Chapter 1

Introduction

1.1 Background:

School aged young children may experience 6 to 8 colds per year. In children, this illness is also more extensive than in adults and usually requires medical attention. Statistics indicate that more than 80% of common colds requiring medical attention affect young children and adolescents. Acute lower respiratory tract infection is one of the most important and common diseases among children, which is accompanied by high mortality rate, especially in young children. This infection is the most important cause of mortality among 6-12 years young children in developing countries, accounting for nearly one-third of the cases (**WHO, 2009)**. Pneumonia is one of the most common implications of lower respiratory tract involvement. The World Health Organization estimates that of approximately 4 million annual deaths due to pneumonia, half of the cases occur in young children. Influenza is a respiratory infection caused by influenza virus (IFV), which produces a variety of symptoms including high fever, sore throat, headache, runny or blocked nose, weakness, muscle pain and sometimes diarrhea (**Barik, 2012**). These clinical symptoms often become severe in young children because of a poor or weakened immune system (**Guillemard et al. 2010; Gasparini et al. 2013**). Vaccination against IFV is usually administered as a practical, prophylactic method, but is not necessarily sufficient because viral mutagenesis occurs rapidly (**Ujike et al. 2010**). Therefore, it is desirable to boost the immune system and promote resistance against IFV infection in daily life. Illnesses range for influenza from mild to severe and even death is occurred worldwide. Most of them are children. School going children are in high risk because it is infectious. Worldwide, these annual epidemics are estimated to result in about 3 to 5 million cases of severe illness and about 290000 to 650000 respiratory deaths. A seasonal variation is present with more episodes in winter and fall and, on average, episodes of common colds last around 10 days **(Grief, 2013; Thompson et al., 2013; Nasreen et al., 2010)**.

Common influenza is believed to be an important cause of morbidity and mortality worldwide but data about its burden in low-income tropical countries like Bangladesh are rarely available. The effects of seasonal influenza epidemics are in developing countries like Bangladesh are high. Corresponding to rainy and winter season was reported to peak month of influenza virus circulation in Bangladesh **(Homaira, 2009).** Data on incidence as well as on risk factors are valuable in prioritizing influenza prevention and control efforts in the light of competing for health interventions **(Azziz-Baumgartner, 2009)**. However, there is little information about the incidence of influenza in low-income tropical countries **(Simmerman et al., 2008; Leo et al., 2009)**. *Lactobacillus brevis* present in yogurt has been reported to be safe for human consumption; it is tolerant to gastrointestinal juices, improves gut health (**Nobuta et al. 2009**) and is useful for early intervention in irritable bowel syndrome (**Murakami et al. 2012**). In addition, it has been revealed that orally administered yogurt enhances interferon (IFN) and immunoglobulin a production in humans (**Kishi et al. 2010**). These findings indicate that oral administration of yogurt may help reduce the risk of influenza in humans. Some LAB strains have been reported to reduce the incidence of respiratory symptoms such as fever, coughing (**Leyer et al. 2009**) and to decrease the duration of common infectious diseases including respiratory tract and gastrointestinal tract infections (**Guillemard et al. 2010**). However, a limited number of studies have evaluated the effects of pro-biotic on rate of subjects diagnosed with influenza in developing countries like Bangladesh. Thus, we conducted a preliminary, open-label, parallel-group trial to evaluate yogurt could reduce the incidence of influenza among young children.

In children, regular vitamin C supplementation resulted in a statistically highly significant reduction in the duration of common cold episodes that occurred during the prophylactic supplementation period. Although the above findings point to a definite physiological effect from regular vitamin C supplementation on common cold duration, the practical significance of these findings is not convincing. It does not seem reasonable to ingest vitamin C regularly throughout the year if the anticipated benefit is to slightly shorten the duration of colds which occur for adults a few times per year and for children half a dozen times per year **(Hemila, 1999)**. The above estimates are not trivial, but instead of regular supplementation, it would seem much more fruitful to consider the possible benefits of therapeutic supplementation and carry out trials to test whether an equivalent benefit might be achieved in children

through appropriate therapeutic supplementation. In light of the consistent effect of vitamin C on the duration of colds, an obvious question is whether there might be dose dependency. Thus, here we showed the effect of oral vitamin C on the onset as well as the duration of common cold at different doses among school going children.

Zinc is an essential micronutrient for human growth, development, and immune function. Mild to moderate zinc deficiency can be best detected through a positive response to supplementation trials. Zinc supplementation has been shown to have a positive effect on the incidence of diarrhea, and pneumonia. Zinc is an essential nutritional element with a broad spectrum of biological activities in humans. This element plays an important and vital role in the physical development of digestive and immune systems. Zinc deficiency in children can cause stunted growth and increased incidence of infections (pneumonia, gastroenteritis) through weakening the immune system and changing neural and behavioral actions. Zinc may work by preventing the rhinovirus from multiplying. It is also helped to stop the rhinovirus from lodging the mucous membranes of the throat and nose. There are some trials had been done in developed countries to evaluate the impact of zinc supplementation as an adjunct in the treatment of infectious diseases (diarrhea, pneumonia, malaria, and tuberculosis) in children 6-12 years of age. Trials with people under heavy acute physical stress, and the pooling of results found that zinc supplementation halved the incidence of colds in this group **(Moolla 2000; Peters 2000)**. Zinc deficiency is common in children in developing countries due to low intake of animal foods, and high dietary phytate content. Zinc deficiency impairs overall immune function and resistance to infection. The effect of zinc on the common cold is still questionable. To determine whether supplementation of zinc could reduce frequency rate and duration of common cold during cold season in 6-12 years aged children living in a low socioeconomic condition. Thus, in this study we tried to show the impacts of zinc at different doses with other supplements in reducing the onset and severity of common cold flu among school going children in developing countries like Bangladesh.

So in this study, the effects of dietary supplementation of vitamin C, zinc and Probiotics food on common cold like influenza was evaluated among the young children aged 6 to 12 years old in developing countries like Bangladesh.

1.3 Aims and Objectives

Aims:

The overall aim of this study is to evaluate how dietary diversity especially some nutrients like Vitamin C, Zinc and pro-biotic impacts on influenza infection especially common cold (CC) and flu.

Objectives:

i. To evaluate the preventive role of pro-biotic, vitamin C and zinc in Common cold and flu.
ii. To measure incidence, severity and duration of CC and flu after supplementation of these nutrients.

Chapter 2

Review of Literature

Relevant studies were selected and reviewed. To further broaden the search, some of the studies referenced in the selected studies were also retrieved and reviewed. Information obtained from several studies is presented below.

2.1 Common cold and Flu:

Common cold and flu (influenza) are infections of the upper respiratory system caused in nose, mouth, throat and lungs. The infections are caused by viruses. The symptoms of cold and flu can include fever, cough, sore throat, headache, runny nose and fatigue. In terms of transmission, seasonal influenza transmits in crowded area including schools. When an infected child cough or sneezes, droplet containing viruses are dispersed in air and can spread up to 1 meter and infect another children who breathe these droplets in **(Allan G. M., 2014)**.

2.1.1 Medicine for curing influenza:

Antibiotics are used to suppress bacteria. But influenza is caused for viruses. No medicine can cure colds and flu. There are many medicines that can ease the discomfort caused by the symptoms of cold and flu. Eating healthy food can be the best solution for reducing influenza.

2.2 Worldwide scenario of influenza like illness:

Illnesses range for influenza from mild to severe and even death is occurred worldwide. Most of them are children. School going children are in high risk because it is infectious. Worldwide, these annual epidemics are estimated to result in about 3 to 5 million cases of severe illness and about 290000 to 650000 respiratory deaths. There are 4 types of influenza viruses which are causing influenza among children worldwide. Those are influenza A, B, C, D viruses.

In china, the rate of influenza associated mortality was estimated to be 12.4per 100000annually for 3 northern cities and 8.8 per 100000 annually in 5 southern countries. In Thailand, the average annual influenza associated mortality was

estimated as 4 per 100000 persons. In South Africa, the death was estimated 20.1/100000 annually for children.

In Hong Kong, 11.1 the mortality rate per 100000 persons for influenza annually. In European populations, adults have from 2 to 5 infections annually, children typically present 6 to 12 “colds” per year, and rates of symptomatic infections increase in the elderly. A seasonal variation is present with more episodes in winter and fall and, on average, episodes of common colds last around 10 days **(Grief, 2013; Thompson et al., 2013; Nasreen et al., 2010)**.

2.3 Effects of common cold and flu in developing countries like Bangladesh:

Common influenza is believed to be an important cause of morbidity and mortality worldwide but data about its burden in low-income tropical countries like Bangladesh are rarely available.

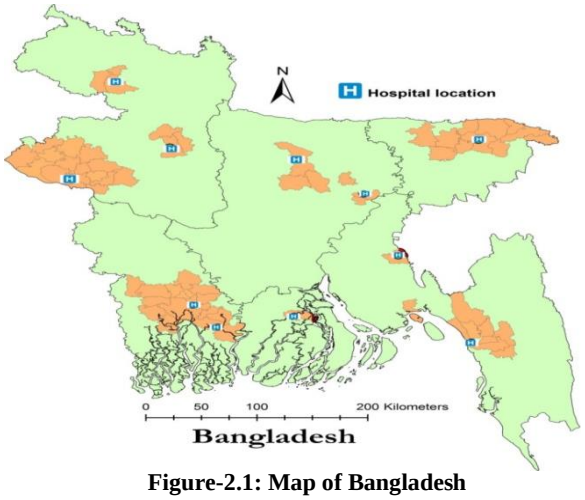

Figure-2.1: Map of Bangladesh

The effects of seasonal influenza epidemics in developing countries like Bangladesh are high. The 99% of deaths in children with influenza related respiratory tract infections are found in developing countries like Bangladesh. Corresponding to rainy and w inter season was reported to peak month of influenza virus circulation in Bangladesh. According to health authorities, the 2009 pandemic influenza A (H1N1) virus caused approximately 6000 deaths in Bangladesh and cost Dhaka 6.1 million United States dollars (US$) in direct medical costs to the patient **(Homaira, 2009; Lenoir-Wijnkoop et al., 2015)**. Data on incidence as well as on risk factors are

valuable in prioritizing influenza prevention and control efforts in the light of competing for health interventions **(WHO, 2009; Azziz-Baumgartner et al., 2009)**.

However, there is little information about the incidence of influenza in low-income tropical countries **(Simmerman et al., 2008; Leo et al., 2009)**. Infrequent hand washing and poor respiratory hygiene (e.g. covering mouth when coughing), limited access to care, lack of awareness of antiviral treatment and its availability, a huge shortage of influenza vaccines early in the pandemic, and a high prevalence of malnutrition as well as impoverished dietary diversity may have worsened the pandemic in low-income countries such as Bangladesh. Seven comparisons examined the effect of therapeutic vitamin C (3249 episodes). No consistent effect of vitamin C was seen on the duration or severity of colds in the therapeutic trials. In general, the rate of hospitalization associated with seasonal and pandemic influenza in low-income tropical and subtropical countries remains largely unknown.

Although national surveillance establish the seasonality of influenza, which typically occurs during the monsoon season from December to February **(Nicholson et al., 2003; Murray et al., 2006; Zaman et al., 2009; Eichenberg et al., 2015)**.As common colds have a self-limited course and resolve without treatment, studies on self-care have shown that common colds are the most frequent cause for self-care **(Parisius et al., 2014; Thielmann et al., 2016; Allan and Arroll, 2014)**.

2.3.1 Collection procedure of data:

There are many procedures are found from previous study to estimate influenza. Virology data were collected from hospitals during 2014-2018.

2.3.1.1 Hospital based surveillance:

During this study, 4221 cases patients data are collected.553 (13%) were positive for influenza viruses. Across 11 study sites, a median of 399 samples was tested for influenza and a median of 46 samples was positive for influenza per site.10092 total deaths in the 22surveys unions of which 1191(12%) deaths were classified as influenza associated deaths.

2.4 Vitamin C for preventing and treating the common cold:

The common cold is a major cause of visits to a doctor in high-income countries and of absenteeism from work and school. There are over 200 viruses which can cause the common cold symptoms including runny nose, congestion, sneezing, sore throat, cough, and sometimes headache, fever and red eyes. Symptoms vary from person to person and cold to cold. Since the common cold is usually caused by one of the respiratory viruses, antibiotics are useless and therefore other potential treatment options are of substantial public health interest.

Vitamin C has been proposed for treating respiratory infections since it was isolated in the 1930s. It became particularly popular in the 1970s when Nobel laureate Linus Pauling concluded from earlier placebo-controlled trials that vitamin C would prevent and alleviate the common cold. Over two dozen new trials were undertaken thereafter. Vitamin C has been widely sold and used as a preventive and therapeutic agent.

This review is restricted to placebo-controlled trials testing 0.2 g/day or more of vitamin C. Regular ingestion of vitamin C had no effect on common cold incidence in the ordinary population, based on 29 trial comparisons involving 11,306 participants. However, regular supplementation had a modest but consistent effect in reducing the duration of common cold symptoms, which is based on 31 study comparisons with 9745 common cold episodes. In five trials with 598 participants exposed to short periods of extreme physical stress (including marathon runners and skiers) vitamin C halved the common cold risk. The published trials have not reported adverse effects of vitamin C.

Trials of high doses of vitamin C administered therapeutically, starting after the onset of symptoms, showed no consistent effect on the duration or severity of common cold symptoms. However, only a few therapeutic trials have been carried out and none have examined children, although the effect of prophylactic vitamin C has been greater in children. One large trial with adults reported benefit from an 8 g therapeutic dose at the onset of symptoms, and two therapeutic trials using five-day supplementation reported benefit. More trials are necessary to settle the possible role of therapeutic vitamin C, meaning administration immediately after the onset of symptoms **(Allan G. M.,2012).**

2.5 Zinc for preventing and treating the common cold:

Only 20 participants in zinc supplementation group required antibiotics for treatment of upper respiratory tract infection compared to 47 individuals that needed antibiotic therapy in placebo group. They carried out a prospective study to determine the prophylactic and therapeutic effectiveness of zinc for the common cold in children **(Hemilä, 1996).**

2.6 Yogurt for preventing and treating the common cold:

As the multiple benefits of probiotics are being realized, an important application is in the area of preventing, rather than treating, disease. Toward this end, a limited number of studies evaluating the efficacy of various probiotics in health maintenance have been performed. There might be a small number of studies in part because these studies must be prospective, must involve relatively large numbers of individuals, and must have extended clinical trial durations. Two prospective probiotic studies using healthy subjects in group child care centers evaluated the contributions of specific probiotic strains in health maintenance. Results ranged from modest and not statistically significant effects on respiratory symptoms in children 6 to 12 years of age to strain specific, significant reductions in cold group child care absences, and antibiotic prescriptions but no differences in respiratory symptoms in an infant population **(Melissa Sammy, 2020).**

2.7 Impacts of Vitamin C, yogurt, zinc on influenza:

Between these numerous non-pharmacological approaches for the prevention and treatment of the common cold, there are the intakes of some nutrients such as yogurt, vitamins C and zinc. The proposed biologic mechanisms are that these nutrients can significantly influence several components of immunity. Seasonal influenza-associated mortality estimates help identify the burden of disease and assess the value of public health interventions such as annual influenza immunization.

2.7.1 Impacts of vitamin C on common cold:

(Anderson, 1972) found about an 8% increase in the proportion of participants who were not ill during the trial, not confined to the house and not off work in the vitamin C group. Accordingly, about one participant in 12 benefited from vitamin C supplementation in this particular setting. Participants in this Canadian trial were asked not to enroll in the trial unless they normally experienced at least one cold in the wintertime and in this respect the participants do not represent the average population. A study in Navajo school children and found a 16% higher proportion of children in the vitamin C group who were never ill on active surveillance by a medically trained clerk or school nurse**.** Thus, these two trials indicate that some individual participants of the two studied populations may have benefited, even though there is strong evidence that regular vitamin C does not affect the average incidence of colds in the general community. In close parallel with vitamin C, lipid-soluble vitamin E is interesting as these two antioxidants interact. Vitamin C reduces the oxidized form of vitamin E under in vitro conditions **(Hemilä, 2006)** and modifies the vitamin E effect on mortality of older males **(Hemilä, 2009)**.

Twenty-nine trial comparisons involving 11,306 participants contributed to the meta-analysis on the risk ratio (RR) of developing a cold whilst taking vitamin C regularly over the study period. In the general community trials involving 10,708 participants, the pooled RR was 0.97 (95% confidence interval (CI) 0.94 to 1.00). Five trials involving a total of 598 marathon runners, skiers and soldiers on subarctic exercises yielded a pooled RR of 0.48 (95% CI 0.35 to 0.64). Thirty-one comparisons examined the effect of regular vitamin C on common cold duration (9745 episodes). In adults the duration of colds was reduced by 8% (3% to 12%) and in children by 14% (7% to 21%). In children, 1 to 2 g/day vitamin C shortened colds by 18%. The severity of colds was also reduced by regular vitamin C administration. Therefore heterogeneity in the vitamin E effect on common cold incidence **(Hemilä, 2006)** and on pneumonia incidence **(Hemilä, 2011)** is relevant when considering the plausible heterogeneity of vitamin C effects on respiratory infections.

2.7.1.1 Cold managements:

Vitamin C supplementation is used to reduce the incidence of colds in the children. Vitamin C has been proposed for treating respiratory infections. Vitamin C has been widely sold and used as a preventive agent for influenza illness. The term 'the common cold' does not denote any precisely defined disease, but this illness is familiar to most people. Typically symptoms of the common cold consist of some combination of nasal discharge and obstruction, sore throat, cough, lethargy and malaise, with or without fever. The common cold is the leading cause of acute morbidity and of visits to a physician in high-income countries and a major cause of absenteeism from work and school. The common cold is usually caused by respiratory viruses which overall have some 200 serotypes. Thus, the term 'the common cold' does not refer to a single entity but to a group of diseases caused by numerous unrelated etiological agents. The most frequent agent causing the common cold is rhinovirus, which is found in 30% to 50% of sufferers. In a third of participants with cold symptoms, the etiology remains undefined even when extensive biological tests are used. It is not clear to what extent this latter group is explained by the low sensitivity of the tests, unidentified viruses, or similar symptoms arising from on-viral etiology, such as allergic or mechanical irritation of the airways. Different respiratory viruses have different symptom profiles, but the patterns are not consistent enough to validate etiological conclusions from the patients symptoms **(Salminen S, 2006).**

2.7.2 Impacts of Zinc on common cold:

The aim of this review is to evaluate the impact of zinc supplementation as an adjunct in the treatment of infectious diseases (diarrhea, pneumonia, malaria, and tuberculosis) in children 6-12 years of age. Trials with people under heavy acute physical stress a previous meta-analysis identified three trials with participants under severe acute physical stress, and the pooling of results found that zinc supplementation halved the incidence of colds in this group **(Hemilä, 1996)**. Zinc may work by preventing the rhinovirus from multiplying. It is also helped to stop the rhinovirus from lodging the mucous membranes of the throat and nose. There is been a lot of talk about taking zinc for colds since 1984 study showed that zinc supplements kept people safe from getting sick from influenza.

2.7.2.2 Cold managements:

Zinc is worked by preventing the rhinovirus from multiplying. It may also stop the rhinovirus from lodging in the mucous membranes of the throat and nose (**Hemilä, 1996).**

2.4.3 Effects of dietary Pro-biotic on influenza illness:

Perhaps lesser known is the health benefits that pro-biotic may confer on the immune system, which may be of particular import during the cold and flu season **(Melissa Sammy, 2020)**. Trials within the general community an analysis pooled the results of the six largest trials in which_1 g/day of yogurt had been administered regularly over the study period.In this study, demonstrated 1089 school going children intake yogurt for preventing influenza. The subjects are not given vaccine. This is unbelievable that the study showed reduced influenza in school going children. Some lab reports have been reported to reduce the incidence of respiratory symptoms by giving pro-biotic **(Leyer et al, 2009).** In another study, 3356 school going children is giving yogurt. After exclusion, 2926 are eligible. In this study, 23.9% and 15.7% of subjects were diagnosed with influenza in the consumption of yogurt group and also in non consumption group. Yogurt consumption groups given better result than non consumption group.

2.4.3.3 Cold managements:

Yogurt is a nutritious food choice and it is beneficial to health. Yogurt can help boost the immune system and fight-off winter illness. Influenza is a respiratory infection caused by influenza virus (IFV), which produces a variety of symptoms including high fever, chills, sore throat, headache, runny or blocked nose, weakness, muscle pain and sometimes diarrhea. These clinical symptoms often become severe in elderly individuals and infants because of a poor or weakened immune system. Therefore, it is desirable to boost the immune system and promote resistance against IFV infection in daily life. probiotic is a plant-derived lactic acid bacterium (LAB) isolated from ‘Suguki’, a traditional pickle produced in Kyoto, Japan. KB290 has been reported to be safe for human consumption; it is tolerant to gastrointestinal juices, improves gut health and is useful for early intervention in irritable bowel syndrome **(Schrezenmeir J. 2005)**.

Chapater-3

Materials and Methods

3.1 Study area and period:

The study period was one month from December, 2020 to January, 2021. All tasks were conducted in Chattogram, Bangladesh.

Figure-3.1: Location Map of Study Area

3.2 Study design:

The randomized, double-blind, placebo-controlled study followed a parallel-arm design and continue 4 weeks. Participants were instructed to restrict all juice or fruit-flavored drinks during the study period. The participants provided 1 cup (about 100gm) yogurt daily (Group1), two vitamin C capsules (500 mg) daily in a divided dose (morning and evening) in group 2,one tablet (5mg) of zinc will supplement in group 3, combined 3 supplements in group 4 and the control group provided chocolate as placebo. All capsules were packaged in re-sealable storage bags. The randomization was conducted by the lead investigator who did not have contact with participants or conduct data entry.

3.3 Participant selection:

Healthy children aged 6-12 years who lived in surveillance areas were eligible for enrolment. A parent or legal guardian provided written informed consent. The family was not expecting to migrate out of the area during the study. A total of 150 samples were randomly selected for this experiment and divided into five groups. Each group contained 30 participants.

3.3.1 Inclusion criteria: The participants those were healthy during study period and not taken any medicine previous month of study period.

3.3.2 Exclusion criteria: The children those were suffered from common cold during the study period and taken medicine.

3.4 Data Collection Tools:

3.4.1 Questionnaire: A form in the structured questionnaire was used to record information. The procedures were followed for taking data is described by (**WHO, 2010**). Healthy children for 5 groups aged 6-12 years who lived in surveillance areas data were taken. From the above study population, the calculated sample size was 150.the data found that combined group whose taken yogurt, Vitamin C and zinc are less infected by influenza. Data were calculated in SPSS (version 17.0). Frequencies of different groups and variables were measured. Chi square tests were also done for 5 groups separately.

3.4.2 Anthropometric measurement

Weight measurement*:* According to CDC (Centre for Disease Control & Prevention), an average weight of 12 years old boys usually falls 30kg. The CDC also reports that, a 12 years old girls weight usually 31kg. Weight was measured by digital weight measurement machine.

Height measurement*:* According to CDC (Centre for Disease Control & Prevention), an average height of 12 years old boys usually falls 151cm. The CDC also reports that, a 12 years old girls height usually 149cm. Height was measured by height measuring tape.

BMI calculation*:* Body Mass Index (BMI) is a person's weight in kg divided by the square of height in meters.BMI is calculated the same way for both adult and children. In kg and meter, the formula is weight (kg) / [height (m)]^2. BMI ranges below 18.5 considered as underweight, 18.5-24.9 count as normal weight and 25.0- 29.9 indicate overweight.

3.5. Data Capture and Analysis Strategy:

3.5.1 Data Capture: Data from questionnaire were captured in a Microsoft Excel spreadsheet for data cleaning and coding.

3.5.2 Data Cleaning: For missing values, the researcher retrieved information from the participants' form for confirmation; if they had missing information on key variables, they were excluded. For extreme values that were captured, information was also retrieved from questionnaire for confirmation; if the information was extreme, it was excluded. For inconsistent values, information was retrieved from questionnaire for confirmation.

3.5.3 Data Coding: Numerical data were grouped for analysis purposes. Qualitative or categorical data were replaced with numbers that could not be used to identify them.

3.5.4 Data Analysis: Data in Microsoft Excel spreadsheet were imported to IBM Statistical Package for the Social Sciences- SPSS (version 17.0) for data analysis. Frequencies of different variables were tabulated. Bivariate analyses of different variables were done using Chi square and Fisher's exact tests.

Chapter 4

Results

This section describes the findings of the study. The socio demographic characteristics of the participants are presented first followed by incidence rate of common cold and flu, dietary diversity score and other variables. Associations between different variables and Common cold and flu were described using Chi square test and Fisher's exact tests.

4.1 Socio-demographic characteristics:

The participants in this study had ages ranging from 6 years to 13 years dividend in 2 groups 6 to 9years and 10 to 13 years. Most of the participants (76.7%) were in range 10-13 years. In this study among 150 children about 45 (30%) of children are male and 105(70%) are female showed in **Table 4.1**.

Table 4.1 Frequency distribution of socio-demographic variables in school going children

Variables	Characteristic	Frequency (N)	Percentage (%)
Age	6-9 years	35	23.3
	10-13 years	115	76.7
Gender	Male	45	36
	Female	105	70
Fathers education	Primary School	19	12.7
	High School	88	58.7
	College & Above	43	28.7
Mothers education	Primary School	72	48
	High School	68	45.3
	College & Above	10	6.7
Fathers occupation	Day labor	31	20.7
	Job holder	108	72.0
	Businessman	8	5.3
	Farmer	3	2
Mothers occupation	Housewife	117	78
	Job holder	33	22
Family members	1-3members	14	9.3
	4-7members	136	90.7

The education was represented as Primary, High school, College and Graduation. About 12.7% father had primary education, majority of father about 58.7% had secondary education and 28.7% father had college & above. On the other hand Majority About 48% mother had primary education, about 45.3% had secondary education and 6.7% mother had college & above education level. Around two third participants parent's occupation is job besides most of the mother of the participants are housewife (78%). Most of the participants (90.7%) come from large family while 9.3% participants belong to small family.

4.2 Health and immunization status:

In this study health status was measured by BMI value and most of the adolescents were normal (82%) and 17.3% and 7% was underweight and overweight respectively presented in **Table 4.2**.

Table 4.2 Frequency distribution of health and immunization status

Variables	Characteristics	Frequency (N)	Percentage (%)
Body Mass Index	Underweight	26	17.3
	Normal	123	82
	Over weight	1	7
Immunization Status	Fully	106	70.7
	Partially	44	29.3

As shown in table 4.2 70.7% of the participants (106) were fully immunized against cold and flu while 29.3% of the participants (44) were partially taken their vaccine work against cold and flu.

4.3 Incidence rate of common cold and flu among children:

Following **Table 4.3** shows the incidence rate of common cold and flu among children in different groups. In group 4 (combined supplementation) the incidence rate of different variable was lower than other groups.

Table-4.3: Frequency distribution of Incidence rate of common cold and flu among children

Variable		Group 1	Group 2	Group 3	Group 4	Control 5
Cough	Yes	2(1.3)	6(4)	14(9.3)	1(0.7)	22(14.7)
	No	27(18)	24(16)	16(10.7)	29(19.3)	8(5.3)
Sore Throat	Yes	3(2)	6(4)	14(9.3)	2(1.3)	19(12.7)
	No	27(18)	24(16)	16(10.7)	28(18.7)	11(7.3)
Running Nose	Yes	3(2)	6(4)	15(10)	4(2.7)	19(12.7)
	No	27(18)	24(16)	15(10)	26(17.3)	11(7.3)
Fever	Yes	7(4.7)	14(9.3)	11(7.3)	12(8)	18(12)
	No	23(15.3)	16(10.7)	19(12.7)	18(12)	12(8)
Headache	Yes	7(4.7)	7(4.7)	3(2)	3(2)	17(11.3)
	No	23(15.3)	23(15.3)	27(18)	27(18)	13(8.7)
Muscular Pain	Yes	3(2)	6(4)	4(2.7)	4(2.7)	3(2)
	No	27(18)	24(16)	26(17.3)	26(17.3)	27(18)
Diarrhea	Yes	6(4)	6(4)	5(3.3)	4(2.7)	12(8)
	No	24(16)	24(16)	24(16)	26(17.3)	18(12)
Air Respiratory Index	Yes	3(2)	9(6)	13(8.7)	4(2.7)	20(13.3)
	No	27(18)	21(14)	17(11.3)	26(17.3)	10(6.7)
Worm Infestation	Yes	14(9.3)	13(8.7)	6(4)	3(2)	12(8)
	No	16(10.7)	17(11.3)	24(16)	27(18)	18(12)
Medicine Intake for Influenza	Yes	5(3.3)	15(10)	13(8.7)	1(0.7)	1(0.7)
	No	25(16.7)	15(10)	17(11.3)	29(19.3)	29(19.3)
Fatigue	Yes	4(2.7)	2(4)	10(6.7)	1(0.7)	11(7.3)
	No	26(17.3)	24(16)	20(13.3)	29(19.3)	19(12.7)
Chronic Pain	Yes	5(3.3)	2(1.3)	3(2)	3(2)	3(2)
	No	25(16.7)	18(18.7)	27(18)	27(18)	27(18)
Physical Disability	Yes	1(0.7)	0(0)	0(0)	0(0)	3(2)
	No	29(19.3)	30(20)	30(20)	30(20)	27(18)

However, in control group (no supplementation) the incidence rate of different variable of common cold and flu was higher than all other groups.

4.4 Dietary diversity score (DDS):

Proper balance diet fill up the nutritional requirement as well as boost up the immunity of young children and help to maintain their proper growth and development. The dietary diversity score (DDS) is meant to reflect in a snapshot form, the economic ability of a household to access a variety of foods. Most of the participants (77.3%) are consumed medium level of diverse food.

Only 2% participants can take higher diversified food while about 20% of the participants had low dietary diversity score presented in **fig. 4.1.**

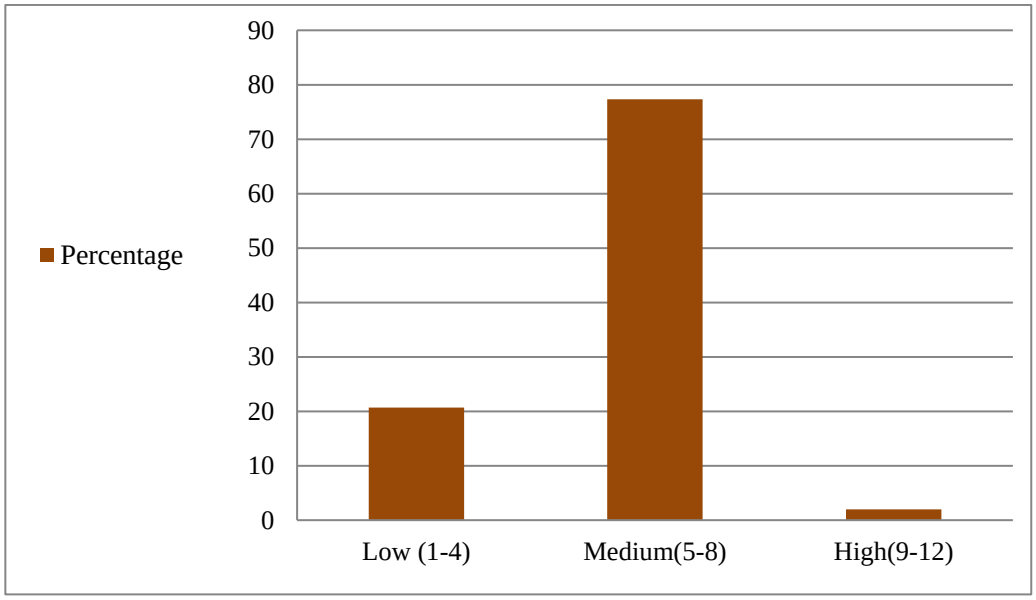

Figure 4.1 Percentage of the participants based on their Dietary diversity score

4.5 Association of socio-demographic characteristics with BMI:

Body mass index (BMI) is a reliable indicator of body fatness for most people. It is used to screen for weight categories that may lead to health problems. Socio-demographic characteristics have huge impacts on BMI as the higher socioeconomic has more access to food than lower one. On contrast, some research showed that Lower socioeconomic status (SES) is generally associated with a higher body mass index (BMI). However, this association is complex and varies by sex and country-level income.

In the present study there was no association found among socio-demographic characteristics with BMI. The results of the obtained value showed in **Table4.4.**

Table 4.4. Association of Socio-demographic characteristics with BMI

Variables	Characteristics	BMI N (%)			Pearson's χ2(df)	P-Value
		Under weight	Normal	Over weight		
Age	6-9 years	4(11.4)	31(19.1)	0	1.463(2)	0.481
	10-13 years	22(88.6)	92(80)	1(100)		
Gender	Male	9(34.6)	36(29.3)	0	0.724(2)	0.696
	Female	17(65.4)	87(70.7)	1(100)		
Fathers education	Primary School	8(30.8)	11(8.9)	0	9.952(4)	0.041
	High School	12(46.2)	75(61)	1(100)		
	College & above	6(23.1)	38(30.1)	0		
Mothers education	Primary School	9(34.6)	63(51.2)	0	3.617(4)	0.460
	High School	15(57.7)	52(42.3)	1(100)		
	College & above	2(7.7)	8(6.5)	0		
Fathers occupation	Day labor	5(19.2)	26(21.1)	0	1.393(6)	0.966
	Job holder	19(73.1)	88(71.5)	1(100)		
	Businessman	2(7.7)	6(4.9)	0		
	Farmer	0(0.00)	3(2.4)	0		
Mothers occupation	Housewife	20(76.9)	96(78.0)	1(100)	0.300(2)	0.861
	Job holder	6(23.1)	27(22.0)	0		
Family members	1-3members	1(3.8)	13(10.6)	0	1.250(2)	0.535
	4-7members	25(96.2)	110(89)	1(100)		

* Chi-square test (Undetermined values were due to unreliability of the test results and P < 0.050 was considered statistically significant)

*χ2 = Chi-square * df = Degrees of freedom

4.6 Association of socio-demographic characteristics with immunization:

Socio-demographic determinants may be the influencing factors for childhood immunization but in this the results show that there was no statistically significant

association of variables of socio-demographic characteristics with immunization status presented in **Table 4.5**.

Table 4.5. Association of socio-demographic characteristics with immunization

Variables	Characteristics	Immunization Status, N (%)		Pearson's χ2(df)	P-Value
		Under weight	Normal		
Age	6-9 years	25(23.6)	10(22.7)	0.013(1)	0.910
	10-13 years	81(76.4)	34(77.3)		
Gender	Male	36(34.0)	9(20.5)	2.702(1)	0.100
	Female	70(66)	35(79.5)		
Fathers education	Primary School	11(10.4)	8(18.2)	1.946 (2)	0.378
	High School	65(61.3)	23(52.3)		
	College & above	30(28.3)	13(29.5)		
Mothers education	Primary School	50(47.2)	22(50)	2.728(2)	0.256
	High School	51(48.1)	17(38.6)		
	College & above	5(4.7)	5(11.4)		
Fathers occupation	Day labor	19(19.9)	12(27.3)	5.885(3)	0.117
	Job holder	76(71.7)	32(72.7)		
	Businessman	8(7.5)	0(0.00)		
	Farmer	3(2.8)	0(0.00)		
Mothers occupation	Housewife	81(76.4)	36(81.8)	0.529(1)	0.467
	Job holder	25(23.6)	8(18.2)		
Family members	1-3members	11(10.4)	3(6.8)	0.465(1)	0.495
	4-7members	95 (89.6)	41(93.3)		

* Chi-square test (Undetermined values were due to unreliability of the test results and P < 0.050 was considered statistically significant)
*χ2 = Chi-square * df = Degrees of freedom

4.7 Association of socio-demographic characteristics with DDS:

Children with high dietary diversity poses nutritionally sound health and their immunity also higher than those have low dietary diversity. High dietary diversity score depends on the family income, nutritional knowledge and the availability of diversity of food. However, the results of this study show that there is no statically significant relation among variables of socio demographic characteristics with DDS presented in **Table 4.6.**

Table 4.6. Association of socio-demographic characteristics with DDS

Variables	Characteristics	DDS, N (%)			Pearson's χ2(df)	P-Value
		Low (1-4)	Moderate (5-8)	High (9-12)		
Age	6-9 years	7(22.6)	27(23.3)	1(33.3)	0.178(2)	0.915
	10-13 years	24(77.4)	89(76.7)	2(66.7)		
Gender	Male	12(38.7)	32(27.6)	1(33.3)	1.458(2)	0.483
	Female	19(61.3)	84(72.4)	2(66.7)		
Fathers education	Primary School	6(19.4)	13(11.2)	0 (0.00)	4.049(4)	0.399
	High School	18(58.1)	67(57.8)	3(100.0)		
	College & above	7(22.6)	36(31.0)	0 (0.00)		
Mothers education	Primary School	17(54.8)	53(45.7)	2(66.7)	1.366(4)	0.850
	High School	12(38.7)	55(47.8)	1(33.3)		
	College & above	2(6.5)	8(6.9)	0 (0.00)		
Fathers occupation	Day labor	4(12.9)	27(23.3)	0 (0.00)	3.011(6)	0.808
	Job holder	24(77.4)	81(69.8)	3(100.0)		
	Businessman	2(6.5)	6(5.2)	0 (0.00)		
	Farmer	1(3.2)	2(1.7)	0 (0.00)		
Mothers occupation	Housewife	27(87.1)	88(75.9)	2(66.7)	2.028(2)	0.363
	Job holder	4(12.9)	28(24.1)	1(33.3)		
Family members	1-3members	4(12.9)	10(8.6)	0 (0.00)	0.845(2)	0.655
	4-7members	27(87.1)	106(91.4)	3(100.0)		

* Chi-square test (Undetermined values were due to unreliability of the test results and P < 0.050 was considered statistically significant)

*χ2 = Chi-square * df = Degrees of freedom

4.8 Association of Dietary Supplements with Common Cold:

The dietary supplements play an important role in the treatments of common cold that reduce the incidence of infection and/or lessen the severity of symptoms and/or shorten the duration of common colds are of high interest both for the individual and for the whole society. The result of this study shows that the cough symptom of common cold statistically significant with the supplement treatments, Chi- square test with 4 degrees of freedom =47.417, p value= 0.001 presented in **Table 4.7.** Similarly sore throat, running nose, fever, muscle pain and fatigue is also significantly associated with treatments. Contrastingly, there was no significant association among headache, diarrhea, air respiratory index (ARI), chronic pain and physical disability with dietary supplementation.

Table 4.7. Association of Dietary Supplements with Common Cold

Variables	Characteristics	Group (%)					Pearson's χ^2 (df)	P-value
		Yogurt	Vitamin C	Zinc	Combined	Placebo		
Cough	Yes	3(10)	6(20)	14(46)	1(3.3)	22(73.3)	47.417(4)	0.001
	No	27(90)	24(80)	16(53)	29(96.7)	8(26.7)		
Sore Throat	Yes	3(10)	6(20)	14(46)	1(3.3)	22(73.3)	35.184(4)	0.001
	No	27(90)	24(80)	16(53)	29(96.7)	8(26.7)		
Running Nose	Yes	3(10)	6(20)	14(46.7)	1(3.3)	22(73.3)	31.791(4)	0.001
	No	27(90)	24(80)	16(53.3)	29(96.7)	8(26.7)		
Fever	Yes	7(23.3)	14(47.7)	11(36.7)	12(40)	18(60)	8.963(4)	0.001
	No	23(76.7)	16(53.3)	19(63.3)	3(10)	17(56.7)		
Headache	Yes	7(23.3)	14(47.7)	11(36.7)	12(40)	18(60)	23.535(4)	0.062
	No	23(76.7)	16(53.3)	19(63.3)	3(10)	17(56.7)		
Muscular Pain	Yes	3(10)	6(20)	4(13.3)	4(13.3)	3(10)	1.731(4)	0.001
	No	27(90)	24(80)	26(86.7)	26(86.7)	27(90)		
Diarrhea	Yes	6(20)	6(20)	6(20)	4(13.3)	12(40)	6.998(4)	0.785
	No	24(80)	24(80)	24(80)	26(86.7)	18(60)		
Air Respiratory Index	Yes	3(10)	9 (30)	13(43.3)	4(13.3)	20(66.7)	29.521(4)	0.136
	No	27(90)	21(70)	17(56.7)	26(86.7)	10(33.3)		
Fatigue	Yes	4(13.3)	6 (20)	10 (33.3)	1(3.3)	11(36.7)	13.745(4)	0.001
	No	26(86.7)	24 (80)	20(66.7)	29(96.7)	19(63.3)		
Chronic Pain	Yes	5(16.7)	2(6.7)	3(10)	3(10)	3(10)	1.679(4)	0.008
	No	25(83.3)	28(93.3)	27(90)	27(90)	27(90)		
Physical Disability	Yes	1(3.3)	0(0)	0(0)	0(0)	3(10)	8.733(4)	0.068
	No	29(96.7)	30(100)	30(100)	30(100)	27(90)		

4.9 Association of Dietary Diversity Score with Common Cold Flu Symptoms

Dietary diversity not only impacts on nutritional status of human being but it has also significant role in the immune system that reduces the onset, severity and duration of common cold symptoms. Nonetheless, this study results show that there is no significant association among the symptoms of common cold with dietary diversity score presented in **Table 4.8.**

Table 4.8. Association of Dietary Diversity Score with Common Cold Flu Symptoms

Variables	Characteristics	Dietary diversity score (DDS), N (%)			Pearson's χ^2 (df)	P-value
		Low(1-4)	Moderate(5-8)	High(9-12)		
Cough	Yes	10(32.3)	36(31)	0(0)	1.371(2)	0.504
	No	21(67.7)	80 (69)	3 (100)		
Sore Throat	Yes	12(38.7)	32(27.6)	0 (0)	2.731(2)	0.255
	No	19(61.3)	84 (72.4)	3(100)		
Running	Yes	6(19.4)	39(33.6)	2(66.7)	4.090(2)	0.129
Nose	No	25(80.6)	27(66.4)	1(33.3)		
Fever	Yes	7(22.6)	55(47.4)	0(0)	8.378(2)	0.015
	No	24(77.4)	61(52.6)	3(100)		
Headache	Yes	7(22.6)	63(55.1)	0 (0)	1.144(2)	0.564
	No	24(77.4)	83(74.1)	3(100)		
Muscular	Yes	3(9.7)	17(14.7)	0 (0)	0.995(2)	0.608
Pain	No	28(90.3)	99 (85.3)	3(100)		
Diarrhea	Yes	9(29.0)	25 (21.6)	0(0)	1.678(2)	0.432
	No	22(71.0)	91(74.4)	3(100)		
Air	Yes	11(35.5)	37(31.9)	1(33.3)	0.144(2)	0.931
Respiratory	No	20(64.1)	79(68.1)	2(67.7)		
Index						
Fatigue	Yes	6(19.4)	26 (80.6)	0(0)	0.967(2)	0.617
	No	25(22.4)	90(76.6)	3(100)		
Chronic	Yes	2(6.5)	102(87.9)	3(100)	1.176(2)	0.556
Pain	No	14(12.1)	0(0)	0(0)		
Physical	Yes	29(93.5)	0(0)	4(3.4)	1.025(2)	0.548
Disability	No	31(100)	112(96.6)	3(100)		

* Chi-square test (Undetermined values were due to unreliability of the test results and $P < 0.050$ was considered statistically significant)

*$\chi 2$ = Chi-square * df = Degrees of freedom

Chapter 5

Discussion

In the current study, 150 school going children aged between 6-12 years completed a 1-month, double-blind, placebo-controlled, intervention trial. No notable adverse events were attributed to study participants. This study showed that dietary supplementation such as yogurt, Vitamin C and zinc are effective for reducing the incidence rate of influenza like illness common cold and flu in school going children compared with the placebo group. Five distinct supplementation treatments were applied such as Group 1 (yogurt), Group 2 (vitamin C), Group 3 (zinc), Group 4 (combined, yogurt + vitamin C + zinc) and placebo, the results exhibited that all treatment reduced the incidence rate compared with control group. However, the group treated with combine supplementation showed the more effective to reduce the incidence compared with placebo group. Where the group treated with zinc showed less effective in incidence rate of common cold. Furthermore, this study also showed the relation of common cold with socio-demographic factors, nutritional status of children, immunization status, and dietary diversity score.

5.1 Socio-demographic factors:

This study was conducted on school going young children of Chattogram, Bangladesh and their age range was between 6–13 years where most of the participants 105(70%) were female and 45 (30%) of children are male. This is because this study was conducted during COVID-19 pandemic and data was collected at day time when most of male children were out of home so the female participant's number was higher than male. The similar study was conducted Garaiova et al. and their participant was children attending preschool age range 3-6 years (**Garaiova et al., 2014**). Parents' education and income have great impacts on child health and nutrition. Parents nutrition knowledge help them to feed proper diet to their children and the balance diet boost up the child's immunity so they are in less chance to get common cold like

illness. In this study the majority fathers' of participants about 88(58.7%) had secondary education and most of fathers 108(72%) were job holder. On the other hand about half of the mothers 72(48%) had only primary education and about 68(45.3%) had secondary education and most of mothers 117(78%) were house maker; this is because the data were collected from middle or lower middle class family where the cost of higher education is unbearable and most of family enter the garments or other mini industry to help their family in term of economic support. Above 90% of the participants of this study belongs large family where family member are 4-7members.

5.2 Health status and dietary diversity score:

Health status measurement is useful in epidemiologic analyses of risk factors as well as for monitoring trends. There are several indicators are used as health status in heath related study but in this study body mass index (BMI) was measured as heath status of the participants and most of the adolescents 123(82%) were normal, 26(17.3%) and 1(7%) was underweight and overweight respectively. This result indicates that most participants were well nourished in considering their weight against their height. Into the bargain, around 70.7% of the participants were fully immunized since the government of Bangladesh provides free vaccination to children in urban and rural area of Bangladesh by adopting Expanded Program on Immunization (EPI) with the help of World Health Organization (WHO).

5.3 Impacts of demographic factors on health, immunization and dietary diversity score:

In many low income developing countries, socioeconomic, environmental and demographic factors have been linked to around half of the disease related deaths that occur each year. A large and growing body of evidence shows that socio-demographic factor – age, race, ethnicity, and language, for example – and socioeconomic status (SES), such as income and education, can influence health outcomes. In the current study the results divulged that socio-demographic factors had no influence on the health, immunization and dietary diversity score of the school going children. This is because the data was collected from a specific group or class of people. If the data was collected from different class of people as well as from different location then it

may be significantly influence the health, immunization and dietary diversity score of the adolescent. The recent study demonstrated that mother schooling and parents working status play important role and helpful to make nutrition decision for their children to improve child height and weight. Furthermore, Socio-economic status of family also has its impact on child health, immunization and dietary diversity score. Poor families have weak and obese children due to lack of money they have access to cheap and unhygienic food items. Additionally, Maternal education is most important factor which effect child health (**Anwar et al., 2015**). The effectiveness of routine children immunization programme relies on multiple factors such as the demographic characteristics of these children. A study noted that maternal education, poverty, seasonality and area of residence were associated with timely adherence to BCG vaccination and completion of vaccination schedule. In rural Bangladesh Rahman and Obaida-Nasrrash showed that mothers age, parity, birth interval, maternal education, wealth and distance from vaccination post, positively affected immunization coverage (**Schoepsa et al., 2013; Rahman and Obaida-Nasrin, 2010**).

5.4 Impacts of dietary supplements on the symptoms of common cold:

In this study the symptoms of common cold such as cough sore throat, running nose, fever, muscle pain and fatigue was statistically significant with the supplement treatments. Meanwhile, there was no significant association among headache, diarrhea, air respiratory index (ARI), chronic pain and physical disability with dietary supplementation. The use probiotics in different disease conditions have been investigated widely for health benefits but a limited number of studies have shown that prophylactic administration of probiotics can contribute to reduced incidence of common cold and flu in healthy subjects. One of the first such studies investigated the effects of natural yogurt on children's health status as well as the incidence rate of common cold and flu. The incidence rate of different symptoms of common cold in group 1 was lower after the combined treatment. Regarding the potential mechanisms through which the reductions in respiratory symptoms could be explained, an immune enhancing effect is a likely explanation, because numerous studies with various probiotics bacteria have demonstrated their ability to modulate immune responses

through interactions with toll-like receptors (**Gueimond and Salminen, 2006; Isolauri et al., 2002; Shi and Walker, 2004**). Another study showed that a probiotic combination combined with vitamins and minerals reduced the duration and severity of common cold symptoms and also enhanced cellular immunity (**Winkler et al., 2005**). The result of this study revealed that vitamin C supplementation has influence on the incidence of common cold symptoms in young children. The most recent Cochrane review on vitamin C and colds examined 29 placebo-controlled trials that supplemented at least 200 mg vitamin C daily and concluded that vitamin C did not reduce the incidence of colds in the general population; however, in stressed populations, such as marathon runners and soldiers, cold incidence was reduced 52% (**Hemila and Chalker, 2013**). Furthermore, the review showed that the duration of colds was shortened significantly, 8% and 14% for adults and children respectively. However, some of the systematic reviews on vitamin C and the common cold study did not find out any relation between vitamin C consumption with the reduction of incidence of common cold but studies were concluded that vitamin C supplementation is associated with reduced severity and duration of colds (**Heimer et al., 200; Heuser and Vojdani,1997**). A specific anti-cold mechanism of vitamin C has not been elucidated but may relate to immune-enhancement orchestrated by vitamin C such as improved natural killer cell activities or improved lymphocyte proliferation or chemotaxis (**Boxer et al., 1979; Anderson et al., 1980**). Although cold duration was impacted by vitamin C supplementation in the present trial, vitamin C did not reduce cold symptom severity as has been reported in the systematic reviews. Both the antioxidant and antihistamine properties of vitamin C have been implicated in cold symptom relief since oxidative stress and histamine contribute to cold severity (**Garofalo et al., 2013; Johnston, 1996**). Millions of people throughout the world may have inadequate levels of zinc in their diet due to limited access to zinc-rich foods (animal products, oysters and shellfish) and the abundance of zinc inhibitors such as phytate, common in plant-based diets. Zinc is a key component of the cell architecture and is required for the production of over 200 enzymes including phosphatase, metalloproteinases, oxidoreductase, and transferase which are involved in protein synthesis, nucleic acid metabolism, and immune function. Zinc deficiency is common in young children in the developing countries and is associated with reduced immune competence and increased rates of serious infectious diseases. Several studies have shown that zinc supplementation has a positive influence on linear, motor development and weight gain (**Lira et al., 1998; Prasad et al., 2008**).

This prospective study found that supplementation with zinc was associated with a decrease in the average occurrence of common cold during cold months of year, among children living in Chattogram city corporation area with low socioeconomic status. However, previous trials failed to show a beneficial effect of zinc for treatment of common cold, perhaps because inadequate doses or inappropriate formulations of zinc were used, resulting in lack of bioavailable zinc(**Douglas et al., 1987; Maknin et al., 1998**). Retrospective chart analysis study by McElroy and coworkers provides strong support for the beneficial effects of zinc in school-aged subjects with common cold. They concluded that treatment with zinc can reduce duration of cold signs and symptoms and the need for antibiotics, and prophylaxis may decrease the incidence of colds. Hulisz showed that zinc administration within 24 hours of the onset of common cold may reduce the duration and severity of symptoms of common cold (**Hulisz, 2004; Diaz–Gomez et al., 2003**). The outcome of this study manifested that the combined supplementation of vitamin C, yogurt and zinc had higher effectiveness on the reduction of symptoms of common cold. This result is in line with the results from the general literature where they also obtained that the combined effect of two or three supplements were highly effective on common cold than separately incorporated (**Singh and Das, 2011; Douglas et al., 2007**). The functional interdependence of vitamin C, yogurt and zinc and their complementary roles in immune support, resistance to infectious diseases and health maintenance indicate that there is a strong rationale for using them in combination. Vitamin C and zinc hold central positions among the micronutrients required to ensure proper immune function (**Maggini et al., 2010**). The frequency of the common cold, coupled with the related social and economic costs and the limited treatment options, supplementation with vitamin C and zinc may represent an efficacious measure, with a good safety profile, to help ameliorate the symptoms of this infectious viral disease.

5.5 Impacts of dietary diversity score on the symptoms of common cold:

The bivariate analysis findings of this study depicted that dietary diversity score had no significant effects on the incidence of the common cold symptoms. There are very few reports directly relating child dietary diversity with common cold symptoms incidence, as assessed in this study. Analysis of the NHANES (National Health and

Nutrition Examination Survey) database, a database that assesses the health and nutritional status of adults and children in the United States, revealed an association between low fiber intake and lower lung function, and increased dietary fiber intake has been associated with a 40–50% decrease in respiratory-related deaths (**Chuang et al., 2012; Park et al., 2011**). Moreover, one study demonstrated that intake of a soluble fiber–containing meal decreases airway inflammation (sputum) and improves lung function in subjects with asthma (**Halnes et al., 2017**). Adequate and appropriate nutrition is required for all cells to function optimally and this includes the cells in the immune system. An "activated" immune system further increases the demand for energy during periods of infection, with greater basal energy expenditure during fever for example. Thus, optimal nutrition for the best immunological outcomes would be nutrition a dietary diversity, which supports the functions of immune cells allowing them to initiate effective responses against pathogens but also to resolve the response rapidly when necessary and to avoid any underlying chronic inflammation. The immune system's demands for energy and nutrients can be met from exogenous sources i.e., the diet, or if dietary sources are inadequate, from endogenous sources such as body stores. Some micronutrients and dietary components have very specific roles in the development and maintenance of an effective immune system throughout the life course or in reducing chronic inflammation. For example, the amino acid arginine is essential for the generation of nitric oxide by macrophages, and the micronutrients vitamin A and zinc regulate cell division and so are essential for a successful proliferative response within the immune system.

Chapter 6

Limitations of the study

This study has limitations; first limitation is the coexistence of COVID-19 pandemic during the collection of the data that impaired the data collection as well as to reach the all classes of people. The study is also limited by the small sample size. A common cold episode was arbitrarily defined in this report and these data may not be easily compared between reports. By design, this study was conducted in winter months and included only low income family's school going children hence, generalize ability of these results can only be extended to similar populations and season. The limitation is that we cannot generalize the data and results to the national level because the sample of patients was limited only to one region in Bangladesh. However, a large sample, good response rate and concordance with the results of other studies assure the validity of this result, which should be replicated in further studies.

Chapter 7

Conclusions

The data of this study suggest that daily supplementation of yogurt, vitamin C and zinc have pivotal role to reduce the onset of common cold in school going children which is major problem among children in developing countries like Bangladesh. The combined supplementation is more effective than separate approaches so it would be better for children to reduce the incidence of common cold supplements two or three supplementation during winter or rainy season. This simple dietary supplementation improves the immunity and promotes the health status of school going children. It also reduces the family budget for health related issues as well as relieves the mental pressure of parents.

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Annex 1: Questionnaire form

Participant Consent Form

My name is Suraiya and I am a student of Chattogram Veterinary and Animal Sciences University. I am conducting a qualitative research study on "**Effects of Dietary Supplementation of Pro-biotic Food, Vitamin C and Zinc on Influenza-like Illness Among Young Children**." The purposes of this study are to evaluate the preventive role of probiotics, vitamin C, and zinc in flu. You and your child's participation in the study will involve an interview with an estimated length of 5 minutes to 10 minutes. This study poses little to no risk to its participants. I will do my best to ensure that confidentiality is maintained by not citing your actual name within the actual study.
By signing below you agree that you have read and understood the above information and would be interested in participating in this study.

Signature of data collector	Signature of the Guardian

Group: **Yogurt/Vitamin C /Zinc/Combined/Placebo**

Socio-demographic Information

Starting Date:

Name of the Participant:

Age: Gender: Number of Family members:

Occupation of Father: ☐ Day Labor ☐Jobholder ☐ Businessman ☐ Farmer

Level of father's education: ☐Up to grade 6 ☐Up to grade 10 ☐ above grade 10
Occupation of Mother: ☐Housewife ☐ Jobholder

Level of mother's education: ☐Up to grade 6 ☐Up to grade 10 ☐ above grade 10
Income of the parents:

Nutritional Status

Height: Wight: BMI:

Immunization status: ☐Fully ☐Partially

Child's Health Status

Cough: ☐Yes☐No If yes the frequency of cough-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Sore throat: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Running nose: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Fever: ☐ Yes ☐ No If yes frequency of fever-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Headache: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Muscular pain: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Diarrhea: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

ARI: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Worm infestation: ☐Yes ☐No If yes the frequency-

1	2	3	4
Null	Mild	Troublesome	Incapacitating

Childs total screen time: ☐ ≤ 6hr ☐ 6-12hr ☐ ≥12hr

Medicine intake for influenza: ☐ Yes ☐ No

Fatigue: ☐Yes ☐No

Chronic pain: ☐Yes ☐No

Physical disability: ☐Yes ☐No

Dietary Diversity Score

Question Number	Food group	Examples	YES=1 NO=0
1	Cereals	Corn/maize, rice, wheat or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)	
2	Roots and Tubers	Potatoes or other foods made from roots	
3	Vegetables And Tubers	Pumpkin, carrot, squash, or sweet potato that are orange inside + *other locally available vitamin A rich vegetables*	
4	Fruits	Ripe mango, ripe papaya, dried peach *other locally available vitamin A rich fruits*	
5	Meat	Beef, lamb, goat ,chicken, duck	
6	Eggs	Eggs from chicken, duck	
7	Fish and Seafood	Fresh or dried fish or shellfish	
8	Legumes, Nuts and Seeds	Dried beans, dried peas, lentils, nuts, seeds or foods made from these	
9	Milk and Milk Products	Milk, cheese	
10	Oils and Fats	Oil, fats or butter added to food or used for cooking	
11	Sweets	Sugar, honey, sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	
12	Miscellaneous		

DSS= Sum of values/Total no of participants

=

=

Annex 2: Photo Album

Photos: Dietary supplementation & Data collection

Brief Biography

Suraiya Akhter Chowdhury, daughter of MD Anwarul Islam Chowdhury and Shamsun Nahar Chowdhury passed the Secondary School Certificate Examination in 2011 with grade 5.00 and then Higher Secondary School Certificate Examination in 2013 with grade 5.00. Suraiya Akhter Chowdhury obtained her B.Sc. (Hons.) in Food Science & Technology in 2018 from Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh with grade 3.74. Now, she is a candidate for the degree of M.S in Applied Human Nutrition and Dietetics under the Department of Applied Food Science and Nutrition, Faculty of Food Science and Technology, Chattogram Veterinary and Animal Sciences University (CVASU). She has immense interest to invent new things in Bangladesh for developing the country.