vulnerable groups, e.g., women and children in hard to reach areas. The EHC package comprises of the following: Health and nutrition education, Family planning, Immunization, Pregnancy related care, Basic curative service, Tuberculosis control and Malaria control program.[41]

Dhaka Ahsania Mission

Dhaka Ahsania Mission has been implementing "Up-Scaling Non Formal Primary Education through Institutionalizing Qualitative Endeavour (UNIQUE) Project" in the 12 Upazilas of the CHTs from 2007, focused on non-formal education to out-of-school children with financial assistance of European Commission (EC). Dhaka Ahsania Mission has been facilitating 2nd phase of SHEWAB CHTs project jointly with ICDP from 2010 with the support of UNICEF for improvement of capacity of ICDP staff and para workers for mobilizing para community for improvement of water, sanitation and hygiene, education and related hand washing in CHTs.[39]

FAO project

Achieving food and nutrition security in remote areas of the Chittagong Hill Tracts- FAO project, implemented in 2013. FAO partnered with ECHO and the Ministry of Chittagong Hill Tracts Affairs (MoCHTA) to implement sustainable agricultural practices in the interest of better food and nutrition security.

The project provided critical agricultural inputs (crops, horticulture, poultry); but the inputs were also an opportunity for an extensive capacity development to enhance agricultural production, diversification and sustainability – as well as nutritional awareness - to rural men

and women. Women were the main target of horticulture and poultry interventions, considering the existing gender dynamics, and the different roles and responsibilities of men and women in the households of the CHTs area.

The combined efforts of distributions and training increased income and flexibility in the communities, as well as provided nutritional benefits through the increased availability and consumption of a wider range of nutrient-rich foods, all the while promoting resource conservation at locations which suffer from natural resource degradation. In addition, the project worked with 200 lead farmers to become community seed providers, in an effort to resolve, in part, the severe lack of quality seed in the region.

The project results have been significant. Men and women beneficiaries were able to increase their rice stock (on average the duration of food stock duration per households went from 4-5 months to 7-8 months) and started to grow vegetables and fruits in the homestead area, resulting in more varied diets rich in vitamins and other nutrients.[34]

Manusher Jonno Foundation

MJF, like other development organizations, has been implementing a range of development activities in integrated manner for ethnic people in the CHTs through 13 local direct partners and seven sub-partners since 2004. The integrated activities are aimed at enabling the poor and vulnerable ethnic people attain adequate standard of living through promoting means of livelihood security and greater capacity to influence policies, practices and attitudes in ways so as to help them overcome poverty and; promote peace and human dignity. In order to achieve this goal, the main focus of MJF has been on - livelihood security through income generation, access to basic services particularly education, and preservation of traditional cultural practices which have already been threatened. A total of 4, 43,736 beneficiaries were being covered through these partner NGOs of which 98, 407 were primary beneficiaries and 3, 45,329 were secondary beneficiaries. Among the direct beneficiaries; 59, 439 were women and 38, 968 were men.

Local NGO partners of MJF in Livelihood development projects

Ensuring Sustainable Livelihood Security of Poor People (ESLSPP) implemented by Humanitarian Foundation (HF) in Bandarban, Sustainable Initiative For Development Reformation (SIDR) implemented by Ethnic Community Development in Bandarbon, Community Action on Natural Resource Management for Decent Living (CANDL) implemented by Trinomul in Khagrachori, promotion of rights of jum cultivators in Rangamati Hill District implemented by Hilehili Education and Social Development Foundation, Empowerment of Jumia Community and Preservation of Culture- Project (EJCPC) implemented by Adibashi Unnayan Kendra (AUK) in Rangamati and Income Generation of Indigenous People through mushroom cultivation by Kabidang in Khagrachori.

Local NGO partners of MJF in educational development projects

Ensuring Right to Education to the Indigenous Children Engaged in Risky jobs and Child Labour through Social and Civil Awareness (EREICA) by Gram Unnayon Sangathon (GRAUS) in Bandarban, promoting Community Rights through a Primary Education and Multi-cultural Activities for Sustainable Development (PCRPEMA) by Mrochaw Chen Chap Eungra Tia (MROCHET) in Bandarban, Strengthen good governance and promote human rights to sustain peace in the Chittagong Hill Tracts by Green Hill in Rangamati, Primary Education in Remote Areas of Rangamati Hill Tracts by Taungya in Rangamati, Collective Action for Quality Education by Zabarang Kalyan Samity in Rangamati and Integrated Socio-Economic Development of Moanoghar's Children by Monoghar in Rangamati.[35]

1.2.5 Socioeconomic status of ethnic people in the CHTs

Poverty

About 62% households in the region irrespective of ethnicities are living below absolute poverty line (below 2,122 kcal), while 36% are hardcore poor (below 1,805 K.cal). Poverty is slightly less pronounced among the Banglis (Barkat Abul et al. (2008)[25]. Households living below lower and upper poverty lines are 78% and 89% respectively among ethnic people and 69% and 83% respectively among Bangalis. The households below lower poverty line range between 100% for Lushai and 71% for Chakma and households below upper poverty line range between 100% for Lushai and 84% for Chakma.[43]

Land

An average household owns 2.3 acres of land (including common property). An ethnic household owns on average 3.2 acres and a Bangalee household owns 1.3 acres. The ethnic households possess significantly higher amount of land compared to the Bangalees in all three districts of the CHTs. In Bandarban Bangalee households possess about 67 decimals of agricultural (plough) land while an ethnic household possesses 48 decimals. In Rangamati, difference in agricultural (plough) land ownership between Bangalee and ethnic household is prominent where an average ethnic household possesses almost two times higher amount of land (39 decimal) compared to that of Bangalis (20 decimals). Besides this scenario, in Khagrachari district Bangalee and ethnic households possess almost equal amount of agricultural (plough) land (around 45 decimals). A 46% of households from among ethnic communities own *jum* land. Higher amount of ownership of jum land has been found in ethnic community compared to Bangalee in all three districts in CHTs. The highest amount of jum land owned by ethnic households has been found as 102 decimals in Bandarban district followed by Rangamati (66 decimals) and Khagrachari (46.5 decimals). Fringe land has been found prominently in Rangamati district where about 35 decimals of such land owned by a household; and ethnic household possesses more land compared to Bengali household by an amount of 11 decimals. It is estimated that ethnic people owned more jhum land then Bangalis. Among the ethnic communities, most lands fall under the category of traditional customary property (55%). Over half (42%) of land properties have been categorized as 'Registered Ownership' for the Bangalis; and the same for the ethnic peoples is 30%. Among the ethnic community, registered ownership is found highest (59%) among Chak community followed by Marma (41%), Tanchangya (38%), and Khyang (36%). Among the Chakma community slightly over one fourth (27%) households possess registered ownership.

About 22% ethnic households have lost their lands. The Chakmas are mostly affected by land dispossession (41%), followed by Tanchangya (22%). Majority of dispossession incidents took place during the life time of fathers of the current owners and 6% lost their lands during his/her own ownership period. On average, a CHTs household has lost about 90 decimals of land during ownership of three generations (the current owner, father and grandfather of the owner). An average ethnic peoples' household has reportedly lost 115 decimals, and the same for Bangalis household is 58 decimals. The total valuation of assets owned by an average Bangalee household at current prices (of January 2008) is around Tk. 62, 000, while the same for an ethnic household is around Tk. 43,000.

Housing

In rural CHTs, almost all households possess own house. On average, a Bangalee household owns assets worth Taka 61,730, which is 30% higher than that among average ethnic Household. The majority (63%) of the houses of ethnic communities are kutcha, among the Bangalees 96% houses are kutcha. Majority of the houses in tribal/ethnic community are

either kutcha (temporary structure) or machan (built on bamboo poles). On average Bangalee households' living space was almost 18% more than the average ethnic household. Within tribal/ethnic communities, Bawm have the highest amount of living space and Chak has the least amount of living space. On average, a Bangalee household in rural CHTs has living space of 333 sft, which is 18% higher than that of an average ethnic household (282 sft).

Employment

About 50% of the total ethnic household members are either employed or employable. One-fifth of the employable ethnic people of the CHTs are unemployed. This pattern of high unemployment is similar among the three districts in the CHTs. Plough and jum cultivation has been found in more than 50% of all ethnic households, while most Bangalee households depend on plough agriculture. Jhum cultivation is the main source of occupation among 14% of the ethnic people.

About one-fifth of the total population (18%) are involved in agriculture, either in the form of plough or *jum* cultivation with 27% ethnic people and only 7% Bangalees reported agriculture as their primary occupation. Moreover 12% CHTs population reported agriculture as their secondary occupation. About 10% household members reported working as day labour either in agricultural sector or non-agricultural sector. More Bangalees are working in non-agriculture sector (8.2%) as compared to ethnic people (4.3%). As secondary occupation, non-agricultural labour was pronounced among both ethnic and Bangalee population. 'Salaried job' as primary occupation has been reported for 3% household members with 2.4% for the ethnic peoples and 4.7% for the Bangalis.

Income and expenditure

The annual household net income of average rural household of the CHTs was around Tk. 66,000 (Bangladesh rural being Tk. 84,000). The households' annual net income of the Bangalis was around Tk. 71,000 and income for ethnic people around Tk. 62,000 on average in 2009, (UNDP 2009). Agriculture related activities are the prime sources of household income across the Communities.

Field cropping as source of income has been reported by substantially higher proportion of Bangalee households hill districts of Bandarban and Rangamati compared to their ethnic counterparts. However, in Khagrachari the scenario is reversing (53% vs. 40%).

The share of food expenditure is extremely high across the communities comprising about 90% of total household expenditure. The annual household expenditure on health and education for an average ethnic household is extremely low at Tk.398 respectively. In terms of per capita savings an average ethnic people household member possesses Tk.467 and Bangalee household member; Tk.890.

NGOs have been appearing as a place of depositing savings for both Bangalis (46%) and ethnic peoples (30%). The Bangalees have higher access to credit as compared to the ethnic communities.

Annual expenditure of a household in rural Chittagong is lower compared to rest of the country, this statement holds true across all ethnic groups. The share of expenditure on food is higher than expenditure on health and education.

An average CHTs household has savings (as on January 2008) amounting to about Tk. 3,542, while on average an ethnic people's household has Tk. 2,647 and a Bangalee household Tk. 4643 as savings which is relatively higher than that of the ethnic household.

An average household has reported around Tk. 4,000 as the annual contribution of the female members. An average ethnic people's household has attributed Tk. 6,728 as female members'

contribution to household income and the Bangalee households, on average, have attributed Tk. 2,898 for the same.

The household annual expenditure for an average Bangalee household in the CHTs is Tk. 68,728, and that for an ethnic people's household is Tk. 57,035. The share of food expenditure is extremely high across the communities (around 90%). The annual household expenditure on health and education for an average household are extremely low with Tk. 605 and Tk. 398 respectively.

About 54% of all CHTs households have some access to credit. The average amount of credit received by a household during 2004-2007 is Tk. 4,597. An average ethnic household has received Tk. 5,283 as credit, while an average Bangalee household has received Tk. 12,674. Bangalee households were found more advanced in taking credit from formal sectors like banks and NGOs.

Education

About 82% children of 5-16 years in CHTs are enrolled in primary or secondary school. The enrollment among the Bangalis is marginally higher than that among the ethnic peoples. More than half the household members aged five years and above are illiterate, irrespective of ethnicity, with little variation between ethnic peoples (54%) and Bengalis (47%). Among ethnic communities, the highest proportion of illiterate persons with no education was found for Khumi (88%), followed by Mro (87%) and Khyang (74%). Educational attainment in terms of having education (i.e., at least class-I passed) is the highest among Lushai (77%), followed by Pangkhua (75%) and Chak (64%).

The rate of completion of the primary education is higher among Bengalis than ethnic peoples, while the completion of secondary education is marginally higher among the ethnic than Bengali. The community wise data indicate that the highest status of education is among Lushai with primary completion rate 10.7 % and secondary completion rate 6.7%, while the lowest level of education is among Mro with 0.7 % completing primary and none completing secondary. The completion rates of primary and secondary education among Bawms are respectively 6.4% and 4.5%, among the Chaks are respectively 7.5% and 4.8%, among the Chakmas are respectively 7.3% and 3.5%, among the Khyangs are respectively 3.9% and 0.8%, among the Khumis are respectively 1.5% and 0.4%, among the Marmas are respectively 6.5% and 2.5%, among the Pangkhuas are respectively 9.8% and 4%, among the Tanchangyas are respectively 6.2% and 1.5%, and among the Tripuras are respectively 5.4% and 1.4%.

Average years of schooling are another crucial indicator of educational attainment. It is to note that average years of schooling have been calculated for those who are at the age of 5 years and above. In the CHTs, it has been estimated that, the average years of schooling, irrespective of ethnicity, is low at only 2.8 years with no significant variation between ethnic peoples (2.7) and Bangalee community (2.9). Among the ethnic peoples the Lushai community has the highest average years of schooling (5.6), followed by the Pungkhua (4.7) and the Chak (3.9).

The medium of instruction in government schools was almost exclusively Bangla. Only 1% of ethnic respondents reported the use of the mother tongue in school books, while 2% reported the mother tongue as the medium of instruction in schools.

Drinking water source

Majority of the households irrespective of districts in the CHTs use unsafe drinking water. This trend is same for ethnic peoples and Bangalis. Rate of possession of tube well is significantly higher among the Bangalis (18.5%) than that among the ethnic peoples (4.6%). Among the eleven ethnic communities, seven possess tube well; others had no tube well at all at their households. Though, in many cases, geographical positioning works as a barrier to sinking of tube-well. According to Jyoti Prakash Dutta, July 2000; 35.25 % and 30.25 % ethnic household use tube well and well water respectively for drinking.[31]

Sex ratio

The sex ratios of both the ethnic peoples and the Bangalis are estimated to be 104.4 (number of male per 100 female; national 106).

Development programmes

In terms of composite score on women and development issues, the ethnic peoples on average, are in a better off position with 12 % points higher scores than that of the Bangalis. However, the ethnic peoples still need to achieve 56% to attain the ideal situation (100%).[41,43,44,46]

1.2.6 Dietary pattern of ethnic people in the Chittagong Hill Tracts

Food habit reflected in food items consumed by the ethnic people of the CHTs is very diversified than the plain land people. Items like nappi (a special type of dry fish), bamboo shoots, dry vegetables and some unconventional foods like – snake, pork, rat, snail and oyster make the dietary pattern of ethnic people different from main land population.

Food consumption pattern and poverty status based on food consumption

Rice, various vegetables, shrimp paste, dry fish, meat, seasonal fruits, vegetable oil, salt and some local spices are the components of the traditional food basket of ethnic people in the CHTs. Generally and usually, they reported to consume a wide variety of foods and enjoy three meals a day. Due to the extent of the damage to Jhum crops, this has forced households to change their food habits and patterns. In some areas given the food shortage, the affected population had consumed foods outside of their usual diet e.g. consumption of bamboo fruit, shoots and the rats themselves. During normal periods ethnic communities consume three meals a day. However, due to their current food shortage and scarcity they have being forced to reduce their meal frequency to once or twice per day (a few women reported skipping meals or going without food for the day), and have reduced their meals both in quantity and quality. Women reported to be taking less food in order to provide more for their children and their working men. From the vast majority of women one meal of rice and one of yam are now a common practice and the norm. The commodities, which are currently either not consumed or consumed in very small quantities, are rice, shrimp paste, dry fish, and vegetable oil. Consumption of wild foods namely yams and bamboo shoots have increased.

The tribal people like dry fishes and vegetables in their every day food. They also collect their foods from nearby forest such as bamboo shoots, tara and some spices. They prefer aromatic and sticky rice which are produced in jum. In jum they cultivate about 30-40 types of fruits, vegetables and spices.

Rice is the staple food for all ethnic households in the CHTs. The physical quantity of daily food intake per person of ethnic people in the CHTs is about 765 gm. Composition-wise, about 52% of total daily intake (by weight) of an average ethnic household member is rice, about 34% is vegetables (including potato, bamboo shoot, arum and dry vegetable) and about

6% is fish, meat and dry fish taken together. The share of fruits in per capita food intake is only around 1%.

In terms of energy intake, the per capita energy intake for an average ethnic household is 1762 k.cal. This is less than the level of the hardcore poor (below 1805 kcal). The prevalence of absolute poor (2122 kcal) and hardcore poor (1805 kcal) among ethnic peoples are 65% and 44% respectively.

Ethnic community-wise analysis shows that in terms of energy intake the Bawms are in the lowest position with 1440 k.cal per person per day. The Lushais, the Chaks and the Khyangs are slightly better-off than the Bawms but receive below 1600 k.cal per person per day. The Chakmas, on average, receive about 1831 k.cal per person per day which is still much below than the absolute poverty level of 2122 k.cal. An average Marma household member receives about 1793 k.cal per day.

Composition of menu-wise analysis reveals that, the ethnic CHTs residents largely depend solely on carbohydrate-based energy. The ethnic population of CHTs receive 76-85% of their daily energy intake from rice. It implies that the intake of protein, fat and other sources of energy are low. The findings show that across the board, only about 6% of the daily food intake constitutes protein energy (ranging between 4% and 9%). egg is not a common item in the menu of ethnic community compared to the Bangalees (35% vs. 64%).pulse is not a common food for ethnic households as about 41% consume dal daily compared to bangalee households (77%).[46-47]

Table 1.2.6.a : Food items consumed by households (%)

Food items	Indigenous people	Bangalees	All CHT
Rice	100	100	100
Flour/wheat	5	15	9
Puffed Rice	25	69	45
Fish	89	98	93
Dry Fish	88	75	82
Meat	67	63	65
Nappi	95	1	53
Egg	35	64	48
Oil	100	100	100
Pulse	41	77	57
Bamboo Shoot	66	7	40
Vegetable	96	100	98
Potato	81	95	87
Arum	69	53	62
Dry Vegetables	25	3	15
Onion/Garlic	95	99	97
Milk	18	31	24
Spice	85	97	90
Fruit	36	40	38
Salt	99	99	99
Sugar	40	75	56
Molasses	14	13	13
Chili	20	24	22
N	1786	1452	3238

Table 1.2.6.b: Per capita daily food consumption of the household (gm)

Food items	Indigenous people	Bangalees	All CHT
Rice	396	423	408
Flour/wheat	1	5	3
Puffed Rice	3	17	9
Fish	24	39	31
Dry Fish	10	7	8
Meat	11	11	11
Nappi	11	0	6
Egg	0	0	0
Oil	1	0	1
Pulse	4	8	5
Bamboo Shoot	50	4	30
Vegetable	147	163	154
Potato	37	47	41
Arum	25	14	20
Dry Vegetables	4	1	2
Onion/Garlic	11	15	13
Milk	3	7	5
Spice	3	4	3
Fruit	7	7	7
Salt	14	16	15
Sugar	4	11	7
Molasses	1	1	1
Chili	2	2	2
All food	765	800	781
N	1786	1452	3238

Table 1.2.6.c : Energy intake by food groups

Food items	Ethnic people All	Bangalees	All CHT
Carbohydrate (kcal)	1368	1464	1411
Protein	121	104	112
Vegetable	223	144	187
All food items	1762	1842	1798
Carbohydrate based energy as % of total energy intake	77.6	79.5	78.5
Protein based energy as % of total energy intake	7	6	6
Vegetable based energy as % of total energy intake	-	8	10
N	1786	1452	3238

Nappi

Nappi is an ethnic fish-foodstuff made through fermentation. Nappi is one of the most popular and traditional fermented fishery products, which is made by most of the ethnic community such as Marma, Tripura, Chakma and specially Rakhaing of hill districts (Chittagong and Chittagong hill Tracts) and coastal area such as Cox's Bazar, Teknaf, Barguna and Patuakhalli in Bangladesh. Rakhaing are most popular nappi maker and seller among the ethnic circle. Nappi is a fermented semi-solid fish-paste with potent flavor. Mainly, the traditional fish and fishery products such as dried, salted, smoked, partially fermented and fermented (Nappi) are popular because of their characteristic colour, flavour, taste, low cost, long shelf life in edible form and long storage life without refrigeration for the fermentation process.[48]

Non-pregnant non-lactating women

This category includes women of reproductive age that is 15-49 years. These women are not either pregnant or lactating at present but their reproductive system is fully functioning.

Lactating women

The lactation process begins in a mother when the hormone oxytocin is produced in response to the birth of a new baby. Both uterine contraction and lactation process more or less begin simultaneously. The milk production is primarily controlled by the hormone prolactin, which relies upon the length of time the infant nurses at the breast. Thus the women called lactating women.[49]

Dietary sources of selected vitamins and minerals

Rich dietary sources of Vitamin A[50]

Richest retinol sources	Richest β carotene sources
Liver (Chicken, beef, pork, fish, sheep)	Sweet potatoes
Cod liver oil, Fish oil	Carrots
Eggs	Pumpkin, Winter squash
Fish, Shellfish	Cantaloupe, Pink grape fruit
Butter, Cheese, Whole milk	Mangoes, papaya, Apricots, Oranges
Fortified milk and dairy products	Spinach, Kale, Beet greens, Broccoli
Sea foods (shark, salmon, tuna, oyster, octopus)	Dark green leafy vegetables, Seaweeds

Conversion factors of vitamin A[51]

1 µg RE = 1 µg retinol
1 µg RE = 12 µg α-carotene
1 µg RE = 6 µg β-carotene
1 µg RE = β-cryptoxanthi

Rich dietary sources of Vitamin E, copper, zinc and iron [53, 55, 56]

Richest Vitamin and mineral sources	Appreciable amount of vitamin and mineral containing foods	Little amount of vitamin and mineral containing sources
Vitamin E **Plant based oil:** Corn oil, Soybean oil, Cotton seed oil, Safflower oil, Sunflower oil, Wheat gram oil, Oil from various nuts **Wheat gram**	**Green leafy vegetables:** - Spinach - Swiss card - Mustard seeds - Turnip greens	**Meat** - Chicken, Beef, pork **Fish** **Animal fat** **Most fruits and vegetables**
Copper **Shellfish** - oyster **Nuts** Cashew nuts, Almonds, Walnuts, Peanuts, pistachios	**Grains** - wheat gram **Seeds** sesame seeds, soybean **Legumes** - chickpeas **Fish**	**Vegetables** **Fruits** **Muscle meats** Chicken Beef pork
Zinc **Shellfish** Oyster **Muscle meats** Beef, Lamb, Crab **Grains** Wheat gram	**Seeds** - Pumpkin - Squash Pork, Chicken **Nuts** - Cashew nuts	**Leafy vegetables** spinach **Vegetables** **Fruits** **Beans-** Mung beans **Mushrooms**
Iron **Muscle meats** - Beef, Lamb, Liver, Poultry - Amaranthus, tender, Coriander leaves, Mint, Sesame seeds, spinach etc	- **Dairy products** - **Whole grains** - **legumes** - **shellfish**	- **Non leafy Vegetables**

1.2.7 Nutritional status

Nutritional status is the current physical status of a person or a group of people in relation to their state of nourishment. Anthropometry is an efficient indicator of nutritional status. The nutritional status is determined by a complex interaction between internal/constitutional factors and external environmental factors which are as follows**:**

1. Internal or constitutional factors: age, sex, nutrition, calorie intake, occupation etc.
2. External environmental factors: food safety, education, nutrition knowledge, social and economic circumstances.

Anthropometry

Anthropometry is the measurement of body height, weight and proportions of an individual. Jelliffe (1966) defined Nutritional Anthropometry as- "Measurements of the variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition." In 1951 FAO/WHO joint expert committee made this anthropometric method to measure nutritional status of a community.[57]

1.2.8 Factors influencing food security, dietary nutrient intakes and nutritional status of ethnic people in CHTs

Food security, nutritional status and dietary nutrient intakes of any population are the outcomes of their living standards, academic and practical education; economic and demographic status. Moreover, food security, nutritional status and dietary intakes interact with one another and influence their status. The socio-economic variables directly or indirectly influence food security, food consumption and nutritional status. Income, education and occupation are directly related to food consumption and food security thus indirectly influences nutritional status of any population. Nutrition knowledge influence right kind and quality of food consumption which is related to good nutritional status. As stated earlier in this study, previously hilly ethnic people of the Chittagong Hill Tracts were poor, underprivileged, neglected, deprived from basic needs and health services having living with lower socio-economic standards which might affected their nutritional status, food security and dietary intakes. It could be assumed that with the improvement of socio-demographic status; food consumption, nutritional status and food security of these ethnic people in the CHTs now has been uplifted to a better position.

1.3 Rationale of the study

Not many investigations have been conducted on socio-demography, food security, dietary habit and nutritional status of ethnic people in CHTs. So far all the surveys addressed the socio-demographic and nutritional status, and dietary habit of the people of the CHTs as a whole. Although, for decades, ethnic communities of Chittagong Hill Tracts were being deprived from basic needs and opportunities compared to the bangalee settlers but the situation has improved in last few years. Many national and international organizations with the help of Government have been implementing various development projects and programmes for the people of CHTs, specially for the ethnic groups of that region.

Adequate nutrient intakes among women of reproductive age (non-pregnant non-lactating women) and lactation period are important determinants of maternal, neonatal and child health outcomes. However data on dietary intake of NPNL and lactating women of ethnic people in CHTs are insufficient. This paper aimed to examine the adequacy of energy, macronutrient and selected micronutrient (vitamin A and E; copper, zinc and iron) intakes among NPNL and lactating women enrolled in this study.

Nutritional status of ethnic people in Chittagong Hill Tracts is not properly documented and nutritional status of female members of ethnic groups has not been addressed yet. Nutritional status of any population is related to its socio-economic status, household demography and food consumption. Higher living standard of a society ensures good nutritional status of that community. These factors are interrelated. The aim of this section of the research is to assess the nutritional status of female ethnic members of the CHTs.

The determinants of any food and nutritional situation of any community are diversified. One or many favourable or non-favourable causes can play role behind food security, dietary nutrient intakes and nutritional status of any community. Each variable is different, of course, and the extent to which effect of one cause will vary with the circumstances. Any food and nutrition related condition can’t be explained without finding the associated or influencing factors working behind it.

This section of the study focuses on the current socio-demography, food security, dietary habit and nutritional status of ethnic groups in three districts of the CHTs. This section of the thesis intended to find the influencing factors behind the food security, dietary nutrient intakes and nutritional status of ethnic people in the CHTs. The influence was seen with education, occupation, age, marital status, nutrition knowledge score, BMI ranges; and interacting dietary nutrients (macro and micro) with said variables. This study will help to improve the livelihood of ethnic people and formulating appropriate policy measures in CHTs. Findings of this study may help in shaping strategy of different NGO’s who are working in study area to improve the health, nutrition and livelihood of these ethnic people.

1.4 Objective of the study

Objective of this study is to assess socio-demography, food security, dietary pattern and food consumption, and nutritional status of ethnic people living in Chittagong Hill Tracts.

To address it, the study has been design to:

i. assess the socio-demographic characteristics of ethnic people in the CHTs
ii. evaluate nutrition knowledge, food security, morbidity and nutritional status among them
iii. collect information on food consumption; and to estimate the intake of energy, macronutrient and micronutrient (vitamin A, vitamin E, copper, zinc and iron) by ethnic people
iv. find out the correlation of the associated factors on food security, intake of dietary nutrient and nutritional status of the ethnic people
v. finally, to provide recommendations to current intervention and food policy programmes to improve the situation, of ethnic people living in CHTs

Chapter 2: Methods and Materials

2.1 Study area

The study was conducted on both the urban and rural areas of Bandarban, Khagra-chori and Rangamati.

2.2 Study design

It was a cross sectional study, conducted among the ethnic communities of Chittagong Hill Tracts using secondary data from NHDSBD-2011 survey under the framework of IMPS (Integrated Multipurpose Sample) design developed on the basis of sampling frame on the population and housing census 2001.

2.3 Study population

A total of 171 blood samples from reproductive aged females (15-40 years) from 156 households were selected as study sample for micronutrient and biochemical analysis. Secondary data on dietary habit and nutritional status of selected 171 female samples of 156 households has been used from the NHDSBD-2011 survey in the first part of this study. These 171 ethnic female participants were categorized into two groups- lactating women and non-pregnant and non-lactating women.

Table 2.3.a: Grouping of ethnic people

Groups	Frequency	(%)
Lactating Woman (15-40 years)	85	49.7
non-pregnant and non-lactating woman (15-40 years)	86	50.3
Total	171	100

Selection criteria for blood collection

Inclusion criteria

- Female of reproductive age (15-40 years)
- Lactating women
- non-pregnant non-lactating women

Exclusion criteria

- Females aged 13-14 years
- Pregnant women
- Pregnant lactating women

2.4 Study period

The study was conducted during the period of April 2013 to December 2015. Data entry, analysis and coding were accomplished in this period.

2.5 Questionnaire development

A questionnaire was designed and prepared to record data on household socio-demographic status, household food security, lifestyle, anthropometry, dietary pattern, health and nutrition knowledge and nutritional status. The questions were pretested and revisions were made.

2.6 Data collection

The data collection teams interviewed household members to obtain information on household socio-demographic and anthropometric data.

This part of the study used the socio-demographic, food security, lifestyle, health and nutrition knowledge, dietary habit and nutritional status related information of 171 female samples of 156 households.

Data collection on food consumption, dietary pattern and micronutrient intake

Food intake and meal patterns were assessed using a pretested food frequency questionnaire (FFQ) and 24-hour dietary recall. Detail information on dietary intake was collected to calculate intake of energy, protein and other important micronutrients at individual level by 24 hours recall method. In this method, the individual were asked to provide estimates of the amount of food and drink they have consumed during the previous 24 hour period. The 24-hours recall method is greatly valued for its ability to estimate nutrient intakes of population groups. This method is used widely to compare nutrient intakes with specific dietary recommendations. A set of standard measuring cups was used for measuring the foods or for indicating the serving and amount (grams) were used to assess the quantity of consumption. The amount of food was collected both in raw and cooked form. Cooked food was then converted to raw food weight by using appropriate conversion factors (Ali, 1991)[66]. Nutrients values (protein, carbohydrates, fat, vitamin A, vitamin E, copper, iron and zinc) were calculated per 100 gm of raw food consumed (edible portion only) by using the food consumption database for Bangladesh.[58,59] (Islam et al. 2010 and Nazma Shaheen et al. 2013)

In food frequency questionnaire, the respondents were asked to tell the number of times that they consumed from each of the food groups listed. Frequency of intake pertaining to food groups was assessed and included fruits, vegetables, bread and cereals, legumes, milk and milk products, meat, fish and poultry. Respondent's options were the following: daily, 4-6 times per week, equal or less than three times per week and never. Foods that were consumed daily or 4-6 times a week were categorised as "frequently consumed". Those eaten occasionally or less than three times a week were classified as "infrequently consumed".

The total intake of calculated macronutrients and micronutrients were compared with the recommendations of the WHO/ FAO/ IOM (2002). The intake was then classified as being below the recommendation, with in recommendation and/or above the recommendation.

Measurement of anthropometric indices

The anthropometric measurements included weight, height and mid-upper arm circumference (MUAC).

Body weight: A UNISCALE was used to record the subjects' body weight. It was measured to the nearest 0.5 kg. The balance was placed on hard flat surface. The body weight was recorded by standing unassisted in the centre of the platform of the weighing machine bare footed with straight look head and with minimum cloth wearing.

Height: Standing height was measured using a wooden height scale developed by BBS to the nearest 1cm. Height of the subject was measured bare footed in standing position with heels, buttocks, shoulders and back of the head touching the upright stand, with straight legs and relaxed shoulder and arms hanging by the sides in natural manner.

MUAC: MUAC tapes were used to measure MUAC to the nearest 0.1cm.This measurement was taken at the midpoint of upper arm midway between the acromion process (the bony tip) of the shoulder and the olecranon process (the point) of the elbow. The left arm was bent about 90º at the elbow and the forearm was placed down across the body. The tip of the acromion process of the shoulder blade at the outer edge of the shoulder and the tip of the olecranon process at the ulna were located and marked. The distance between these two points was measured using a non-stretchable tape and mid point was marked with a soft pen. After the left arm was extended so that it is hanging loosely by the side, the tape was wrapped gently but firmly around the arm at the midpoint and not squeezed.

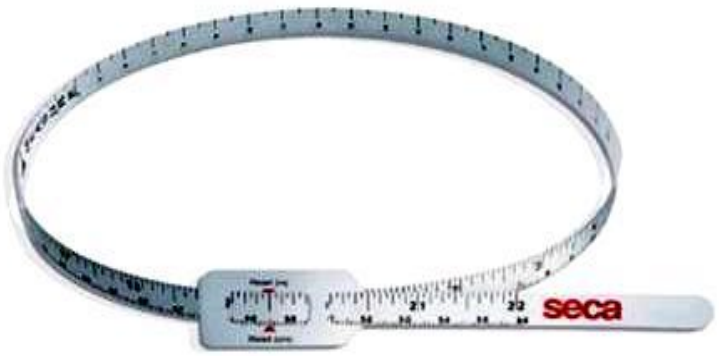

Figure 2.6.a: Adult MUAC tape

Estimation of nutritional status

The nutritional status of these ethnic people was assessed using Body Mass Index (BMI). The BMI is used to measure thinness or obesity. Weight and height were used for computing BMI (weight [kg]/height [m^2]) in accordance with the reference of WHO.

Table 2.6.a: BMI classification by WHO [61]

Nutritional status	BMI
Underweight	<18.5
Normal Weight	18.5-24.9
Overweight	≥25

2.7 Data analysis and presentation

IBM SPSS Statistics 21 software packages and Microsoft excel was used for data entry. IBM SPSS Statistics 21 software package was used to analyze the data. Descriptive statistics (frequencies, cross tables, descriptive) and compare means (one sample t-test) were used to calculate all variables. Values were expressed as frequency, percentage, mean and standard deviation. Tables, diagrams and figures were used to present the data. The statistical analysis was performed by chi-square and fisher's exact test to assess any association. The significance of the difference was tested using one sample t-test with the 5% level of confident interval, test statistic and its variance for categorical variables. Fisher exact tests were applied to estimate the level of significance when a cell value of any category was less than 5.

Chapter 3: Results

3.1 Samping distribution in households

The study conducted in three districts of the CHTs, and included 156 households from the three districts where 36.5 %, 24.3% and 39.1% were situated in Bandarbon, Khagrachori and Rangamati respectively (Table 3.1.a and Figure 3.1.a).

Table 3.1.a: Distribution (%) of households in the CHTs

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)
Household distribution	36.5 (57)	24.3 (38)	39.1(61)	100 (156)

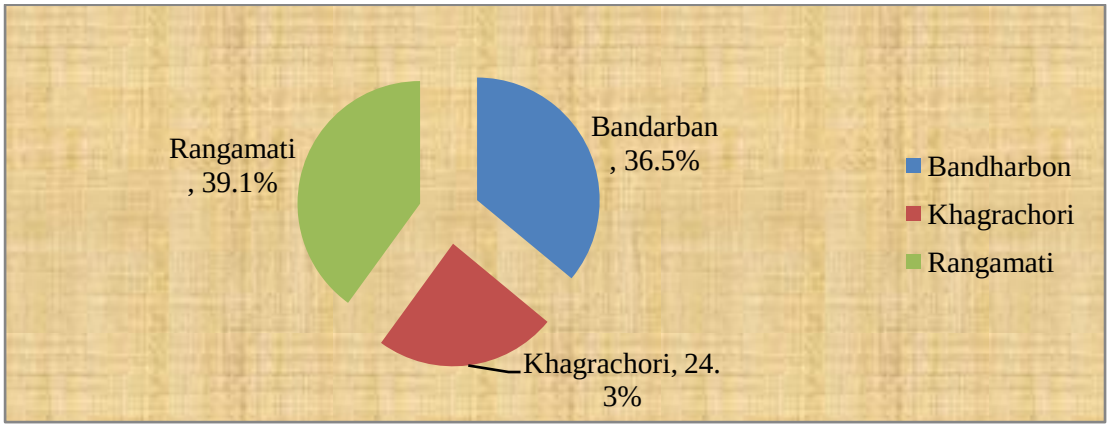

Figure 3.1.a: Distribution of households among three districts of the CHTs

Out of the 156 households, 94.9% had single participants, 1.3% had two participants and 3.8% households had three to four participants each (Table-3.1.b, Figure -3.1.b).

Table 3.1.b: Distribution of samples collected from each household in three districts of the CHTs

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)
Sample collected				
One sample	94.7 (54)	86.8(33)	100 (61)	94.9 (148)
Two samples	3.5 (2)	0 (0)	0 (0)	1.3 (2)
Three/four samples	1.8 (1)	13.2 (5)	0 (0)	3.8 (6)

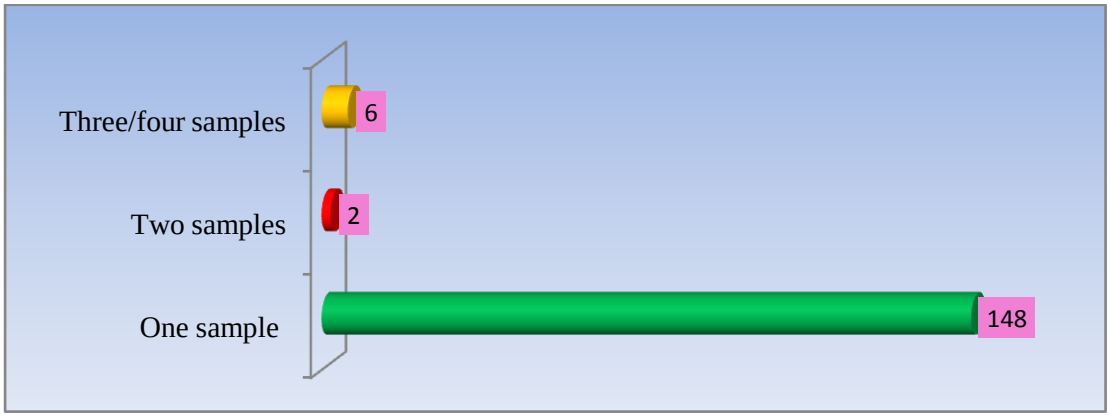

Figure 3.1.b: Number of samples collected from each of the ethnic household

3.2 Education and occupation of HH head and spouses

Table 3.2.a shows the profile of household heads and their spouses. Among 156 participating household heads, 81% were literate and mostly (68%) occupied with non-agricultural services such as- governmental, non-governmental jobs and business etc. Relatively smaller portion (30.7%) was employed in agriculture. Occupation wise the picture was similar for both Bandarban and Rangamati, but different image was observed in Khagrachori where 57.8% of the household heads engaged with agricultural activities. About 66% participating ethnic spouses were literate. Literary rate of spouse was 15.6% lower than their male counterparts (Figure 3.2.a). In Khagrachori among 38 participanting spouses of the household heads, 47.4% were illiterate, representing higher rate of iliteracy among the districts in this group. In total, greater number (83.9%) of spouses keeps themselves busy with household chores and doesn't contribute to family income, while only 11% and 5.1 % occupy themselves with non-agricultural and agricultural jobs respectively. No major difference was observed in the three districts in terms of occupation of spouse of the household heads.

Considerable occupational difference was observed among the genders of the three study area (Figure-3.2.b)

Table 3.2.a: Education and occupation of the ethnic HH head and their spouses

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)
Head of the family (n=156)				
Education				
Illiterate	17.5 (10)	16 (6)	21.3 (13)	19 (29)
Literate	82.5 (47)	84 (32)	78.7 (48)	81 (127)
Occupation				
Agriculture	24.6 (14)	57.8 (22)	19.7 (12)	30.7 (48)
House hold chores	1.7 (1)	0 (0)	1.6 (1)	1.3(2)
Non Agriculture (Job, Business)	73.7 (42)	42.2 (16)	78.7 (48)	68 (106)
Spouse of the head (n=156)				
Education				
Illiterate	29.8(17)	47.4 (18)	31.1 (19)	34.6 (54)
Literate	70.2 (40)	52.6 (20)	68.9 (42)	65.4 (102)
Occupation				
Agriculture	5.3 (3)	5.3 (2)	5 (3)	5.1 (8)
House hold chores	86 (49)	76.3 (29)	86.8 (53)	83.9 (131)
Non Agriculture (Job, Student, Business)	8.7 (5)	18.4 (7)	8.2 (5)	11 (17)

*HH- Household

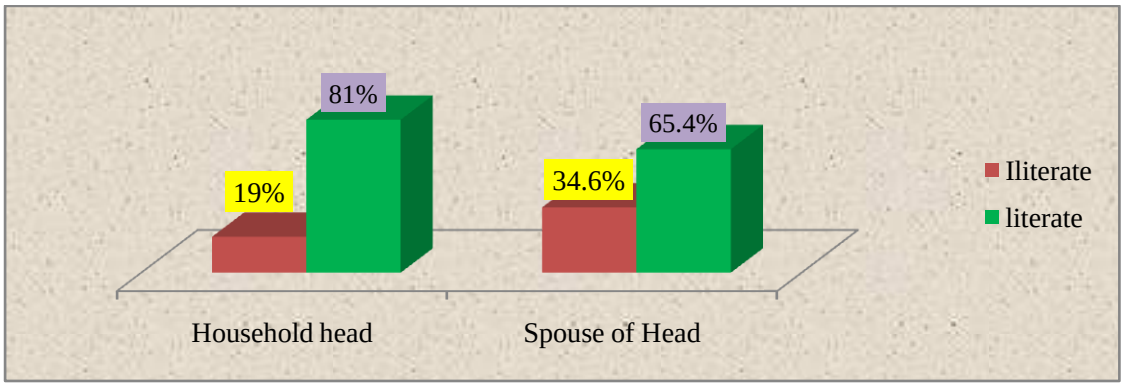

Figure 3.2.a: Comparison of literacy rates between ethnic household heads and their spouses

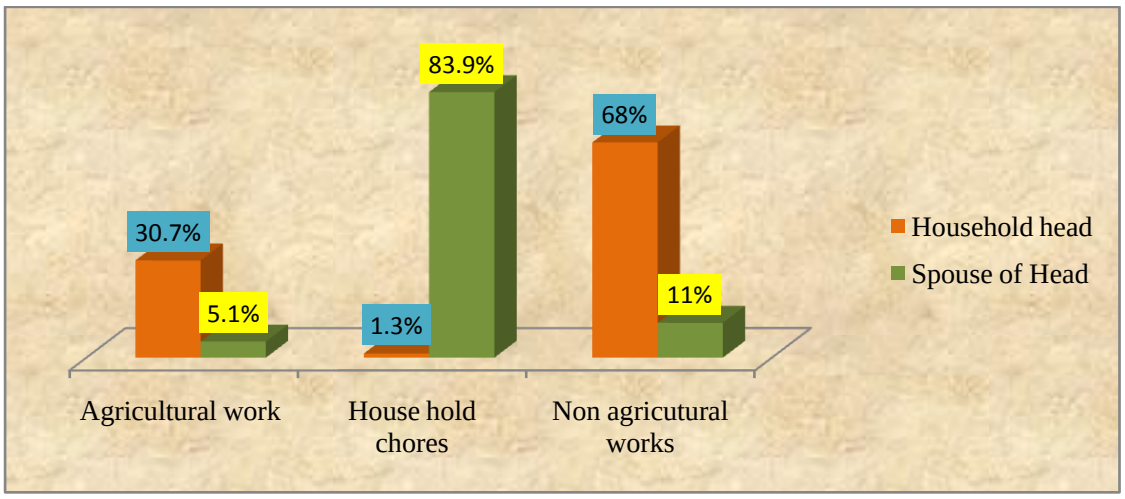

Figure 3.2.b: Difference of occupational pattern of household heads and their spouses

3.3 Socio-economic status of ethnic people in the CHTs

Table 3.3.a presents the socio-economic characteristics of the study samples. Among them, 28.6% and 71.5% were illiterate and literate respectively, where 57.3% of the respondents completed secondary education (Figure- 3.3.a). About 33% illiteracy was obsereved in Rangamati, higher than the remaining two districts. Those, who completed secondary education, were 10-11% higher among participants of Bandarban districts (64%) than the two districts.

Among these ethnic people, 78.4% were engaged in household chores, followed by 7% in agriculture, 5.3% in jobs, remaining 7% were students and 2.3 % were in business (Figure - 3.3.b). Higher percentage (11.5%) of students and service holders (8.2%) were found in Bandarban district compared to that in Khagrachori (student 4.1% and service holder 4.1%) and in Rangamati (student 4.9% and service holder 3.3%).

About 94% of the ethnic people belonged to the age group of 18-40 years. In Bandarban, out of 61 participants 9.8 % were age group of 15-17 years, where in Khagrachori and Rangamati, 4% and 3.2 % belonged to this age group respectively. The average age of the ethnic people was 28 years.

In total, 91.3% of the ethnic people were ever married (married, divorced, widow) and 8.7 % were unmarried. Percentage of unmarried people was found to be higher in Bandarban (13.1%) than that in Khagrachori (4.1%) and Rangamati (8.2%).

Table 3.3.a: Socio-economic characteristics of ethnic people in the CHTs

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)	Mean± SD
Education, n=171					
Illiterate	24.6 (15)	28.6 (14)	32.7 (20)	28.6 (49)	
Primary	8.2 (5)	14.3 (7)	11.5 (7)	11.2 (19)	
Secondary level	64 (39)	53 (26)	54.2 (33)	57.3 (98)	
Above secondary level	3.2 (2)	4.1 (2)	1.6 (1)	2.9 (5)	
Occupation, n=171					
Agriculture	6.5 (4)	10.2 (5)	4.9(3)	7 (12)	
House hold chores	72.2 (44)	77.5(38)	85.2 (52)	78.4 (134)	
Job (NGO, Servant, private and public job)	8.2(5)	4.1 (2)	3.3 (2)	5.3 (9)	
Student	11.5 (7)	4.1 (2)	4.9 (3)	7 (12)	
Business	1.6 (1)	4.1(2)	1.7 (1)	2.3 (4)	
Age group, n=171					
15- 17 years	9.8 (6)	4 (2)	3.2 (2)	6 (10)	28±7.2
18-40 years	90.2 (55)	96 (47)	96.7 (59)	94 (161)	
Marital status, n=171					
Unmarried	13.1 (8)	4.1 (2)	8.2 (5)	8.7 (15)	
Ever Married	86.9 (53)	95.9 (47)	91.8 (56)	91.3 (156)	

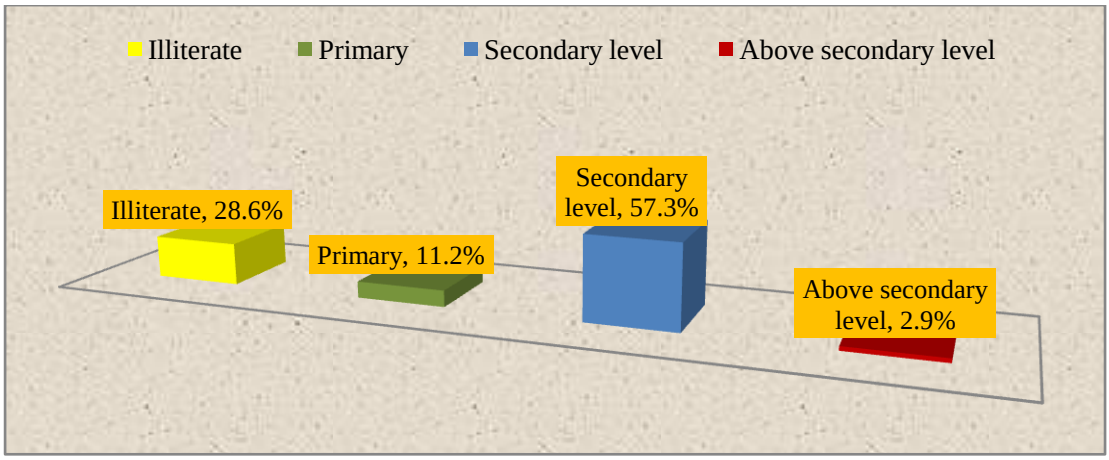

Figure 3.3.a: Educational level of ethnic people in the CHTs (%)

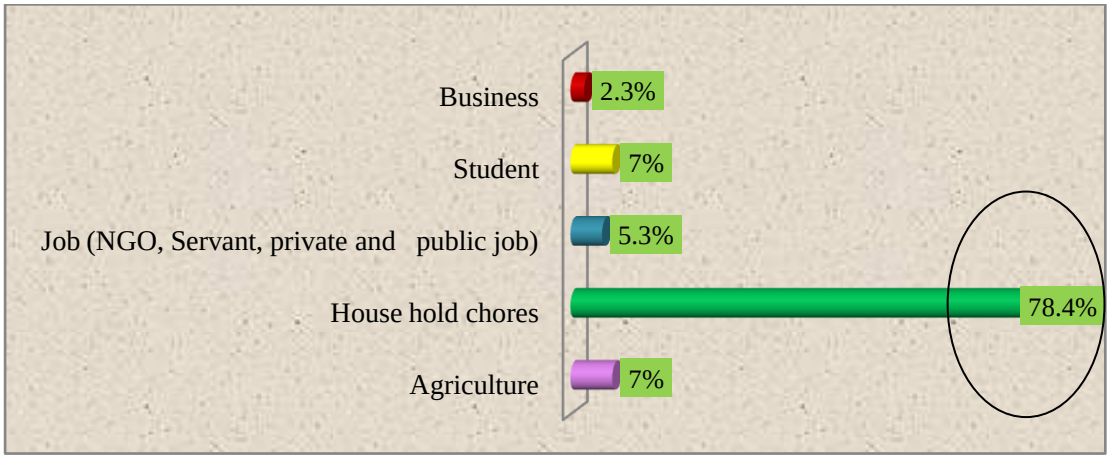

Figure 3.3.b: Professional variations seen among ethnic people (%)

3.4 Socio-demographic status of the ethnic people in CHTs

Table 3.4.a shows the socio-demographic status of ethnic people in three districts. Among these 171ethnic people, 61, 49 and 61 samples were shorted from Bandarban, Khagrachori and Rangamati respectively.

Of the ethnic community, Chakma (39.8%) and Marma (44.4%) were the predominant tribe types in CHTs, where 8.2%, 5.8%, 0.6% were respectively Bam, Tripura, and Tonchoanga; and remaining 1.2% belongs to others (Figure -3.4.a). About two third of participants (67.2 %) from Bandarban, were followers of Marma tribe type, whereas 57.1% and 59% of the ethnic people of Khagrachori and Rangamati were chakmas respectively.

This study found that about 59 % of the ethnic people live in a single family with parents and siblings, while 41% live in a joint family with parents, siblings and grandparents with or without uncles and aunts. Similar pattern was found in all the three districts, where 60.6%, 63.3% and 54.1% of ethnic people from Bandarban, Khagrachori and Rangamati belong to a single family respectively (Figure-3.4.b).

Majority of them (84.2 %) were Buddhist, and 10.5% and 5.3 % were Christian and Hindu respectively (Figure -3.4.c). In Khagrachori, 100% were Buddhists. 13.1% practiced Hindu religion in Rangamati and 26.2 % were Christian in Bandarban.

In Chittagong Hill Tracts, 81.9 and 9.9 % were found to use tube well and well water for drinking respectively. About 5.8% and 1.2% used river and pond water and also 1.2% used bottle water as drinking water (Figure -3.4.d).

In CHTs different organigations are carrying out development programmes. About (83%) programmes are implemented by local NGOs, where 8.8% and 8.2% of the programmes are conduct by BRAC and other international NGOs respectively (Figure- 3.4.e). In Bandarban, 26.2 % and 23 % of developmental projects were implemented by BRAC and International NGO's UNICEF, WHO, UNDP, FAO, but in Khagrachori and Rangamati 100 % developmental programmes were implemented by local NGOs like- Agape, Balipara Nari Kallyan Samity, Chaindha Rakkhita Shishu Sadan, Community Advancement Forum, Ethonic Community Development, Grous (Gram Unnayan Sangathan), Hanani Lantri, Humanitarian Foundation Tripura Kallyan Sangsad, N.Z. Ekata Mohila Samiti, Poverty Alleviation and Social and Toymu.

Table 3.4.a: Socio-demographic characteristics of ethnic people in three districts of CHTs

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)
Tribe types (n=171)				
Tonchaonga	1.7 (1)	0 (0)	0 (0)	0.6 (1)
Chakma	6.5 (4)	57.1 (28)	59 (36)	39.8 (68)
Marma	67.2 (41)	38.8 (19)	26.2 (16)	44.4 (76)
Tripura	0 (0)	4.1 (2)	13.1 (8)	5.8 (10)
Bam	22.9 (14)	0 (0)	0 (0)	8.2 (14)
Others	1.7 (1)	0 (0)	1.7 (1)	1.2 (2)
Family types (n=171)				
Single family	60.6 (37)	63.3 (31)	54.1(33)	59.1 (101)
Joint family	39.4 (24)	36.7 (18)	45.9 (28)	40.9 (70)
Religions (n=171)				
Hindu	1.6 (1)	0 (0)	13.1 (8)	5.3 (9)
Christian	26.2 (16)	0 (0)	3.3 (2)	10.5 (18)
Buddhist	72.2(44)	100 (49)	83.6 (51)	84.2 (144)
Drinking water source (n=171)	77 (47)	96 (47)	75.4 (46)	81.9 (140)
Tube well/tap	16.4 (10)	4 (2)	8.2 (5)	9.9 (17)
Well	3.3 (2)	0(0)	13.1(8)	5.8 (10)
River/cannel water	3.3 (2)	0(0)	0(0)	1.2 (2)
Pond/ditch	0 (0)	0(0)	3.3 (2)	1.2 (2)
Bottle water				
***NGOs** (n=171)				
Local NGOs	50.8 (32)	100 (49)	100 (61)	83 (142)
Brac	26.2 (15)	0 (0)	0 (0)	8.8 (15)
International NGOs	23 (14)	0 (0)	0 (0)	8.2 (14)

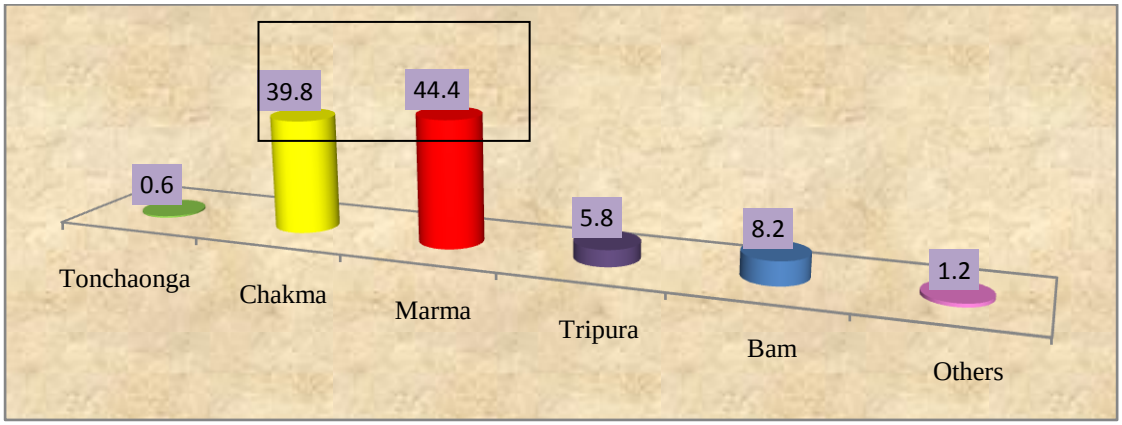

Figure 3.4.a: Ethnic people belonged to various tribal communities (%)

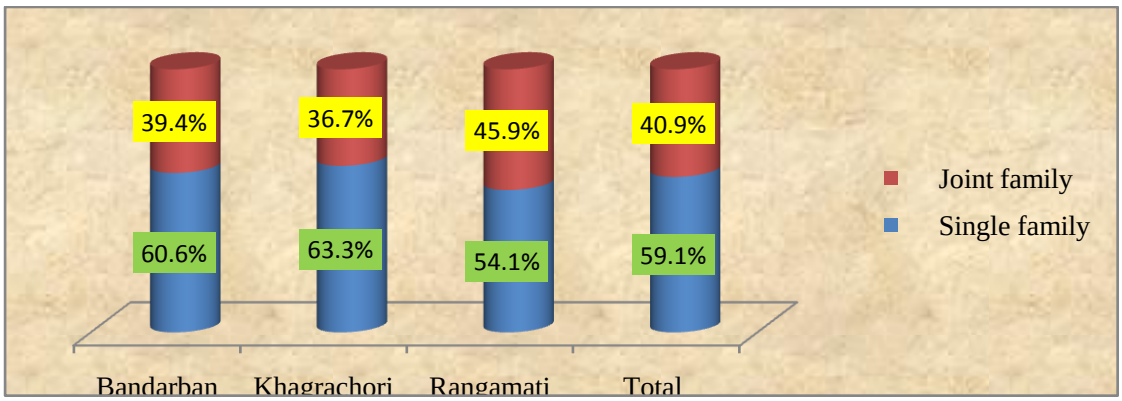

Figure 3.4.b: Family types observed among ethnic people in three districts of the CHTs

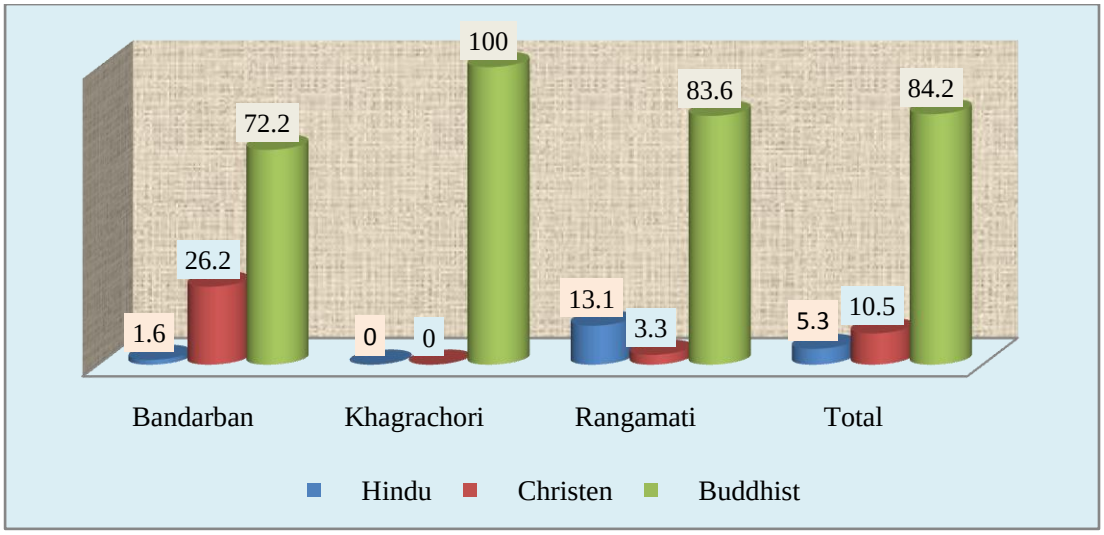

Figure 3.4.c: Religions practice by ethnic people in CHTs (%)

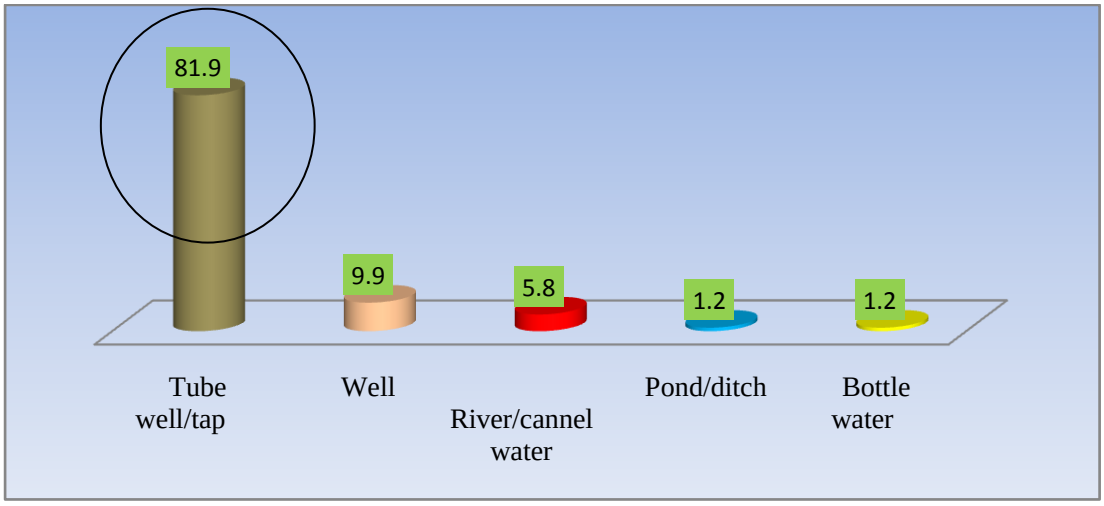

Figure 3.4.d: Drinking water source in CHTs (%)

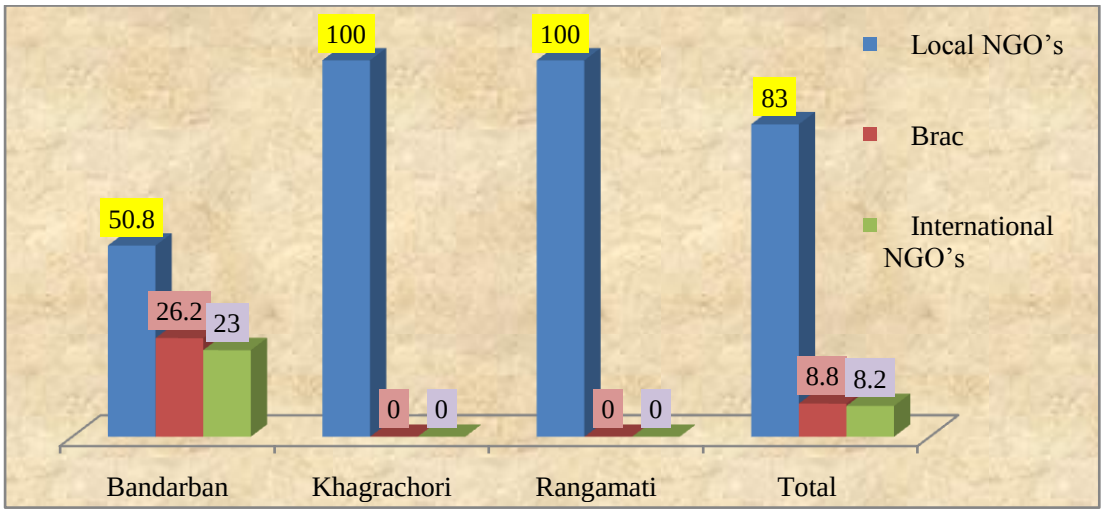

Figure 3.4.e: Distribution of organizations implemented developmental programmes in three districts of the CHTs (%)

3.5 Economic condition of ethnic people in CHTs

Table 3.5.a illustrates the monthly income and expenditure pattern of ethnic samples of three districts in CHTs. Average monthly income was 18822.22 taka. Among 171 ethnic people's families, 61.9 % had earned more than 10,000 taka. About 45% and 37% samples families respectively expend monthly 6000-9999 taka and more than 10,000 taka on various sectors like food, education, clothes and medicine etc. Average monthly family expenditure was 15654±20329.514 taka. Collectively, ethnic people use almost half (47.6%) of their expenditure on education, while 34%, 1.4%, 4.7%, 3.4%, 3%, 4.2% respectively on food, medicine, transports, housing, clothing , agriculture (Figure-3.5.a). The district-wise results were very different. In Bandharbon, 70.3% of total expenses were related to education, but in Khagrachori and Rangamati, only 4.5% and 6.1% spendings used on education respectively.

The ethnic people in the CHTs communally spend 34% on food. But independently families of participants in Bandarban, Khagrachori and Rangamati respectively spent 18.4%, 62.5% and 63.1% on food. Ethnic people were found to spent minimum on medicine in three districts, 1%, 1.6% and 2.4% of total expenditure in Bandarban, Khagrachori and Rangamati respectively.

Table 3.5.b shows the debt situation of the 171 ethnic people in the three districts of the CHTs. About 18% of participants' families were at some kind of monetary debt. Among them 64.5% and 35.5% took loan between taka 1000-20,000 and 20,001-1, 00,000 taka. Average amount of loan taken was 18027.48 ± 14046.138 taka. About 45% loans were given by various banks like- Krishi, Sonali, Agrrani, Janata,Grameen banks etc, while 42% loans were given by other organizations like - Podokkep, Ideal, IDF, BRDP, Onggo, Somajseba, Mohila Songtha, Siyam, Akij company, Ipsha, Progressive, CIPD, Bono etc. 13% loans were taken from BRAC.

Figure -3.5.b illustrates the reason behind taking loan of these ethnic peoples' families. About 45% loans were taken for various reasons like business, surgery, farming and to go to abroad to earn livelihood etc; whereas 22.6% and 22.6% loans were taken for family needs and agricultural purposes respectively. In Khagrachori 66.67% loan was taken for agricultural use.

Table 3.5.a: Income and expenditure pattern of ethnic people in the CHTs (n=171)

Parameter	Bandharbon % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)	Mean± SD
Monthly family income (Tk)					18822.22 ± 30914.774
Less than 6000	8.2 (5)	10.2 (5)	16.4 (10)	11.7 (20)	
6000-9999	29.5 (18)	22.4 (11)	26.2 (16)	26.3 (45)	
More than 10000	63.3 (38)	67.3 (33)	57.4 (35)	61.9(106)	
Monthly family expenditure					15654 ± 20329.514
Less than 6000	13.1 (8)	20.4 (10)	21.3 (13)	18.2 (31)	
6000-9999	50.8 (31)	55.1 (27)	31.1 (19)	45 (77)	
More than 10000	36.1 (22)	24.5 (12)	47.5 (29)	36.8 (63)	
Expenditure on					
Food	18.4	62.5	63.1	34	
Non food					
Education	70.3	4.5	6.1	47.6	
Medicine	1	1.6	2.4	1.4	
Others	10.3	31.4	28.4	17	

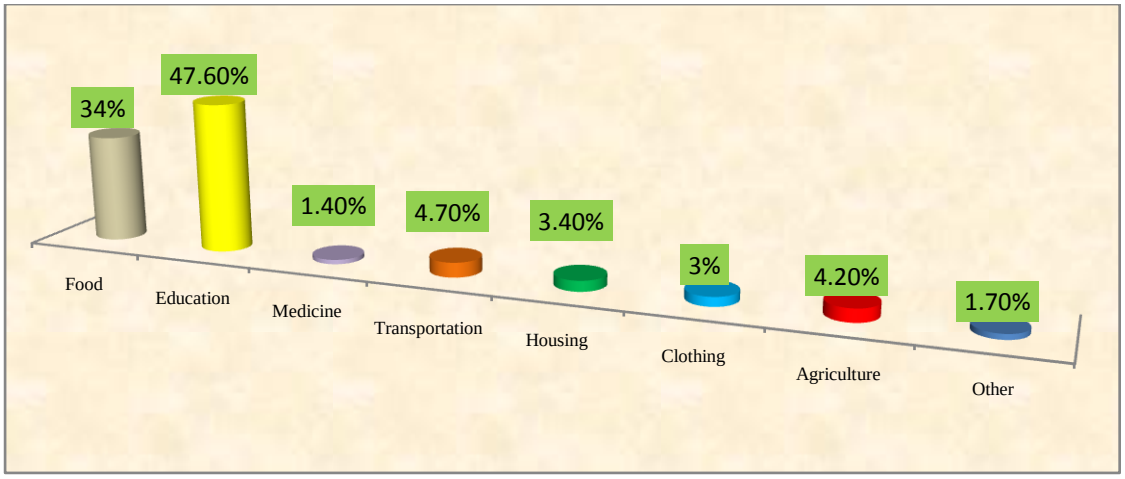

Figure 3.5.a: Monthly expenditure of ethnic people on various sectors in the CHTs

Table 3.5.b: Debt situation of ethnic people in the CHTs

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)	Mean±SD
People with liability of loan (n=171)					
Yes	26.2 (16)	6.1(3)	19.6 (12)	18.2 (31)	
No	73.8 (45)	93.9 (46)	80.4 (49)	81.8 (140)	
Amount of loan taken (Tk) (n=31)					18027.48 ± 14046.138
1000-20000	56.3 (9)	66.7 (2)	75 (9)	64.5(20)	
20001-100000	43.7 (7)	33.3 (1)	25 (3)	35.5(11)	
Organization gives loan (n=31)	0 (0)	33.4 (1)	25 (3)	13 (4)	
BRAC	50 (8)	33.3 (1)	41.7 (5)	45 (14)	
Bank	50 (8)	33.3 (1)	33.3 (4)	42 (13)	
Others					
Reason for taking loan					
Family need	12.5 (2)	0 (0)	41.7(5)	22.6 (7)	
Agricultural purpose	25 (4)	66.67 (2)	8.3 (1)	22.6 (7)	
House building/ repair	12.5 (2)	0 (0)	8.3 (1)	9.7 (3)	
Other	50 (8)	33.3 (1)	41.7 (5)	45. 2(14)	

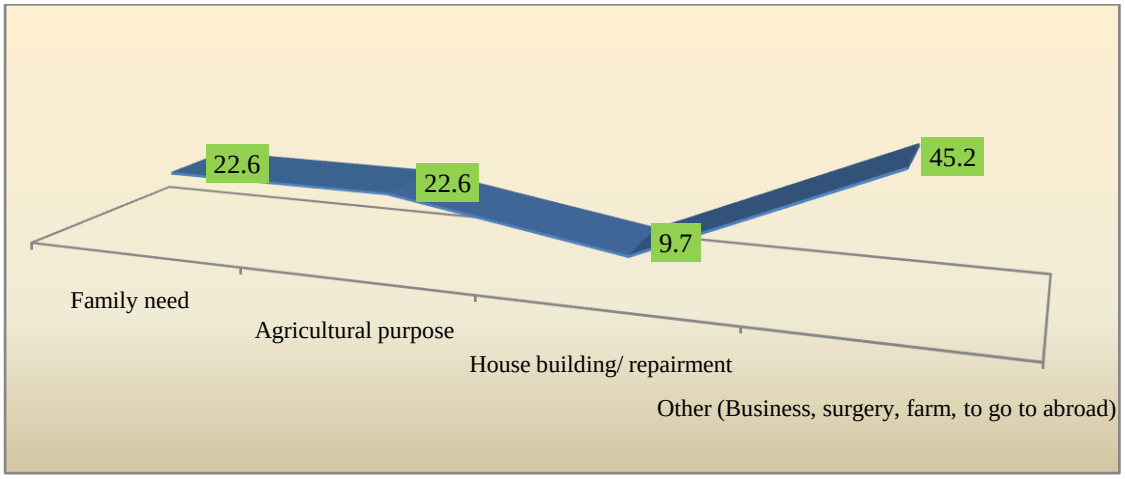

Figure 3.5.b: Reason for taking loan (%)

3.6 Nutrition knowledge level of ethnic people in the CHTs

Table 3.6.a illustrates the level of nutrition knowledge of ethnic people in CHTs. Mean nutrition knowledge score was found to be 35 ± 5.8. About 44.4%, 38.6% and 17% of the ethnic people scored between 30-37, 38-48 and 14-29 points respectively on nutrition knowledge. In Bandharbon among 61 participants, 47.6% obtained very good nutrition knowledge score, whereas in Khagrachori and Rangamati 49% (n=49) and 54% (n=61) had good nutrition knowledge respectively (Figure- 3.6.a).

Table 3.6.a: Nutrition knowledge score of ethnic people in three districts of the CHTs

Parameter	Bandharbon % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)	Mean ± SD
*** Nutrition knowledge Score (n=171)** 14-29 30-37 38-48	 21.3 (13) 31.1 (19) 47.6 (29)	 18.4 (9) 49 (24) 32.6 (16)	 11.5 (7) 54 (33) 34.5 (21)	 17 (29) 44.4 (76) 38.6 (66)	35 ± 5.8

* Nutrition knowledge score: several questions were asked on nutrition to respondents.
1 point was given for every correct answer and no point given for wrong answers.

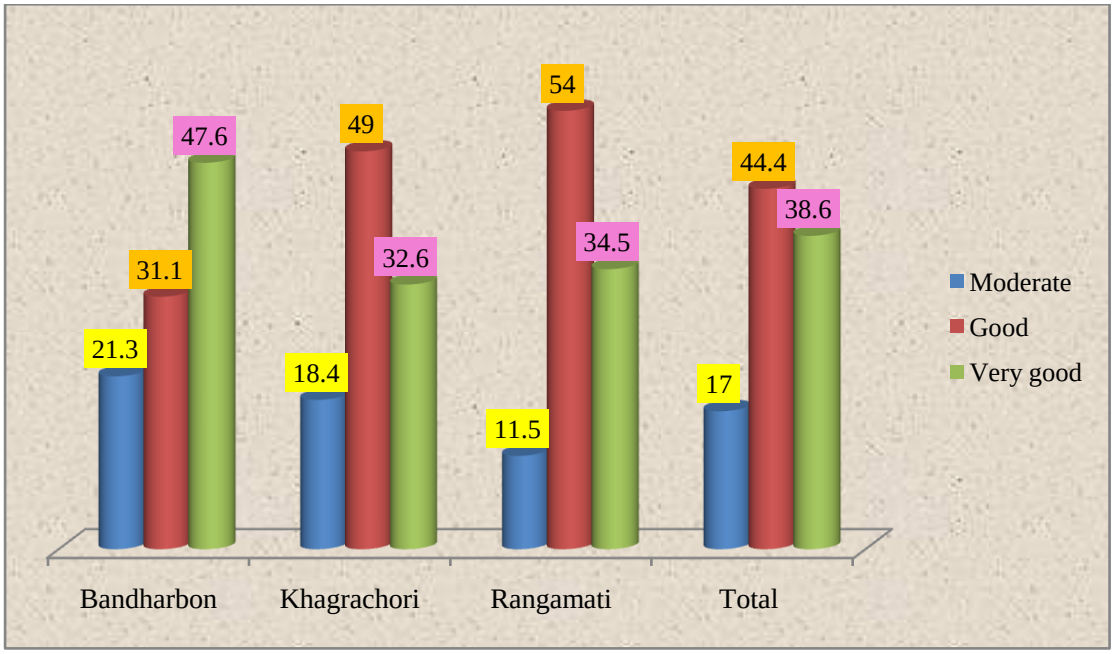

Figure 3.6.a: Level of nutrition knowledge of ethnic people in the CHTs (%)

3.7 Morbidity pattern of ethnic people in the CHTs

Table 3.7.a shows prevalence of common diseases among ethnic people in the CHTs. Gastritis were predominant among 66.1% ethnic people, 21.6 % had either high or low blood pressure. Prevalence of other common diseases was low, 5.3% and 5.3% had asthma and jaundice respectively (Figure-3.7.a). Asthma was more prevalent in Bandarban (55.6%) among three districts. Heart disease was more widespread in Rangamati (87.5%).

Table 3.7.a: Common diseases seen in three districts of the CHTs

Morbidity	Bandharbon % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)
Disease				
Jaundice	44.4 (4)	11.1 (1)	44.4 (4)	5.3 (9)
Blood pressure	37.8 (14)	27 (10)	35.1 (13)	21.6 (37)
Diabetes	25(2)	0 (0)	75 (6)	4.7 (8)
Heart disease	12.5 (1)	0 (0)	87.5 (7)	4.7 (8)
Asthma	55.6 (5)	11.1 (1)	33.3 (3)	5.3 (9)
Kidney disease	100 (1)	0 (0)	0 (0)	0.6 (1)
Gastritis	44.2 (50)	20.4 (23)	35.4 (40)	66.1 (113)
Mental problem	0 (0)	0 (0)	100 (1)	0.6 (1)

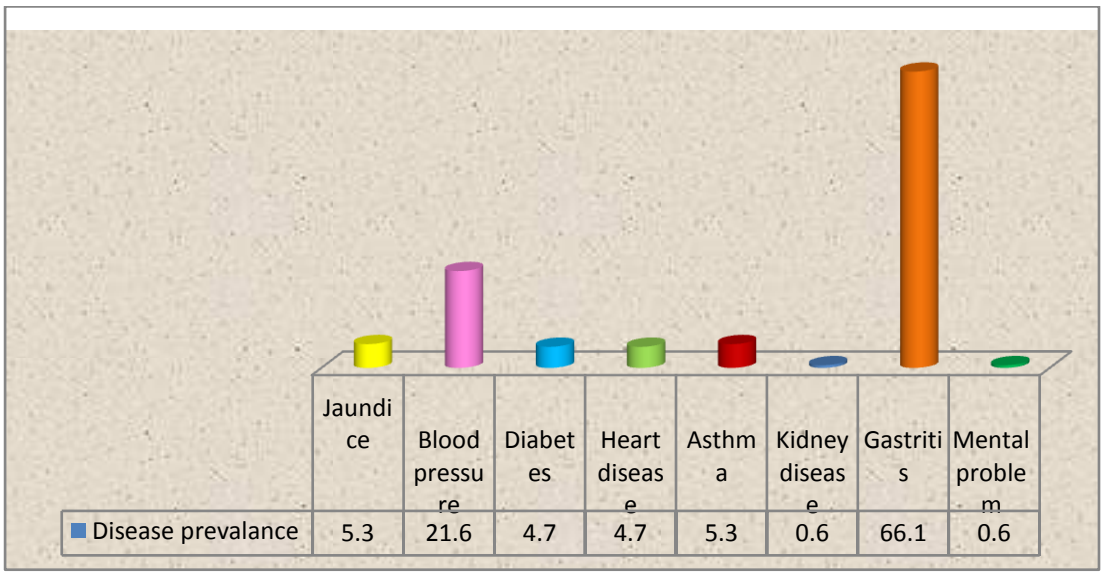

Figure 3.7.a: Prevalence of common diseases in CHTs (%)

3.8 Food insecurity in CHTs

Table 3.8.a represents the food insecurity scenario of ethnic people. About 13.5% of the ethnic people in CHTs had occasionally seen any food insecurity, among them 69.5 % had taken less food for shortage. Of the food insecure participants, 69.5% had sometimes faced inadequacy of balanced food and 8.6% always faced inadequacy of balanced food. Of 49 participants in Khagrachori, only 8.2% occasionally faced food inadequacy, but among them no one had ever taken less food for shortage or lacked balanced food.

Table 3.8.a: Distribution (%) of food insecurity scenario in three districts of the CHTs

Parameter	Bandarban % (Freq)	Khagrachori % (Freq)	Rangamati % (Freq)	Total % (Freq)
Faced Food inadequacy (n=171)				
Never	88.5 (54)	91.8 (45)	80.3 (49)	86.5 (148)
Occasionally	11.5 (7)	8.2 (4)	19.7 (12)	13.5(23)
Taken less food for shortage (n=23)	28.6 (2)	0 (0)	41.7 (5)	30.5 (7)
Never	71.4 (5)	100 (4)	58.3 (7)	69.5 (16)
Occasionally				
Inadequacy of balanced food (n=23)	0 (0)	0 (0)	16.7 (2)	8.6 (2)
Always	71.4 (5)	100(4)	58.3 (7)	69.5 (16)
Sometimes	28.6(2)	0 (0)	25(3)	21.7 (5)
Never				

3.9: Relationship of food security with socio-economy and nutrition knowledge

Table 3.9.a shows the relationship of food security with socio-economy and nutrition knowledge of the ethnic people in CHTs. In lactating women, education was found to be statistically associated to food security (p=0.00) and occupation (p=0.01). Participants who involved in agriculture were more food insured. Occupations like household works and non-agricultural works were associated to individual food security. Monthly income of households was found to have statistical influence (p= 0.00) on food security. Food security of lactating women in the CHTs was significantly associated (p=0.00) with nutrition knowledge. Better nutrition knowledge score positively influenced food security of participants. Statistical association of food security with age and marital status of lactating women could not be established as age between 18-40 years and ever married status were constant.

As far as NPNL women are concerned, significant association was found between food security with education (p=0.02), nutrition knowledge (p=0.05) and monthly income (p=0.02).

Table 3.9.a: Relationship of food security with socio-economy and nutrition knowledge

Parameter	Food security					
	Lactating Woman		Significance Level	NPNL Woman		Significance Level
	Never	Occasi-onally		Never	Occas-ionally	
Education Illiterate Literate	11 63	9 2	p=0.00	21 53	8 4	p=0.02
Occupation Agriculture House hold chores Non Agriculture	1 69 4	3 8 0	Fisher exact value=9.088 P=0.01	6 51 17	2 6 4	Fisher exact test value=2.3 P= 0.326
Age in years 15-17 years 18-40 years	- 74	- 11	ND, 18-40 years is constant	9 65	1 11	P=1.00
Marital status Unmarried Ever married	- 74	- 11	ND, Ever married is constant	12 62	3 9	p=0.432
Income (Tk) <6000 ≥ 6000	6 68	5 6	p=0.00	5 69	4 8	p=0.02
NK Score 14-29 30-45	5 69	7 4	p=0.00	12 62	5 7	p=0.05

Significant: p<0.05
Association: fisher exact test

3.10: Food consumption pattern of ethnic people

Table 3.10.a demonstrate the food consumption pattern of ethnic people in the CHTs with regard to breakfast, lunch and dinner. The majority of the ethnics consumed atap chal, rice, roti, and maize daily in breakfast 94.7%, lunch 100% and dinner 100%.

They consumed less legumes. Only 5.8 %, 14.6 % and 14% had consumed legumes daily in breakfast, lunch and dinner respectively, whereas 30.4 %, 52.6% and 43.9% had taken various kinds of dals in breakfast, lunch and dinner less than four days per week respectively. That means legume is not a frequently consumed food of ethnic people.

Fishes (fresh and dry fish) were found to be consumed by only 8.8%, 14.6% and 11.7% participants daily in breakfast, lunch and dinner respectively, while 33.9%, 62% and 62% of the ethnic people took fish in their breakfast, lunch and dinner at least three days per week respectively. In breakfast, 45.6 % never had any kind of fish, while in lunch and dinner, only 6.4 and 9.4% of ethnic people never had any fish (fresh fish, dry fish, shellfish and nappi) respectively.

Majority of the ethnic people consumed meat infrequently in the seven day menu. About 49.1%, 36.8% and 47.4% had never consumed meat (chicken, beef, lamb, mutton, pork, snake etc) in breakfast, lunch and dinner respectively, while 35.7%, 52% and 45% consumed meat in their breakfast, lunch and dinner three days per week respectively.

A large portion of the ethnics, that is 62%, 63.7% and 77.2% never consumed egg in breakfast, lunch and dinner respectively, while 19.9%, 26.6% and 17.5 % consumed egg three days per week in breakfast, lunch and dinner respectively.

About 55%, 44% and 45% had never eaten any dairy products in seven days in breakfast, lunch and dinner respectively, whereas 17%, 19.3% and 21.1% had consumed dairy products daily in breakfast, lunch and dinner respectively.

Daily consumption of leafy vegetable was observed in 56.1%, 63.7% and 61.4% of participants in breakfast, lunch and dinner respectively.

About 53%, 59% and 51% of ethnic people had consumed non leafy vegetables seven days per week respectively in three major meals, while 28.7%, 21.1% and 35.7% never had non leafy vegetables in major meals respectively.

Fruit consumption was found to be low among the ethnic people. About 74.9%, 69% and 79.5% of of the ethnic never had fruits in their meals in last seven days. Daily consumption of fruits in breakfast, lunch and dinner were observed to be 2.3%, 3.5% and 0.6% respectively in 171 ethnic people.

Table 3.10.a: Food consumption pattern of ethnic people

Food Groups (n=171)	Daily % (n)	4-6 x/wk % (n)	≤ 3 x/wk % (n)	Never % (n)
At breakfast				
Cereals (Atap chal, Rice, Bread, Roti, Maize)	94.7 (162)	1.2 (2)	1.8 (3)	2.3 (4)
legumes	5.8 (10)	12.3 (21)	30.4 (52)	51.5 (88)
Fish (fresh fish, dry fish,shellfish, nappi)	8.8 (15)	11.7 (20)	33.9 (58)	45.6 (78)
meat	8.8 (15)	6.4 (11)	35.7 (61)	49.1 (84)
egg	11.1 (19)	7.0 (12)	19.9 (34)	62 (106)
Milk and dairy products	17 (29)	9.9 (17)	18.7 (32)	54.4 (93)
Leafy vegetables	56.1 (96)	8.8 (15)	18.1 (31)	17 (29)
Non leafy vegetables	52.6 (90)	4.1 (7)	14.6 (25)	28.7 (49)
Fruits	2.3 (4)	5.3 (9)	17.5 (30)	74.9 (128)
At lunch				
Cereals (Atap chal, Rice, Bread, Roti, Maize)	100 (171)	0	0	0
legumes	14.6 (25)	15.8 (27)	52.6 (90)	17 (29)
Fish (fresh fish, dry fish,shellfish, nappi)	14.6(25)	17 (29)	62 (106)	6.4 (11)
meat	1.8 (3)	9.4 (16)	52 (89)	36.8 (63)
egg	5.3 (9)	4.1 (7)	26.9 (46)	63.7 (109)
Milk and dairy products	19.3 (33)	13.5 (23)	23.4 (40)	43.9 (75)
Leafy vegetables	63.7 (109)	12.3 (21)	20.5 (35)	3.5 (6)
Non leafy vegetables	59.1 (101)	5.3 (9)	14.6 (25)	21.1 (36)
Fruits	3.5 (6)	9.4 (16)	18.1 (31)	69 (118)
At dinner				
Cereals (Atap chal, Rice, Bread, Roti, Maize)	100(171)	0	0	0
legumes	14 (24)	16.4 (28)	43.9 (75)	25.7 (44)
Fish (fresh fish, dry fish,shellfish, nappi)	11.7 (20)	17 (29)	62 (106)	9.4 (16)
meat	2.3 (4)	5.3 (9)	45 (77)	47.4 (81)
egg	2.3 (4)	2.9 (5)	17.5 (30)	77.2 (132)
Milk and dairy products	21.1 (36)	12.3 (21)	21.6 (37)	45 (77)
Leafy vegetables	61.4 (105)	11.1 (19)	19.3 (33)	8.2 (14)
Non leafy vegetables	50.3 (86)	5.8 (10)	8.2 (14)	35.7 (61)
Fruits	0.6 (1)	8.2 (14)	11.7 (20)	79.5 (136)

3.11: Food consumption pattern of the ethnic lactating and NPNL women

Table 3.11.a illustrates food consumption pattern of lactating and NPNL women. Among lactating women, 100% consumed cereal food frequently. Cereal food contains atap chal, rice parboiled, maize matured, bread and roti.

Infrequent consumption (0-3 days per week) of legumes was observed among 96.4% of the lactating women, while only 3.6% ate legumes frequently (4-7 days per week). About 56% of ethnic people ate fish (fresh fish, dry fish and nappi) occasionally (0-3 days per week), while 45% consumed fish frequently. With regard to meat consumption, 90.6% had taken meat infrequently through out the week.

Infrequent consumption of egg was found among 80% of lactating women. About 82.2% of lactating ethnic people were found to have taken milk and dairy products infrequently seven days and 63.5% never had fruits in their daily diet menu.

About 62% and 98% lactating women were found to have consumed leafy and non leafy vegetables frequently (4-7 days per week) respectively. Irregular consumption of fruits was found among 64.7% of lactating women.

Similar findings was also observed in NPNL women, whereas 100% consumed cereal products frequently and daily, nearly 93% ate legumes infrequently (0-3 days per week), 58.2% consumed fish 4-7 days per week, 82.6% consumed meat infrequently; and 62.8% and 70.9% of NPNL women consumed egg and dairy products infrequently. About 58.1% and 98.8 % consumed leafy vegetables and non leafy vegetables frequently (4-7 days per week) respectively. Infrequent fruit consumption was seen among 53.5% NPNL people. Both lactating and NPNL women consumed more of cereals and non leafy vegetables other than any foods.

Table 3.11.a: Frequency of food consumption from different food groups

Food Groups	Frequent consumption			Infrequent consumption		
	Daily % (n)	4-6 x/wk % (n)	Total % (n)	≤ 3 x/wk % (n)	N %	Total n (%)
Lactating women (n=85)						
Cereals (Atap chal,Rice, Bread, Roti, Maize)	100 (85)	0	100 (85)	0	0	0
legumes	2.4(2)	1.2 (1)	3.6(3)	60(51)	36.5(31)	96.4(82)
Fish (fresh fish, dry fish, shellfish, nappi)	16.5 (14)	28.2 (24)	44.7 (38)	54.1 (46)	1.2 (1)	55.3 (47)
Meat	1.2 (1)	8.2 (7)	9.4 (8)	71.8 (61)	18.8 (16)	90.6 (77)
Egg	10.6 (9)	9.4 (8)	20 (17)	55.3 (47)	24.7 (21)	80 (68)
Milk and dairy products	14.1 (12)	4.7 (4)	18.8 (16)	17.6 (15)	63.5 (54)	82.2(69)
Leafy vegetables	28.2 (24)	34.1 (29)	62.3 (53)	30.6 (26)	7.1 (6)	37.7 (32)
Non leafy vegetables	97.6 (83)	0	97.6 (83)	2.4 (2)	0	2.4 (2)
Fruits	10.6 (9)	24.7 (21)	35.3 (30)	49.4 (42)	15.3 (13)	64.7(55)
NPNL women (n=86)						
Cereals	100 (86)	0	0	0	0	0
legumes	2.3 (2)	4.7 (4)	7 (6)	70.9 (61)	22.1 (19)	93 (80)
Fish	25.6 (22)	32.6 (28)	58.2 (50)	41.9 (36)	0	41.9 (36)
Meat	8.1 (7)	9.3 (8)	17.4 (15)	72.1 (62)	10.5 (9)	82.6 (71)
Egg	17.4 (15)	19.8 (17)	37.2 (32)	47.7 (41)	15.1 (13)	62.8 (54)
Milk and dairy products	19.8 (17)	9.3 (8)	29.1 (25)	12.8 (11)	58.1 (50)	70.9 (61)
Leafy vegetables	37.2 (32)	20.9 (18)	58.1 (50)	38.4 (33)	3.5 (3)	41.9 (36)
Non leafy vegetables	97.6 (83)	1.2 (1)	98.8 (84)	0	1.2 (1)	1.2 (1)
Fruits	33.7 (29)	12.8 (11)	46.5 (40)	41.9 (36)	11.6 (10)	53.5 (46)

3.12: Energy and macronutrient intake

The energy and macronutrient intake by lactating and NPNL women in term of quantity and percentage are presented in table 3.12.a. The average energy, protein, fat and carbohydrate intake of lactating and NPNL women were 2731±803.23 and 2531±790 kcal, 85.5±36.9 and 81.6±38 g, 43.3±36.42 and 35.9±30.82 g and 490±121.3 and 468±128.7 g respectively. It was noticed that lactating women took more energy and nutrients than the NPNL women. In both lactating and NPNL women 72% and 74% of energy came from carbohydrate respectively. Both groups obtained 13% of this energy from protein. Similarly 15% and 13% energy was obtained from fat in lactating and NPNL women respectively.

Table 3.12.b represents the dietary intake of energy, protein and fat by ethnic people groups. It was showed that 79.5% ethnics fulfilled their energy as per RDA. Above 81% lactating women and 78% NPNL women obtained energy requirement as per RDA. Protein intake was met by 51% lactating and 62% NPNL women and fat intake was met 36.5% lactating and 62.8% NPNL women.

Table 3.12.a: Mean intake of energy and macronutrient, and percent of energy obtained from macronutrients

Parameter	Lactating Woman (n=85)		NPNL Woman (n=86)	
	Mean ±SD	%	Mean ±SD	%
Calorie intake (kcal)	2731± 803.23		2531 ± 790	
Protein (gm)	85.5 ± 36.9	13%	81.6 ± 38	13%
Fat(gm)	43.3 ± 36.42	15%	35.9± 30.82	13%
Carbohydrate(gm)	490 ± 121.3	72%	468 ± 128.7	74%

Table 3.12.b: Dietary energy, protein and fat intake by the ethnic groups

Parameter	Groups	RDA	Ranges	%	Mean±SD	Total % (n)
Energy (kcal)	Lactating woman (15-40 years) Total	*	<RDA ≥RDA	18.8 (16) 81.2 (69) 100 (85)	1656.5±261.3 2980.9±668.7 2731± 803.23	20.5 (35) 79.5 (136)
	NPNL woman (15-40 years) Total	*	<RDA ≥RDA	22 (19) 78 (67) 100 (86)	1416.9 ±361.7 2801.3 ± 618.6 2531 ± 790	
Protein (g)	Lactating woman (15-40 years) Total	*	<RDA ≥RDA	49 (41) 51 (44) 100(85)	58.8 ± 13.5 110.4±34.4 85.8 ± 36.9	42.7 (73) 57.3 (98)
	NPNL woman (15-40 years) Total	50	<RDA ≥RDA	38 (32) 62 (54) 100 (86)	50.5 ±12.8 100± 35.8 81.6 ± 38	
Fat (g)	Lactating woman (15-40 years) Total	45	<RDA ≥RDA	63.5 (54) 36.5 (31) 100 (85)	21.85±10.10 79.37±40.6 43.3 ± 36.42	50.3 (86) 49.7 (85)
	NPNL woman (15-40 years) Total	20	<RDA ≥RDA	37.2 (32) 62.8 (54) 100(86)	12.6±4.03 45.5±31 35.9± 30.82	

Descriptive statistics: frequencies, descriptive

***RDA of energy in lactating women** [64]

In 0-6 months of lactation	**1n 6-12 months of lactation**	***RDA of energy in NPNL women**
Sedentary worker – 1875 +550 kcal	Sedentary worker – 1875 +400 kcal	Sedentary worker – 1875 kcal
Moderate worker- 2225+550 kcal	Moderate worker- 2225+400 kcal	Moderate worker- 2225 kcal
Heavy worker- 2925+550 kcal	Heavy worker- 2925+400 kcal	Heavy worker- 2925 kcal

***RDA of protein in Lactating women :** In 0-6 months of lactation- 50+25 gm and 1n 6-12 months of lactation- 50+ 18 gm

3.13: Micronutrient (vitamin A, vitamin E, zinc, copper and iron) intake

The average micronutrient intake of lactating and NPNL women is represented in table 3.13.a. Vitamin A, vitamin E, zinc, copper and iron intake of lactating and NPNL women were 920±236 and 826±234.7 µg RE, 6.8±4.8 and 6±3.63 mg, 14.96±2.81 and 14.75±3.12 mg, 4.1±1.8 and 4.1±2.6 mg and 20±15.3 and 20.7±14.5 mg respectively.

Table 3.13.b represents the dietary vitamin A, vitamin E, zinc, copper and iron intake of ethnic people by groups. Overall results showed that out of 171 ethnic people 84%, 93% and 99% had fulfilled their vitamin A, zinc and copper requirements as per RDA respectively. In respect of vitamin E and iron intake, 95.3% and 51% did not fulfill their intakes as per RDA respectively.

Vitamin A intake as per RDA was obtained by 78 % lactating women, and 91% and 89% NPNL women of 15-18 and 19-40 years age group respectively.

Dietary vitamin E intake analysis results showed that, 95.3% from both the groups consumed vitamin E less than the RDA. About 87% and 99 % lactating and NPNL women had consumed zinc equivalent or nearer to the RDA respectively.

Copper intake results showed that, for lactating and NPNL women, 98% and 100% had consumed copper as per RDA respectively.

The iron intake per day equivalent or nearer to the recommended limit was obtained by 48 %, 55% and 49% lactating and NPNL women of two age groups (15-18 and 19-40 years) respectively.

Table 3.13.a: Mean daily micronutrients (vitamin A, vitamin E, zinc, copper and iron) intake by the ethnic groups

Parameter	Lactating Woman (n=85) Mean±SD	NPNL Woman (n=86) Mean±SD
Vitamin A (µg RE/day)	920 ± 236	826 ± 234.7
Vitamin E (mg/day)	6.8 ± 4.8	6 ± 3.63
Zinc (mg/day)	14.96 ± 2.81	14.75 ± 3.12
Copper (mg/day)	4.1± 1.8	4.1 ± 2.6
Iron (mg/day)	20 ± 15.3	20.7 ± 14.5

Table 3.13.b: Dietary micronutrients (vitamin A, vitamin E, zinc, copper and iron) intake

Parameter	Groups	RDA	Ranges	%(n)	Mean ±SD	**Total %(n)**
Vitamin A[52] (µgRE/day)	Lactating woman (15-40 years) Total	850	<RDA ≥RDA	22 (19) 78 (66) 100 (85)	580.4±137.3 1018.2±152.7 920±236	16(28) 84(143)
	NPNL woman (15-18 years) Total	600	<RDA ≥RDA	9 (1) 91 (10) 100 (11)	546±0.0 933.1±150 901±183.7	
	NPNL woman (19-40 years) Total	500	<RDA ≥RDA	11(8) 89 (67) 100(75)	342.6±114.9 860±186 815±240	
Vitamin E[54] (mg/day)	Lactating woman (15-40 years) Total	19	<RDA ≥ RDA	95.3 (81) 4.7 (4)	6.2 ±3.8 20.14 ±27.0 6.8 ± 4.8	95.3 (163) 4.7(8)
	NPNL woman (15-40 yrs) Total	15	<RDA ≥ RDA	95.3 (82) 4.7 (4)	5.3±2.9 16.1±21.6 6 ± 3.63	
Zinc[52] (mg/day)	Lactating woman (15-40 years) Total	12 -13	<RDA ≥RDA	13 (11) 87 (74) 100 (85)	11.0±0.6 15.7±2.6 14.97±2.81	7(12) 93(159)
	NPNL woman (15-40 years) Total	8 -9	<RDA ≥RDA	1 (1) 99(85) 100 (86)	8.57±0.0 14.82±3.5 14.46 ±2.7	
Copper (mg/day)	Lactating woman (15-40 years) Total	1.3	<RDA ≥ RDA	2 (2) 98 (83) 100 (85)	1.05±0.2 4.2±1.8 4.1±1.8	1(2) 99 (169)
	NPNL woman (15-40 yrs) Total	[52] 0.89 - 0.9	≥ RDA	100 (86) 100(86)	4.1±2.6	
Iron (mg/day)	Lactating woman (15-40 years) Total	[52]9 -18	<RDA ≥RDA	52 (44) 48 (41) 100 (85)	12.1±2.7 28.52±19.5 20±15.89	51(87) 49 (84)
	NPNL woman (15-18 years) Total	15	<RDA ≥RDA	45(5) 55 (6) 100 (11)	12.7±3.8 31.3±27.99 22.8±22.2	
	NPNL woman (19-40 years) Total	18	<RDA ≥RDA	51(38) 49(37) 100 (75)	11.4±3.4 28.8±13.1 21.6±15.3	

Descriptive statistics: frequencies, descriptive

[52]RDA of zinc in lactating women
15-18 years- 13 mg/day
19-40 years – 12 mg/day

[52]RDA of zinc in NPNL women
15-18 years- 9 mg/day
19-40 years – 8 mg/day

[52]RDA of copper in NPNL women
15–18 years-0.89 mg/day
19-40 years- 0.90 mg/day

[52]RDA of iron in lactating women
15-18 years- 10mg/day
19-40 years- 9 mg/day
After 12 months of lactation in 15-18 years – 15 mg/day
After 12 months of lactation in 19-40 years – 18 mg/day

3.14: Consumption of micronutrient from ethnic and general foods

Table 3.14.a represents the mean consumption of micronutrients from ethnic and general foods by ethnic groups.

In lactating and NPNL women, almost all vitamin A came from general foods as average vitamin A was 903±235 and 808±234 µg RE/day, while from ethnic foods mean vitamin A consumed was 16.9±2.8 and 18.2±4.3 µg RE/day respectively.

Greater part of dietary vitamin E came from general foods in both lactating and NPNL women; on average 3.9±3.9 and 4.2±2.63 mg/day respectively. Comparatively less vitamin E was obtained from ethnic foods; on average 1.7±0.9 and 1.8±1 mg/day respectively.

Zinc is the only nutrient which was obtained from both ethnic and general foods almost equally by the two groups. In lactating and NPNL women, average zinc consumed from ethnic foods was 7.7±1.3 and 7.6 ±0.9 mg/day and from general foods 7.3±2.8 and 7.2±2.7 mg/day respectively. It is evident that ethnic foods are zinc rich.

Average copper and iron consumed from general foods was 3.3±1.9 and 3.4±2.6 mg/day and 16.6±16.02 and 17.5±14.33 mg/day for both the groups respectively. It was noticed from the results that less dietary copper and iron were obtained from ethnic foods.

Table 3.14.a: Consumption of micronutrient from ethnic and general foods per day

Parameter	Ethnic foods		General foods	
	Lactating woman Mean ± SD	NPNL Woman Mean ± SD	Lactating woman Mean ± SD	NPNL Woman Mean ± SD
Vitamin A (µg RE/day)	16.9±2.8	18.2±4.3	903±235	808±234
Vitamin E (mg/day)	1.7±0.9	1.8±1	3.9±3.9	4.2±2.63
Zinc (mg/day)	7.7±1.3	7.6 ±0.9	7.3±2.8	7.2±2.7
Copper (mg/day)	0.89±0.6	0.77±0.4	3.3±1.9	3.4±2.6
Iron (mg/day)	3.4±0.74	3.2±0.6	16.6±16.02	17.5±14.33

3.15: Relationship of dietary vitamin A intake (RDA) status with socio-economy, nutritional status and knowledge; and household food security

Table 3.15.a represents the relationship of dietary vitamin A intake (RDA) status with socio-economy, nutritional status and knowledge; and household food security of the ethnic people of both the groups (lactating and NPNL women). Education, occupation, income, nutrition knowledge, food security and BMI ranges were found to be significantly influenced positively the dietary vitamin A status of both lactating and NPNL women.

Table 3.15.a: Relationship of dietary vitamin A intake (RDA) status with socio-economy, nutritional status and knowledge; and food security

Parameter	Dietary vitamin A					
	Lactating Woman		Significance level	NPNL Woman		Significance level
	< RDA	≥RDA		< RDA	≥RDA	
Education			X^2=27.407			
Illiterate	13	7	Df=1	7	22	P=0.00
Literate	6	59	P=0.00	2	55	
Occupation			Fisher exact			Fisher exact
Agriculture	3	1	test	3	5	test
House hold chores	16	61	value=5.861	4	53	value=5.537
Non Agriculture	0	4	P=0.04	2	19	P=0.03
Income (Tk)			X^2=7.544			
<6000	6	5	Df=1	3	6	P=0.05
≥6000	13	61	P=0.00	6	71	
HH food insecurity						
Never	10	64	P=0.00	4	70	P=0.00
Occasionally	9	2		5	7	
Nutrition Knowledge score						
14-29	8	4	P=0.00	5	12	P=0.01
30-45	11	62		4	65	
BMI (kg/m^2)			Fisher exact			Fisher exact
<normal	5	4	test	5	6	test
Normal 18.5-24.99	12	48	value=5.812	3	54	value=11.271
> normal	2	14	P=0.05	1	17	P=0.00

Association: chi-square test, Fisher exact test (when cell value of any category was less than 5)
Significant: $p<0.05$

3.16: Relationship of dietary vitamin E intake (RDA) status with socio-economy, nutritional status and knowledge; food security and dietary fat intake

Table 3.16.a represents the relationship of dietary vitamin E intake (RDA) status with socio-economy, nutritional status and knowledge; and household food security of ethnic people of both the groups (lactating and NPNL women). In lactating and NPNL women, education, occupation, income, nutrition knowledge, BMI ranges and dietary fat were found not to be significantly associated to the dietary vitamin E status.

Although, it is apparent from results that; literacy, occupancy in household chores, better income and nutrition knowledge, and normal BMI negatively influenced dietary vitamin E intake in both the groups.

Table 3.16.a: Relationship of dietary vitamin E intake (RDA) status with socio-economy, nutritional status and knowledge; food security and dietary fat intake

Parameter	Dietary vitamin E					
	Lactating Woman		Significance level	NPNL Woman		Significance level
	< RDA	≥RDA		< RDA	≥RDA	
Education						
Illiterate	20	0	P=0.569	28	1	P=1.0
Literate	61	4		54	3	
Occupation			Fisher exact test			
Agriculture	4	0	value=0.665	8	0	P=1.0
House hold chores	73	4	P=1.0	54	3	
Non Agriculture	4	0		20	1	
Income (Tk)						
<6000	10	1	P=0.432	9	0	P=1.0
≥6000	71	3		73	4	
HH food insecurity						
Never	71	3	P=0.432	70	4	P=1.0
Occasionally	10	1		12	0	
Nutrition Knowledge score						
14-29	12	0		17	0	
30-45	69	4	P=1.0	65	4	P=0.581
BMI (kg/m^2)			Fisher exact test			
<normal	9	0	value=0.759	11	0	P=1.0
Normal 18.5-24.99	56	4	P=0.730	54	3	
> normal	16	0		17	1	
Dietary fat (g/day)						
<RDA	51	3	P=1.0	32	0	P=0.292
≥RDA	30	1		50	4	

Association: Fisher exact test (when cell value of any category was less than 5)
Significant: p<0.05

3.17: Relationship of dietary zinc intake (RDA) status with socio-economy, nutritional status and knowledge; and food security

Table 3.17.a represents the relationship of dietary zinc intake (RDA) status with socio-economy, nutritional status and knowledge; and household food security of ethnic people of both the groups (lactating and NPNL women).

Dietary zinc status of lactating women is clearly associated with education (p=0.00), income (p=0.00), household food security (p=0.04) and nutrition knowledge score (p=0.00), while no influence were found of occupation and BMI ranges on dietary zinc intake (p=0.687 and 0.150 respectively).

No significant association of dietary zinc status was found with any of these factors in NPNL women.

Table 3.17.a: Relationship of dietary zinc intake (RDA) status with socio-economy, nutritional status and knowledge; and food security

Parameter	Dietary Zinc					
	Lactating Woman		**Significance level**	NPNL Woman		**Significance level**
	< RDA	≥RDA		< RDA	≥RDA	
Education			X^2=6.755			
Illiterate	6	14	Df=1	1	28	P=0.337
Literate	5	60	P=0.00	0	57	
Occupation						
Agriculture	1	3	P=0.687	1	7	
House hold chores	10	67		0	57	P=0.09
Non Agriculture	0	4		0	21	
Income (Tk)			X^2=11.855			
<6000	5	6	Df=1	1	8	P=0.105
≥ 6000	6	68	P=0.00	0	77	
HH food insecurity			X^2=11.855			
Never	6	68	Df=1	0	74	
Occasionally	5	6	P=0.00	1	11	P=0.140
Nutrition Knowledge						
14-29	4	8	P=0.04	1	16	P=0.198
30-45	7	66		0	69	
BMI (kg/m^2)			Fisher exact			
< normal	3	6	test	0	11	P=1.0
Normal 18.5-24.99	7	53	value=3.502	1	56	
> normal	1	15	P=0.150	0	18	

Association: chi-square test, Fisher exact test (when cell value of any category was less than 5)
Significant: p<0.05

3.18: Relationship of dietary copper intake (RDA) status with socio-economy, nutritional status and knowledge; and food security

Table 3.18.a represents the relationship of dietary copper intake (RDA) status with socio-economy, nutritional status and knowledge; and household food security of the ethnic people of both the groups (lactating and NPNL women). In lactating women, literacy, income, food security and nutrition knowledge were found to be significantly associated to the dietary copper intake equal or greater than RDA (p=0.05, 0.01, 0.02, and 0.01 respectively), while no influence was observed of occupation and BMI ranges (p=0.180 and 0.730 respectively).

In NPNL women, statistical association of dietary copper intake with these factors could not be established as dietary copper intake as per RDA was constant, but from the table it is apparent that; literacy, occupancy in household chores, better income and nutritional knowledge, normal BMI and household food security positively influenced dietary copper intake as greater number of dietary copper intake nearer or equal to RDA falls in these categories.

Table 3.18.a: Relationship of dietary copper intake (RDA) status with socio-economy, nutritional status and knowledge; and food security

Parameter	Dietary Copper				
	Lactating Woman		Significance level (fisher exact test)	NPNL Woman	Significance level (fisher exact test)
	< RDA	≥RDA		≥RDA	
Education					ND, Copper ≥RDA is constant
Illiterate	2	18	P=0.05	29	
Literate	0	65		57	
Occupation					ND, Copper ≥RDA is constant
Agriculture	1	3	P=0.180	8	
House hold chores	1	76		57	
Non Agriculture	0	4		21	
Income (Tk)			P=0.01		ND, Copper ≥RDA is constant
<6000	2	9		9	
≥6000	0	74		77	
HH food insecurity			P=0.01		ND, Copper ≥RDA is constant
Never	0	74		74	
Occasionally	2	9		12	
Nutrition Knowledge					ND, Copper ≥RDA is constant
14-29	2	10	P=0.02	17	
30-45	0	73		69	
BMI (kg/m^2)			Fisher exact test value=8.443 P=0.730		ND, Copper ≥RDA is constant
< normal	2	7		11	
Normal 18.5-24.99	0	60		57	
> normal	0	16		18	

Association: Fisher exact test (when cell value of any category was less than 5)
Significant: p<0.05

3.19: Relationship of dietary iron intake (RDA) status with socio-economy, nutritional status and knowledge; food security and dietary protein intake

Table 3.19.a represents the relationship of dietary iron intake (RDA) status with socio-economy, nutritional status and knowledge; and food security of ethnic lactating and NPNL women. Positive influence was noticed of BMI ranges and dietary protein intake on dietary iron intakes, while association with other factors were found to be insignificant.

Table 3.19.a: Relationship of dietary iron intake (RDA) status with socio-economy, nutritional status and knowledge; food security and dietary protein intake

Parameter	Dietary iron					
	Lactating Woman		Significance level	NPNL Woman		Significance level
	< RDA	≥RDA		< RDA	≥RDA	
Education			X^2=0.033			X^2=0.468
Illiterate	10	10	Df=1	16	13	Df=1
Literate	34	31	P=.857	27	30	P=0.494
Occupation			Fisher exact			Fisher exact
Agriculture	2	2	value=0.261	2	6	value=4.469
House hold chores	40	37	P=1.0	33	24	P=0.116
Non Agriculture	2	2		8	13	
Income (Tk)						
<6000	7	4	P=0.523	4	5	P=1.0
≥6000	37	37		39	38	
HH food insecurity						
Never	40	34	P=0.341	36	38	P=0.757
Occasionally	4	7		7	5	
Nutrition Knowledge score			X^2=0.241			X^2=3.592
14-29	7	5	Df=1	5	12	Df=1
30-45	37	36	P=0.623	38	31	P=0.06
BMI (kg/m^2)			Fisher exact			
<normal	6	3	value=5.862	8	3	Fisher exact
Normal 18.5-24.99	26	34	P=0.05	23	34	value=6.243
> normal	12	4		12	6	P=0.04
Dietary protein (g/day)			X^2=35.815			X^2=33.644
<RDA	35	6	Df=1	29	3	Df=1
≥RDA	9	35	P=0.00	14	40	P=0.00

Association: chi-square test, Fisher exact test (when cell value of any category was less than 5), Significant: p<0.05

3.20: Nutritional status of ethnic people in the Chittagong Hill Tracts

Table 3.20.a illustrates the anthropometric indices and nutritional status of ethnic people in CHTs. Among them, 53.2% had the length (height) between 151 to 175 cm. The average height measured was 151.5±6.7 cm. Majority (53.8%) of the ethnics had the weight between 31 kg to 50 kg. The average weight measured of ethnic people was 51.1±8.3 kg.

According to MUAC cut off point which is 22.4 cm, 87.2% were considered to have normal weight and 12.8% were underweight. The average measured MUAC for the ethnic people was 25.4±2.6 cm.

In the assessment of nutritional status of these ethnic people according to WHO classification of BMI, prevalence of underweight was found to be 11.7%, while 68.4% had normal weight and 19.9% were overweight. The average BMI measured for these ethnic people was 22.3±3.9.

Table 3.20.b. represents the anthropometric indices of ethnic people by groups. For lactating and NPNL women, 54% and 52% had the length (height) between 151cm to 175 cm, 55% and 52% had the weight between 31 kg to 50 kg, and 87% and 87% had the MUAC as per cut off point and were considered to have normal weight according to UNICEF- WCARO, 2009 (Figure-3.20.a).

About 11% and 18% lactating women were found to be underweight and overweight according to WHO classification of BMI, while 71% were considered to have normal weight (Figure-3.20.b).

Prevelence of underweight and overweight was found to be 13% and 21% respectively among these ethnic NPNL women, but greater number (66%) of them were found to be wellnourished as they manage to have an expected weight (Figure-3.20.b).

Although, the mean value of weight, MUAC and BMI except mean value of height were apparently observed a little higher in NPNL women than the lactating women, the difference was insignificant (p=0.2-0.7).

Table 3.20.a: Anthropometric indices and nutritional status of ethnic people in the CHTs

Parameter	Frequency	Percentage	Mean±SD
Height (cm)			
126-150	80	46.8	151.5 ± 6.7
151-180	91	53.2	
Total	171	100	
Weight (kg)			
31-50	92	53.8	51.1 ± 8.3
51-75	79	46.2	
Total	171	100	
MUAC (cm)			
<22.4 cm	22	12.8	25.4± 2.6
≥22.4 cm	149	87.2	
Total	171	100	
BMI (kg/ m^2)			
<18.5	20	11.7	
18.5-24.99	117	68.4	22.3 ± 3.9
≥25	34	19.9	
Total	171	100	

Descriptive statistics: Frequencies, descriptive

Table 3.20.b: Anthropometric indices and nutritional status of the ethnic people by groups

Parameter	Lactating Woman		NPNL Woman		Significance level
	% (freq)	Mean±SD	%(freq)	Mean±SD	
Height (cm)					
126-150	46 (39)	147.7±2.4	48 (41)	145.2±7.4	t=-1.259
151-180	**54 (46)**	156.4±4.3	**52 (45)**	155.4±3.0	p=0.211
Total	100 (85)	**151.6±5.7**	100 (86)	**150.5±7.5**	
Weight (kg)					
31-50	**55 (47)**	44.5±4.2	**52 (45)**	45.4±3.7	t =0.288
51-75	45 (38)	58.7±6.4	48 (41)	57.5±5.6	p=0.774
Total	100 (85)	**50.9±8.7**	100 (86)	**51.1±7.7**	
MUAC (cm)					
<22.4 cm	13 (11)	21.5±0.5	13(11)	21.2±0.4	t =0.824
≥22.4 cm	**87(74)**	25.7±2.5	**87(75)**	26.3±2.1	p=0.412
Total	100 (85)	**25.4±2.75**	100 (86)	**25.6±2.6**	
BMI (kg/ m^2)					
<18.5	11(9)	16.5±1.2	13(11)	17.3±1.7	
18.5-24.99	**71(60)**	21.2±1.8	**66 (57)**	21.9±1.8	t =1.249
≥25	18 (16)	27.4±2.4	21 (18)	28.1±51	p=0.215
Total	100 (85)	**22.12±3.4**	100 (86)	**22.6±4.3**	

Significant: p<0.05
Descriptive statistics: Frequencies, descriptive, cross tables
Compare mean: One sample t-test

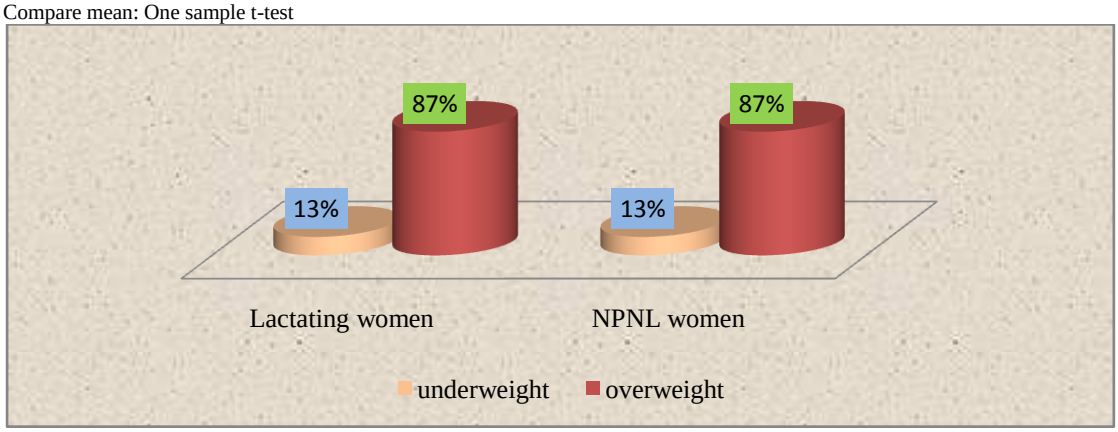

Figure 3.20.a: Nutritional status of lactating and NPNL women using MUAC classification (UNICEF – WCARO) [62]

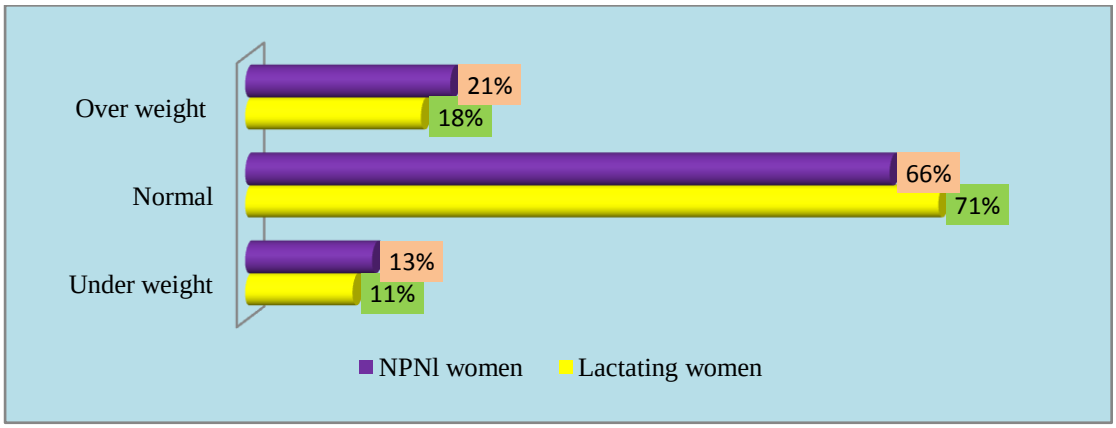

Figure 3.20.b: Nutritional Status of lactating and NPNL women using BMI classification (WHO classification) [61]

3.21 Relationship of nutritional status with socio-economy, nutritional knowledge, food security and calorie intake

Table 3.21.a demonstrates the relationship of nutritional status of ethnic people with their socio-economic status, food security, nutrition knowledge and calorie intake. It was noticed that normal nutritional status of ethnic lactating and NPNL women were significantly associated with literacy (p=0.00 and 0.02), occupation (p=0.02 and 0.00), income (p=0.01 and 0.01), food security (p=0.02 and 0.02); nutrition knowledge (p=0.03 and 0.04) and calorie intake (p=0.00 and 0.049). Statistical association of normal nutritional status with age and marital status of lactating women could not be established as age between 18-40 years and ever married status were constant. Although, apparently it could be said that age between 18-40 years and ever marital status had a positive relationship with normal nutritional status as most cases fell in these three categories (n=60). Age and marital status were found not to be significantly associated with normal nutritional status of ethnic NPNL women (p=0.227 and p=0.222 respectively).

Table 3.21.a: Relationship of nutritional status of ethnic groups with their socio-economic status, nutritional knowledge, food security and calorie intake

parameter	BMI							
	Lactating Woman			Significance Level (Fisher's exact test)	NPNL Woman			Significance Level (Fisher's exact test)
	Under Weight (<18.5)	Desirable Weight (18.5 - 25)	Over Weight (≥25)		Under Weight (<18.5)	Normal Weight (18.5 - 25)	Over Weight (≥25)	
Education				X^2=9.343				X^2=8.176
Illiterate	6	10	4	p=0.00	8	17	4	p=0.02
Literate	3	50	12		3	40	14	
Occupation				Value				X^2=13.084
Agriculture	3	1	0	=10.146	5	2	1	p=0.00
House hold chores	6	56	15	p=0.02	4	41	12	
Non Agriculture	0	3	1		2	14	5	
Age in years				ND,				X^2=2.982
15-17 years	-	-	-	18-40 years	3	6	1	p=0.227
18-40 years	9	60	16	is constant	8	51	17	
Marital status				ND, ever				Value=3.064
Unmarried	-	-	-	married is	4	9	2	p=0.222
Ever married	9	60	16	constant	7	48	16	
Income (Tk)				Value=8.236				Value=7.798
<6000	4	7	0	p=0.01	4	5	0	p=0.01
≥ 6000	5	53	16		7	52	18	
*** food insecurity**				X^2=7.178				X^2=6.959
Never	5	55	14	p=0.02	7	49	18	p=0.02
Occasionally	4	5	2		4	8	0	
NK Score				Value=6.182				Value
14-29	4	7	1	p=0.03	5	11	1	=6.247
30-45	5	53	15		6	46	17	p=0.04
Calorie intake				X^2=11.502				value=6.027
<RDA	6	8	2	p=0.00	2	9	8	p=0.049
≥RDA	3	52	14		9	48	10	

Significant: p<0.05, Association: fisher exact test

Chapter **4:** Discussions, key findings, conclusion, recommendations and references

Discussions

Socio-demographic status of a group of population is a measure of combination of education, income, occupation, religion, family type, food security, food consumption and disease prevalence. It is commonly conceptualized as the social standing or class of an individual or group. Ethnic people of CHTs are considered as an underdeveloped, unprivileged and neglected population of Bangladesh. But in last few years this scenario has been changing. Over the last decades, the government, NGOs and many international organizations have made a commendable contribution to the process of successful building of infrastructure and improving the socio-demographic conditions of the ethnic people in the CHTs. The first chapter of this study focused on the socio-demographic status of ethnic people, but it is not well documented.

This study address the socio-demographic profile of household head and spouse, sex, age, education, occupation, income and expenditure, food security, religion, tribe and family types of ethnic peoples of CHTs. Detailed information were collected and analysed with a statistical software package (SPSS version 21).

It was observed that, out of 156 household heads and their spouses, 81% and 65.4% respectively were literate. Literacy rate of spouses was 15.6% lower than their counterparts. Among 171 ethnic people, 71.5% were literate, where 57.3% of respondents completed secondary education. An acceleration of literacy rate is seen compared to previous surveys conducted on the ethnic people of the CHTs. In 2009, the socio-economic baseline survey of CHTs by CHTDF documented that 54.5% of the ethnic household heads had no education and 53.9% of the ethnic people were illiterate. This study also indicated that the number of individuals who completed secondary education were marginally higher among the ethnic people (15%) than Bangalee people. In another study conducted in 2014 among 150 participants of both the male and female members of ethnic people in CHTs, illiteracy rate was found to be 36.7%. This increased literacy could be the outcomes of various projects and services like – provision of new schools; mother language based multi lingual pre-primary education; and new recruitment and training of teachers provided for ethnic people in the CHTs by local, national and international NGOs.

Among 156 ethnic household heads, 68% were occupied with non-agricultural services such as governmental, non- governmental jobs and business etc. Relatively smaller portion (30.7%) employed themselves with agriculture. The result is not similar to the CHTDF, 2009, where 71.3% of the ethnic household heads occupationally involved with some kind of agriculture (plough and jum cultrivation and agri labour) and 9.7% were involved in jobs and businesses. This alteration in occupation from agricultural to non-agricultural services could be the results of land dispossession (21.8 % ethnic people in CHTs have been dispossessed of their own land), higher percentage of educational attainment, new job opportunities, development of new social infrastructure (roads and transportation facilities), and provision of 10% tribal quota for ethnic community in civil services (Nuzhat yasmin, 2010).[45]

Greater percentage (83.9%) of spouses of household heads kept them busy with household chores and did not contribute to family income. Only 11% and 5.1 % occupyed themselves with agricultural and non-agricultural jobs respectively. Considerable professional difference was seen between the household heads and their wives in the study area.

Among 171 ethnics, 78.4% occupyed themselves with household chores, 7% had taken agriculture as profession, 5.3% were employed with jobs, 7% were students and 2.3 % were doing some kind of businesses. Similar results were found in CHTDF, 2009. It was revealed

there that 11% of the household annual income had been contributed by the working or earning female members of ethnic households.

In a whole, Chakma (39.8%) and Marma (44.4%) were the predominant tribe types of ethnic people in CHTs, where 8.2%, 5.8%, 0.6% of the ethnic people were Bam, Tripura, Tonchoanga and remaining 1.2% belonged to other types.

This study documented that, 59.1 % of the ethnic people lived in a single family with their parents and siblings, while 40.9 % lived in a joint family. Similar pattern was seen in all the three districts, where 60.6%, 63.3% and 54.1% ethnics from Bandarban, Khagrachori and Rangamati belong to single families respectively. This picture indicates that the concept of joint family is losing its place in the ethnic communities of CHTs with an impact that they do not have to share their resources with family members.

Majority of (84.2 %) the ethnic people were the followers of Buddhism, where 10.5% and 5.3% were Christian and Hindu.

Among 171ethnic people, 81.9% and 9.9 % were found to use tube well and well water for drinking respectively. River (5.8%), pond (1.2%) and bottle water (1.2%) were other less common sources of drinking water. Similar results also found in CHTDF, 2009, where tube wells and dug wells were the major sources of drinking water for the ethnic people.

Different development programmes were running during data collection. Most (83%) of the programmes were implemented by local NGOs, where 8.8% and 8.2% of development programmes were implemented by BRAC and international NGOs respectively. This analysis shows that every ethnic household in the CHTs is currently under some kind of development project conducted by either local NGOs or international NGOs. It was observed that average monthly family income and expenditure of ethnic people were Tk.18,822 and Tk. 15,654 respectively, unlike the findings of the CHTDF, 2009, where monthly family income and expenditure of ethnic people were shown to be Tk. 5,200 and Tk. 4,750 respectively. The current result is supported by the NHDSBD-2011 survey, where CHTs exceeded the national average household income and expenditure of Tk. 11839 and Tk.10578 respectively. This is also indicating a major alleviation of living standards of the ethnic people in the CHTs.

Collectively ethnic people used almost half (47.6%) of their expenditure on education, while 34%, 1.4%, 4.7%, 3.4%,3%,4.2% used their income on food, medicine, transportation, housing, clothing , agriculture and 1.7% on other less common sectors respectively. The CHTDF, 2009 indicated that food expenditure in ethnic community constitutes the predominant (89.4%) share of household expenditure. Therefore, the present analysis showed that the ethnic people in CHTs now use less portion of their expenditure on food, thus representing a decrease of poverty in the ethnic households based on the concept that "poor people spend most of their income on food". High expenditure on education explains the elevated literacy rate of these ethnic people.

Of the 171 ethnics families only 18.2% were at some kind of monetary debt. It is an indication of financial stability of ethnic people.

Nutrition knowledge among these ethnic people was in the categories of 'good' and 'very good', as 44.4% of the ethnic people scored between 30-37 and 38.6% scored between 38-48 points when they were asked to answer questions on nutritious foods, vitamin and mineral rich fruits and vegetables, about deficiency diseases etc.

This study also documented the morbidity pattern of ethnic people. Results showed that 66.1% had gastritis, 21.6 % of ethnic people had either high or low blood pressure, 5.3% had asthma and 5.3% had jaundice. The observation from the results is that prevalence of common non-communicable diseases was very low in CHTs. This is due to the health facilities provided by various developmental organizations (WHO, UNICEF, UNDP, UNFPA, WFP, Chittagong Hill Tracts Development Facility, Hill District Councils etc.), better nutrition knowledge and elevated literacy rate.

About 13.5% of the ethnic people in CHTs had occasionally seen any food insecurity, of which, 69.5 % had consumed less food due to shortage of the same. Of the 13.5% of participants, 69.5% of faced inadequacy of balanced food at some point of time and 8.6% always faced inadequacy of balanced food. A Similar picture was found in the analysis of food security in CHTDF, 2009, this revealed that the ethnic people in CHTs were more or less secured in relation to availability of food round the year.

A balance diet provides all macro and micronutrients essential for growth, maintenance and repairment. This study also intended to find the food consumption pattern of ethnic people and emphasized on the selected micronutrient consumption by these people.

Food consumption data revealed that rice, particularly atap chal, was found to be the staple food of the ethnic people. Around 95-100% of the total participants consumed rice in three major meals per day. Legume is not a frequently consumed food by these people. Only 5.8 %, 14.6 % and 14% had consumed legumes daily at breakfast, lunch and dinner respectively.

Only 8.8%, 14.6% and 11.7% ate various kinds of fishes (fresh and dry fish) daily in breakfast, lunch and dinner respectively, while 33.9%, 62% and 62% of ethnic people took fish in their breakfast, lunch and dinner three days per week respectively.

Almost majority of the ethnic people consumed meat infrequently in the seven day menu. About 49%, 37% and 48% had never consumed meat (chicken, beef, lamb, mutton, pork, snake etc) in breakfast, lunch and dinner respectively, while 35.7%, 52% and 45% had consumed meat for breakfast, lunch and dinner three days per week respectively.

A large portion of the ethnic people i.e. 62%, 63.7% and 77.2% never consumed egg in breakfast, lunch and dinner respectively, while 19.9%, 26.6% and 17.5 % consumed egg three days per week in breakfast, lunch and dinner respectively.

About 55%, 44% and 45% had never eaten any dairy products in seven days prior to interview in breakfast, lunch and dinner respectively, whereas 17%, 19.3% and 21.1% consumed dairy products daily in breakfast, lunch and dinner respectively. About 56.1%, 63.7% and 61.4% of the ethnic people had eaten leafy vegetables daily for breakfast, lunch and dinner respectively, and 52.6%, 59.1% and 50.3% of the ethnic people had consumed non leafy vegetables seven days per week in three major meals respectively, while 28.7%, 21.1% and 35.7% never had non leafy vegetables in their major meals respectively. In case of fruit consumption 74.9%, 69% and 79.5% had never fruits in their meals prior seven days. Daily consumption of fruits in breakfast, lunch and dinner were observed among 2.3%, 3.5% and 0.6% respectively in 171 participants. Fruit consumption was found to be less among ethnic people.

In lactating women, 100% consumed cereals frequently and daily. Cereals were atap chal, rice parboiled, maize matured, bread and roti. Infrequent consumption (0-3 days per week) of legumes was seen among 96.4% of 85 lactating women, while only 3.6% took legumes frequently (4-7 days per week). About 56% of the lactating women had eaten fish (fresh fish,

dry fish and nappi) occasionally (0-3 days per week), while 44.7% consume fish frequently. About 91% took various meats through the week infrequently. Infrequent consumption of egg was observed among 80% of lactating women; 82.2% of the lactating women were found to take milk and dairy products infrequently seven days prior to interview and 63.5% of the participants never had fruits in their daily diet menu, 62.3% and 97.6% was found to consume leafy and non leafy vegetables frequently (4-7 days per week). Among lactating women, 64.7% were found to consume fruits infrequently.

Similar results were also observed in NPNL women, 100% frequently and daily consumed cereal products. Ninety three percent NPNL women had eaten legumes infrequently (0-3 days per week), 58.2% consumed fish 4-7 days per week, 82.6% consumed meat infrequently, 62.8% and 70.9% of the ethnic people consumed egg and dairy products infrequently, 58.1% had consumed leafy vegetables frequently and 98.8 % had consumed non leafy vegetables frequently (4-7 days per week). Infrequent fruit consumption was also seen among 53.5% NPNL women. In both lactating and NPNL groups, participants consumed more of cereals and non leafy vegetables other than any foods. Similar findings were also found in the CHTDF Survey, 2009. This survey also indicated that rice and vegetables are the main energy source of ethnic people in the CHTs. It also mentioned that legumes, meat and fish were not commonly consumed food items of ethnic people in the CHTs. Fruit consumption also found to be very low among ethnic people.

Analysis of energy intake showed that the average energy intake of lactating and NPNL women were 2731±803.23 and 2531±790 kcal respectively.

This indicated an increase of energy intake and reduction of poverty in terms of calorie intake in the ethnic people of CHTs from 2009 to 2011. In CHTDF, 2009 revealed that, the per capita energy intake for ethnic household was 1762 k.cal, which is less than the level of the hardcore poor (below 1805 kcal). The prevalence of absolute poor (2122 kcal) and hardcore poor (1805 kcal) among ethnic peoples were 65% and 44% respectively.The average protein, fat and carbohydrate intake of lactating and NPNL women were 85.5±36.9 and 81.6±38 gm, 43.3±36.42 and 35.9±30.82 g; and 490±121.3 and 468±128.7 g respectively. In both lactating and NPNL women, 72% and 74% of energy was obtained from carbohydrate respectively. Only 13% energy was acquired from protein in both groups. Similarly 15% and 13% energy was obtained from fat in lactating and NPNL women respectively. thus indicating that major part of total energy comes from carbohydrates. According to Islam et al, 2010[58]; a balanced diet should provide around 50-55% of total calories from carbohydrates, 15-20% from protein and 20-25% from fats and oil. Obviously ethnic diet did not resemble a balanced diet as most of the calorie of ethnic diet is coming from carbohydrates, which is 20% greater than what actually is recommended. Energy coming from fat was very low in ethnic diet.

It was shown that among 171 ethnics, 79.5% had fulfilled their energy requirements as per RDA; 57.3 % and 49.7% fulfilled protein and fat requirements respectively. The total energy intake per day equivalent or nearer to the recommended limit was obtained by 81.2% and 78% of the lactating and NPNL women respectively, 51% and 62% lactating and NPNL women met protein RDA and 63.5% lactating and 62.8 % NPNL women had RDA of fat requirement.

In case of micronutrient intake 84%, 4.7%, 93%, 99% and 49% ethnic people met their dietary vitamin A, vitamin E, zinc, copper and iron RDA requirements respectively. Dietary vitamin A, vitamin E, zinc, copper and iron requirements as per RDA was met by 78%, 4.7%, 87%, 98% and 48% lactating and 90%, 4.7%, 99%, 100% and 52% of NPNL women respectively.

Most of vitamin A, vitamin E, copper and iron were obtained from general foods, while zinc was derived equally from both general and ethnic food.

Nutritional status of ethnic people was estimated using WHO classification of BMI. It was observed that 11.7% of the 171 ethnic people were undernourished and 19.9% were overweight, and the rest had normal nutrition.

In a study conducted in 2014[63] among both the male and female members of ethnic communities in the CHTs where prevalence of underweight was 4.7% and overweight was 17.3%.

In lactating women, 11% were undernourished or underweight or chronically energy deficient, 71% had normal nutritional status and 18% of the participants been overweight. Where, in NPNL women, 13% were undernourished and 21 % were overweight.

A survey conducted by HKI in 2000[60] observed that chronic energy deficiency among non pregnant women was 27%. Comparing the two results it can be concluded that there has been an increase of rate of better nutritional status in the ethnic people of the CHTs from 2000 to 2011.

Analysis of Food security condition showed that, in lactating women, education, occupation, income and nutrition knowledge were found to be statistically associated to food security. In NPNL women, significant association was found between food security with education, nutrition knowledge and income, other factors were found to be insignificant.

Relationships of dietary vitamin A, vitamin E, copper, zinc and iron with socio-economy, nutritional status and knowledge; and household security demonstrated variety of results. In both the groups; literacy, occupancy in household chores, better income and nutrition knowledge, normal BMI positively influenced vitamin A intake equal or greater than RDA. Apparently these factors negatively influenced dietary vitamin E intake of both lactating and NPNL women.

Findings of dietary copper intake relations with other factors are- in lactating women, literacy, income, food security and nutrition knowledge were found to be significantly associated to the dietary copper intakes. In NPNL women, association could not be made.

Dietary zinc relationship with other factors showed that, in lactating women, education, income, food security and nutrition knowledge score were found to be significantly associated to the dietary zinc status, but no such association was found in NPNL women.

Positive influence had seen of BMI ranges and dietary protein intake on dietary iron intakes.

Relationship of nutritional status of ethnic people are like- in both lactating women and NPNL women, nutritional status was found to have positive association with literacy, occupation, income, food security, nutrition knowledge and calorie intake. With the improvement of living standards, the nutritional status, food security and dietary intakes of the ethnic people in the Chittagong Hill Tracts has also got better.

Key findings

The aim of this section of the study was to evaluate the socio-demographic status of ethnic people of Chittagong Hill Tracts. Maximum number of ethnic people was found to be literate and occupaid with household chores. Single families were predominat among ethnic people. Chakma (39.8%) and Marma (44.4%) were the predominant tribe types of the ethnic people in CHTs. Majority of (84.2 %) the ethnic people from CHTs were the followers of Buddhism. Many local NGO's are currently working for the development of the ethnic people in CHTs. The avergave family income was much higher than the national average household income, of which almost half was expended on education. Nutrition knowledge among these ethnic people was good and very good. About 67% of the ethnic people had gastritis, 21.6 % had either high or low blood pressure, 5.3% have asthma and 5.3% had jaundice. Prevalence of other diseases was low. These ethnic people occasionally had seen any kind of food insecurity. Majority of ethnic people frequently consumed cereals, leafy and non leafy vegetables in three major meals. Infrequent consumption of flesh foods, dairy products, eggs, fruits and legeumes had been observed among ethnic people.

Results showed that 79.5% of the ethnic people had fulfilled their energy requirements as per RDA. In respect of protein and fat intake, 57.3 % and 49.7% of the ethnic people had fulfilled their requirements respectively. About 84% had fulfilled their vitamin A requirements as per RDA. In respect of vitamin E intake, 95% of the ethnic people did not fulfill their requirements as per RDA, 93% had fulfilled their daily zinc requirements as per RDA. In respect of copper intake, 99% of the ethnics had fulfilled their requirements as per RDA, 51% did not fulfill their iron requirements as they consumed less iron from foods than RDA. Ethnic foods were found to be rich in zinc.

About 12% of the ethnic people were undernourished, 69% were normal and 20% were overweight.

Education, occupancy in household chores, better income and nutrition knowledge were found to be statistically associated to food security of these ethnic people. In both lactating and NPNL women, literacy, occupancy in household chores, better income and nutrition knowledge, normal BMI positively influenced vitamin A intake equal or greater than RDA, while these factors negatively influenced dietary vitamin E intake. Dietary copper and zinc intake was found to be positively influenced by better socio-economic status, while no such association was found in respect of iron intake. Protein intake positively influenced diatry iron intakes of these ethnic people. Nutritional status of the ethnic people was found to be significantly associated to literacy, occupation, income, food security, nutrition knowledge and calorie intake.

Conclusion

Socio- demographic data revels that ethnic peoples' situation has improved in the CHTs with regard to access and utilization of basic social services. The concept of joint family lost its priority in ethnic community. Tremendous increase of monthly income and expenditure of ethnic people were seen in the CHTs in last few years. Ethnic people used almost half of their expenditure on education, which explains elevated literacy rate of these ethnic people. Financially these ethnic people have become stable thus have good nutrition knowledge; prevalence of common non-communicable diseases are low and are somewhat secured in relation to availability of food round the year.

Although food poverty has reduced among ethnic people in the CHTs, the study shows that a large proportion of the lactating and NPNL women adhered to an inadequate food consumption characterised by the overconsumption of energy and inadequate consumption of protein and fat. Adequate consumption of micronutrients (zinc, copper and vitamin A) was more common in females of both the groups. Inadequate consumption of vitamin E and iron was seen among them. The results clearly show that there is a need for nutrition education programmes. The focus of education should be on encouraging in improving the intake of fruit and consumtion of animal sources of protein and on adequate amount of fat.

Nutritional status of ethnic people is in a better position. Occurrence of chronic energy deficiency and overweight are low. It can be concluded that improved lifestyle of the ethnic people in the CHTs ensured better nutritional status.

Food security, good nutritional status, adequate dietary intake of copper, zinc and vitamin A are due to increased percentage of education, income, and nutrition knowledge of both lactating and NPNL women of the ethnic people in the Chittagong Hill Tracts. Imbalanced dietary pattern is the reason behind inadequate intake of iron, vitamin E and protein intake.

Recommendations

1. Current socio-economic status of ethnic people in the Chittagong Hill Tracts should be nationally documented in large scale in near future.
2. Currently running and future intervention programmes need to focus on the more employment of ethnic members in services and businesses, as they are literate and can contribute to the family income.
3. Food intervention programmes need to be started to improve the dietary intake of protein and fat rich foods.
4. Nutrition education programmes need to be conducted to teach these ethnic people about protein and fat rich foods.

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Section B: Haemoglobin and ferritin profile; and prevalence of anemia and Iron deficiency among ethnic people in CHTs

Chapter 1: Introduction

1.1 Overview

Anemia is a public health concern in Bangladesh like many other developing countries. Several studies indicated that Chittagong Hill Tracts is the most anemia prevalent region of Bangladesh. Although the living standard of the ethnic people in CHTs has improved during the last few years, no positive impact is seen on anemia incidence, rather the situation seems to be getting worse. It was also documented in some surveys that anemia is more prevalent among ethnic people than mainland population living in the CHTs. This section of the research tends to analyse the anemia status among ethnic people in the CHTs and identify the factors which are responsible for this condition.

1.2 Background

1.2.1 Anemia

Anemia is defined as a decrease in the amount of red blood cells (RBCs) or hemoglobin in the blood. It can also be defined as a lowered ability of the blood to carry oxygen. When anemia comes on slowly the symptoms are often false and may include feeling tiredness, weakness, shortness of breath or a poor ability to work. Anemia has greater symptoms which may include confusion, feeling like one is going to pass out and increased thirst.[1] The World Health Organization (WHO) defines anemia among women of childbearing age as the condition of having a hemoglobin concentration of < 12.0 g/dL at sea level.[2]

1.2.1.a. Causes of anemia

Principal causes of anemia: There are three main causes of anemia. Anemia caused by blood loss, decreased or faulty red blood cell production and increased red blood cell breakdown.

- **Blood loss**

Blood loss includes trauma and gastrointestinal bleeding. Ulceration, hemorrhoids, gastritis, and stomach or colon cancers; Use of non steroidal anti-inflammatory drugs (NSAIDs) such as aspirin or ibuprofen, which can cause ulcers and gastritis; menstruation and childbirth in women, especially if menstrual bleeding is excessive and if there are multiple pregnancies; trauma which results in bleeding. Infection by intestinal nematodes feeding on blood, such as hookworms and the whipworm *Trichuris trichiura* also can cause blood loss.[3]

- **Decreased red blood cell production**

Causes of decreased red blood cell production include either the body does not produce enough red blood cells, or they may not work properly. People with this type of anemia may have:

1. **Iron deficiency**
   Anaemia may occur because of a lack of the mineral iron in the body. Bone marrow in the centre of the bone needs iron to make haemoglobin, the part of the red blood cell that transports oxygen to the body's organs. Without adequate iron, the body cannot produce enough haemoglobin for red blood cells. The result is iron-deficiency anaemia. This type of anaemia can be caused by either an iron deficient diet especially in infants, children, teens, vegans, and vegetarians; the metabolic demands of pregnancy and breastfeeding that deplete a woman's iron stores; menstruation, frequent blood donation, digestive conditions such as Crohn's disease or surgical removal of part of the stomach or small intestine, among pregnant women who do not take an iron supplement is common and with other nutrient interactions (phytates and phosphates, dietary calcium inhibit iron absorption from food).[4]
2. **Protein deficiency**
   Protein is needed both for the framework of the red blood cells and for the manufacture of the haemoglobin to go with it.
3. **Vitamin deficiencies**
   Vitamin deficiency anemia may occur when vitamin B_{12} and folate are deficient. These two vitamins are needed to make red blood cells. Conditions leading to anemia caused by vitamin deficiency include:

- Megaloblastic anemia: Vitamin B_{12} or folate or both are deficient.
- Pernicious anemia: Poor vitamin B_{12} absorption caused by conditions such as Crohn's disease, an intestinal parasite infection, surgical removal of part of the stomach or intestine, or infection with HIV.
- Sickle cell anemia: Vitamin E deficiency enhances red cell susceptibility to peroxidation and promotes a vicious cycle in SCA.
- Dietary deficiency: Eating little or no meat may cause a lack of vitamin B_{12}, while overcooking or eating fewer vegetables may cause a folate deficiency.
- Other causes of vitamin deficiency: pregnancy, certain medications, alcohol abuse, intestinal diseases such as tropical sprue and celiac disease.

4. **Bone marrow and stem cell problems**

   Bone marrow and stem cell problems may prevent the body from producing enough red blood cells. If the bone marrow is faulty it may not be producing enough red blood cells. This may be caused by a lack of vitamin B_{12}, a serious bone marrow disorder (e.g. leukemia), long term inflammation (e.g. rheumatoid arthritis), or long term infection. Some of the stem cells found in bone marrow develop into red blood cells. If stem cells are too few, defective, or replaced by other cells such as metastatic cancer cells, anemia may result. Anemia resulting from bone marrow or stem cell problems includes:

   - Aplastic anemia occurs when there's a marked reduction in the number of stem cells or absence of these cells. Aplastic anemia can be inherited, can occur without apparent cause, or can occur when the bone marrow is injured by medications, radiation, chemotherapy or infection.
   - Thalassemia occurs when the red cells can't mature and grow properly.
   - Lead exposure is toxic to the bone marrow, leading to fewer red blood cells production. Lead poisoning occurs in adults from work-related exposure and in children who eat painted chips. Improperly glazed pottery can also taint food and liquids with lead.

5. **Some conditions or diseases**

   Anemia associated with other conditions usually occurs when there are very few necessary hormones for red blood cell production. People with HIV/AIDS, rheumatoid arthritis, and Crohn's disease may have problems with adequate red blood cell production. Malaria causes anemia in millions of people worldwide. A protein produced by immune cells during malaria infection triggers severe anemia. Patients with chronic kidney disease often have low levels of erythropoietin (a hormone that stimulates the formation of red blood cells) and develop anemia.

6. **Some medications**

   Specially some cancer medications which are given in combination. Avastin, a cancer drug, given in combination with sutent, is linked to microangiopathic hemolytic anemia, which is caused by a build up of platelets and other organic obstructions on the inner walls of very small blood vessels. These destroy healthy red blood cells as they pass through, eventually leading to a whole body shortage of them.

- **Increased breakdown of red blood cells**

  When red blood cells are fragile and cannot withstand the routine stress of the circulatory system, they may rupture prematurely, causing hemolytic anemia. Hemolytic anemia can be present at birth or develop later. Sometimes there is no known cause. Known causes of hemolytic anemia may include:

  - Inherited conditions, such as sickle cell anemia: an inherited disorder which causes the red blood cells to have a crescent shape. The red blood cells break down rapidly, before sufficient oxygen and nutrients can reach vital organs, causing anemia.
  - Thalassemia
  - Stressors such as infections, drugs, snake or spider venom, or certain foods.
  - Toxins from advanced liver or kidney disease.
  - Inappropriate attack by the immune system (called hemolytic disease of the newborn when it occurs in the fetus of a pregnant woman).
  - Vascular grafts, prosthetic heart valves, tumors, severe burns, exposure to certain chemicals, severe hypertension and clotting disorders.
  - In rare cases, an enlarged spleen can trap red blood cells and destroy them before their circulating time up.[1,3,5]

1.2.1.b Sign and symptoms of anemia

People whose anemia develops gradually may have no symptoms for a long time. If it develops rapidly, symptoms will usually be developed much faster. Symptoms will vary according to the type of anemia, its underlying cause, and if there is any underlying health

problems. Tiredness and lethargy are the most common symptoms of anemia. Lethargy is a mental state while fatigue is a physical state. Lethargy may or may not be associated with physical symptoms. If somebody suffers from fatigue, is physically tired, it is not uncommon for his/her mental state to be affected as well.

Some of the more common symptoms of anemia

Fatigue (tiredness), lethargy - sluggishness, apathy, a feeling of laziness, malaise - a vague feeling that one is not well, dyspnea - shortness of breath; difficult breathing, poor concentration, palpitations - unpleasant irregular and/or forceful beating of the heart and sensitivity to cold temperatures.

Less common symptoms

Tinnitus (ringing in the ears), headache, sense of taste is affected, sore tongue, dysphagia - difficulty in swallowing, pallor (pale complexion), atrophic glossitis - very smooth tongue, dry and flaky nails, angular chelosis - ulcers in the corner of the mouth, restless leg syndrome - this is more common among patients with iron deficiency anemia.

Extremely rare symptoms

Swelling of the legs and/or arms, chronic heartburn, vomiting, increased sweating and blood in stools (faeces).[5]

1.2.1.c Laboratory test of anemia

Haemoglobin level is measured to diagnose anemia in an individual. Iron deficiency anemia is estimated by analysing both haemoglobin and serum ferritin level. Anemia is defined as haemoglobin level <12 g/dl in reproductive non-pregnant women. Iron deficiency anemia is defined as haemoglobin level <12 g/dl and serum ferritin level <15 µg/l in reproductive non-pregnant women (WHO, 2001).[7]

1.2.2 Red blood cell

Red blood cells contain no nucleus. The blood's red colour is due to the spectral properties of the hemic iron ions in hemoglobin. Each human's red blood cell contains approximately 270 million hemoglobin biomolecules, each carrying four heme groups. Haemoglobin comprises about a third of the total cell volume. This protein is responsible for the transport of more than 98% of the oxygen (the remaining oxygen is carried dissolved in the blood plasma). The red blood cells of an average adult human male store collectively about 2.5 grams of iron, representing about 65% of the total iron contained in the body.[8]

The distribution of body iron stores shows the importance of iron to red blood cell production. Normally, about 70% of iron is found in the circulating erythrocytes. Approximately 20% of iron is stored as ferritin, primarily in the liver. Smaller amounts of iron are coupled with enzymes, myoglobin and other proteins. The high iron content of erythrocytes reflects the fact that iron is an integral part of hemoglobin. Hemoglobin comprises over 95% of the protein in red blood cells.[9]

Folate is necessary for the production and maintenance of new cells, for DNA synthesis and RNA synthesis, and for preventing changes to DNA. Folate is needed to carry one-carbon groups for methylation reactions and nucleic acid synthesis (the most notable one being thymine, but also purine bases). Thus, folate deficiency hinders DNA synthesis and cell division, affecting hematopoietic cells and neoplasms the most because of their greater frequency of cell division. RNA transcription and subsequent protein synthesis are less affected by folate deficiency, as the mRNA can be recycled and used again (as opposed to DNA synthesis, where a new genomic copy must be created). Since folate deficiency limits cell division, erythropoiesis, production of red blood cells, is hindered and leads to megaloblastic anemia, which is characterized by large immature red blood cells. This pathology results from persistently dissatisfied attempts at normal DNA replication, DNA repair, and cell division, and produces abnormally large red cells called megaloblasts (and hypersegmented neutrophils) with abundant cytoplasm capable of RNA and protein synthesis,

but with clumping and fragmentation of nuclear chromatin. Some of these large cells, although immature (reticulocytes), are released early from the marrow in an attempt to compensate for the anemia. is required to make red blood cells and white blood cells and folate deficiency may lead to anemia, which causes fatigue, weakness and inability to concentrate.[10]

Vitamin B_{12} is also involved in this process because in creating methylcobalamin (used in the HCY to methionine reaction), vitamin B_{12} produces a form of folate needed to make DNA. If there is no vitamin B_{12} available, this form of folate can become depleted (known as the methyl-folate trap) and DNA production slows. That is how low levels of vitamin B_{12} can lead to pernicious anemia, a form of megaloblastic anemia characterized by larger than normal red blood cells. Pernicious anemia develops when the body cannot absorb vitamin B_{12}.[11-12]

1.2.3 Haemoglobin

Hemoglobin is the protein molecule in red blood cells that carries oxygen from the lungs to the body's tissues and returns carbon dioxide from the tissues back to the lungs. In body's tissue it releases the oxygen to permit aerobic respiration to provide energy to power the functions of the organism in the process called metabolism.[13]

Structure of haemoglobin

Haemoglobin consists of protein globin united with the pigment haem. Haem is an iron-containing porphyrin known as iron-protoporphyrin IX. The porphyrin nucleus consists essentially of four pyrrole ring joined together by four methane (=CH-) bridges; the porphyrins are thus tetrapyrroles. The pyrrole rings, are numbered I, II, III, IV; the carbon atoms of methane bridges are labelled L, B, R, G; the positions to which side chains are attached are numbered 1-8. The side chains at the respective positions are 1, methyl ($-CH_3$); 2, vinyl ($-CH=CH_2$); 3, methyl; 4, vinyl; 5, methyl; 6, propionoic acid ($-CH_2.\ CH_2.\ COOH$); 7, propionic acid; 8, methyl. Thus the side chains 1,3,5 and 8 are methyl; 2and 4 are vinyl; 6 and 7 are propionic acid.

Hemoglobin is made up of four protein molecules (globulin chains) that are connected together. The normal adult hemoglobin (Hbg) molecule contains two alpha-globulin chains and two beta-globulin chains. Two sub units of heam combains with 2 alpha chains and another two sub-units of heam combains with two beta chains. Each alpha chain contains 141 amino-acids. Each beta chain contains 146 amino-acids.

Iron in heam is in ferrous (Fe^{2+}) form. Iron is attached to the nitrogen of each pyrrole ring and to the nitrogen of iminazole group in the associated globin, a bond is available for loose union with O_2 (in oxy-haemoglobin), or CO (in carbomonoxy haemoglobin).[14]

The iron contained in hemoglobin is also responsible for the red color of the blood. Hemoglobin also plays an important role in maintaining the shape of the red blood cells. In their natural shape, red blood cells are round with narrow centers resembling a donut without a hole in the middle. Abnormal hemoglobin structure can, therefore, disrupt the shape of red blood cells and impede their function and flow through blood vessels.[15]

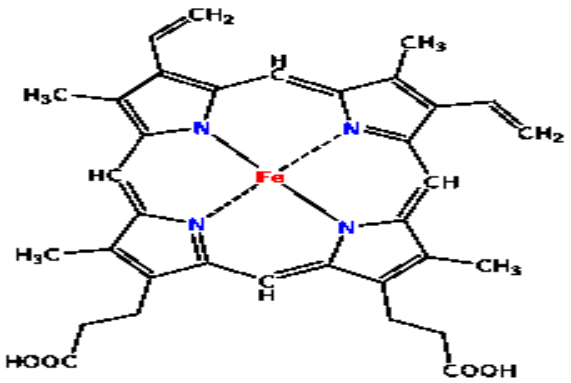

Figure: Heme molecule. Four Nitrogen molecules interact with iron atom surrounded in cyclic ring structures

1.2.4 Serum ferritin

Ferritin is an ubiquitous intracellular protein that stores iron and releases it in a controlled fashion. In humans, it acts as a buffer against iron deficiency and iron overload. Ferritin is found in most tissues like liver, spleen, skeletal muscles and bone marrow as a cytosolic protein. Only a small amount of ferritin is found in the blood, but small amounts secreted into the serum functions as an iron carrier. Plasma ferritin is also an indirect marker of the total amount of iron stored in the body. Stored iron is important because when iron intake is low, the body relies on ferritin to release the iron it needs. If enough iron isn't available in storage, a person will progress through several stages of iron deficiency. If the situation isn't corrected, iron deficiency can lead to anemia (a decreased amount of hemoglobin in the blood, resulting in difficulty delivering oxygen to the cells and tissues). Hence serum ferritin is used as a diagnostic test for iron deficiency anemia.[16-18]

Structure of ferritin

Ferritin is a ball shaped protein which can store about 4500 iron atoms (Fe^{3+}) in its interior. Ferritin is a globular protein complex consisting of 24 protein subunits and is the primary intracellular iron-storage protein, keeping iron in a soluble and non-toxic form. Inside the sphere, iron is stored in the Fe(III) oxidation state. Inside the ferritin shell, iron ions form crystallites together with phosphate and hydroxideions. The resulting particle is similar to the mineral ferrihydrite, which is attached to the inner wall of the sphere. Up to 4500 ion can be stored although the normal value is about 2000. To release iron when the body needs it, it must be changed from the Fe (III) to the Fe(II) oxidation state. Then, the iron leaves through channels in the spherical structure. Thus, the structure of ferritin is extremely important for the protein's ability to store and release iron in a controlled fashion. Hence, ferritin can control the amount of available iron in the body, preventing iron disorders like anemia and iron overload.[16, 19, 20]

1.2.5 Haemoglobinopathies

Hemoglobinopathy is a kind of genetic defect that results in abnormal structure of one of the globin chains of the hemoglobin molecule. Hemoglobinopathies are inherited single-gene disorders; in most cases, they are inherited as autosomal co-dominant traits. Common hemoglobinopathies include sickle-cell disease.

Hemoglobinopathies imply structural abnormalities in the globin proteins themselves. Thalassemias, in contrast, usually result in underproduction of normal globin proteins, often through mutations in regulatory genes. The two conditions may overlap, however, since some

conditions which cause abnormalities in globin proteins (hemoglobinopathy) also affect their production (thalassemia). Thus, some hemoglobinopathies are also thalassemias.[21]

Thalassemia

Thalassemia is a form of inherited autosomal recessive blood disorder characterized by abnormal formation of hemoglobin. The abnormal hemoglobin formed results in improper oxygen transport and destruction of red blood cells. Thalassemia is caused by variant or missing genes that affect how the body makes hemoglobin, the protein in red blood cells that carries oxygen. People with thalassemia make less hemoglobin and have fewer circulating red blood cells than normal, which results in mild or severe anemia.[22]

Sickle cell anemia

Sickle-cell disease (SCD), also known as sickle-cell anaemia (SCA) and drepanocytosis, is a hereditary blood disorder, characterized by an abnormality in the oxygen carrying haemoglobin molecule in red blood cells. This leads to a propensity for the cells to assume an abnormal, rigid, sickle-like shape under certain circumstances. Sickle-cell disease occurs when a person inherits two abnormal copies of the haemoglobin gene, one from each parent. Several subtypes exist, depending on the exact mutation in each haemoglobin gene.

Sickle cell anemia (sickle cell disease) is a disorder of the blood caused by inherited abnormal hemoglobin (the oxygen-carrying protein within the red blood cells). The sickle cell mutation results in the substitution of the amino acid valine for glutamic acid in the sixth position of the beta polypeptide. In turn; this alters the conformation of the haemoglobin molecule. The abnormal hemoglobin causes distorted (sickled) red blood cells. The sickled red blood cells are fragile and prone to rupture. These sickle shaped cells, no longer able to pass smoothly through small capillaries, can block the flow of blood. When the number of red blood cells decreases from rupture (hemolysis), anemia is the result. This condition is referred to as sickle cell anemia.[23-24]

1.2.6 Nutrient-nutrient interaction

Nutrient-nutrient interaction means the impact of the nutrient on other nutrient bioavailability in human body. Nutrient bioavailability includes two important components, absorption and utilization. Absorption is the process by which a nutrient moves from the intestinal lumen into the body. Utilization of the absorbed nutrients includes transport to various parts of the body, assimilation by cells and conversion to biologically active forms. Nutrient-nutrient interactions may affect- bioavailability in either in positive or negative way, may either enhance or inhibit nutrient absorption or utilization, high or low levels of one or more nutrients may affects bioavailability of other nutrients.[31-32]

Hemoglobin and vitamin E interaction

Serum vitamin E deficiency is related to hemolysis. Vitamin E deficiency can cause a form of anemia (haemolytic anemia) in which red blood cells rupture. Vitamin E deficiency causes fragility of RBCs. Vitamin E (tocopherol) is an antioxidant, it protects cells against damage by free radicals, which are by-products of normal cell activity and which participate in chemical reactions within cells. If red blood cells are destroyed prematurely (hemolysis), the bone marrow tries to compensate by producing new cells faster, when destruction of red blood cells exceeds their production, hemolytic anemia results.[33-34]

1.2.7 Prevalence of anemia among ethnic people in the CHTs

According to UNICEF report published in 2002, women and children in the CHTs are anemic. Anemia prevalence for children aged 6-59 months and for adolescent girls aged 13-19 years was noted to 62 % and 43.4% respectively, considerably higher than the national coverage of 49% and 28% respectively.

According to Anaemia Prevalence Survey of Urban Bangladesh and Rural Chittagong Hill Tracts 2003[25], in rural areas of CHTs the prevalence of anemia was highest in Children aged 6-59 months (62%), followed by pregnant women (49%), adolescent girls (46%), lactating women (43%), adolescent boys (40%) and NPNL women (35%). The overall prevalence in all non-pregnant women (lactating and NPNL) was 39%. Severe anaemia was more prevalent in rural areas than in the urban areas: highest among children aged 6-59 months (3.2%), followed by non-pregnant women (1.8%) and adolescents (1.6%).

The CHTs had higher anaemia prevalence than elsewhere in rural Bangladesh and in urban areas in most of the age groups, particularly adolescents and pregnant women. Adolescent anaemia (43%) in CHTs is a severe public health problem.

A strong ethnic differential was observed in the prevalence of anaemia in the CHTs, with the tribal population (Chakma, Marma and others) having a 1.5-fold or greater prevalence than the non-tribal population. In addition, a marked difference was observed between the prevalence of anemia in the CHTs among pregnant women of ethnic minority groups (61 percent) and the prevalence among pregnant women who do not belong to ethnic groups (41 percent).

Family religion and ethnicity were also found to be strongly associated with anaemia in the CHTs, with Buddhists and tribal peoples having a much higher prevalence compared with other religious groups and non-tribal, respectively.[25-26]

According to Nutrition Health and Demographic survey of Bangladesh, 2013[28], anemia prevalence is extremely high in women (93.5%) of Chittagong Hill Tracts division.

1.3 Rationale of the study

Anemia is the biggest public health concern of Bangladesh. The most vulnerable groups are adolescent girls, pregnant and lactating women. Many studies indicated that the Chittagong Hill Tracts is the most anemia prevalent regions of Bangladesh, and prevalence was much higher among ethnic communities compared with mainland population. This section of the study focuses on the blood haemoglobin and serum ferritin status of the ethnic people of the CHTs as an indicator of anemia and iron deficiency anemia to find the current anemia incidence rate. The present study was undertaken to provide statistically representative data on anaemia and iron deficiency anemia prevalence for vulnerable ethnic population groups e.g., lactating and non-pregnant non-lactating women of reproductive age. This study was planned to assess the magnitude of problem of anemia in lactating women and NPNL women of ethnic population in the CHTs and its association with other socio-demographic and dietary factors. The influence was seen with education, occupation, food security, age, marital status, nutrition knowledge score, BMI ranges; and interacting dietary and serum nutrients (macro and micro) with said variables.

1.4 Objective of the study

The objective of this section is to estimate the prevalence of anemia among ethnic people in three districts of the Chittagong Hill Tracts.

In line of this view, this aimed to

1. analyse blood haemoglobin level and serum ferritin level of ethnic people in CHTs
2. estimate anemia prevalence among selected lactating and NPNL women
3. compare the current data with national micronutrient data and find the difference
4. find the influence of socio-demographic and dietary factors on blood hemoglobin level and serum ferritin level
5. provide recommendations to improve the situation

Chapter 2: Methods and Materials

2.1Study design

This section of the study used secondary data of haemoglobin level of the ethnic people in Chittagong Hill Tracts from NHDSBD-2011. NHDSBD-2011 survey team collect blood samples from 5418 subjects for further studies which were not used in NHDSBD -2011. Processed serum was used freshly for ferritin analysis for this study only.

2.2 Estimation of biochemical indices

This section of study measured haemoglobin level and ferritin level of lactating and NPNL women from blood (haemoglobin) and serum (ferritin).

2.3 Blood collection method for haemoglobin

A volume of 20 µl blood from each subject was pipetted onto a filter paper strip (2.5×2 cm, Watman, Xinhua paper Mill, China) by pinching in finger. It was dried for 10 minutes and stored at room temperature for analysis within 7 days.

2.4 Serum conditions for serum ferritin analysis

Serum was stored at -80 ^{o}C, which has been analyzed freshly for serum ferritin.

2.5 Study population

Blood haemoglobin concentration data of 85 lactating women and 86 NPNL women of ethnic people of CHTs from NHDSBD-2011 survey were used in this section. A sub sampling was used to determine the sample size for serum ferritin analysis. Serum samples were sorted from 171 blood samples on the basis of anemic and non anemic condition. All the non anemic samples (n=10) were being included in serum ferritin analysis list and 138 samples were sorted randomly from 161 anemic samples. A total 148 samples were analyzed to estimate serum ferritin status of ethnic people in the CHTs. Among 148 samples, 76 were lactating women samples and 72 were NPNL women samples.

2.6 Estimation of haemoglobin level

The cyanmethemoglobin method was employed to estimate blood haemoglobin using a commercial kit of Human, Germany.[29]

Contents of kit

RGTA	10×25 ml Reagent concentrate A	
	Potassium hexacyanoferrate (iii)	12 mmol/l
	Potassium bicarbonate	230 mmol/l
RGTB	10×25 ml Reagent concentrate B	
	Potassium cyanide	14 mmol/l
	Potassium bicarbonate	230 mmol/l

Preparation of working reagent and stability

One bottle of RGTA and one bottle of RGTB were mixed together with 450 ml deionised water and stored in a close dark glass container at 15 to 25 º c. This working reagent is stable for 12 months in the dark.

Principle of the method

The method is based on the determination of cyanmethemoglobin which has been adopted as a standard method. Haemoglobin from whole blood sample is released from erythrocytes and is oxidised by ferricyanide to methemoglobin. The methemoglobin is further converted by

cyanide to stable cyanmethemoglobin. The absorbance of cyanmethemoglobin is measured at 540 nm and is directly proportional to the haemoglobin concentration in the sample.

Procedure for analysis

Collected and processed blood in a filter paper as stated earlier was soaked in 5 ml of working reagent in a glass test tube for 30 minutes and then centrifuged at 3000rpm for 10 minutes. A 2ml of the clear supernatant was taken into a cuvette of spectrophotometer and the absorbance was recorded after 3 minutes at earliest against reagent blank (ΔA) at 540 nm in a spectrophotometer (UV-1201, UV-VIS, spectrophotometer, Shimadzu Corporation, Japan).

Calculation of haemoglobin concentration

The concentration of haemoglobin in blood was calculated as follows:

Concentration, C= Haemoglobin/4 (Hb/4) (mmol/l) = 22.8 ×ΔA

Figure 2.6.a: Spectrophotometer (UV-1201, UV-VIS, spectrophotometer, Shimadzu Corporation, Japan)

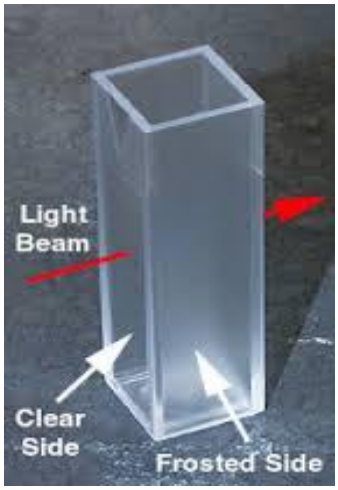

Figure 2.6.b: Cuvette

Figure 2.6.c: Pipetteing working reagent in test tubes.

2.7 Estimation of serum ferritin level

The Enzyme immunoassay method was used for the quantitative determination of ferritin in human serum using a commercial kit of omega Diagnostics, UK. As described in White., D, 1986.[30]

Contents of the kit

1. Microtitre Plate — 12×8 wells
   Breakable wells coated with specific antibody contained in a resalable foil bag.
2. Cal | A | 0 ng/ml — 0.5 ml
   Reference standard: Human serum free of ferritin (colourless)
3. Cal | B | 15 ng/ml — 0.5 ml
   Reference standard: ferritin diluted in human serum (colourless).
4. Cal | C | 80 ng/ml — 0.5 ml
   Reference standard: ferritin diluted in human serum (colourless).
5. Cal | D | 250 ng/ml — 0.5 ml
   Reference standard: ferritin diluted in human serum (colourless).
6. Cal | E | 500 ng/ml — 0.5 ml
   Reference standard: ferritin diluted in human serum (colourless).
7. Cal | F | 1000 ng/ml — 0.5 ml
   Reference standard: ferritin diluted in human serum (colourless).
8. Conjugate — 11 ml
   Anti-ferritin HRP conjugate: Anti-ferritin conjugate to Horseradish peroxidise. (Pink colour).
9. Substrate Solution — 11 ml
   3,3`, 5,5` Tetramethyl Benzidine in a citrate buffer (colourless)
10. Stop solution — 11 ml
    Hydrochloric Acid diluted in purified water (colourless)
    All these elements are in ready to use condition.

Reagent preparation

All reagents were brought to room temperature (20-25°C) and mixed gently prior to use.

Principle of the method

A specific anti-ferritin antibody is coated on to microtitration wells. Test serums are applied. Then monoclonal anti-ferritin labelled with Horseradish peroxidise enzyme (conjugate) is added. If serum ferritin is present in the sample, it will combine with the antibody on the well and the enzyme conjugate, resulting in the ferritin molecules being sandwiched between the solid phase and the enzyme linked antibodies. After incubation, the wells are washed with distilled water to remove unbound labelled antibodies. On addition of the substrate (TMB), a colour will develop only in those wells in which enzyme are present, indicating the presence of ferritin. The reaction is stopped by the addition of dilute Hydrochloric acid and the absorbance is then measured at 450 nm. The concentration of ferritin is directly proportional to the colour intensity of the test sample.

Procedure for analysis

1. A volume of 20 µl Serum was thawed and mixed well prior to testing.
2. All the kit components and the test serum were brought to room temperature (20-25 °C) prior to the start of the assay.
3. One set of standards was being run with each batch of test serum.
4. 20 µl of standards and test serum were pipetted into the assigned wells.
5. 100 µl of Anti-Ferritin HRP conjugate was dispensed into each well with multi channel pipette.
6. These solutions were mixed thoroughly for 30 seconds and the plate was incubated for 45 minutes at room temperature (20-25°C).

7. At the end of the incubation period, the contents of the wells were discarded by flicking into a biohazard container. Then the plate was stroked sharply against absorbent paper.
8. Next the wells were being filled with a minimum of 350 µl of distilled water per well and plate contents were flicked into a biohazard container; and stroked sharply against absorbent paper. This process was done 5 times. The residual water droplets were removed by striking the plate sharply onto absorbent paper.
9. 100 µl substrate solutions was distributed into each well with micro pipette and mixed gently for 5 seconds. This mixture was incubated in the dark for 20 minutes at room temperature. The colour of the mixture was turned into blue colour.
10. 100 µl stop solution was added to each well to stop the reaction.
11. To ensure that the blue colour changed completely to a yellow colour it was mixed gently for 30 seconds.
12. At last the optical density was immediately read by using a ELISA plate reader machine with a 450 nm filter. (Labsystems, Multiskan EX, Finland).

Calculation

Concentration of serum ferritin was calculated as follows

$$\text{Concentration, } C = \frac{\text{Sample OD}}{\text{Standard OD}} \times \text{Standard Concentration}$$

Preparation of standard curve

The pathozyme ferritin kit of omega diagnostics contains six reference standards. First one is human serum free of ferritin and other five are ferritin diluted human serum with the concentration of 0 ng/ml and 15 ng/ml, 80ng/ml, 250 ng/ml, 500 ng/ml and 1000 ng/ml respectively. Accurately measured 20 µl of each standard were pipette into the assigned wells of microtitre ELISA plate. Duplicate wells were prepared for each standard. The remaining steps were exactly the same as described in procedure for analysis. Software package for the ELISA machine constructed curve for serum ferritin standards. To construct a calibration curve for each of the standard serum ferritin, the mean absorbances read were plotted against their respective concentrations. It gave a straight or linear line.

Figure 2.7.a: Pipetting standards and test serum into the assigned wells.

Figure 2.7.b: Optical density reading by ELISA plate reader.

Chapter 3: Results

3.1 Biochemical profile of ethnic people in CHTs

Biochemical indices of ethnic people in the CHTs were evaluated by their reference cut off levels. In female, cut off points for serum ferritin and blood haemoglobin are 15µg/L and 12 g/dl respectively. Table 3.1.a demonstrates the blood haemoglobin and serum ferritin level level of ethnic people from CHTs. Haemoglobin analysis showed that average haemoglobin concentrations was 8.8±2.4 g/dl, lower than the cutoff point (12 g/dl). About 95% ethnic samples had blood haemoglobin concentrations (average, 8.4±1.9 g/dl) below cut off point and considered as anemic (Figure -3.1.a).

Serum ferritin analysis was done among 148 serum samples of the 171 ethnic samples. Serum ferritin results showed that average serum ferritin concentration was 39.1±33.7µg/L. About 78% had serum ferritin level at reference cut off point or above and 24.3% had serum ferritin level below reference cut off point (15µg/L). These 24.3% were considered as iron deficient (Figure 3.1.b). Serum ferritin level of the ethnic people was estimated from calibration curve (Table – 3.1.b, Figure 3.1.c).

Table 3.1. a: Haemoglobin and serum ferritin level of ethnic people in CHTs

Parameter	(%) freq	Mean±SD
Haemoglobin (g/dl) (n= 171)		
Below cutoff (<12 g/dl**)**	94.2 (161)	8.4 ± 1.9
Within or Above cutoff (≥12 g/dl)	5.8 (10)	14.4 ± 3
Total	100(171)	8.8 ± 2.4
Serum ferritin (µg/l) (n =148)		
Below cutoff (<15 µg/L**)**	24.3(36)	10.5 ± 3.8
Within or Above cutoff (≥15µg/L)	75.7(112)	48.3 ± 33.9
Total	100(148)	39.1 ± 33.7

Cut off point of haemoglobin in both the groups: 12 g/dl

Cut off point of serum ferritin in both the groups: 15 µg/l

WHO.Iron deficiency anemia, Assessment, Prevention, and Control: A guide for programme managers; WHO/ NHD/01.3 (2001).

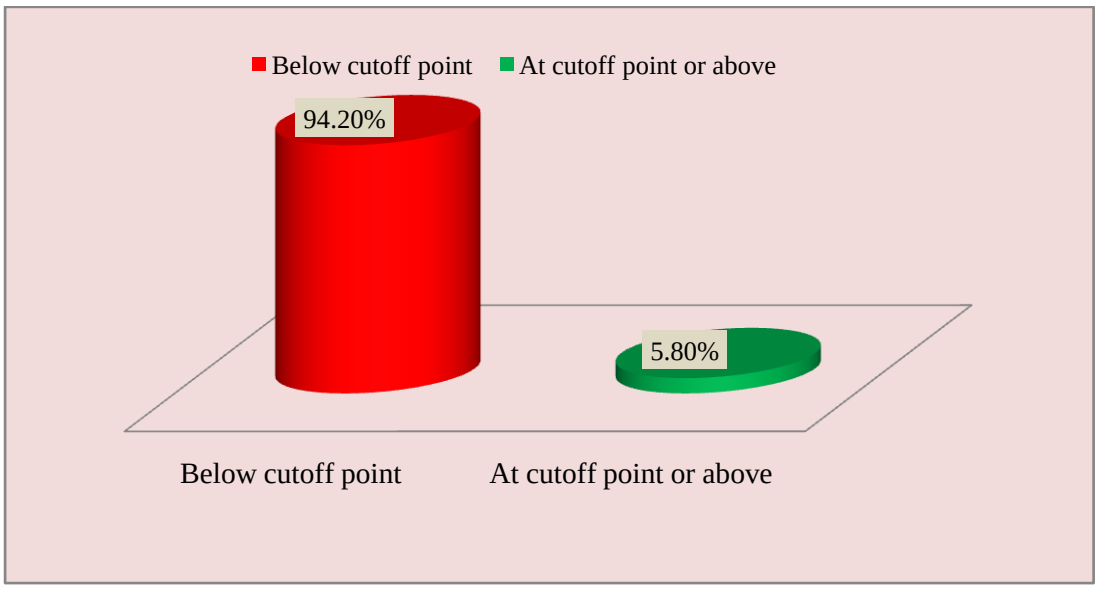

Figure 3.1.a: Haemoglobin status of study population in the CHTs

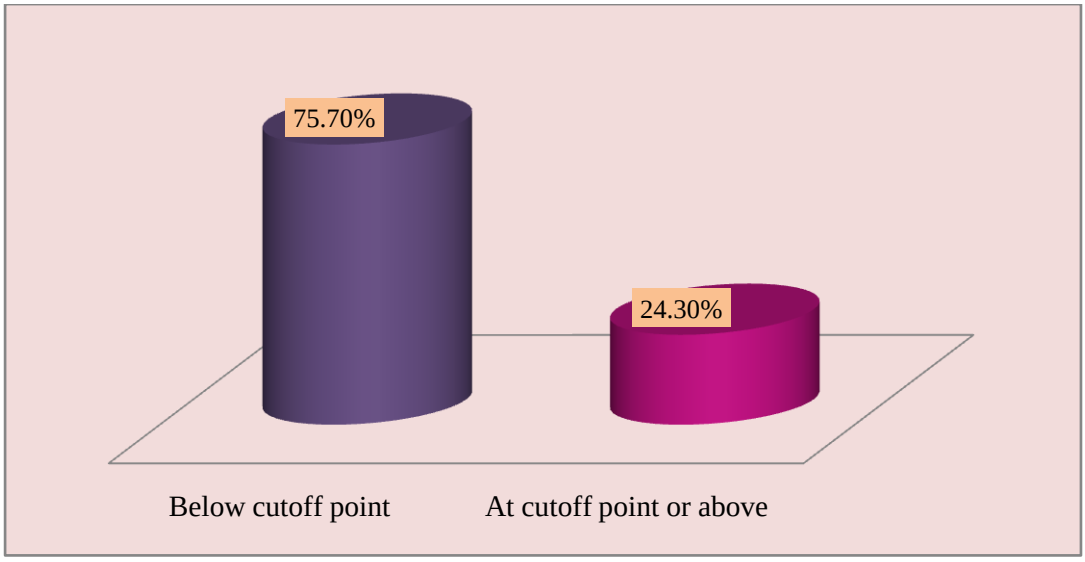

Figure 3.1.b: serum ferritin level of ethnic population in the CHTs

Table 3.1.b: Mean OD of serum ferritin standards (concentration µg/L)

Concentration of standards (µg/L)	OD1	OD2	Mean OD
0	0.08	0.06	0.07
15	0.11	0.13	0.12
80	0.27	0.29	0.28
250	0.8	1	0.9
500	1.5	1.7	1.6
1000	2.8	3	2.9

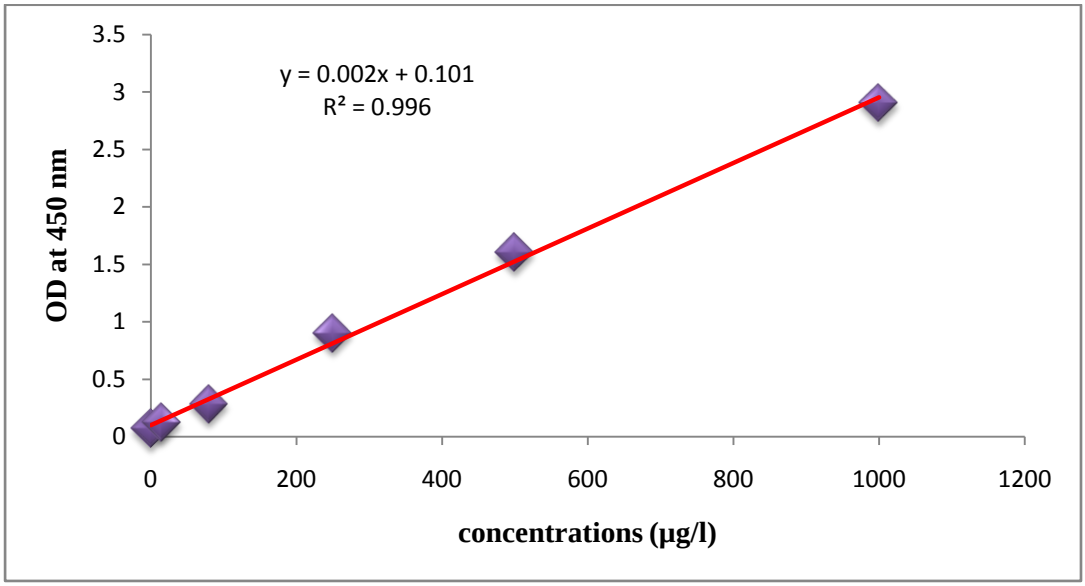

Figure 3.1.c: Standard curve for serum ferritin standard

3.2: Biochemical profile of ethnic people by groups

Table 3.2.a illustrates biochemical profile (blood haemoglobin and serum ferritin) of ethnic people by groups (lactating and NPNL women).

Blood haemoglobin analysis showed similar results in respect to lactating and non-pregnant non-lactating women. In lactating women, 93% had blood haemoglobin concentrations below cut off point (12g/dl) (Figure-3.2.a). In NPNL women, 96% were anemic (Figure-3.2.a).

Although, the mean value of hemoglobin was little high in lactating women compared to NPNL women but the difference was insignificant, p= 0.06.

Serum ferritin analysis of both the groups is demonstrating quite similar results. In lactating women, 78% had serum ferritin concentration at reference cut off point or above, where 22% were considered as iron deficient (Figure- 3.2.b), whereas in NPNL women, 74% had serum ferritin level at reference cut off point or above and 26% had serum ferritin concentration below cut off point (Figure-3.2.b).

No significant (p=0.08) difference has been observed between two mean values of serum ferritin of lactating women and non pregnant non lactating women, even though mean value of NPNL women was slightly higher than lactating women.

Table 3.2.a: Biochemical profile of ethnic people by groups

Parameter	Lactating Woman		Non Pregnant and non Lactating woman		
	% (freq)	Mean±SD	% (freq)	Mean±SD	Significance level
Hemoglobin					
<12 g/dl	**93 (79)**	8.5 ± 1.7	**96 (82)**	8.3 ± 2	t = 1.854
≥12 g/dl	7 (6)	14.9 ± 3.7	4(4)	13.8 ± 1.5	p = 0.067
Total	100(85)	**9 ± 2.5**	100(86)	**8.5 ± 2.3**	
Serum ferritin					
<15 µg/L	22(17)	11.5 ± 3.4	26 (19)	8.9 ± 3.2	t = - 2.7
≥15µg/L	**78 (59)**	42.5 ± 30	**74 (53)**	55 ± 36.7	p = 0.08
Total	100(76)	35.5 ± 29.4	100(72)	**42.4 ±37.51**	

Cut off point of haemoglobin in both the groups: 12 g/dl
Cut off point of serum ferritin in both the groups: 15 µg/l
WHO.Iron deficiency anemia, Assessment, Prevention, and Control: A guide for programme managers; WHO/ NHD/01.3 (2001).

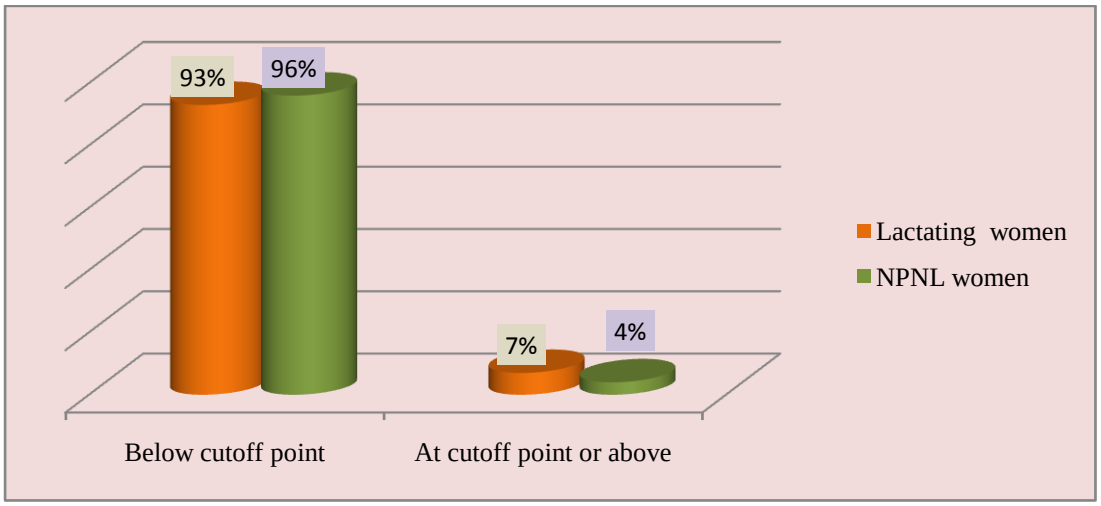

Figure 3.2.a: Blood haemoglobin status of lactating and NPNL women of CHTs (WHO classification)

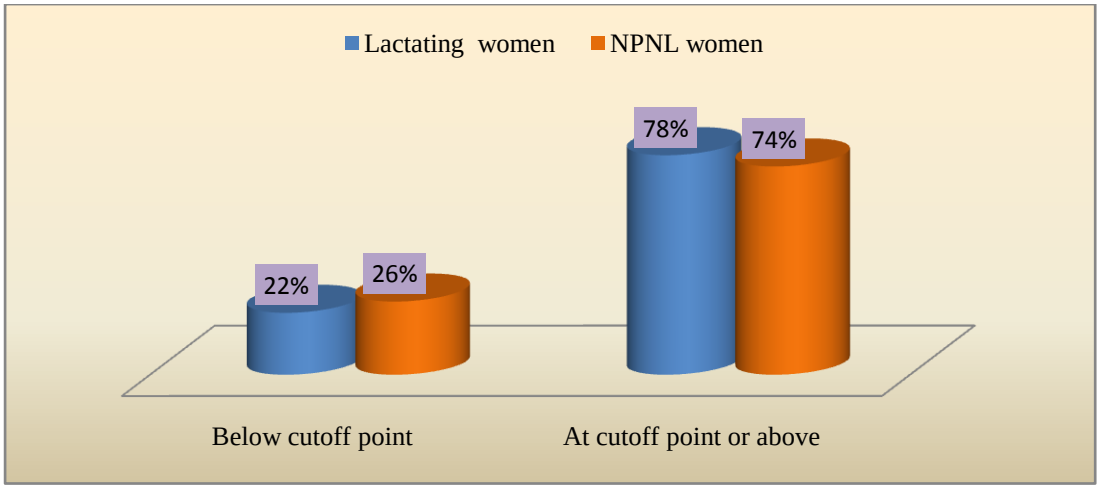

Figure 3.2.b: Serum ferritin status of lactating and NPNL women in CHTs (WHO classification)

3.3: Anemia status of ethnic people in CHTs

Table 3.3.a illustrates the anemia situation among both the groups' of the ethnic people in CHTs by using WHO classification of anemia.

In Lactating women, among 85 participants 79 were anemic, among them 56% were moderately anemic, 34% severely anemic and 10% were mildly anemic (Figure-3.3.a). In case of NPNL women, among 86 participants 82 were anemic, among them 49% were moderately, 45% severely and 6% were mildly anemic (Figure- 3.3.a).

Table 3.3.a: Anemia status of ethnic people on the basis of Hb level in serum (WHO classification)[37]

Severity of anemia	Lactating Woman (n=79)		NPNL woman (n=82)		
	% (freq)	Mean±SD	% (freq)	Mean±SD	Significance level
Mild anemic (<11.0 -11.9 g/dl)	10 (8)	11.3 ± 0.3	6 (5)	11.3 ± 0.2	
Moderate anemic (8.0- 10.9 g/dl)	**56(44)**	9.3 ± 0.8	**49(40)**	9.1 ± 0.8	t=1.682
Severely anemic (<8.0 g/dl)	34(27)	6.7 ± 1	45(37)	6.8 ± 0.8	p=0.07

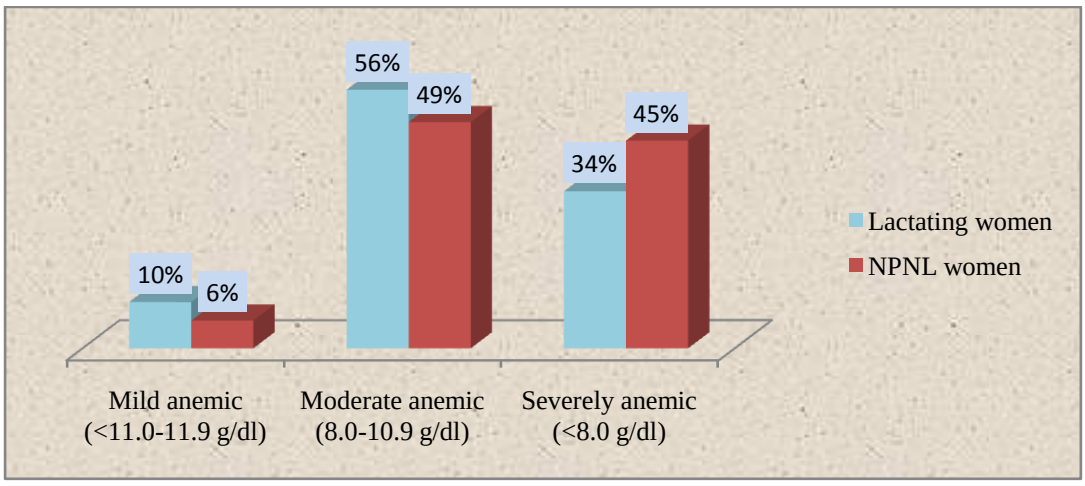

Figure 3.3.a: Anemic status of lactating and NPNL women in the CHTs (WHO classification)

3.4: Serum ferritin Status among anemic samples of the ethnic people in CHTs

Table 5.3.4.a demonstrates the serum ferritin status among anemic ethnic samples. In lactating women, among 70 anemic samples 79% (n=55) had serum ferritin concentration at cut off point or above and 21% (n=15) were iron deficient.

In NPNL women, among 68 anemic samples 72.1% had a serum ferritin level at cut off point or above, while 27.9% (n=19) were iron deficient.

Table 3.4. a: Serum ferritin Status among anemic samples of the ethnic people[37]

Serum ferritin (Cutoff point 15 µg/L)	Lactating woman % (freq)	NPNL woman % (freq)
<15 µg/L	21 (15)	27.9 (19)
≥15µg/L	79 (55)	72.1(49)
Total	70	68

3.5: Anemia incidence among iron deficient ethnic samples

In lactating women, among 17 iron deficient samples 88% (n=15) were identified as anemic, while only 12% (n=2) iron deficient samples were recognized as non anemic (Figure –3.5.a).

In NPNL women, 19 samples were analyzed iron deficient, among them 100% were viewed as anemic (low Hb level) (Figure-3.5.a).

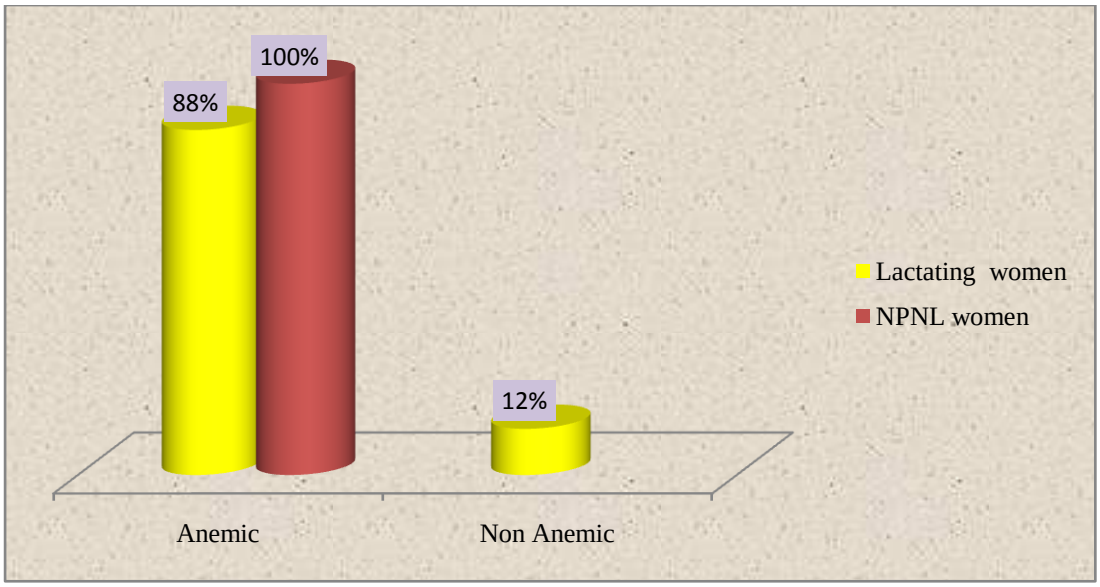

Figure 3.5.a: Anemia incidence among serum deficient lactating and NPNL women

3.6: Comparison of serum ferritin deficiency and anemia prevalence among NPNL women with National Micronutrients Status Survey (2011-2012)

Table 3.6.a illustrates the comparison of serum ferritin deficiency and anemia prevalence among NPNL women with National Micronutrients Status Survey 2011-2012. In respect of serum ferritin status, 26% NPNL women in present study was iron deficient, while in National micronutrients status survey only 7.1% found to be iron deficient anemic (Figure 3.6.a). On the other hand, anemia (low Hb) prevalence was very high compare to national data. In this study anemia incidence was seen among 96% ethnic people, where in national data 26% NPNL women was anemic (Figure 3.6.b). Serum ferritin deficiency and anemic prevalence was remarkably high in current data compare to national data.

Table 3.6.a: Comparison of serum ferritin deficiency and anemia prevalence among NPNL woman with National micronutrients status survey (2011-2012) [27, 6]

Parameter	National Micronutrients Status Survey (2011-2012) %	Current Data %
Iron deficiency anemia (Serum ferritin) (<15 µg/L)	7.1	26
Anemic (Low Hb) (<12 g/dl)	26	96

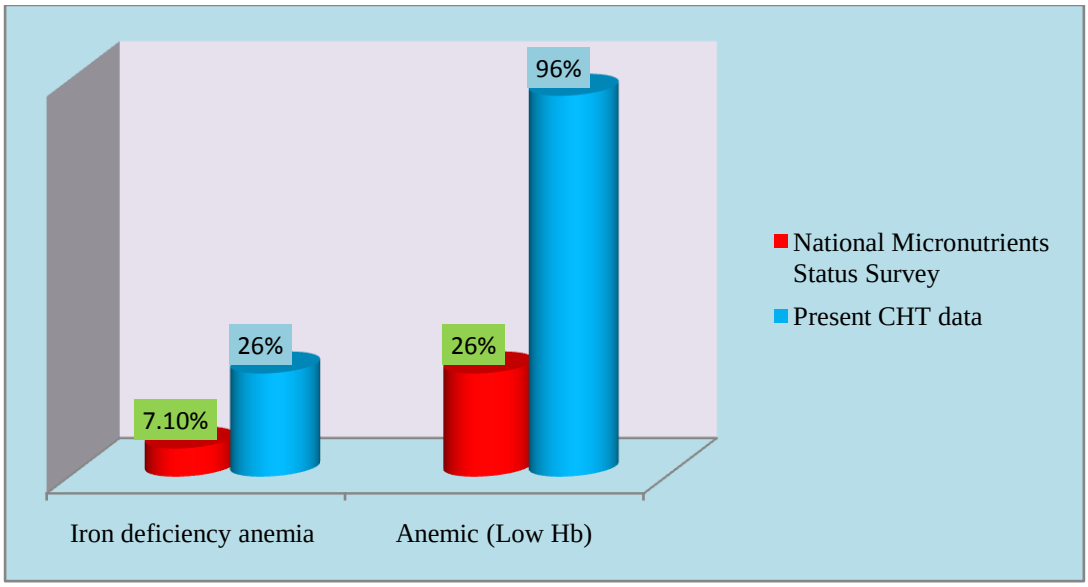

Figure 3.6.a: Prevelance of iron deficiency (lower concentration of serum ferritin) and anemia (low Hb level) among NPNL women.

3.7: Relationship of blood haemoglobin status with socio-economy, nutritional status and knowledge, dietary nutrients and drinking water source

Table 3.7.a demonstrats the relationship of blood haemoglobin with socio-economy, nutritional status and knowledge, dietary nutrients and drinking water source. It was shown that blood haemoglobin of lactating and NPNL women was found to be negatively related to the socio-demographic and nutritional factors. However, it was observed that anemic ethnic people mostly used tube well as drinking water source.

Dietary iron, protein and vitamin E were significantly associated with hemoglobin level of lactating women of ethnic group (p=0.01, 0.03 and 0.00 respectively). Unlike lactating women, dietary iron and dietary protein was not significantly associated to haemoglobin level (p=0.116 and 0.292 respectively), but dietary vitamin E was significantly associated to haemoglobin level (p=0.01).

Dietary vitamin A take was not found to be significantly influencing haemoglobin level; p values were 0.33 and 1.0 respectively in lactating and NPNL women.

Table 3.7.a: Relationship of blood hemoglobin level with socio-economy, nutritional status and knowledge, dietary nutrients and drinking water sources

Parameter	Hemoglobin (cuttoff 12 g/dl)					
	Lactating Woman		Significance Level	NPNL Woman		Significance Level
	<12	≥12		<12	≥12	
Education						
Illiterate	19	1	P=1.0	27	2	P=1.0
Literate	60	5		55	2	
Occupation						Value=1.207
Agriculture	2	2	Value = 0.323	8	0	P=0.711
House hold chores	73	4	P=1.0	53	4	
Non Agriculture	4	0		21	0	
Age in years			ND,			
15-17 years	-	-	18-40 years is	10	0	Value=1.014
18-40 years	79	6	constant	72	4	P=1.0
Marital status			ND,			
Unmarried	-	-	Ever married is	15	0	P=1.0
Ever married	79	6	constant	67	4	
Income (Tk)						
<6000	9	2	P=0.171	9	0	P=1.0
≥ 6000	70	4		73	4	
***HH food insecurity**						
Never	71	3	P=0.171	70	4	P=1.0
Occasionally	8	3		12	0	
NK Score			Value=1.9			P=0.173
14-29	11	1	P=0.588	15	2	
30-45	68	5		67	2	
BMI (kg/m2)			Value=1.486			
< normal	9	0	P=0.506	11	0	Value=1.043
Normal 18.5-24.99	54	6		53	4	P=0.752
> normal	16	0		18	0	
Dietary iron(mg)						
< RDA	44	0	P=0.01	43	0	P=0.116
≥RDA	35	6		39	4	
Dietary protein (g)						
<RDA	41	0	P=0.03	32	0	P=0.292
≥RDA	38	6		50	4	
Dietary Vitamin E(mg)						
<RDA	79	2	P=0.00	80	2	
≥RDA	0	4		2	2	P=0.01
Drinking water source						
Tap/tube well	64	4	Value=6.935	68	4	
Other source	15	2	P=0.225	14	0	P=1.0
Dietary vitamin A						
< RDA	19	0	P=0.330	9	0	P=1.0
≥RDA	60	6		73	4	

Significant: p<0.05, Association: fisher exact test

3.8: Relationship of serum ferritin level with socio-economy, nutritional status and knowledge, dietary nutrient, drinking water sources and hemoglobin level

Table 3.8.a demonstrats the relationship of serum ferritin level with socio-economy, nutritional status and knowledge, dietary nutrients, drinking water source and haemoglobin level.

No significant association was found of serum ferritin level of lactating and NPNL women with education, occupation, income, food security, BMI, nutrition knowledge, source of drinking water, haemoglobin level, dietary vitamin A, age and marital status.

Dietary iron had significantly influenced (p=0.00) serum ferritin concentration of these lactating and NPNL women.

Table 3.8.a: Relationship of serum ferritin level with socio-economy, nutritional status and knowledge, dietary nutrient and drinking water sources

Parameter	Serum Ferritin (cutoff 15µg/L)					
	Lactating Woman		Significance Level	NPNL Woman		Significance Level
	<15	≥15		<15	≥15	
Education Illiterate Literate	2 15	16 43	P=0.331	7 12	15 38	χ^2 =0.481 df=1 p=0.493
Occupation Agriculture House hold chores Non Agriculture	0 17 0	4 53 3	Value=1.153 P=0.622	1 13 5	5 37 11	Value= 0.479 P=0.831
Age in years 15-17 years 18-40 years	- 17	- 59	ND, 18-40 years is constant	3 16	4 49	p=0.371
Marital status Unmarried Ever married	- 17	- 59	ND, 18-40 years is constant	6 13	6 47	p=0.69
Income (Tk) <6000 ≥ 6000	1 16	9 50	p=0.441	1 18	7 46	p=0.672
***HH food insecurity** Never Occasionally	16 1	50 9	p=0.441	16 3	45 8	p=1.0
NK Score 14-29 30-45	4 13	8 51	p=0.449	2 17	11 42	p=0.491
BMI (kg/m^2) < normal Normal 18.5-24.99 > normal	2 10 5	7 45 7	Value=3.117 p=0.221	3 10 6	6 39 8	Value=3.229 p=0.225
Dietary iron(mg) < RDA ≥RDA	17 0	24 35	Value=25.2 P=0.00	18 1	18 35	Value=24.1 P=0.00
Drinking water source Tap/tube well Other source	14 3	46 13	p=1.0	16 3	42 11	p=0.747
Hemoglobin level (g/dl) <12 ≥12	22 1	48 5	P=0.661	19 0	49 4	P=0.567
Dietary vitamin A < RDA ≥RDA	3 14	14 45	0=0.748	3 16	6 47	P=0.690

Significant: p<0.05, Association: fisher exact test

Chapter 4: Discussions, key findings, conclusion, recommendations and references

Discussions

It was demonstrated that mild, moderate and severe anemia prevelance among lactating women were 56%, 34% and 10% respectively. These were 49%, 45% and 6% in NPNL women.

In 2002 the prevalence of anemia was found to be 43.4% among females aged 13-19 years in CHTs (UNICEF 2002). In 2003[25], 46% adolescent girls, 43% lactating women and 35% NPNL women were found to be anemic in CHTs. The overall prevalence of anemia in all non-pregnant women (lactating and NPNL) was 39%, and only 1.8% non pregnant women and 1.6% adolescent girls were found severely anemic. In addition, a marked difference was observed between the prevalence of anemia in the CHTs among pregnant women of ethnic minority groups (61%) and (41%) among pregnant non ethnic women (BBS and UNICEF 2003). According to Nutrition Health and Demographic survey of Bangladesh, 2013[28], anemia prevalence is extremely high in women (93.5%) of Chittagong Hill Tracts division. According to National Micronutrient Status Survey 2011-2012[6], the prevalence of anemia was 26% nationwide. This result is a clear indication as to how anemia has become increasing among ethnic people in the CHTs over years.

The iron deficiency anemia (low serum ferritin concentration) was found to be 24.3% among ethnic people and average serum ferritin concentration was 39.1±33.7µg/L. The findings showed that iron deficiency anemia is more prevalent among NPNL women (26%) than lactating women (22%). According to National Micronutrient Status Survey 2011-2012[27], the prevalence of iron deficiency anemia was only 7.1%. It was observed that iron deficiency and anemic prevalence is remarkably high in present data.

Results of serum ferritin status among anemic ethnic samples showed that 21% lactating anemic women and 27.9% NPNL anemic women had iron deficient anemia. In addition, analysis of anemia incidence among iron deficient ethnic samples showed that 88.2% iron deficient (low serum ferritin level) lactating women and 100% iron deficient NPNL women had anemia (low blood Hb level). From this observation a conclusion can be made that iron deficiency (serum ferritin) could be the prime factor behind high anemia prevalence among ethnic people and somehow justify the higher anemia prevalence in NPNL women compare to lactating women.

There is a question of increased prevalence of anemia that emphasize on the investigation of the factors associated with anemia in CHTs. Though there are various factors that contribute to the prevalence of anemia in the CHTs, the present study has helped identify the major contributor such as dietary deficiencies and malaria prevalence.

Results showed that in lactating and NPNL women, greater prevalence of anemia was seen among literate, household workers, high monthly family income holders, food secure households, normal nutritional status; and better nutrition knowledge and tube well water drinkers. It was apparent from the cross tables, these factors might have negatively influenced low level of hemoglobin of the lactating and NPNL women respectively.

In lactating women, greater number of anemic cases consumed dietary iron, protein and vitamin E below the reference RDA, where all the non anemic participants had fulfilled their iron and protein requirements; and greater number of non anemic samples had fulfilled their vitamin E requirement through diet. Dietary iron, protein and vitamin E were significantly associated with hemoglobin level of lactating women of ethnic people. Dietary iron and protein was not significantly associated to blood haemoglobin status of NPNL women but dietary vitamin E was significantly associated to blood haemoglobin status of NPNL women.

In both the groups, haemoglobin level was not found to be significantly influenced by dietary vitamin A consumption.

Relationship of serum ferritin status with socioeconomic factors and dietary factors showed that, education, occupation, and income level, food security in households, nutrition knowledge, BMI ranges, drinking water sources, age groups and marital status were not significantly associated to serum ferritin level.

Dietary iron found to be significantly influenced serum ferritin concentration of the lactating and NPNL women and dietary vitamin A intakes had no significant influence on serum ferritin concentrations.

Khan and Baseer (1996) found that vitamin A has relation with iron metabolism and haemoglobin formation. Thus vitamin A deficiency can inhibits haemoglobin formation and iron metabolism can be impaired. In this study no significant influence had found of dietary vitamin A consumption on serum ferritn level and haemoglobin level.

In both lactating and NPNL women, haemoglobin level found to be insignificantly associated to serum ferritin level. Though haemoglobin concentrations were found to be insignificantly associated to serum ferritin level but in section 2 of this study, it was seen that most of iron deficient anemic (serum ferritin) samples were anemic in terms of haemoglobin level. Analysis of anemia incidence among iron deficient ethnic people showed that 88.2% iron deficient (low serum ferritin level) lactating samples and 100% iron deficient NPNL women had anemia (low blood Hb level). Partially serum ferritin deficiency might be the reason behind the high prevalence of anemia among ethnic people.

Another reason of anemia in lactating and NPNL women on the basis of low blood haemoglobin level would be due to less intake of dietary vitamin E. As serum vitamin E deficiency is related to hemolysis, vitamin E deficiency may cause haemolytic anemia. Vitamin E deficiency causes fragility of RBCs. Vitamin E (tocopherol) is an antioxidant, it protects cells against damage by free radicals, which are by-products of normal cell activity and which participate in chemical reactions within cells. If red blood cells are destroyed prematurely (hemolysis), the bone marrow tries to compensate by producing new cells faster, when destruction of red blood cells exceeds their production, hemolytic anemia results.[33-34]

As identified in this study, both dietary macro and micronutrients are the prime reason behind higher anemia prevalence. Other reasons of anemia might be due to overflow during menstruation, malaria infection, dietary vitamin B_{12} and folate deficiencies, thalassemia and sickle cell diseases, that these were not addresses in this research.

As assumed in national strategy for anemia prevention and control in Bangladesh, malaria may also be an important cause of anaemia among the 14 million people living in the malaria endemic hilly areas of the country. Malaria cases are reported from 13 of the country's 64 districts, but the number of cases in the three CHTs districts accounts for nearly 90% of the total caseload in the country.

Haemoglobinopathies such as thalassemia, sickle cell may also contribute to anaemia. These genetic disorders are known to occur in specific geographic areas and ethnic groups in Asian countries; however there is limited data for Bangladesh. Haemoglobinopathies may explain the higher prevalence of anaemia among the ethnic groups of the CHTs compared with Bengali population living in the same area, but this needs to be confirmed (IPHN, 2007).[35]

This same inherited disease of red blood cells may confer a degree of protection against malaria (specifically, malaria caused by the protozoan parasite *Plasmodium falciparum*), which is or was prevalent in the regions where the trait is common. This selective survival advantage of carriers (known as heterozygous advantage) may be responsible for perpetuating the mutation in populations. In that respect, the various thalassemias resemble another genetic disorder affecting hemoglobin, sickle-cell disease.

Poor dietary intake can also contribute to deficiencies in other micronutrients and macronutrients that are needed to enhance the absorption and metabolism of iron and production of haemoglobin and red blood cells, including folic acid, vitamin B12, vitamin C, vitamin A and animal protein. Maintenance of red blood cell needs vitamin E as antioxidants. Dietary surveys and studies suggest that a large proportion of children and women do not meet daily requirements for several micronutrients, and have multiple micronutrient deficiencies (Jahan & Hossain, 1998; Lutter & Rivera, 2003; Ahmed et al., 2005).[36]

So, it could be assumed that anemia prevalence among participants of ethnic groups in CHTs may be due to high malaria incidence or dietary micronutrient (iron, vitamin $B_{12,}$ folate, vitamin C, vitamin E) and macro-nutrient (protein) deficiencies or due to thalassemia or sickle cell disease or combination of two to three factors.

Key findings

It was revealed that 94.2% of ethnic people were identified as anemic and 24.3% were iron deficient. Socio-demographic factors were found to be negatively related to anemia. Dietary vitamin E was significantly associated to haemoglobin level. Dietary iron had significantly influenced serum ferritin concentration of these lactating and NPNL women.

Conclusion

Socio-demographic factors and nutritional status were found to have no positive relation to the prevelance of anemia. Only dietary vitamin E was significantly associated to haemoglobin level. High malaria incidence, dietary iron, vitamin $B_{12,}$ folate, vitamin C, and protein deficiencies, thalassemia and sickle cell disease combinedly might have created this anemic condition of the ethnic people in CHTs. Further research is needed to find the causes of the high prevalence of anemia in the CHTs. Further analysis like serum vitamin B_{12} and folic acid status, malaria prevalence and thalassemia and sickle cell disease incidence need to be conducted in future research plan.

Recommendations

1. Prevention and control of anaemia in CHTs should be given immediate priority in the health and nutrition sector.
2. Interventional research need to be conducted to identify effective new approaches to anaemia prevention and control of the ethnic people.
3. National anaemia survey with special preference for the ethnic community need to be repeated periodically to measure progress towards the reduction of anaemia among ethnic people in CHTs.

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Section C: Micronutrient status of ethnic people in Chittagong Hill Tracts

Chapter 1: Introduction

1.1 Overview

Micronutrients are required in small quantities to carry out normal physiological functions. They play important roles in human development and well-being, including the regulation of metabolism, heartbeat, cellular pH and bone density. They enable the body to produce enzymes, hormones and other substances essential for proper growth and development. The National Micronutrient Status 2011-2012 Survey did not have any information on specific community like ethnic people. This section particularly focuses vitamin A, vitamin E; copper, iron and zinc status of ethnic people living in the CHTs.

1.2 Rationale of the study

Micronutrient status of the ethnic people in the Chittagong Hill Tracts has not been addressed yet. Very few studies have been done on night blindness situations of ethnic children and mothers which are years back. This section of the study represented the present micronutrient status of the ethnic people and be inclined to analyze the association with socio-economic and socio-demographic status; nutritional knowledge and status; and dietary micronutrient status.

1.3 Objective

The aim of this section of study is to assess the micronutrient status of ethnic people living in the Chittagong Hill Tracts.

In view with this objective, this study

1. analyzed serum micronutrients- vitamin A, vitamin E; copper, zinc, iron levels
2. assessed prevalence of vitamin A, vitamin E, copper, zinc and iron deficiency among the ethnic lactating women and NPNl women in the CHTs
3. attempted to find out socio-demographic status, nutrition knowledge level, nutritional status and dietary micronutrient intake
4. find the difference between national mainstream micronutrients status with ethnic micronutrients status of the CHTs
5. provide recommendations to national health and nutrition programme policy

Section C (a): Vitamins (A & E) status of ethnic people in Chittagong Hill Tracts

a.1.1 Background

a. 1.2 Vitamins

Vitamins are essential organic nutrients, most of which are not made in the body, or only in insufficient amounts, and are mainly obtained through food. When their intake is inadequate, vitamin deficiency disorders are the consequence. Although vitamins are only present and required in minute quantities, they are vital to health and need to be considered when determining nutrition security.[1]

a.1.3 Fat soluble vitamins

Fat-soluble vitamins are those which disperse and are stored in fat. Vitamin A, D, E, and K are fat-soluble vitamins. Some phytonutrients, such as the carotenoids (e.g. beta-carotene) are also fat-soluble. Fat-soluble vitamins are stored in the body for long periods of time and generally pose a greater risk for toxicity when consumed in excess. Eating a normal, well-balanced diet will not lead to toxicity or deficiency.[2]

Vitamin A

Vitamin A is a fat soluble vitamin. It is the name of a group of fat-soluble retinoids, including retinol, retinal, retinoic acid and retinyl esters and several provitamin A carotenoids, among which beta-carotene is the most important.

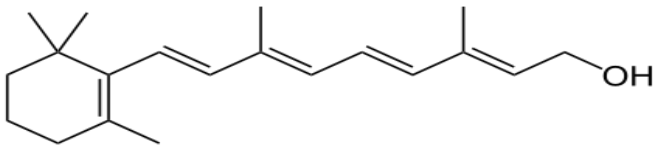

Figure: Chemical structure of retinol

There are two dietary forms of vitamin A, one is the performed vitamin A or retinol and its esterified form, retinyl ester. This is the natural vitamin found in animal sources. The second form is provitamin A, the β carotene. The original source of retinol is β carotene which animals eat and then convert to retinol for being stored to support important biological functions. Both retinyl esters and provitamin A carotenoids are converted to retinol, which is oxidized to retinal and then to retinoic acid. Most of the vitamin A is stored in the liver in the form of retinyl esters. [3-5]

Functions of Vitamin A

Vitamin A is involved in immune function, vision, reproduction and cellular communication.

Vision support

The human retina contains four kinds of photo pigments that store vitamin A compounds. One of these pigments, called rhodopsin, is located in the rod cells of the retina. Rhodopsin allows the rod cells to detect small amounts of light, and, thus, plays a fundamental role in the adaptation of the eye to low-light conditions and night vision. Retinal, the aldehyde form of the vitamin, participates in the synthesis of rhodopsin, and in the series of chemical reactions that causes visual excitation, which is triggered by light striking the rod cells. The remaining three pigments, collectively known as iodopsins, are found in the cone cells of the retina and are responsible for day vision.[6]

Epithelial tissue

Vitamin A is very essential to build and maintain epithelial tissue, which provides the primary barrier to infection. The epithelium includes the outer skin and the inner membranes.

Reduces free radical

Beta-carotene is an antioxidant. Antioxidants protect cells from damage caused by substances called free radicals. Beta carotene increases the risk of accelerating the aging process and/or health conditions.

Reproduction

Retinol and retinal are essential for reproduction, supporting spermatogenesis in the male and preventing fetal resorption in the female.

Cell Growth Support

Vitamin A is required for normal cell growth and development. It is a very essential pre-requisite for the growth of skeletal and soft tissues. It is known that retinoic acid is necessary for the synthesis of many glycoproteins, which control cellular adhesion (the ability of cells to attach to one another), cell growth, and cell differentiation. Retinol and retinoic acid (RA) are essential for embryonic development. During fetal development, RA functions in limb development and formation of the heart, eyes, and ears. Additionally, RA has been found to regulate expression of the gene for growth hormone.[7-8]

Red blood cell production

Red blood cells, like all blood cells, are derived from precursor cells called stem cells. Stem cells are dependent on retinoid for normal differentiation into red blood cells. Vitamin A appears to facilitate the mobilization of iron from storage sites to the developing red blood cell for incorporation into haemoglobin.[9-10]

Immunity

Vitamin A is commonly known as the anti-infective vitamin, because it is required for normal functioning of the immune system. The skin and mucosal cells (cells that line the airways, digestive tract, and urinary tract) function as a barrier and form the body's first line of defence against infection. Retinol and its metabolites are required to maintain the integrity and function of these cells. Vitamin A and retinoic acid (RA) play a central role in the development and differentiation of white blood cells, such as lymphocytes, which play critical roles in the immune response.[11-13]

Mucoprotein synthesis

Vitamin A is essential for the synthesis of mucoproteins and glycoproteins.[14]

Consequences of vitamin A deficiency

Eye changes: The important vitamin A deficiency is related to eye changes which lead to night blindness and xeropthalmia.

Night blindness: This is due to failure information of visual purple (rhodopsin) in the rods for dim light vision. In early stages of vitamin A deficiency, the individual cannot see well in dim light. Difficulty in reading or driving the car in dim light is experienced. In advanced deficiency, the subject cannot see objects in dim light.

Xeropthalmia: This is the comprehensive term now used by the WHO to denote all vitamin A deficiency manifestations affecting the structure or function of the eyes, including the conjunctiva, cornea and retina. The following manifestations are included under the category.

Conjunctival xerosis (X1A): Xerosis means dryness. This is dryness of conjunctiva. The conjunctiva is dry, thickened, wrinkled and pigmented. This is due to the keratinisation of the epithelial cells.

- **Bitot's spots (X1B)**: Grayish or glistening white plaques formed of desquamated thickened conjunctival epithelium, usually triangular in shape and firmly adhering to the conjunctiva.
- **Corneal xerosis (X2):** Appear in Cornea. When dryness spreads to cornea, an extension of Conjunctival xerosis is called corneal xerosis. It takes on a dull, hazy, lusterless appearance. This is due to the keratinisation of the epithelial tissue over the cornea.
- **Keratomalacia/corneal ulceration (X3A, X3B)**: It attacks equal or greater (X3B) or less (X3A) than **1**/3rd of the corneal surface. Ulcers are formed due to infection with Staphylococcus or pseudomonas Organisms.
- **Corneal scar (XS)**: These are white, opaque patches on the cornea and the result of healing of an older ulcer. Vision may be seriously affected, depending on the size of the scars.
- **Xeropthalmic fundus (XF)**: This is the ulcer in retina. The retina has white dots around the periphery of the fundus.
- **Total blindness**: It is the end stage of vitamin A disorders and it is not curable.[15]

Epithelial changes

a) **Keratinization**: An inadequate supply of vitamin A may lead to definite changes in the epithelial tissues throughout the body; this is called keratinization or a noticeable shrinking, hardening and progressive degeneration of the cells, occurs, which increases the susceptibility to severe infections of the eye, the nasal passages, the sinus, middle ear, lungs and genitourinary tract.

b) **Follicular hyperkeratosis**: Skin changes in severe vitamin A deficiency known as follicular hyperkeratosis have been described. The skin become rough, dry and scaly.

Muscular weakness

Muscular weakness is seen if there is vitamin A deficiency in diet.

Reproduction

The deficiency of vitamin A produces sterility, testicular degeneration in the males and malformation or aborted offspring in the females.[16]

Impairment of nervous system

Deficiency of vitamin A develops abnormalities of gait and could not maintain proper balance while walking. Impairment of the sensation of taste and smell is seen.[16-17]

Alimentary tract

In vitamin A deficiency thickening and dryness of the alimentary tract results in diminished secretion of digestive juices, impaired absorption, and increased liability to intestinal infection and diarrhea.

Genito- urinary tract

Vaginitis in females, urinary tract infection, and a tendency to stone formation has been ascribed to vitamin A deficiency.[18]

Toxicity of vitamin A

Toxicity in adults is seen with intakes more than 50,000 IU for months or years.The common symptoms of toxicity are- anorexia, hyperirritability, drying and desquamation of the skin, loss of hair, bone and joint pain, bone fragility, headaches, hypercalcemia and enlargement of the liver and spleen are other manifestations of toxicity.[19]

Interaction of vitamin A with other micronutrients

Vitamin A and iron interaction

Vitamin A and its derivatives are important not only for normal functioning of the eyes but also for normal differentiation of several tissues. Several reports have suggested an interrelation between vitamin A and iron metabolism. These studies demonstrated a reduction of hematopoietic cells in the bone marrow and also have evidenced hemosiderosis in the liver and spleen in vitamin A deficient subjects.[33-37]

Imrana Khan and Abdul Baseer in 1996 showed that Retinol was significantly positively associated with Haemoglobin and Hematocrit. This indicates that vitamin A and iron metabolism are inter-related. The relationship between vitamin A and haematopoiesis could be explained from following factors:

- Vitamin A influences the differentiation of the red cells, Red blood cells, like all blood cells, are derived from precursor cells called stem cells. Stem cells dependents on retinoids for normal differentiation into red blood cells.

- Vitamin A deficiency inhibits the mobilization of the endothelial iron deposits. Vitamin A appears to facilitate the mobilization of iron from storage sites to the developing red blood cell for incorporation into hemoglobin, the oxygen carrier in red blood cells. Iron metabolism can be described as a closed loop in which the primary processes are the formation and destruction of red blood cells. Small amounts of iron enter this loop via the absorption of dietary iron and, in balancing; an equivalent amount of iron exits the loop as losses from blood and tissues. Vitamin A has been proposed to influence iron metabolism either via its effect on erythropoiesis, with vitamin A deficiency leading to decreased erythropoiesis with less iron incorporated into red blood cells, or indirectly by its beneficial effects on immune function leading to a decrease in the anemia of infection.

- Vitamin A enhances immunity and reduces infection and thus the anemia of infection. Vitamin A deficiency increases one's susceptibility to infections and consequently to an impaired hematopoiesis. In addition, as infection is reported to block iron absorption. The promotion of immune function by vitamin A may remove this blockade of iron absorption by reducing inflammation. However, testing these theories and confirming the effect of vitamin A on iron absorption has proved difficult, and the exact mechanism by which vitamin A interacts with iron metabolism remains obscure. The anemia of infection is characterized by a set of cytokine-

induced mechanisms that lead to shortened red blood cell survival, impaired red blood cell production, and decreased mobilization and utilization of iron. This form of iron-deficient erythropoiesis is also accompanied by up-regulation of ferritin and down-regulation of transferring as part of the acute phase response. Vitamin A status can influence mechanisms of host resistance and severity of infection.[38-39]

- Vitamin A deficiency reduced serum iron and transferrin saturation levels, increased spleen iron concentrations, reduced hepatic Hamp and kidney erythropoietin messenger RNA (mRNA) levels and up-regulated hepatic and spleen heme oxygenase-1 gene expression while reducing the liver HO-1 specific activity. Vitamin A deficiency leads to ineffective erythropoiesis by the down-regulation of renal erythropoietin expression in the kidney, resulting in erythrocyte malformation and the consequent accumulation of the heme group in the spleen. Vitamin A deficiency indirectly modulates systemic iron homeostasis by enhancing erythrophagocytosis of undifferentiated erythrocytes.[40-43]

Vitamin A and Zinc interaction

Zinc status influences several aspects of vitamin A metabolism, including its absorption, transport, and utilization. Zinc deficiency is thought to interfere with vitamin A metabolism in several ways:

- Zinc is required for protein synthesis, including the hepatic synthesis and secretion of retinol binding protein (RBP) and transthyretin; therefore, zinc deficiency influences the mobilization of vitamin A from the liver and its transport into the circulation. Zinc deficiency results in decreased synthesis of retinol-binding protein (RBP), which transports retinol through the circulation to peripheral tissues and protects the organism against potential toxicity of retinol.
- Zinc deficiency results in decreased activity of the enzyme that releases retinol from its storage form, retinyl palmitate, in the liver.
- The oxidative conversion of retinol to retinal that requires the action of a zinc-dependent retinol dehydrogenase enzyme.

Vitamin A also affects zinc absorption and utilization. Severe vitamin A deficiency may reduce absorption and lymphatic transport of zinc by altering synthesis of a zinc dependent binding protein.

In humans, circulating zinc and vitamin A concentrations appear unrelated in well-nourished states but tend to co-vary in marginally nourished individuals with coexisting zinc and vitamin A deficiencies.[44-46]

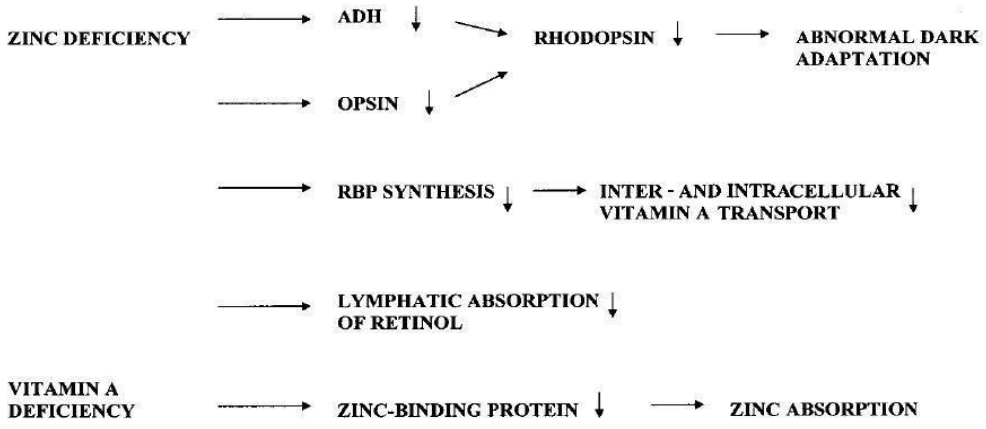

Figure a.1.3.a: Potential mechanism for zinc and vitamin A interaction. ADH, alcohol dehydrogenase; RBP, retinol binding protein, zinc-binding protein.

The impact of fat on the absorption of vitamin A

Fat is the dietary vehicle for transport of both vitamin A and carotenoids. Fat facilitates the absorption of β-carotene by increasing the bile-flow which intern facilitates the transport of β-carotene into the mucosal cells .Thus, one important issue is to determine the amount of fat needed for an optimal absorption. Raising the level of fat in a low fat diet by one gram per kg body weight (aged three to 13) per day improved the absorption of carotenoids. However, a study on healthy volunteers in the Netherlands showed that the optimal uptake of β-carotene requires a limited amount of fat, 3g per portion (Roodenburg et al., 2000). The type of fat in the meal ingested with β-carotene may also influence the degree of absorption; beef tallow resulted in a greater absorption when compared with sunflower oil (Hu et al., 2000) and long-chain triglycerides were better than medium-chain triglycerides, which primarily are absorbed via the portal vein (Borel et al., 1998).[47-50]

Vitamin E

Vitamin E is a fat soluble vitamin. Vitamin E refers to a group of compounds that include both tocopherols and tocotrienols. The nutritional content of vitamin E is defined by α-tocopherol activity. The molecules that contribute α-tocopherol activity are four tocopherols and four tocotrienols, identified by the prefixes alpha- (α-), beta- (β-), gamma- (γ-), and delta- (δ-). Natural tocopherols occur in the RRR-configuration [2, 5, 7, 8-tetramethyl-2*R*-(4′*R*, 8′*R*, 12′ trimethyltridecyl)-6-chromanol] only. Water soluble forms such as d-alpha-tocopheryl succinate are used as food additive. Of the many different forms of vitamin E, α-tocopherol, the most biologically active form of vitamin E, is the second-most common form of vitamin E in the diet. As a fat-soluble antioxidant, it stops the production of reactive oxygen species formed when fat undergoes oxidation.[20]

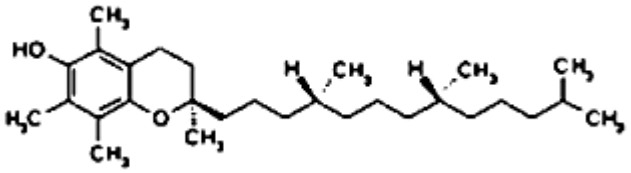

Figure: chemical structure of α- tocophero

Functions of vitamin E

Vitamin E has many biological functions, the antioxidant function being the most important. Other functions include enzymatic activities, gene expression, cell signalling and neurological functions.

- As an antioxidant, vitamin E acts as a peroxyl radical scavenger, preventing the propagation of free radicals in tissues, by reacting with them to form a tocopheryl radical, which will then be reduced by a hydrogen donor (such as vitamin C) and thus return to its reduced state. As it is fat-soluble, it is incorporated into cell membranes, which protects them from oxidative damage.
- As an enzymatic activity regulator, for instance, protein kinase C (PKC), which plays a role in smooth muscle growth, can be inhibited by α-tocopherol. α-Tocopherol has a stimulatory effect on the dephosphorylation enzyme, protein phosphatase 2A, which in turn, cleaves phosphate groups from PKC, leading to its deactivation, bringing the smooth muscle growth to a halt.
- Vitamin E also has an effect on gene expression. Macrophages rich in cholesterol are found in the atherogenetic tissue. Scavenger receptor CD36 is a class B scavenger receptor found to be up-regulated by oxidized low density lipoprotein (LDL) and binds it. Treatment with α-tocopherol was found to downregulate the expression of the CD36 scavenger receptor gene and the scavenger receptor class A (SR-A) and

modulates expression of the connective tissue growth factor (*CTGF*). The *CTGF* gene, when expressed, is responsible for the repair of wounds and regeneration of the extracellular tissue lost or damaged during atherosclerosis.

- Vitamin E is one of the primary factors in body defence system because it is lipid soluble and therefore can directly protect cell membranes. It also protects lipids and prevents the oxidation of polyunsaturated fatty acids.
- Vitamin E protects against heavy metals, hepatotoxins generating free radicals, various drugs that cause oxidant injury and environmental pollutants such as ozone.
- Vitamin E is important for normal immune function, particularly the function of T- lymphocytes.
- A very important function of vitamin E in humans is the protection of nervous system, skeletal muscle and the ocular retina from oxidative damage. The production of neurotransmitters in the nervous system is accompanied by generation of large amounts of free radicals, thus vitamin E appears to be essential in preventing damage to mitochondria and axonal membranes of the nervous system caused by free radicals.[20-21]

Consequences of vitamin E deficiency

Hemolytic anemia

Severe vitamin E deficiency may lead to increased haemolysis of red blood cells due to presence of dilute hydrogen peroxide.[22]

Neurological effects

Vitamin E works as an antioxidant, thus deficiency of this vitamin will result to a series of great oxidative stress by many cells or tissues. Observations suggested that people who have vitamin E deficiencies are suffered from certain neurologic effects, thus affects the central nervous system. A person greatly lacking vitamin E will experience nerve degeneration of the hands and feet, poor reflexes, impaired coordination and loss of balance.

Muscle Weakness

Another symptom of vitamin E deficiency is myopathy, wherein the muscular fibers do not function well or are weakened.

Sight Problems

Vitamin E deficiency may also lead to vision problems. One of the symptoms is retinal thinning or degeneration, where the inner lining of the eye is damaged and begins to become thinner. People with vitamin E deficiency may also experience blurred vision and difficulty seeing at night.[23]

Toxicity of vitamin E

It appears relatively non toxic. However, several effects can be seen. Such as- Large intakes of vitamin E might interfere with absorption of vitamin A and K, gastrointestinal upset, elevation of serum lipids, impaired blood coagulation by decreasing platelet adhesion and reduction in serum thyroid hormone.[19]

Night blindness prevalence among the ethnic people of Chittagong Hill Tracts

According to HKI, 2003, the prevalence of night blindness in lactating women of CHTs was 1.1 %. [27]

Vitamin E deficiency prevalence among women of Bangladesh

Shamim, 2014 reported that 72.3% of the pregnant rural Bangladeshi women had vitamin E deficiency. [28]

Chapter 2: Methods and materials

a.2.1 Study design

Fresh serum samples were used from NHDSBD-2011survey in this section of the study. NHDSBD-2011 survey team collect blood samples from 5418 subjects for further studies which were not used in NHDSBD -2011. Processed serum was used freshly for vitamin A and E analysis for this study only.

a.2.2 Collection of blood specimen

A 5 ml of venous blood sample was collected aseptically from antecubital vein of each of the ethnic participants.

a.2.3 Processing of serum from blood

5 ml blood was collected in a heparin tube. Immediately after collection, the blood specimen was kept undisturbed for 60 min and then centrifuged at 3000 rpm for 30 min to extract serum. Extracted serum was equally distributed in 3 eppendrof tubes and triplicate was made for each sample. All of the aliquoted serum were then stored at -80°C in a refrigerator for later analysis.

a.2.4 Study population

Serum samples of 31 lactating women and 19 NPNL women were used in this part of research. A sub sampling was used to determine the sample size for serum vitamin A and E analysis. A total 50 serum samples were sorted from 171 serum samples to determine vitamin A and E status of ethnic participants. These 50 samples were selected from 98 samples which were used for iron, copper and zinc analysis. These 50 samples included both deficient and with normal value of iron, copper and zinc in serum.

a.2.5 Data analysis

IBM SPSS Statistics 21 software package and Microsoft excel were used for data entry. IBM SPSS Statistics 21 software package was used to analyze the data. Descriptive statistics (frequencies, cross tables, descriptive) was used to calculate all variables. Values were expressed as frequency, percentage, mean and standard deviation. Tables, diagrams and figures were used to present the data. Chi-square and fisher exact tests were applied to find relations. The significance of the difference was tested using one sample t-test with the 5% level of confident interval, test statistic and its variance for categorical variables.

a.2.6 Estimation of α- tocopherol and retinol

Serum α −tocopherol and retinol were estimated simultaneously by High Performance Liquid Chromatography (HPLC). Extraction of retinol and α −tocopherol were done as described by Bieri et al, (1979) and Islam et al, (2001).[24-25]

Vitamin A and vitamin E are present in serum in high enough concentration to be detected easily by their ultraviolet absorption and because there appear to be no substances in serum that interfere in the HPLC assay. Pool sample method was applied in this research to estimate retinol and α-tocopherol in serum. Two plasma pool samples with assigned value set against standard serum from National Institute of Science and Technology (NIST) were run with each set of samples, and the concentration of retinol and α −tocopherol were calculated based on known concentration of retinol and α −tocopherol in the pool samples. This method only uses internal standards (retinyl acetate and tocopheryl acetate). Analysis of retinol and α −tocopherol concentrations in serum samples were done in icddr,b by anjan roy, researcher in icddr,b. [26]

Preparation of standard stock solutions

Retinyl acetate (5 mg/dl)	5 mg dissolved in 100 ml HPLC grade ethanol
Tocopheryl acetate (30 mg/dl)	30 mg dissolved in 100 ml HPLC grade ethanol

Preparation of working standard solutions

The standard stock solutions were diluted to prepare working standard as follows-

Retinyl acetate	50 µg/dl in HPLC grade ethanol of 10 ml
Tocopheryl acetate	1000 µg/dl HPLC grade ethanol of 10 ml

These solutions were stored in dark at -20ºC. Retinyl acetate was used within 7 days and tocopheryl acetate within 15 days. Prior to serum analysis, concentrations of working standards were checked by spectrophotometer and adjusted using extinction coefficients of the reagents.

Table a.2.6: Extinction coefficient and wave length of α-tocopherol and retinol standards

Standard	Extinction Coefficient	Wave length (nm)
α-tocopherol	75.8	292
tocopheryl acetate	40	292
Retinol	1850	325
Retinyl acetate	1550	325

Calculation

$$\text{Concentration, } C = \frac{\text{Absorbance of the standard}}{\text{Extinction coefficient of the standard}} \text{ g/dl}$$

Figure a.2.6.a : HPLC machine

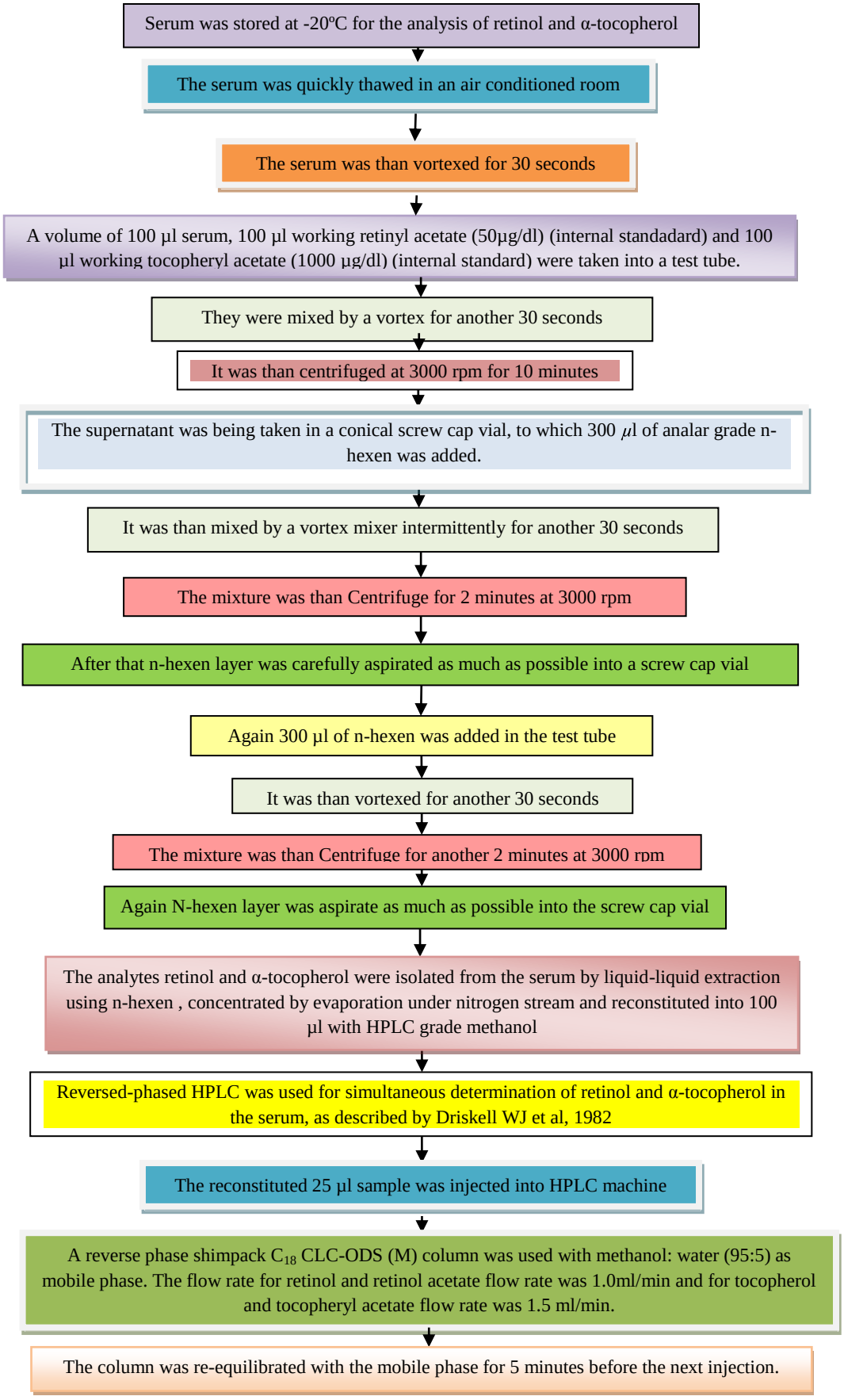

Figure a.2.6.b: Flow chart of Retinol and α-tocopherol extraction and estimation in serum

Calibration and calculation

The calculation was perfomed using Maxima 825 software and was based on the peak area ratios of the determined α-tocopherol and retinol; and the internal standard tocopheryl acetate and retinyl acetate. A linear relationship was assumed between the concentration of the α-tocopherol and retinol; and the peak area ratio.

Concentration, C= Wavelength and E 1%1cm †Standard Wavelength (nm) E1%1cm

E 1%1cm is absorbance of 1% solution in 1cm light path.

For retinol, C= (µg/dl ×0.03491) µmole/L

For α-tocopherol, C= (µg/dl ×) µmole/L

The 0.03491 and 23.22 are conversion factors respectively for retinol and α- tocopherol for standard international unit (young, 1998). [51]

Chapter 3: Results

a.3.1 Micronutrient (vitamin A& E) status of the ethnic people

Serum vitamin A and E levels of ethnic people were evaluated by their reference cut off points. In female serum, cut off points for vitamin A and vitamin E are 0.7 µmol/L and 12 µmol/L respectively. Table a.3.1.a illustrates the serum vitamin A and vitamin E level of the ethnic people from CHTs. Serum vitamin A analysis showed that average vitamin A concentration was 1.7±0.6 µmol/L, much higher than the cut off value (0.7 µmol/L). All 50 ethnic participants had vitamin A concentration at cut off point or above (Figure- a.3.1.a).

Serum vitamin E analysis was also done among 50 ethnic serum samples. Average vitamin E value was 5.4±3.5 µmol/L, lower than the cut off value (12 µmol/L). 100% of 50 ethnic people had serum vitamin E concentration below the cut off value (Figure-a.3.1.b).

Serum vitamin A and E levels of the ethnic people were estimated from pooled method (Figure-a.3.1.c, a.3.1.d).

Table a.3.1.a: Micronutrient (vitamin A & E) status of the ethnic people (n=50)

Parameter	n	%	Mean ±SD
Vitamin A (Retinol) At cutoff point or above (≥ 0.7 µmol/L)	50	100	1.7 ± 0.6
Vitamin E (α-tocopherol) Below cutoff point (<12 µmol/L)	50	100	5.4±3.5

[30]Cut off point of Vitamin A in human serum: 0.7 µmol/L

[31]Cut off point of Vitamin E in human serum: 12 µmol/L

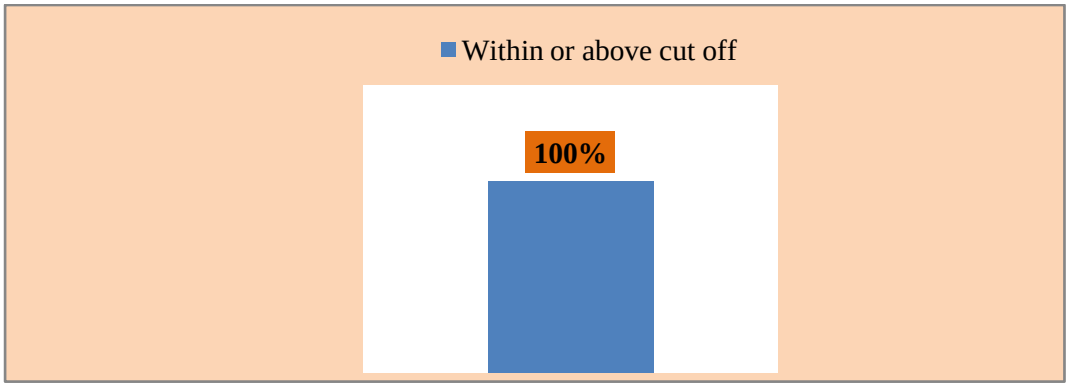

Figure a.3.1.a: Vitamin A status of study population

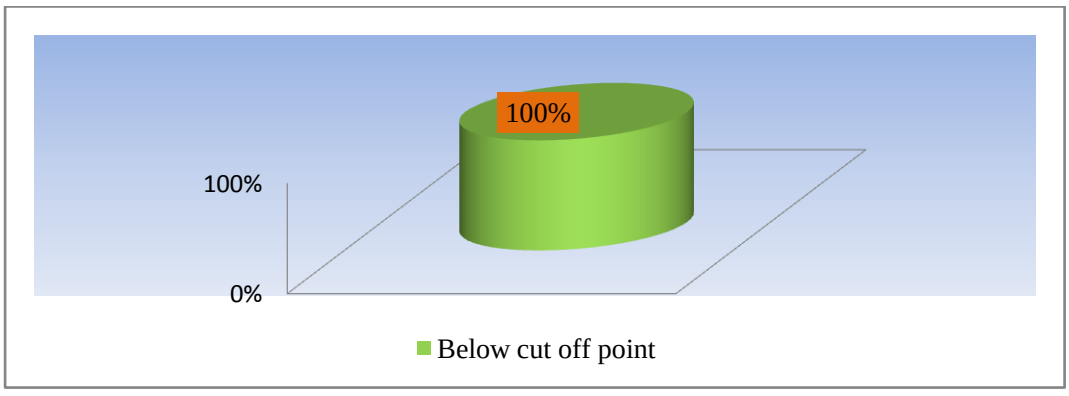

Figure a.3.1.b: Vitamin E status of study population

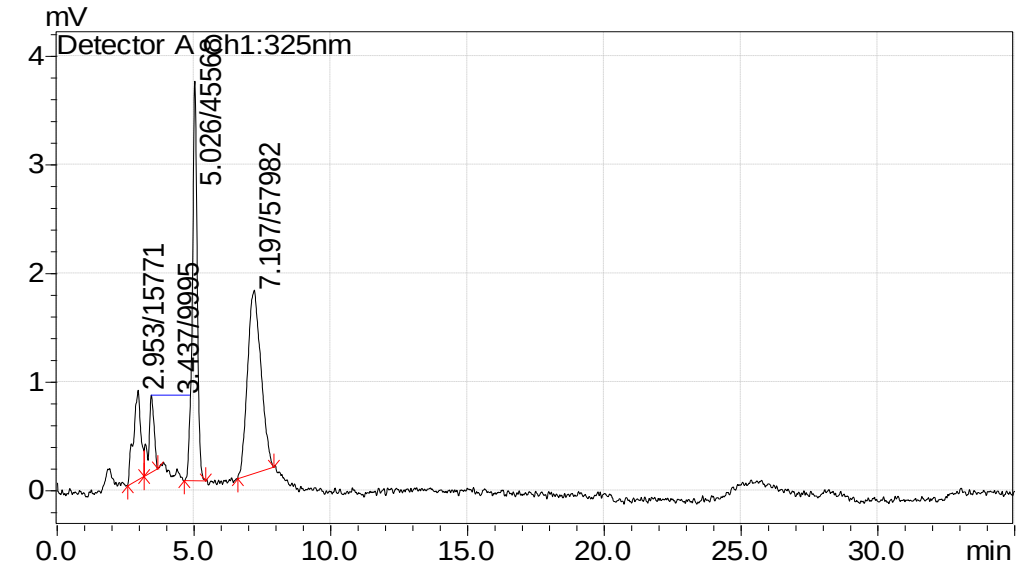

Figure a.3.1.c: Peaks of serum sample for retinol (retention time for retinol was 5 minutes) and for retinyl acetate (retention time for retinyl acetate was 7.2 minutes).

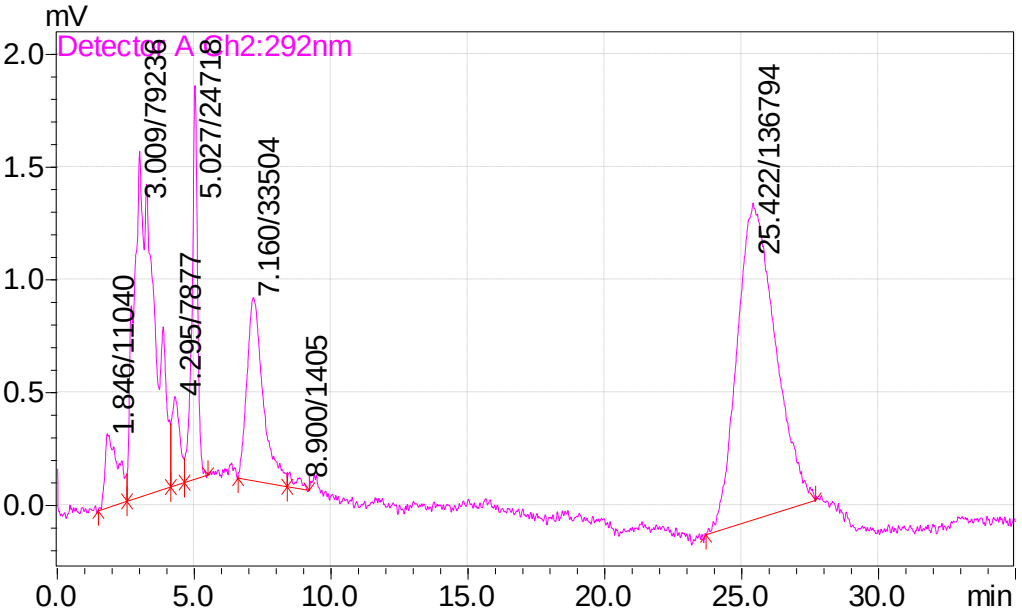

Figure a.3.1.d: Peaks of serum sample for α-tocopherol (retention time for α-tocopherol was not detected, considered as deficient) and tocopheryl acetate (retention time for tocopheryl acetate was 25.5 minutes).

a.3.2 Vitamin A and vitamin E status of lactating and NPNL women

Table a.3.2.a illustrates vitamin A and E status of the ethnic people by groups (lactating and NPNL women). Serum vitamin A analysis showed exactly similar results in respect to lactating and non-pregnant non-lactating women. In both groups, 100 % samples had serum vitamin A concentrations at cut off point or above (0.7 µmol/L) (Figure- a.3.2.a). In lactating women the mean vitamin A value was 1.3±0.5µmol/L, while in NPNL women the value was 1.6±0.54µmol/L.

The mean value of serum vitamin A was significantly higher (p=0.00) in NPNL women compared to lactating women.

Vitamin E analysis in serum of both the groups demonstrates similar results. In lactating women, 100% had serum vitamin E concentrations below cut of point (12 µmol/L) and considered as vitamin E deficient (Figure- a.3.2.b). The average Vitamin E concentration of lactating women was 5±3.5 µmol/L. In NPNL women, 100% had serum vitamin E concentrations below cut of point (12 µmol/L) (Figure- a.3.2.b).

No significant difference (p=0.120) has been observed between two mean values of serum Vitamin E of lactating and NPNL women respectively, even though mean value of NPNL women was slightly higher than lactating women.

Table a.3.2.a: Vitamin A and vitamin E status of the ethnic people

Parameter	Lactating Woman (n=31)		NPNL woman (n=19)		
	% (freq)	Mean±SD	% (freq)	Mean±SD	Significance level
Vitamin A (Retinol) At cutoff point or above(≥ 0.7 µmol/L) Total	100 (31) 100(31)	1.3 ± 0.5	100 (19) 100 (19)	1.6 ±0.54	t = -2.954 p = 0.00
Vitamin E (α-tocopherol) Below cutoff point (<12 µmol/L) Total	100 (31) 100 (31)	5±3.5	100(19) 100(19)	6 ±3.4	t= - 1.60 P= 0.120

[30]Cut off point of Vitamin A in human serum in respect of both the groups: 0.7 µmol/L

[31]Cut off point of Vitamin E in human serum serum in respect of both the groups: 12 µmol/L

Significant: p <0.05
Legend: Duplicate analysis was carried out for every sample.
Descriptive statistics: frequencies, descriptive, crosstabes.
Compare mean: One sample t-test.

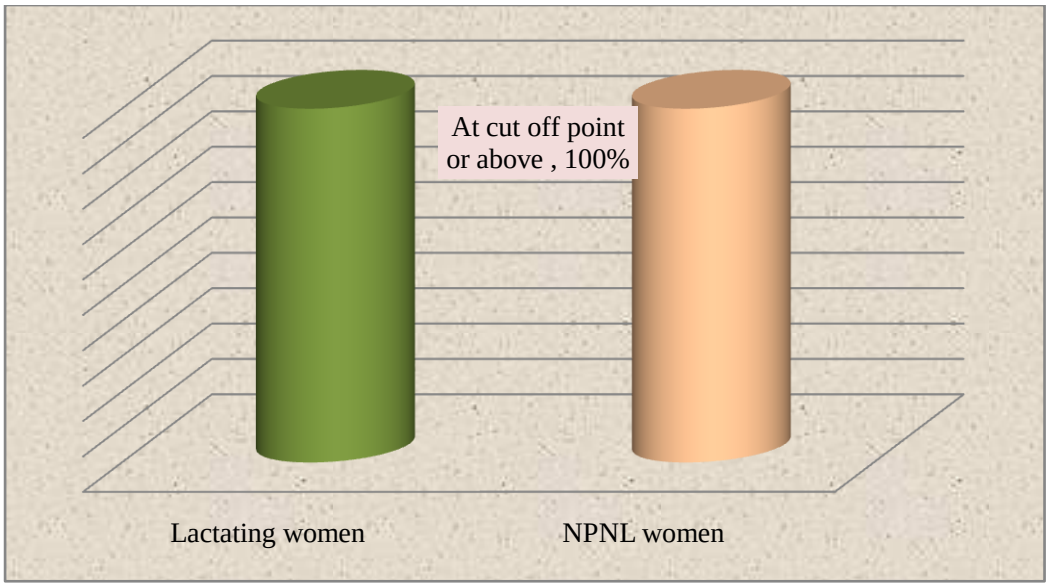

Figure a.3.2.a: Vitamin A status of the ethnic people by groups

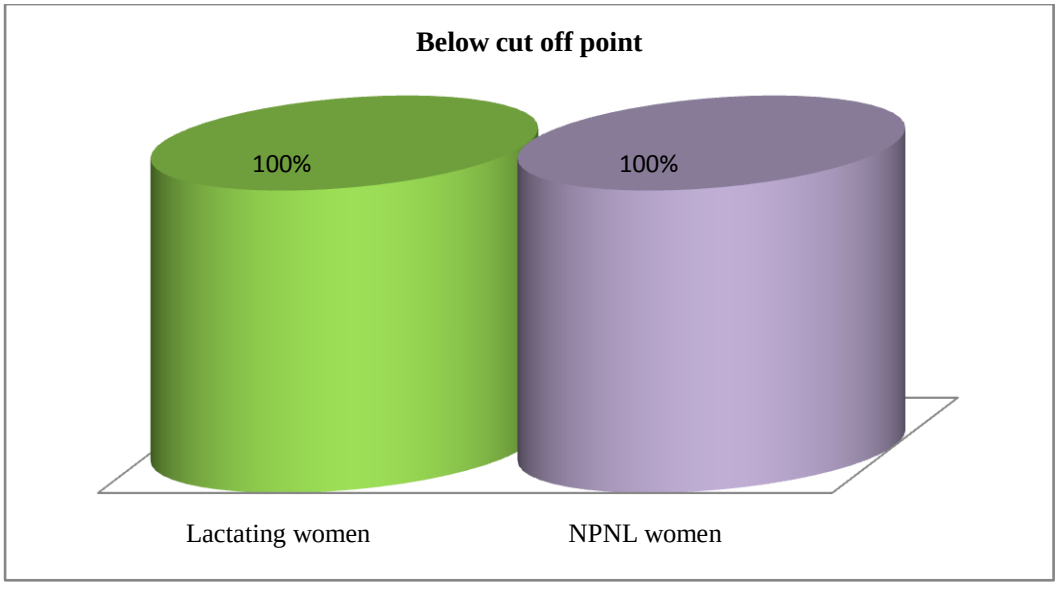

Figure a.3.2.b: Vitamin E status of the ethnic people by groups

a.3.3: Vitamin A deficiency prevalence among NPNL women

Table a.3.3.a and Figure a.3.3.a illustrates the comparison of vitamin A deficiency prevalence among NPNL women with National Micronutrients Status Survey 2011-2012. No vitamin A deficiency was found among NPNL women in the present study, while in National Micronutrients Status Survey 5.4 % were found to be vitamin A deficient.

Table a.3.3.a : Vitamin A deficiency prevalence. [32]

Parameter	National Micronutrients Status Survey (2011-2012) %	Current Data %
Vitamin A deficiency (<0.7 µmol/L)	5.4	0

Descriptive statistics: frequencies.

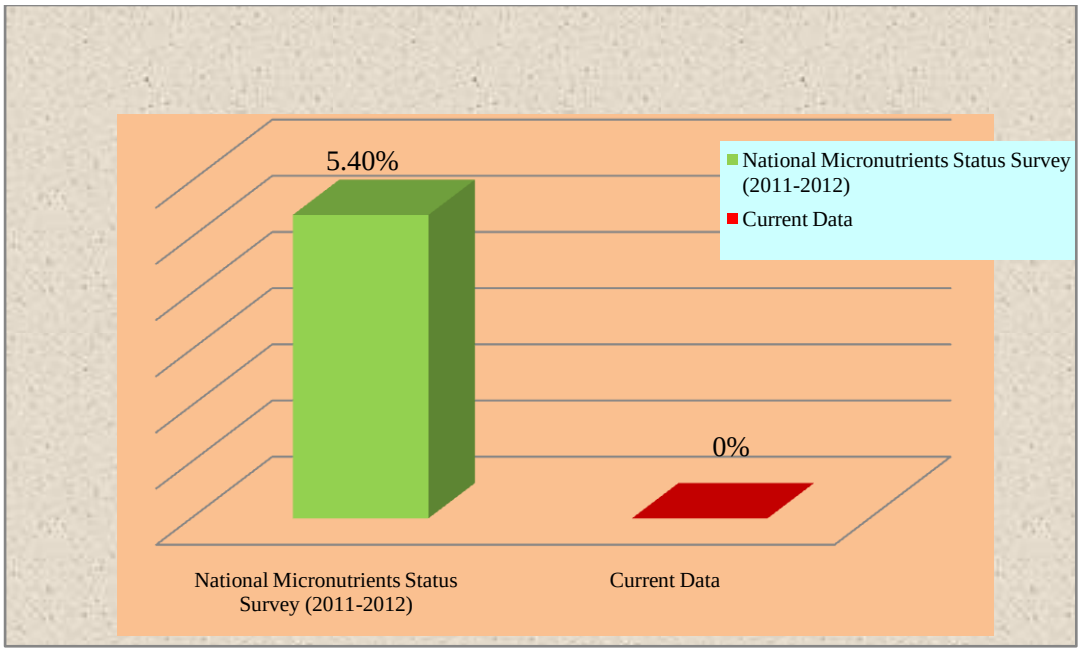

Figure a.3.3.a: Vitamin A deficiency prevalence

a.3.4: Relationship of serum vitamin A status with socio-economy, nutritional status and knowledge; dietary nutrients and serum micronutrients (zinc)

Table a.3.4.a demonstrats the relationship of serum vitamin A status with mostly associated factors. In lactating and NPNL women, statistical association of serum vitamin A level with socio-demographic and nutritional factors could not be established as vitamin A ≥ 0.7 µmol/L were constant. It is apparent that, literacy, occupancy in household chores, 18-40 years of age, ever marital status, better income and nutritional knowledge, household food security, normal BMI, vitamin A intake as per RDA and better serum zinc level positively influence better serum vitamin A level (≥ **0.7**µmol/L). Greater number of vitamin A concentrations with at or above cut off points falls in these categories. It is apparent that dietary fat intakes did not influenced serum vitamin A level.

Table a.3.4.a: Relationship of serum vitamin A status with socio-economy, nutritional status and knowledge; dietary nutrients, serum micronutrients (zinc)

Parameter	Vitamin A(cutoff 0.7µmol/L)			
	Lactating Woman ≥ 0.7	Significance level	NPNL Woman ≥ 0.7	Significance level
Education		ND,		ND,
Illiterate	5	Vitamin A ≥ 0.7,	4	Vitamin A ≥ 0.7,
Literate	26	is constant	15	is constant
Occupation		ND,		ND,
Agriculture	0	Vitamin A ≥ 0.7,	1	Vitamin A ≥ 0.7,
House hold chores	30	is constant	15	is constant
Non Agriculture	1		3	
Age in years		ND,		ND,
15-17 years	-	Vitamin A ≥ 0.7,	-	Vitamin A ≥ 0.7,
18-40 years	31	is constant	19	is constant
Marital status		ND,		ND,
Unmarried	-	Vitamin A ≥ 0.7,	2	Vitamin A ≥ 0.7,
Ever married	31	is constant	17	is constant
Income (Tk)		ND,		ND,
<6000	2	Vitamin A ≥ 0.7,	-	Vitamin A ≥ 0.7,
≥ 6000	29	is constant	19	is constant
HH food insecurity		ND,		ND,
Never	28	Vitamin A ≥ 0.7,	18	Vitamin A ≥ 0.7,
Occasionally	3	is constant	1	is constant
Score on NK		ND,		ND,
14-29	5	Vitamin A ≥ 0.7,	4	Vitamin A ≥ 0.7,
30-45	26	is constant	15	is constant
BMI (kg/m2)		ND,		ND,
< normal	2	Vitamin A ≥ 0.7,	2	Vitamin A ≥ 0.7,
Normal 18.5-24.99	23	is constant	13	is constant
>normal	6		4	
Dietary Nutrient(mg)		ND,		ND,
Below Cutoff	4	Vitamin A ≥ 0.7,	-	Vitamin A ≥ 0.7,
Within or Above Cutoff	27	is constant	19	is constant
Serum zinc level		ND,		ND,
<10.1 µmol/L	-	Vitamin A ≥ 0.7,	-	Vitamin A ≥ 0.7,
≥10.1 µmol/L	31	is constant	19	is constant
Dietary fat (g/day)		ND,		ND,
<RDA	17	Vitamin A ≥ 0.7,	8	Vitamin A ≥ 0.7,
≥RDA	14	is constant	11	is constant

a.3.5: Relationship of serum vitamin E status with socio-economy, nutritional status and knowledge; and dietary nutrients

Table a.3.5.a demonstrates the relationship of serum vitamin E status with socio-economy, nutritional status and knowledge and dietary nutrients. In lactating and NPNL women, statistical association of serum vitamin E level with socio-economy, nutritional status and knowledge and dietary nutrients could not be established as vitamin E concentrations below 12µmol/L were constant. But it is apparent that; literacy, occupancy in household chores, 18-40 years of age group, ever marital status, income and nutritional knowledge, food security and BMI was negatively influenced serum vitamin E status. Dietary vitamin E is related to serum vitamin E level as all serum vitamin E deficient samples consumed dietary vitamin E below the reference RDA.

Table a.3.5.a: Relationship of serum vitamin E status with socio-economy, nutritional status and knowledge and dietary nutrients

Parameter	Vitamin E (cutoff 12 µmol/L)			
	Lactating Woman <12 µmol/L	**Significance level**	**NPNL Woman <12 µmol/L**	**Significance level**
Education Illiterate Literate	 5 26	ND, Vitamin E<12, is constant	 4 15	ND, Vitamin E<12, is constant
Occupation Agriculture House hold chores Non Agriculture	 0 30 1	ND, Vitamin E<12, is constant	 1 15 3	ND, Vitamin E<12, is constant
Age in years 15-17 years 18-40 years	 - 31	ND, Vitamin E<12, is constant	 - 19	ND, Vitamin E<12, is constant
Marital status Unmarried Ever married	 - 31	ND, Vitamin E<12, is constant	 2 17	ND, Vitamin E<12, is constant
Income (Tk) <6000 ≥ 6000	 2 29	ND, Vitamin E<12, is constant	 - 19	ND, Vitamin E<12, is constant
HH food insecurity Never Occasionally	 28 3	ND, Vitamin E<12, is constant	 18 1	ND, Vitamin E<12, is constant
Score on NK 14-29 30-45	 5 26	ND, Vitamin E<12, is constant	 4 15	ND, Vitamin E<12, is constant
BMI (kg/m2) < normal Normal 18.5-24.99 >normal	 2 23 6	ND, Vitamin E<12, is constant	 2 13 4	ND, Vitamin E<12, is constant
Dietary Nutrient (mg) Below Cutoff	 31	 ND	 19	 ND

Significant: $p<0.05$
Association: fisher exact test

Chapter 4: Discussion, key findings, conclusion, Recommendations and references

Discussions

The average serum retinol concentration estimated was 1.7±0.6 µmol/L. No deficiency has seen among the ethnic people in respect to vitamin A status.

Situation has improved from 2003 to the present time. In a study conducted in 2003 by HKI indicated that night blindness was common among lactating mothers with 1.1% prevalence rate in the CHTs. According to National Micronutrient Status Survey 2011-2012[32], the prevalence of vitamin A deficiency among mainstream population was 5.4%.

In the present study it was seen that, both lactating and NPNL women found to have significantly good vitamin A status.

Compared with previous HKI and National data it showed that vitamin A status of ethnic people has improved.

Vitamin E deficiency was found to be 100% in ethnic people. No significant difference was observed between lactating and NPNL women, although mean value of NPNL women was slightly higher than lactating women.

Shamim, 2014[28] reported that 72.3% of the pregnant rural Bangladeshi women have vitamin E deficiency. This data somewhat supports the current vitamin E deficiency in the ethnic people of CHTs.

In lactating and NPNL women, apparently literacy, occupancy in household chores, age, marital status, income and nutritional knowledge, food security, BMI, dietary vitamin A intake as per RDA, serum zinc level were found to be positively influenced serum vitamin A. Parul Christian, 1998[16] established that zinc status influences several aspects of vitamin A metabolism, including its absorption, transport, and utilization. There is a positive relation between zinc and vitamin A.

Fat facilitates the absorption of β-carotene by increasing the bile-flow which in term facilitates the transport of β-carotene into the mucosal cells. This association was not seen in current study. Vitamin A concentration was seen to be associated to dietary vitamin A intakes.

Conclusion

Vitamin A and vitamin E levels among the ethnic people were at and below the cut off value respectively. Vitamin E deficiency status was found to be related to less intake of dietary vitamin E from foods.

Recommendations

1. Vitamin E status needs to be investigated furthur.
2. Programmes needs to be taken to overcome the vitamin E deficiency among ethnic people in CHTs.

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Section C (b): Micro minerals status of ethnic people in CHTs

b.1.1 Background

Minerals

Minerals constitute 3-4% of the total body weight. A mineral is an inorganic element occurring in the form of its salt. The body needs many essential minerals. Essential minerals are sometimes divided up into major minerals (macrominerals) and trace minerals (microminerals), which are equally important. Macro minerals are minerals that one needs in quantities greater than 100mg/day and make up about 1 percent of ones total body weight. These include sodium, chloride, potassium, phosphorus, magnesium, and calcium. Trace minerals are elements that are needed in smaller amounts, less than 100mg/day by adults and are less than 0.01 percent of total body weight. These include copper, chromium, fluoride, iodine, iron, molybdenum, manganese, selenium, and zinc. They may be present in the body as organic compounds such as phosphoproteins, phospholipids, haemoglobin, thyroxine, or as inorganic compounds such as sodium chloride, calcium phosphate and as free ions.[1-3]

Trace mineral or Micro minerals

Micro minerals are those that human need to ingest only in tiny amounts in the range of micrograms to milligrams per day in order to maintain levels conducive to good health. Chromium, cobalt, copper, iodine, iron, manganese, molybdenum, selenium and zinc are nine trace elements generally accepted as essential micronutrients without which good health would not be possible.[4]

The Importance of Trace Minerals

Trace minerals are necessary to make enzymes and their functions work. Trace elements are essential for proper functioning of hormone and neurotransmitter, supports blood building, promotes immune response and blood vessel strength; promotes normal blood sugar metabolism, helps maintain thyroid function, maintain tendons and ligaments, promotes bone health and detoxify sulphites.[5] Deficiencies of specific trace minerals have been associated with adverse impacts on cardiovascular health, carbohydrate metabolism, immune health, reproductive health, bone health, neurological health, and circulatory health etc. Even mild deficiencies can result in poor growth and development. Trace elements are frequently involved in modulating enzyme activity or are an integral part of enzyme prosthetic groups.[6]

Copper

Copper is an essential trace element (i.e., micronutrient) that is required for plant, animal, and human health; and is essential for proper function of the immune system. In solution, as well as in living organisms, copper is found almost exclusively in the +2 and +1 valence states, the former is predominating. The adult contents 80 gm of copper.[7]

In humans, copper is essential for the proper functioning of organs and metabolic processes. The human body has complex homeostatic mechanisms which attempt to ensure a constant supply of available copper, while eliminating excess copper whenever this occurs. However, like all essential elements and nutrients, too much or too little nutritional ingestion of copper can result in a corresponding condition of copper excess or deficiency in the body, each of which has its own unique set of adverse health effects. Copper is important as an electron donor in various biological reactions.[8]

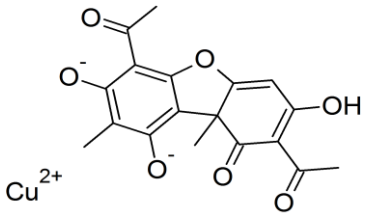

Fig: Chemical structure of copper

Functions of copper in human body

Copper is involved in the formation of red blood cells, the absorption and utilization of iron, the metabolism of cholesterol and glucose, and the synthesis and release of life-sustaining proteins and enzymes. These enzymes in turn produce cellular energy and regulate nerve transmission, blood clotting and oxygen transport. Several enzymes contain copper. Some of the important enzymes and the reactions they catalyse are given below:

- Ferroxidase I(Ceruliplasmin) and ferroxidase II are involved in the oxidation of ferrous to ferric iron. Copper influences iron absorption and mobilisation of iron from liver and other tissue stores. The oxidation of ferrous iron to ferric and reduction of ferric to ferrous is essential for the transport of iron from the intestines to blood and then bone marrow, liver and other organs and incorporation of haemoglobin.
- Cytochrome c oxidase and its coenzyme cytochrome c are among the most conserved proteins in nature and found in every living cell, where they function in respiration. Respiration reflects the delivery and use of molecular oxygen so that the carbohydrate, fat and amino acid fuels can be oxidized to general cell energy. Most cell energy is transiently held in the form of ATP, derived from oxidative phosphorylation involving the electron transport chain of mitochondria, the terminal components of which are cytochorme c and its oxidase. Thus, as with most other copper enzymes, cytochrome c oxidase is the site where molecular oxygen is bound and reduced.
- Copper is needed for the formation of a web structure of collagen in the blood vessel walls, which provides extra strength. A copper containg enzyme (Lysyl oxidase) is involved in the oxidation of α- amino group of lysine to aldehyde group which reacts with lysine to form desmosine, the crosslinking group of collagen and elastin. It is fundamental to the functioning and formation of connective tissue, including that needed for wound healing and maintain the integrity of blood vessels.
- The melanin polymer that protects our skin against excess ultraviolet light and determines the pigmentation of our eyes and hair is formed from tyrosine with the aid of copper- containg enzyme tyrosinase. This enzyme is responsible for melanin formation.
- Widely distributed intracellular and extra cellular superoxide dismutases (SODs), extracellular ceruplasmin and the mainly the intracellular copper thioneins enzymes appear to have a role in antioxidant defence. They are involved in free radical scavenging.
- Three copper containing proteins, cerebrocuprein, erythrocuprein and hepatocuprein occur in brain, RBC and liver respectively.
- Copper produces the important neurotransmitters epinephrine, norepinephrine, histamine, serotonin and dopamine.
- Copper is incorporated into a variety of proteins . This micronutrient is necessary for the proper growth, development, and maintenance of bone, connective tissue, brain, heart, and many other body organs. Copper proteins have several non enzymatic functions. Which includes- Copper distribution (ceruloplasmin, albumin and transcuprein), temporary storage (metallothioneins), electron transport (plastocyanin, ceruloplasmin) and blood clotting via nonenzymatically active factor V and VIII.[9-11]

Consequences of copper deficiency

At the cellular level

At the cellular level deficiency would result in a reduction in the capacity to carry out respiration and oxidative phosphorylation and thus in a deficit in energy supply. This would slow down various cell activities, from active

transport to transcription, translation and other biosynthetic process. Even in moderate copper deficiency, the activity of cytochrome c oxidase is reduced in cells of several organs, notably liver and heart.

Enhance cell membranes fragility

In copper deficiency Cu/Zn SOD tends to reduced, which would be expected to enhance the fragility of cell membranes in general because unsaturated lipids in the cell periphery are particularly vulnerable to oxidative damage. Indeed, deficiency results in a shortened life span of erythrocytes and leads to enhanced accumulation of lipid oxidation products in these cells.[7]

Bone development

Copper deficiency produces marked skeletal changes, osteoporosis and spontaneous fractures. Histological studies revealed a marked failure of deposition of bone in the cartilage matrix accompanied by a normal growth of cartilage. These changes are similar to those seen in scurvy. Copper like ascorbic acid, is specially necessary for the functional activity of osteoblasts.[10]

Elastin formation

The lysine content of elastin is markedly increased due to failure of conversion of lysine to desmosine, the cross linking residues of elastin. A copper containing enzyme plays an important role in connective tissue metabolism, specially in the oxidation of α-amino group of lysine into aldehyde group which is necessary for cross linkage of the polypeptide chains of elastin and collagen. Copper deficiency is also reported to be involved in connective tissue dysfunctions, bone fragility and cardiovascular disorders.

Optic Neuropathy

Some patients suffering from copper deficiency have shown signs of vision and color loss. The vision is usually lost in the peripheral views of the eye. The bilateral vision loss is usually very gradual. An optical coherence tomography (OCT) shows some nerve fiber layer loss in most patients, suggesting the vision loss and color vision loss was secondary to optic neuropathy or neuro degeneration.[12-13]

Stroke

A copper deficiency has been associated with weakening of connective tissue that can be a contributing factor for the development of cerebral aneurysms and hemorrhagic strokes.[14]

Immune function

Inadequate copper intake can lead to neutropenia, a deficiency of white blood cells (also called neutrophils). The main function of neutrophils in the body is to fight off infection. The fewer neutrophils body has, the more it becomes susceptible to infectious diseases.[15]

Hemorrhoids

A copper deficiency has been associated with weakening of connective tissue that can be a contributing factor for the development of hemorrhoids.[16]

Aceruloplasminemia

Ceruloplasmin contains 95% of the copper in plasma and it functions as a ferroxidase. Deficiency is associated with progressive iron accumulation involving the retina and basal ganglia. Aceruloplasminemia is an autosomal recessive condition. Copper does not directly affect the rate of synthesis or the secretion of ceruloplasmin; however, failure to incorporate copper into apoceruloplasmin results in an unstable apoprotein that is rapidly degraded. The clinical consequences of aceruloplasminemia include dystonia, abnormal gait, dysarthria and dementia.[17-18]

Prion diseases

The prion diseases are a group of neurodegenerative diseases that affect the gray matter of the central nervous system and produce neuronal loss, gliosis and spongiform degeneration.[19]

Toxicity of copper

Copper is relatively nontoxic to humans. Acquired copper toxicity can result from ingesting or absorbing excess copper (e.g., from ingesting an acidic food or beverage that has had prolonged contact with a copper container). Self-limited gastroenteritis with nausea, vomiting, and diarrhea may occur. More severe toxicity results from ingestion (usually with suicidal intent) of gram quantities of a copper salt (e.g., copper sulfate) or from absorption of large amounts through the skin (e.g., if compresses saturated with a solution of a copper salt are applied to large areas of burned skin). Hemolytic anemia and anuria can result and may be fatal. Indian childhood cirrhosis, non-Indian childhood cirrhosis, and idiopathic copper

toxicity are probably identical disorders in which excess copper causes cirrhosis. All appear to be caused by ingesting milk that has been boiled or stored in corroded copper or brass vessels.[20]

Interactions of Copper with other nutrients

Copper and zinc

Zinc intakes, well in excess of the amount normally found in the diet can decrease copper absorption in adults. Very high doses of zinc have been used to treat patients with Wilson's disease, an inborn error of copper metabolism resulting in copper toxicity (Brewer et al., 1983). This zinc-induced inhibition of copper absorption could be the result of competition for a common, apically oriented transporter or the induction of metallothionein in intestinal cells by zinc. Excess zinc levels cause an upregulation of metallothionein production in the enterocytes, which are the majority of cells in the intestinal epithelium. Copper has a higher affinity for metallothionein than zinc, so it displaces zinc from metallothionein. Copper then remains in the enterocytes and is sloughed off into the intestinal tract, absorption is reduced and eliminated. This response has been used as a therapy to diminish copper absorption in patients with Wilson's disease (Yuzbasiyan-Gurkan et al., 1992). The interaction could also be responsible for reducing copper absorption during consumption of zinc supplements.[32-34]

Copper and iron

Copper has an essential role in several enzymatic reactions in RBCs, and copper deficiency interferes with iron transport and utilization and, therefore, with heme synthesis. Hephaestin is a copper containing ferroxidase enzyme located in the duodenal muscosa that oxidizes iron and facilitate its transfer across the basolateral membrane into circulation. Most important one ceruloplasmin (which incorporates copper) is a ferroxidase that converts ferrous (+2) to ferric (+3) iron, allowing it to bind transferrin and be transported. The copper dependent enzyme cytochrome-c oxidase also is required for the reduction of ferric iron to incorporate it into the heme molecule. In addition to interference with heme synthesis, there is approximately 85% reduction of superoxide dismutase in the RBC membrane in copper deficiency, which decreases RBC survival time. It was also researched that copper deficiency produces a functional defect in bone marrow. [35-39]

Zinc

Zinc is a small ion (0.065 nm) and has a concentrated 2+ charge (Zn^{2+}). It is a strong lewis acid (electron acceptor). About 2-3 g zinc is present in the adult body. It is distributed widely in all tissues but not evenly. High concentrations are found in the eye, specially in iris and retina, in the liver, bone, prostate and prostatic secretions and in hair. In the blood about 85 % of the zinc is in the red blood cells, however, each leukocyte contains about 25 times as much zinc as each red blood cell.

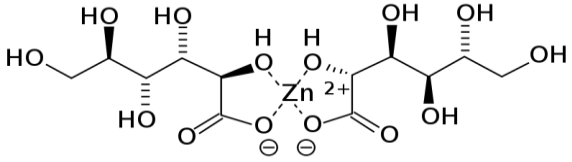

Figure: Zinc gluconate

Functions of zinc

Zinc is essential for many important biological functions, including immunity, growth, neurological transmission and reproduction.

Zinc metalloenzymes

Zinc is needed for the function of about 300 zinc metalloenzymes, and among the classes of enzymes with zinc metalloenzymes are oxidoreductases, transferases, hydrolases, lyases, isomerases and ligases. These zinc metalloenzymes are broadly involved in structural, regulatory, catalytic and non catalytic functions. Alcohol dehydrogenase, superoxide dismutase, DNA-polymerase, RNA- polymerase, alkaline phosphatise and carboxypeptidase are all zinc metalloenzymes. This means that zinc is involved in, for example nucleic acid synthesis, protein digestion, protein synthesis, carbohydrate metabolism, dark adaptation, bone metabolism, oxygen transport and protection against free radical damage.

Zinc fingers

The binding of regulatory proteins to specific recognition sequences of genes is important to gene expression and regulation. Zinc fingers are protein complexes that form a tetrahedral complex with zinc and provide structural stability for small polypeptides. The region of the protein containing the zinc-binding domains is essential for binding to DNA and plays a role in protein-protein interaction. Zinc-finger domains are found in regulatory proteins in the nucleus and the cytoplasm and among signal transduction factors.

Zinc and biomembranes

Zinc is a common divalent ion within the cytoplasm of cells, and zinc may play an important role in the structure and function of biomembranes because of its ability to stabilize thiol groups and phospholipids and to quench free radicals.

Zinc and immune function

Given that cells produced by the immune system in response to infection have a large number of zinc-dependent enzymes; it is not surprising that zinc deficiency has profound effects on immune function. Zinc may also have an important role in immunity because of its function as an antioxidant and its role in apoptosis. Zinc has a role in both nonspecific immunity and adaptive immunity mechanisms. Zinc deficiency is associated with impaired T and B-lymphocyte function and the generation of antibody responses. Lymphocytes become less responsive to cytokine activation, and microbicidal ability of macrophages and neutrophils is suppressed.

Other functions of zinc

Zinc has been implicated as playing a potential role in many other important biological functions, including synaptic transmission, the activity of growth hormone, the polymerization of tubulin and signal transduction. In the brain, zinc is stored in specific synaptic vesicles by glutamatergic neurons and can "modulate brain excitability". It plays a key role in synaptic plasticity. The highest concentration of zinc is in the prostate and parts of the eye. Semen is particularly rich in zinc, which is a key factor in prostate gland function and reproductive organ growth.[10, 21, 30]

Consequences of Zinc deficiency

Retardation of growth and genital development

Zinc deficiency is related to failure of growth and retarded genital development. The subjects of zinc deficient suffer from dwarfism and hypogonodism. Bone development is retarded. Tooth growth and eruption may also be retarded.

Zinc and reproduction

Zinc is needed to produce testosterone. Thus, zinc deficiency can lead to reduced circulating testosterone, hypogonadism (small sex glands in boys) and delayed puberty.

Acrodermatitis enteropathica

It is an inherited disorder characterized by chronic diarrhea, severe dermstitis, emotional disturbance, growth retardation and loss of hair.

Other consequences of zinc deficiency

Loss of appetite, hypogeusia- impairment of sense of taste, dysgeusia is an unpleasant or perverted taste, hyposmia- impairment of sense of smell, liver enlargement, mental lethargy, delayed wound healing, increased susceptibility to infections, white spots on fingernails, abnormal dark adaptation, DNA damage, leading to cancer, birth defects, exhibited anorexia, reduced immune response, associated with pregnancy complications, such as

prematurity, prolonged labour, pregnancy-induced hypertension, and intrapartum haemorrhage and behavioral changes.[10, 30]

Toxicity of zinc

The recommended upper limit for zinc intake is 40 mg/day. Toxicity is rare. Ingesting doses of elemental zinc ranging from 100 to 150 mg/day for prolonged periods interferes with copper metabolism and causes low blood copper levels (causing anemia), RBC microcytosis, neutropenia, and impaired immunity. Ingesting larger amounts (200 to 800 mg/day), usually by consuming acidic food or drink from a galvanized (zinc-coated) container, can cause anorexia, vomiting, and diarrhea. Chronic toxicity may result in copper deficiency and may cause nerve damage. Fever has been observed after intake of food and beverages contaminated with zinc from galvanized container. And lethargy observed after the ingestion of 4-8 g of zinc. Metal fume fever, also called brass-founders' ague or zinc shakes, is caused by inhaling industrial zinc oxide fumes; it results in fever, dyspnea, nausea, fatigue, and myalgias. Symptom onset is usually 4 to 12 hour after exposure. Zinc toxicity impairs immune responses.[22]

Iron

Iron is the element of 26 of the periodic table and has an atomic weight of 55.85. The amount of iron in the body of adult male is 3.5 g; in women it is about 2.3 g. All body cells contain some iron. A greater part (70%) of the iron in the body is present as haemoglobin, 5% held as myoglobin, 5% is present in cellular constitutes including the iron-containing enzymes, and 20% is stored as ferritin by the liver, spleen and bone marrow. Iron circulates in the plasma bound to a betaglobulin, transferring. Iron is an essential nutrient responsible for the formation of haemoglobin of the red blood cells and plays an important role in transport of oxygen (from lungs to tissues). Iron can be found in two forms-

Heme iron- found as ferrous form (Fe^{2+}) in non plant and animal sources as prophylin group.

Non heme iron- found as a salt form (Fe^{3+}) in plant, cooking utensils and drinking water sources. Examples- ferric phytate, ferric oxalate and ferric carbonates.[23]

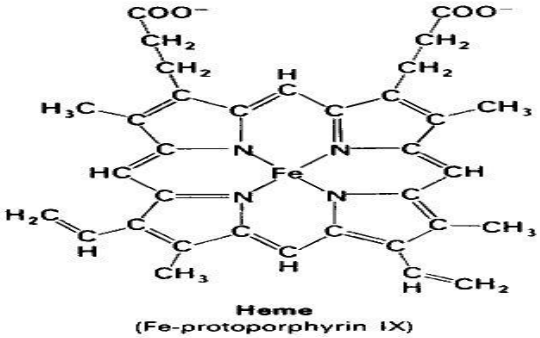

Figure: Heme molecule

Functions of iron

Iron is present in haemoglobin, myoglobin, cytochromes and many oxidative enzymes.

Oxygen transport

- **Hemoglobin:** Hemoglobin contains ferrous iron. Hemoglobin plays an essential role in transfer of oxygen from the lungs to tissues in erythrocytes. Hemoglobin combines with oxygen in the pulmonary circulation and becomes largely deoxygenated in the capillary circulation of tissues. In severe anemia, the hemoglobin content of erythrocytes is reduced, decreasing oxygen delivery to tissues and leading to chronic tissue hypoxia.

- **Myoglobin:** Myoglobin is the iron-protein complex in the muscles that stores oxygen for immediate use by the cells. Myoglobin is found in muscle, where it transports and stores oxygen needed for muscle contraction. The structure of myoglobin is a single heme group with a single globin chain. Myoglobin accounts for about 10% of the total body iron.
- **Transferrin and ferritin:** Transferrin is the circulating form of iron, while ferritin is the storage form of iron. As such, iron functions as a major transport medium of vital oxygen to the cells for both respiration and metabolism.

Cytochormes

Cytochromes contain heme and are essential to respiration and energy metabolism. Cytochromes a,b and c are involved in oxidative phosphorylation and production of cellular energy. Cytochromes serve as electron carriers in transforming adenosine disphosphosphate (ADP) to adenosine triphosphate (ATP), the primary energy storage compound. Cytochrome p450 is found in microsomal membranes of liver and intestinal mucosal cells.

Other iron containing enzymes

NADH (nicotinamide adenine dinucleotide phosphate) dehydrogenase and succinate dehydrogenase are two nonheme, iron-containing enzymes involved in energy metabolism. Hydrogen peroxidases also contain iron and protect against the accumulation of hydrogen peroxide. Catalase and peroxidase are two heme-containing enzymes that convert hydrogen peroxide to water and oxygen. Other iron-containing enzymes include aconitase, phosphoenolpyruvate carboxykinase and ribonucleotide reductase.[7, 10, 24, 30]

Consequences of iron deficiency

Haemoglobin contains the majority of functional iron in the body; in addition, there are a number of other iron-dependent enzymes that can be adversely affected by iron deficiency. The functional consequences of iron deficiency, which are of major public health importance, are reviewed here.

1. **Anemia**
   - **Nutritional anemia:** It is due to inadequate dietary supply of iron and other nutrients for hemoglobin and red blood cell production.
   - **Hemorrhagic anemia:** It means excessive loss of blood iron.
   - **Post-gastrectomy anemia:** Lack of gastric HCL (after stomach removal), which is otherwise necessary for liberating iron for absorption.
   - **Malabsorption anemia:** It is due to the presence of iron –binding agents that prevent its absorption or else the mucosal lesions that reduce the absorbing surface.[24]

Work performance

It is well established that significant anemia related to iron deficiency will reduce work performance. The adverse effect of iron deficiency on work or energy output appears to be mediated through a combination of decreased oxygen-carrying capacity from anemia and the effect of iron deficiency on muscle function.

Behavior and intellectual performance

A relationship between iron deficiency and behavioural impairment such as less attention, memory loss and decreased learning ability has been observed in children. Iron deficiency in women is also related to depression. Iron deficiency in adolescent girls without anemia is associated with reduced physical endurance and changes in mood and ability to concentrate.

Body temperature regulation

Iron-deficiency anemia is also responsible for impaired capacity to maintain body temperature in a cold environment. This abnormality appears to be related to decreased secretion of thyroid –stimulating hormone and thyroid hormone. Impaired heat production appears to result from the anemia itself, since a blood transfusion corrects the abnormality.

Heavy metal absorption

An important consequence of iron deficiency is an increased risk of lead poisoning. Iron deficiency individuals have increased efficiency of lead absorption.

Iron and defense against infection

Iron is a pro-oxidant and potentially increases oxidative stress; and exacerbate some types of infections. Iron deficiency increases the morbidity and mortality of infections. The phagocytosis and killing of bacteria by the neutrophil leucocytes is an important component of the defence against infection. The killing function is based on

the information of free hydroxyl radicals, the respiratory burst, and results from the activation of the iron-sulphur enzyme NADPH oxidase and probably also cytochrome B (a heme enzyme). Myeloperoxidase, another important enzyme is also impaired in iron deficiency.

Adverse pregnancy outcomes

Anemia of early pregnancy has been associated with preterm delivery, low birth weight and fetal death.[7, 10, 30]

Toxicity of iron

Iron overload is known as hemochromatosis and usually is caused by a gene that enhances iron absorption. Other causes of iron overload include repeated blood transfusions, massive doses of dietary iron and rare metabolic disorders. Additionally, long-term overconsumption of iron may cause hemosiderosis, a condition characterized by large deposits of the iron storage protein hemosiderin in the liver and other tissues. Iron overload is most often diagnosed when tissue damage occurs, especially in iron-storing organs such as the liver. Infections are likely to develop because bacteria thrive on iron-rich blood. Ironically, some of the signs of iron overload are analogous to those of iron deficiency: fatigue, headache, irritability and lowered work performance. Other common symptoms of iron overload include enlarged liver, skin pigmentation, lethargy, joint diseases, and loss of body hair, amenorrhea and impotence. Untreated hemochromatosis aggravates the risks of diabetes, liver cancer, heart disease and arthritis.

High levels of iron promote carcinogenesis or faster rates of tumour growth. It also increases the risk of coronary heart disease. Free radicals induced by free iron cause increased peroxidation of low density lipoprotein and thereby contribute to atherogenesis.[7, 25]

Chapter 2: Methods and materials

b.2.1 Study design

Fresh serum samples were used from NHDSBD-2011survey in this section of the study. Processed serum was used freshly for zinc, copper and iron analysis for this study only.

b.2.2 Collection of blood specimen

A 5 ml of venous blood sample was collected aseptically from antecubital vein of each of the ethnic participants.

b.2.3 Processing of serum from blood

5 ml blood was collected in a heparin tube. Immediately after collection, the blood specimen was kept undisturbed for 60 min and then centrifuged at 3000 rpm for 30 min to extract serum. Extracted serum was equally distributed in 3 eppendrof tubes and triplicate was made for each sample. All of the aliquoted serum were then stored at -80°C in a refrigerator for later analysis.

b.2.4 Study population

From 171 serum samples 123 samples were randomly sorted for serum zinc analysis. Of 123 samples 65 serum samples were lactating women's and 58 were NPNL women samples. From these 123 samples 98 samples were shorted to analyze copper and iron. Of 98 samples 56 samples were from lactating women and 42 samples were from NPNL women. Zinc deficient sample were included in this list and samples with concentrations at cut off point or above were selected randomly for the analysis of copper and iron.

b.2.5 Data analysis

IBM SPSS Statistics 21 software packages and Microsoft excel was used for data entry. IBM SPSS Statistics 21 software package was used to analyze the data. Descriptive statistics (frequencies, cross tables, descriptive) was used to calculate all variables. Values were expressed as frequency, percentage, mean and standard deviation. Tables, diagrams and figures were used to present the data. The statistical analysis was performed by chi-square and fisher's exact test to assess any association. The significance of the difference was tested using one sample t-test with the 5% level of confident interval, test statistic and its variance for categorical variables. Fisher exact tests were applied to estimate the level of significance when a cell value of any category was less than 5.

b.2.6 Estimation of micro minerals (zinc, copper and iron)

Serum zinc, copper and iron levels of ethnic people were estimated by atomic absorption spectrophotometric method (I> perkin Elmer, Atomic Absorption Spectrometer AAnalyst, 200, version-8.0, copy right -2013) as described by Hossain et al, 2007.[31]

Calibration of standard curve

Calibration curve was obtained using standard samples (containing 0.2, 0.4, 0.8, 1 and 1.6 mg/L for copper; 0.1, 0.2, 0.5, 1, 2 and 3 mg/L for iron; and 0.1, 0.2, 0.4 and 0.8 mg/L for zinc). All standard solutions were dissolved in nano pure water. Standards were aspirated through nebulizer and the absorbance was measured with a blank as reference, read in the atomic absorption spectrophotometer at 324.8 nm, 248.3 nm and 213.9 nm wavelengths respectively for copper, iron and zinc. Blank sample was Nitric acid (HNO3) without any mineral. A software package for the spectrophotometer constructed calibration curves for copper, iron and zinc by plotting absorbances against their respective concentrations. It gave straight lines. The correlation coefficient was found for copper 0.999, for iron 0.998 and for zinc 0.996. (Figure- b.3.1.d, b.3.1.e, b.3.1.f)

Preparation of standard solutions

Standard solutions containing 0.1, 0.2, 0.4, 0.5, 0.8, 1, 1.6, 2 and 3 mg/L mineral concentrations (Cu, Fe and Zn): 10, 20, 40, 50, 80, 100, 160, 200 and 300 µl standards dissolved in 100 ml nano pure water in a volumetric flux.

Procedure for serum analysis

Ethnic serum was centrifuged at 3000rpm for 10 minutes to make a clear supernatant. A volume of 150 µl serum samples were collected in eppendrof tubes for the analysis of copper, iron and zinc separately. A volume of 150 µl serum was diluted in 1350 µl nano pure water for separate mineral analysis and vortexed for half minutes. Within two hour of mixing, absorbances were read at 324.8 nm, 248.3 nm and 213.9 nm wavelengths respectively for copper, iron and zinc in the atomic absorption spectrophotometer. Machine software calibrated standard curve with standard preparation at every 10- sample interval. Specific hollow cathode lamps were used to analyze the samples. The instrument has minimum detected limit of 0.03 mg/L for copper, 0.04 mg/L for iron and 0.01 mg/L for zinc in the flame method.

Calculation

Concentration of minerals was calculated as follows

Concentration, C = Absorbance of sample × dilution factor (10 fold) × F µmole/L

F= 0.1574, 0.1791 and 0.1530 were factors for copper, iron and zinc respectively for standard international unit (young, 1998).[27]

Figure b.2.6.a: Analysis of serum minerals in the laboratory

Chapter 3: Results

b.3.1 Zinc, copper and iron status of the ethnic people

Serum zinc, copper and iron of ethnic people were evaluated by their reference cut off points. In female serum, cut off points for zinc, copper and iron are 10.1 µmol/L, 11 µmol/L and 11 µmol/L respectively. Table b.3.1.a illustrates the serum zinc, copper and iron level of ethnic people from CHTs. Serum zinc analysis showed that average zinc concentration was 25.9±6.2 µmol/L. Among 123 ethnic people, 99.2% had serum zinc concentrations at cut off point or above (Figure- b.3.1.a).

Serum copper results showed that average copper value was 20.3±6.5 µmol/L. About 99% of the ethnic people had serum copper concentrations at cut off value or above (Figure-b.3.1.b).

The average iron value was 22±8.8 µmol/L and about 89.8% had serum iron concentrations at cut off value or above (Figure-b.3.1.c).

Serum zinc, copper and iron of the ethnic people were estimated from calibration curve (Figure-b.3.1.d, b.3.1.e, b.3.1.f).

Table b.3.1.a: Micro mineral profile of ethnic peple in the CHTs

Parameter	n	%	Mean±SD
Zinc (n= 123)			
<10.1 µmol/L	1	0.8	8.57 ± 0.0
≥ 10.1 µmol/L	122	99.2	26.1 ± 6.1
Total	123	100	25.9 ± 6.2
Copper (n= 98)			
<11 µmol/L	1	1	8.66 ± 0.0
≥ 11 µmol/L	97	99	20.4 ± 6.5
Total	98	100	20.3 ± 6.5
Iron (n= 98)			
<11 µmol/L	10	10.2	8.6 ± 1.6
≥ 11 µmol/L	88	89.8	23.6 ± 8
Total	98	100	22 ± 8.8

[26]Cut off point of zinc in human serum: 10.1 µmol/L

[27]Cut off point of copper in human serum: 11 µmol/L

[27]Cut off point of iron in human serum: 11 µmol/L

Descriptive statistics: frequencies, descriptive.

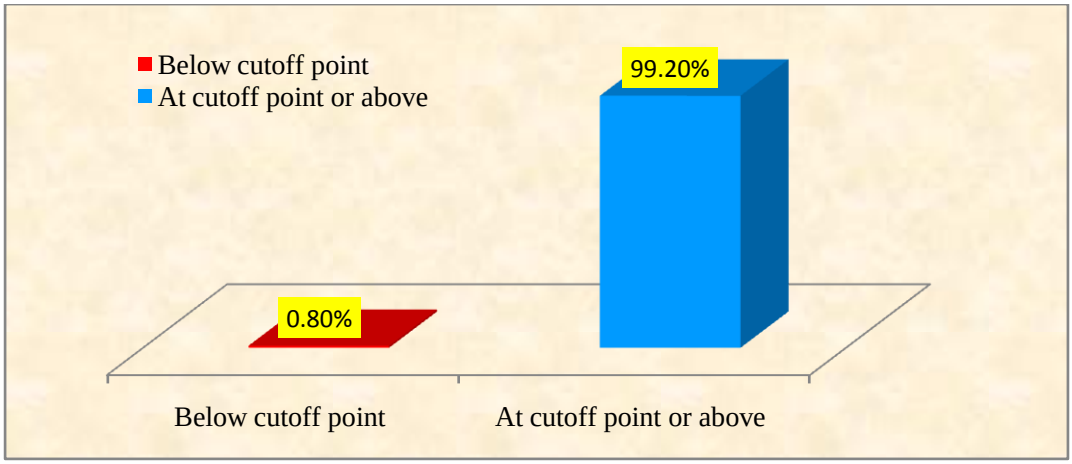

Figure b.3.1.a: Serum zinc status of the ethnic people (%)

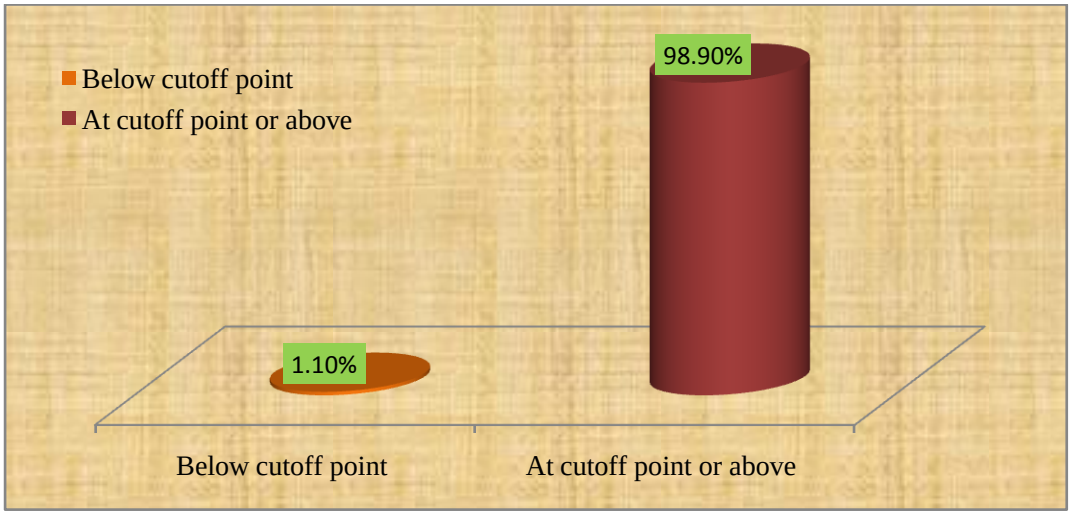

Figure b.3.1.b: Serum copper status of the ethnic people in the CHTs (%)

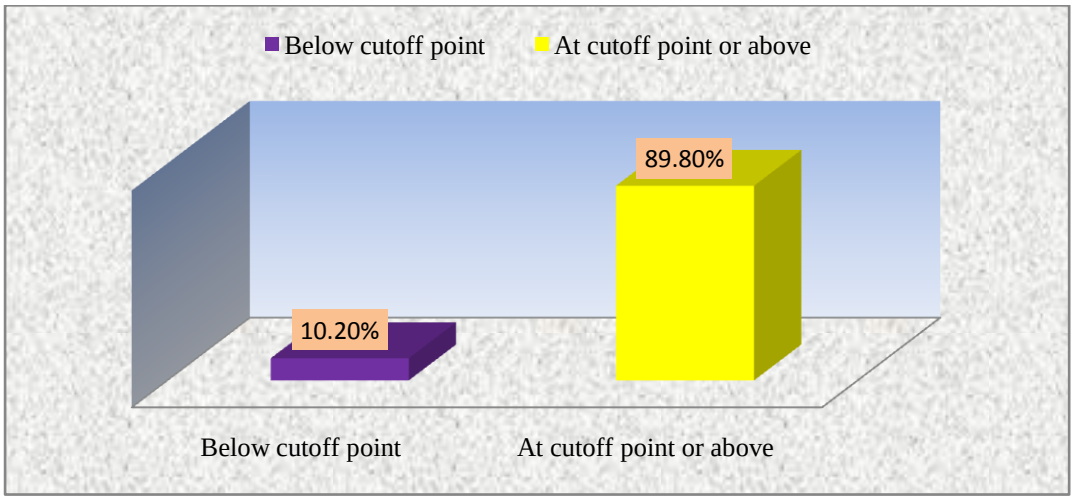

Figure b.3.1.c: Serum iron status of the ethnic people (%)

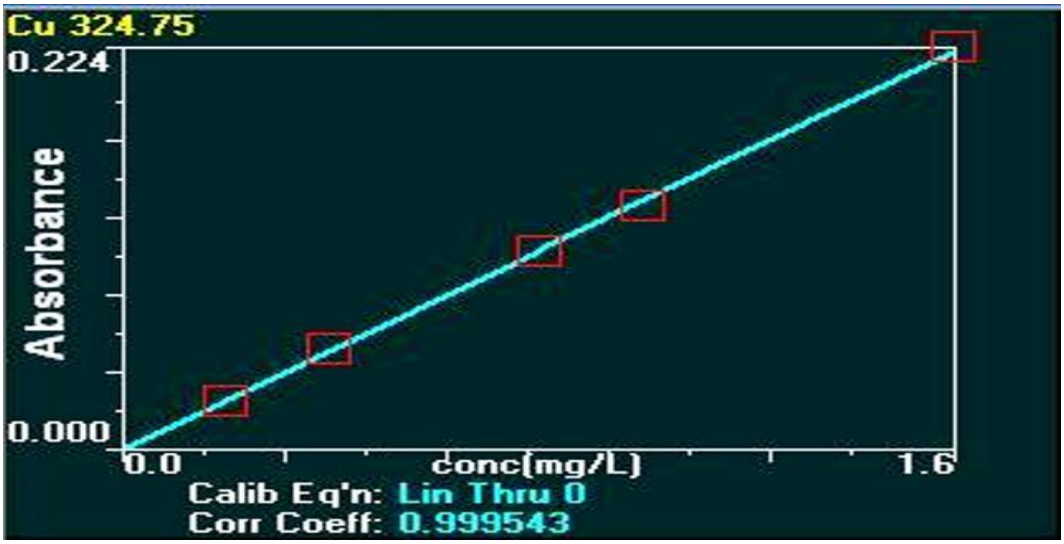

Figure b.3.1.d: Calibration curve for copper standards

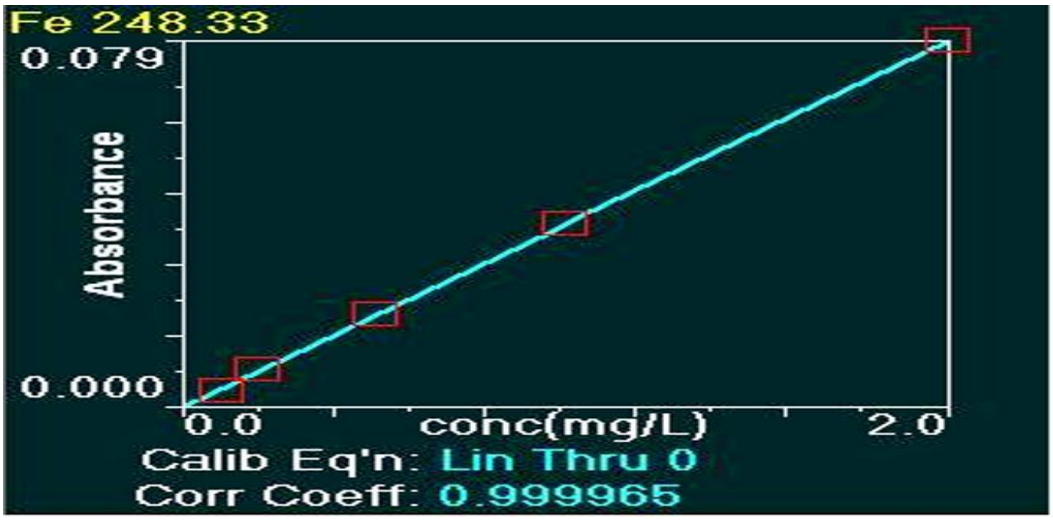

Figure b.3.1.e: Calibration curve for iron standards

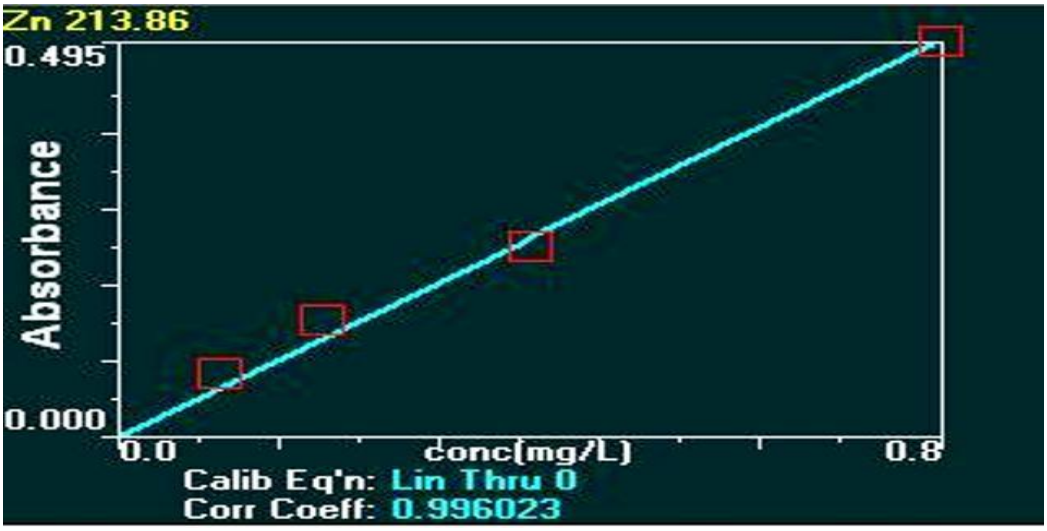

Figure b.3.1.f: Calibration curve for zinc standards

b.3.2 Micro mineral status of the ethnic people

Table b.3.2.a illustrates serum zinc, copper and iron status of ethnic people by lactating and NPNL women.

Serum zinc analysis showed that 100 % and 99% of lactating and NPNL women had serum zinc concentrations at cut off point or above (10.1 µmol/L) (Figure-b.3.2.a). In respect of serum copper status, 1% copper deficiency seen among lactating women, while no deficiency seen among NPNL samples (Figure-b.3.2.b).

Results of serum iron status showed that, in lactating and NPNL women 91% and 88% had serum iron levels at cut off point or above (Figure-b.3.2.c).

Table b.3.2.a: Micro mineral status of the ethnic people

Parameter	Lactating Woman		NPNL woman		Significance level
	%(freq)	Mean ± SD	% (freq)	Mean± SD	
Zinc					
<10.1 µmol/L	-		1 (1)	8.57 ± 0.0	t = 0.762
≥ 10.1 µmol/L	100(65)	26.2±6.2	99 (57)	25.9 ± 5.9	p = 0.449
Total	100(65)		100(58)	25.6 ± 6.3	
Copper					
<11 µmol/L	1 (1)	8.66 ± 0.0	-		t = - 1.42
≥ 11 µmol/L	99 (55)	20 ± 6.1	100(42)	20.98 ± 7	p = 0.162
Total	100(56)	19.8±6.2	100(42)		
Iron					
<11 µmol/L	9 (5)	8.5±1.9	12(5)	8.6 ± 1.3	t = 0.843
≥ 11 µmol/L	91 (51)	23.8±7.9	88 (37)	23.2 ± 8.3	p = 0.403
Total	100(56)	22.48±8.7	100(42)	21.5 ± 9.09	

[26]Cut off point of zinc in human serum in respect of both the groups (lactating and NPNL women): 10.1 µmol/L

[27]Cut off point of copper in human serum in respect of both the groups (lactating and NPNL women): 11 µmol/L

[27]Cut off point of iron in human serum in respect of both the groups (lactating and NPNL women): 11 µmol/L

Significant: $p < 0.05$

Legend: Duplicate analysis was carried out for every sample.

Descriptive statistics: frequencies, descriptive, crosstabes.

Compare mean: One sample t-test.

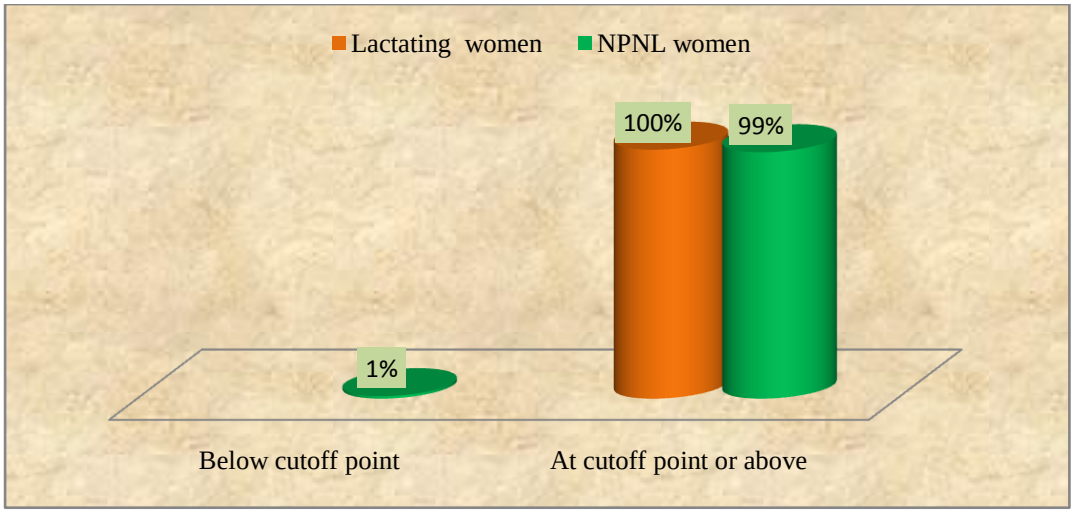

Figure b.3.2.a : Serum zinc status of lactating and NPNL women in the CHTs (IZINCG cutoff of zinc)

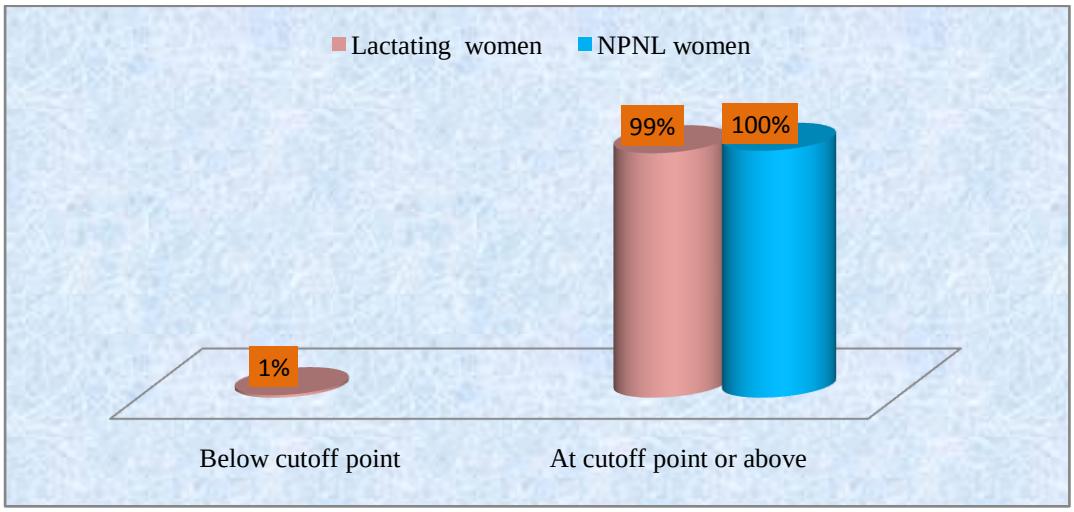

Figure b.3.2.b: Serum copper status of lactating and NPNL women in the CHTs (S.I. units)

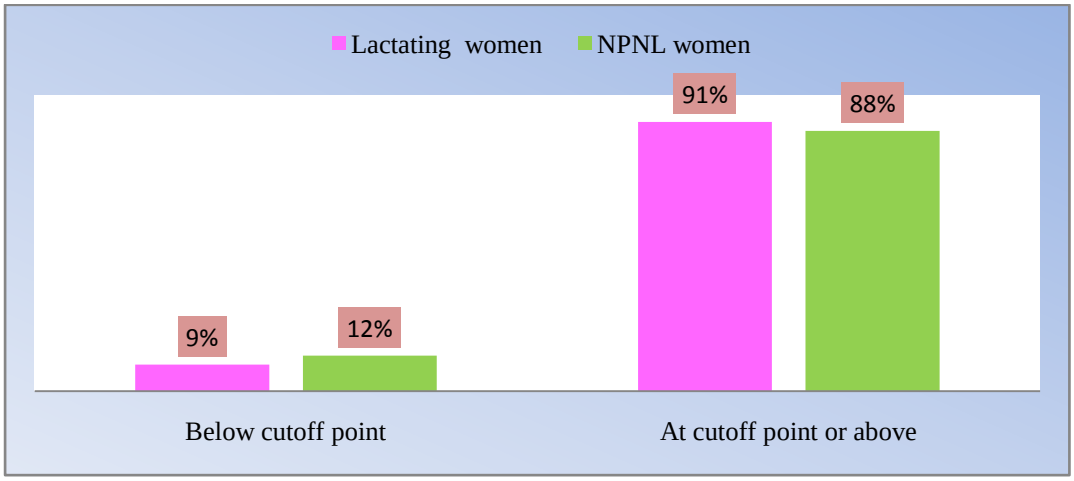

Figure b.3.2.c: Serum iron status of lactating and NPNL women in the CHTs (S.I. units)

b.3.3: prevelance of zinc deficiency prevalence among NPNL women

Table b.3.3.a and Figure b.3.3.a illustrate the prevelance of zinc deficiency among NPNL women is compared to the National Micronutrients Status Survey 2011-2012. It was observed that, 1 % zinc deficiency was present among NPNL women, while National Micronutrients Status Survey represented 57.3 % zinc deficiency. It is remarkably high in national data for general population.

Table b.3.3.a : Zinc deficiency among NPNL women[29].

Parameter	National Micronutrients Status Survey (2011-2012) %	Present Data %
Zinc deficiency (<10.1 µmol/L)	57.3	1

Descriptive statistics: frequencies.

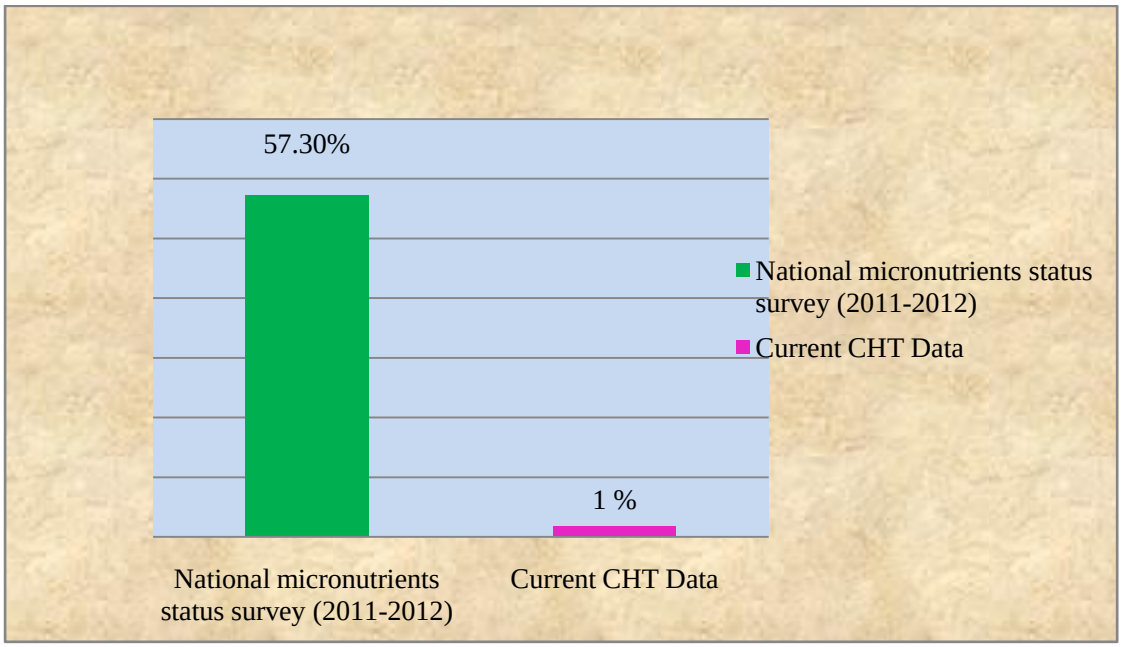

Figure b.3.3.a: Prevalence of zinc deficiency among NPNL women (%)

b.3.4: Relationship of serum zinc status with socio-economy, nutritional status and knowledge; and dietary nutrients

Table b.3.4.a demonstrates the relationship of serum zinc status with socio-economy, nutritional status and knowledge and dietary nutrients. In lactating women, statistical association of serum zinc level with other mentioned factors could not be established as zinc concentrations as per cut off was constant. From the table it is apparent that; literacy, occupancy in household chores, 18-40 years of age group, ever marital status, better income and nutritional knowledge, household food security, normal BMI and dietary zinc intake nearer or equal to reference RDA positively influence better serum zinc level (≥ 1**0.1**µmol/L) as greater number of zinc concentrations with at or above cut off points fells in these categories.

In NPNL women, academic education, occupation, age group, marital status, monthly income, nutrition knowledge score, household food security and BMI range had no significant association with serum zinc status. Only dietary zinc was found to be significantly (p=0.02) associated to serum zinc status.

Table b.3.4.a: Relationship of zinc status with socio-economic condition, nutritional status and knowledge and dietary nutrients

Parameter	Zinc (cutoff 10.1 µmol/L)				
	Lactating Woman (≥ 10.1)	Significance Level	NPNL Woman		Significance level
			< 10.1	≥10.1	
Education		ND,			
Illiterate	18	Zinc ≥ 10.1,	1	11	p=0.207
Literate	47	is constant	0	46	
Occupation		ND,			Fisher exact test value=1.658 p=1.0
Agriculture	3	Zinc ≥ 10.1,	0	4	
House hold chores	59	is constant	1	44	
Non Agriculture	3		0	9	
Age in years		ND,			
15-17 years	-	Zinc ≥ 10.1,	0	4	p=1.0
18-40 years	65	is constant	1	53	
Marital status		ND,			
Unmarried	-	Zinc ≥ 10.1,	0	7	p=1.0
Ever married	65	is constant	1	50	
Income (Tk)		ND,			
<6000	8	Zinc ≥ 10.1,	1	6	p=0.121
≥ 6000	57	is constant	0	51	
food insecurity		ND,			
Never	56	Zinc ≥ 10.1,	0	47	p=0.190
Occasionally	9	is constant	1	10	
Score on NK		ND,			
14-29	11	Zinc ≥ 10.1,	1	8	p=0.155
30-45	54	is constant	0	49	
BMI (kg/m^2)		ND,			
Underweight	5	Zinc ≥ 10.1,	1	6	p=0.121
Normal weight	48	is constant	0	39	
Overweight	12		0	12	
Dietary Nutrient (mg)		ND,			
Below Cutoff	8	Zinc ≥ 10.1,	1	0	p=0.02
Within or Above Cutoff	57	is constant	0	57	

Significant: p<0.05, Association: fisher exact test

b.3.5: Relationship of serum copper status with socio-demography, nutritional status and knowledge; dietary and serum nutrients

Table b.3.5.a demonstrates the relationship of serum copper status with socio-demography, nutritional status and knowledge; dietary and serum nutrients. It was indicated that only dietary copper intake was associated (p=0.02) with copper status of lactating women. For NPNL women, statistical association of serum copper level with socio-economy, nutritional status and knowledge; and dietary nutrients could not be established as copper concentrations equal or greater than 11µmol/L was constant. From the table it is apparent that; literacy, occupancy in household chores, 18-40 years of age, ever marital status, better income and nutritional knowledge, food security, normal BMI and dietary copper, zinc and iron intake nearer or equal to reference RDA positively influence better serum copper level (≥ 1**1**µmol/L) as greater number of copper concentrations as per cut off points falls in these categories.

Table b.3.5.a: Relationship of copper status with socio-economic condition, nutritional status and knowledge, and dietary and serum nutrients

Parameter	Copper (cutoff 11 µmol/L)				
	Lactating Woman		Significance level	NPNL Woman (≥ 11)	Significance level
	< 11	≥11			
Education					
Illiterate	0	15	P=1.00	11	ND, copper ≥ 11, is constant
Literate	1	40		31	
Occupation					
Agriculture	0	3	Fisher exact test value=2.554	1	ND, copper ≥ 11, is constant
House hold chores	1	49	P= 1.00	36	
Non Agriculture	0	3		5	
Age in years					
15-17 years	-	-	ND, 18-40 years is constant	2	ND, copper ≥ 11, is constant
18-40 years	1	55		40	
Marital status					
Unmarried	-	-	ND, Ever married is constant	4	ND, copper ≥ 11, is constant
Ever married	1	55		38	
Income (Tk)					
<6000	0	6	P=1.00	6	ND, copper ≥ 11, is constant
≥ 6000	1	49		36	
HH food insecurity					
Never	1	48	P=1.00	36	ND, copper ≥ 11, is constant
Occasionally	0	7		6	
Nutrition Knowledge					
14-29	0	9		7	ND, copper ≥ 11, is constant
30-45	1	46	P=1.0	35	
BMI (kg/m^2)					
< normal	0	4		9	ND, copper ≥ 11, is constant
Normal 18.5-24.99	1	40	P=1.0	24	
>normal	0	11		9	
Dietary copper intake (mg)					
Below Cutoff	1	0	P=0.02	-	ND, copper ≥ 11, is constant
Within or Above Cutoff	0	55		42	
Dietary zinc intake (mg)					
<RDA	1	6	P=0.125	1	ND, copper ≥ 11, is constant
≥RDA	0	49		41	
Serum iron level (µmol/L)					
<11	1	4	P=0.08	5	ND, copper ≥ 11, is constant
≥11	0	51		37	

b.3.6: Relationship of serum iron status with socio-economy, nutritional status and knowledge; dietary nutrients; and serum ferritin and haemoglobin status

Table b.3.6.a demonstrates the relationship of serum iron status with socio-economy, nutritional status and knowledge and dietary nutrients. Serum iron levels of two groups were mostly associated to education, occupation, monthly income; household food security, nutrition knowledge score and BMI ranges. In both the groups, dietary iron intake, serum ferritin and haemoglobin level were found to have no significant influence on serum iron concentrations, but drinking water source found to be positively influenced serum iron level (p=0.00).

Table b.3.6.a: Relationship of iron status with socio-economy, NS, knowledge, dietary nutrient, drinking water sources, serum ferritin and hemoglobin level

Parameter	Iron (cutoff 11 µmol/L)					
	Lactating Woman		Significance Level	NPNL Woman		Significance Level
	<11	≥11		<11	≥11	
Education						
Illiterate	5	10	p=0.00	4	7	p=0.02
Literate	0	41		1	30	
Occupation						
Agriculture	3	0		1	0	Fisher exact test value=5.721 P= 0.05
House hold chores	2	48	P=0.00	3	33	
Non Agriculture	0	3		1	4	
Age in years						
15-17 years	-	-	ND, 18-40 years is constant	0	2	P=1.00
18-40 years	5	51		5	35	
Marital status						
Unmarried	-	-	ND, Ever married is constant	1	3	p=0.410
Ever married	5	51		4	34	
Income (Tk)						
<6000	3	3	p=0.00	4	2	p=0.00
≥ 6000	2	48		1	35	
***HH food insecurity**						
Never	1	48	P=0.00	2	34	P=0.02
Occasionally	4	3		3	3	
NK Score						
14-29	3	6	p=0.03	4	3	p=0.00
30-45	2	45		1	34	
BMI (kg/m2)						
< normal	2	2	P=0.05	4	5	Fisher exact test value=8.278 p=0.02
Normal 18.5-24.99	3	38		1	23	
> normal	0	11		0	9	
Dietary iron(mg)						
< RDA	5	25	P=0.06	4	15	P=0.158
≥RDA	0	26		1	22	
Drinking water source						
Tap/tube well	1	45	p=0.00	2	35	P=0.00
Other source	4	6		3	2	
Serum ferritin level (µg/L)						
<15	3	14	P=0.158	2	9	P=0.593
≥15	2	37		3	28	
Hemoglobin level (g/dl)						
<12	5	48	P=1.0	5	34	Fisher exact test, value=0.996, p=1.0
≥12	0	3		0	3	

Association: Fisher exact test

Chapter 4: Discussion, key findings, conclusion and references

Discussions

To the author's knowledge this is the first time any study has conducted on micro minerals such as copper, zinc and iron status of the ethnic people of the Chittagong Hill Tracts.

Among 123 ethnic people, 99.2% had serum zinc concentration at cut off point or above. In Lactating and NPNL women, 100 % and 99% samples had serum zinc concentrations at cut off point or above (10.1 µmol/L).

Serum copper and iron analysis was done among 98 ethnic serum samples, about 99% and 89.8% had copper and iron concentrations at cut off value or above respectively.

In lactating women, 99% and 91 % of the ethnic people had serum copper and iron levels at cut off point or above, where as for NPNL women, 100% and 88% of samples had serum copper and iron value as per cut offs.

Among these three micro minerals National Micronutrient Status Survey 2011-2012[29] estimated only zinc status of the whole national. About 58% zinc deficiency was seen nationwide, while only 1% in present study. From the comparison it is evident that ethnic people are in a better position in respect to zinc status.

The relationship of zinc, copper and iron status by groups of the ethnic people with socio-economic, food security, nutrition knowledge, and dietary micronutrient intake and interaction with other serum micro nutrient was estimated in this section of the study. Only dietary zinc and copper were found to be significantly ($p=0.02$) associated to serum zinc and copper status in NPNL and lactating women respectively.

IOM (2001)[21] established that dietary zinc intake greater than 40 mg/day considered as excess consumption which decrease copper absorption in adults. In current analysis average zinc intake of lactating and NPNL women was 14.97±2.81 and 14.46 ±2.7 mg/day, which is much less than excess zinc intake limit. The affect of excess zinc intake on copper absorption might not be observed in this study because zinc intake was within the recommended limit.

Education, occupation, monthly income, food security, nutrition knowledge and BMI were found to be significantly associated to serum iron level of lactating and NPNL women. In both the groups, dietary iron intake found to have no significant influence on serum iron concentrations, but drinking water source found to be positively influenced serum iron level ($p=0.00$).

From micro mineral analysis of these ethnic people it is clear that ethnic zinc, copper and iron status is far better. This better status of zinc and copper found to have direct relation to dietary zinc and copper intake.

Iron status of these ethnic people was found to be related to water drinking from tube well. Many studies indicated that ground water of Bangladesh which also included the CHTs, had a high content of iron. Rebecca Merrill, j nutr. 2011 established that daily iron intake of 42 mg from water was positively correlated with plasma ferritin and total body iron. It was revealed a strong, positive, dose response association between natural iron content in ground water, intake of iron from such sources, and iron status of woman. The study linked the finding with very high iron in ground water consumtion through drinking water.[33] Kinniburgh, british geological survey 2001, showed that iron concentration is high in most parts of Bangladesh, Upto 61 mg/l.[34] WSSPS, 2005 observed that tube well water of the Chittagong Hill Tracts have high content of iron.[36] Drinking from tube well water could be an explanation of good iron status of ethnic people despite of being dietary iron deficient.

Key findings

Ethnic people were found to have good zinc, copper and iron status. Serum zinc and copper status were found to be directly associated to dietary zinc and copper intake. In case of serum iron status it was found to be related to drinking water source.

Conclusion

Zinc, copper and iron status of ethnic people in CHTs is good. Only 0.8 % and 1% zinc and copper deficiency respectively was observed among ethnic people, while 10.2% iron deficiency was observed among them. Zinc status was far better in ethnic population of CHTs than what has been represented nationally.

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