Vitamin-D status among adolescent attending in the Out Patient Department of Selected Tertiary Hospitals in Bangladesh

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A dissertation submitted to the University of Dhaka for the partial fulfillment of the requirement for the degree of Master of Philosophy in Nutrition and Food Science

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CERTIFICATE

This is to certify that the thesis entitled "**Vitamin-D status among adolescent attending in the Out Patient Department of Selected Tertiary Hospitals in Bangladesh"** has been completed sincerely and satisfactorily bySanni Jaiswal for the partial fulfillment of the requirement for the degree of Master of Philosophy (M.Phil) inNutrition and Food Science from the Institute of Nutrition and Food Science, University of Dhaka-1000,Bangladesh.

The Thesis has been supervised by us and can be submitted to the committee for evaluation.

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March, 2024

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ABSTRACT

Context/Background:

Lack of vitamin D is a global issue that has been linked to a number of health problems. In Bangladesh, it is quite prevalent in all age categories, but it is particularly prevalent in children and adolescents of both sexes. Since vitamin D is produced by cutaneous synthesis when exposed to plenty of sunlight, the incidence of vitamin D insufficiency in Bangladesh is often disregarded. The objective of the current study was to assess the vitamin D status of adolescents attending in the outpatient department (OPD) of selected tertiary hospitals in Bangladesh, as well as the relationship between vitamin D status and dietary habits and socio-demographic traits.

Techniques/Methods

Two chosen hospitals' outpatient departments recruited adolescents (10–19 years old) for a cross-sectional survey. The study employed convenience sampling of 384 adolescents who came to these hospitals and their medical reports were available at the hospital. Vitamin D status was evaluated based on the medical reports. Alongside, dietary habits were recorded using the Food Frequency Questionnaire (FFQ). A multinomial logistic regression model was built to determine the predictors of the participants' vitamin D status.

Results:

More than 58% of the respondents were younger adolescents (aged 10-14 years) and around two-thirds were girls. It was discovered that 36.7% of the adolescents had inadequate amounts of vitamin D, and 32% were vitamin D deficient. Deficiency level was significantly higher among older adolescents (15-19 years of age). Girls were significantly more deficient 36.2% than boys 24.6%. In addition to other socio-demographic factors, mothers with low-paying jobs, mothers whose education level was primary/below or no institutional education, families with lower incomes, etc., had higher prevalence of vitamin D deficiency. Regarding dietary habits, the study found that respondents who regularly consumed foods high in vitamin D i.e. beef, fatty fish, egg, dairy, fortified oils, nuts, fruits and vegetables, Horlicks had lower rate of vitamin D deficiency. A multinomial logistic regression analysis showed

that the occupation level of the mother (service holder), the less frequent consumption of beef, dairy, fortified oil, and Horlicks (a nutritional supplement drink) as significant predictors for vitamin D deficiency.

Conclusion: The present study found a positive impact of consumptionof certain vitamin D-rich food items (beef, dairy, fortified oil, and Horlicks) on vitamin D levels of adolescents. Adolescents who consumed these items frequently had a lower risk of vitamin D deficiency than those who did so occasionally or never. Therefore, if any awareness programs or campaigns could be conducted for both parents and adolescents, it might be beneficial for reducing vitamin D deficiency. Additionally, if it's feasible, more study can be done to fortify food with vitamin D through further research.

Key words: Adolescents, Vitamin D, Serum 25(OH) D, Socio-demographics, Dietary habits, Bangladesh.

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ABBREVIATIONS

VDD	Vitamin D deficiency
25(OH) D	25-Hydroxyvitamin D
S-25OHD	Serum 25-Hydroxyvitamin D
1,25(OH)2 D	1,25-dihydroxyvitamin D
UV	Ultraviolet
7DHC	7-dehydrocholesterol
MED	Minimal Erythema Dose
Vitamin D2	Ergocalciferol
Vitamin D3	Cholecalciferol
IU	International Unit
IOM	Institute of Medicine
HFLVD	"high-fat low-vegetable DP"
HEI	Healthy Eating Index
NMS	National Micronutrients Survey
OR	Odds ratio
AOR	Adjusted odds ratio
FAO	Food and Agriculture Organization
WHO	World Health Organization
DP	Dietary Patterns
FFQ	Food Frequency Questionnaire
EAR	Estimated Average Requirement
CLIA	Chemiluminescence immunoassay
ECLIA	Electrochemiluminescence immunoassay
RIA	Radioimmunoassay
ELISA	Enzyme-linked immunosorbent assay
LC-MS	Liquid chromatography with mass spectrometry
HPLC	High-performance liquid chromatography
HPLC-UV	High-performance liquid chromatography with ultraviolet detection

CHAPTER – I

INTRODUCTION

1. Introduction

1.1 Background

"The Sunshine Vitamin" is the moniker given to vitamin D. For most humans, exposure to solar radiation is the primary source of vitamin D. When exposed to ultraviolet (UV) radiation, the process of photo isomerization of 7-dehydrocholesterol (7DHC) in human skin produces pre-vitamin D3 [1]. Consuming 20,000 IU of vitamin D is equivalent to getting the amount of sunlight exposure necessary it cause a mild pinkish tint on the skin after 24 hours (1MED) [2]. One of the most common micronutrient deficits in children and adults globally is vitamin D insufficiency (VDD) [3].

Seldom found foods that naturally contain vitamin D include milk, cereal, orange juice, yoghurt, margarine, shitake mushrooms, tuna, salmon, sardines, tuna, and hardboiled eggs. However, those don't meet adults' and children's needs for vitamin D [3]. In children, vitamin D deficiency can lead to rickets, but this is just the tip of the vitamin D deficiency iceberg. In addition to osteoblasts, the small intestine, colon, activated T and B lymphocytes, B islet cells, mononuclear cells, and the majority of human organs, including the brain, heart, skin, gonads, prostate, and breast, vitamin D receptors are present in these tissues [4].

Bangladesh, a small nation in South Asia with a total size of 147,570 km2, is home to 163 million people, making it the eighth most densely populated nation worldwide. It is situated in an area with a tropical to subtropical climate that has enough UV radiation (290–315 nm) and spans latitudes 200°43′ to 260°36′N and longitudes 880°3′ to 920°40′E. It was therefore long believed that Bangladeshis have sufficient amounts of vitamin D. Nevertheless, despite Bangladesh's abundance of sunshine, a few previous studies consistently shown that vitamin D insufficiency are a quiet epidemic [5].

Just twenty years ago, there was a dearth of research on vitamin D insufficiency in various population groups in Bangladesh. The last several years have seen a rise in interest in vitamin D deficiency and insufficiency as a possible public health concern and a significant field of study. Numerous factors, including as age, the amount of time spent in the sun, the area of skin exposed, the time of day, latitude, atmospheric pollution, season, clothing, melanin pigmentation, use of sunscreen, use of supplements, food, and heredity, are associated with

low levels of vitamin D [6].

A global issue, vitamin D insufficiency is linked to a number of negative health effects. All age groups in Bangladesh are affected by vitamin D deficiency, although adolescents and children of both sexes are more likely to be susceptible from it. One billion individuals worldwide are estimated to be vitamin D deficient [7].

Any person can have the deficiency, regardless of location, ethnicity, age, gender, or socioeconomic status. The nutrient vitamin D is essential for maintaining strong bones. Research indicates that rickets and osteomalacia can result from a vitamin D deficit. Additionally, there is a clear correlation between osteoporosis and a higher risk of fractures and vitamin D deficiency. It has also been proven by researchers in this field that low vitamin D levels are linked to further skeletal repercussions, such as elevated risks of diabetes mellitus, cancer, cardiovascular disease, multiple sclerosis, and autoimmune disorders [8].

A hidden and often ignored global public health concern these days is vitamin D insufficiency. Worldwide, over one billion individuals experience insufficiency or deficit in vitamin D [6]. It's a common misconception that vitamin D deficiency only affects people in western countries, but the reality is far different. Previous hypotheses proposed that hypovitaminosis D is less common in tropical countries because sun exposure increases the synthesis of vitamin D on the skin. Surprisingly, nevertheless, 80% of the population who appears healthy is deficient in vitamin D (<20 ng/mL), whereas up to 40% of people in South Asia suffer from severe deficiency (<10 ng/mL) [9].

Many variables have been linked to vitamin D insufficiency, including an indoor lifestyle, inadequate solar exposure, air pollution, skin tone, the mother's educational background, and the mother and child's clothing choices. Lack of vitamin D is another effect of exclusively breastfeeding an infant [10] [11] [12].

Since it's important for children to grow and develop properly, nutrition is essential. Tragically, a child's diet alone cannot provide them with adequate vitamin D. Rather, in order to sustain adequate amounts of vitamin D, children, like adults, need to rely on sunshine and supplements. Even in areas with plenty of sunlight, vitamin D deficiency is now recognized as a sign of lifestyle disorders in the general public. Because of their extended school days and lack of exercise and physical activity, they are not exposed to enough sunlight [13].

Blood 25(OH)D is a commonly used indicator of vitamin D nutritional status because it can represent both dietary intake and endogenous production of vitamin D in the skin [14].

Research have indicated that certain foods high in vitamin D can considerably increase serum 25(OH)D concentrations [15] [16]; whereas other research have not demonstrated that vitamin D intake has a significant effect on serum 25(OH)D concentrations [17]. The main source of circulating plasma 25(OH)D is ultraviolet (UV) radiation [18]. But because they wear sunscreen lotion more frequently, spend more time indoors, and are advised against sun exposure, children and adolescents are more likely to be exposed to low vitamin D status [19]. Thus, whether or not there is a reduction in sun exposure, diet may have a big impact on the amount of serum 25(OH) D in the blood.

1.2 RATIONALE OF THE STUDY

Despite the abundance of sunlight in Northern Pakistan, Siddiqui and Rai; 2005 [20] reported that rickets was a widespread issue among infants and children because of prenatal causes, malnutrition, and a lack of awareness [20].

The high frequency of the sunshine vitamin insufficiency in the region of South Asia attributed to traditional clothes and skin colouring. Additionally, the metropolitan population's low levels of outdoor activity and air pollution are to blame for this [21]. Because of its large diet of marine seafood, Japan has a considerably superior vitamin D status than other parts of South Asia [22].

In America, vitamin D deficiency was more common in children aged 6 to 11 (73%) than in children aged 1 to 5 (63%); in females (71%) than in boys (67%); and in non-Hispanic black (92%) and Hispanic (80%) children as opposed to non-Hispanic white children (59%) [23].

Numerous investigations have assessed how often it is to be inadequate in or lacking in vitamin D adolescents, revealing a significant worldwide frequency of vitamin D insufficiency [24] [25]. As this was true even in nations where sunlight is plentiful, which is essential for the creation of endogenous vitamin D. For instance, studies on vitamin D deficiency's frequency in adolescents indicated that it had been 85%–98% in India [26] [27] and approximately 96% in Saudi Arabia [57 28]. Data on vitamin D levels in paediatric and adolescent populations are scarce in Arab states in the Gulf or the larger Middle East. Significant methodological flaws plagued the few research that reported a high occurrence of vitamin D insufficiency in teenagers [28] [29] [30].

Other research indicates that between 30% and 50% of children in Australia, Turkey, India, and Lebanon may be vitamin D insufficient [31] [32] [33].

It's anticipated that Bangladesh is susceptible to rickets and other health effects connected to a deficit of vitamin D according to all these reports from other Asian countries.

The availability of vitamin D deficiency in Bangladesh was often disregarded because as it was thought to pose little danger because of the capacity of the skin to produce vitamin D when exposed as to plenty that of sunlight. A recent study discovered that, similar to other places, children in Bangladesh possessed a significant frequency of inadequate vitamin D (80.0%) [34].

Published evidence, however, pertaining to the evaluation of vitamin D levels among adolescents within Bangladesh is still scarce. The current investigation aimed as to evaluate the vitamin D status among adolescent attending into the outpatient department (OPD) of selected tertiary hospitals in Bangladesh as well as evaluate its association with socio-demographic characteristics and dietary habits.

CHAPTER – II

LETERATURE REVIEW

2. Literature Review

The pandemic status of vitamin D inadequacy is being recognized more and more. The primary cause of vitamin D deficiency is a lack of awareness that the majority of people get their vitamin D mostly from modest sun exposure. For healthy growth and the accretion of bone mineral during adolescence, an ideal vitamin D level is crucial. Because there are few natural sources of vitamin D, most people on the planet do not get enough of it. Thus, in the twenty-first century, vitamin D insufficiency has garnered a lot of attention [35]. On a global basis between 30% and 50% of people lack enough vitamin D [36].

SOURCES OF VITAMIN D

There are two varieties of vitamin D: D2 and D3. The skin manufactures vitamin D3 following exposure to UVB rays from sunshine. Roughly 90% of the entire amount of vitamin D3 consumed comes from this source [37]. The sole difference between the two forms' sterol structures is their side chain [38]. The prevailing consensus is that vitamin D2 and D3 have comparable relative potencies [39] [40]. But according to recent findings, vitamin D3 may work far more effective at raising serum 25(OH)D than vitamin D2 concentrations [41] [42].

The skin's endogenous production of vitamin D3, which accounts for around 90% of blood 25 (OH)D concentrations, is a major source of vitamin D [18]. Two more substantial means of getting vitamin D are supplements and foods that have been fortified. There are quite a number of naturally occurring foods that contain vitamin D. fatty fish, such as salmon, sardines, and tuna [18], as well as fresh or sun-dried shiitake mushrooms, are examples of natural sources [6]. Foods such as milk, orange juice, yoghurts, cheeses, butter, margarine, infant formulae, and breakfast cereals are examples of fortified foods [6] (**Figure 1**). Nutritional supplement sources can be obtained over-the-counter or with a prescription in the US. They may be purchased in a variety of forms and dosages [6].

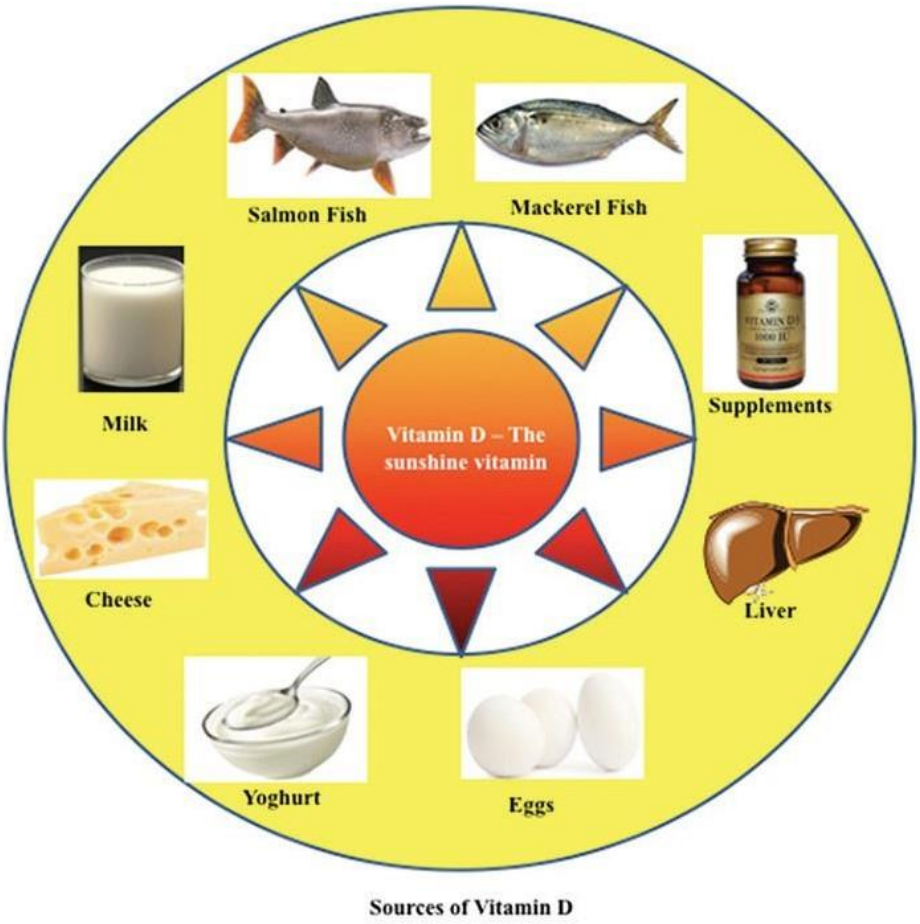


Figure 1 Sources of Vitamin D (Adapted from Wadhwa, et al, August 2018 [77])

VITAMIN D PRODUCTION AND METABOLISM

Ergocalciferol, or vitamin D2, and cholecalciferol, or vitamin D3, are the two forms of vitamin D. Ergosterol, a naturally occurring sterol, is the source of vitamin D2, whereas UV light exposure causes skin cells to produce vitamin D3 from 7-dehydrocholesterol. While vitamin D2 metabolises from ergosterol to 25(OH)D in the liver and subsequently to 1,25(OH)2D in the kidneys, vitamin D3 metabolises in two non-catalytic steps, depending on skin pigmentation and UV light exposure, to 25-hydroxyvitamin D (25OHD) and then to 1,25-dihydroxyvitamin D (1,25(OH)2D), which is a hormonal form and enhances intestinal calcium absorption [43] as shown in **Figure 2**. Melanin in skin cells prevents UV radiation from interfering with the synthesis process, thereby limiting the amount of Vitamin D3 produced. Therefore, using sunscreen and dressing in full sleeves helps reduce its formation. The brain, colon, prostate, breast, and macrophages are among the body tissues that possess an enzyme that facilitates the synthesis of 1, 25(OH) 2 D [44]. 1, 25 (OH) 2 D production

participates in cellular differentiation and proliferation and reduces the risk of a subsequent malignant cell transformation in non-calcium-regulating tissues [45].

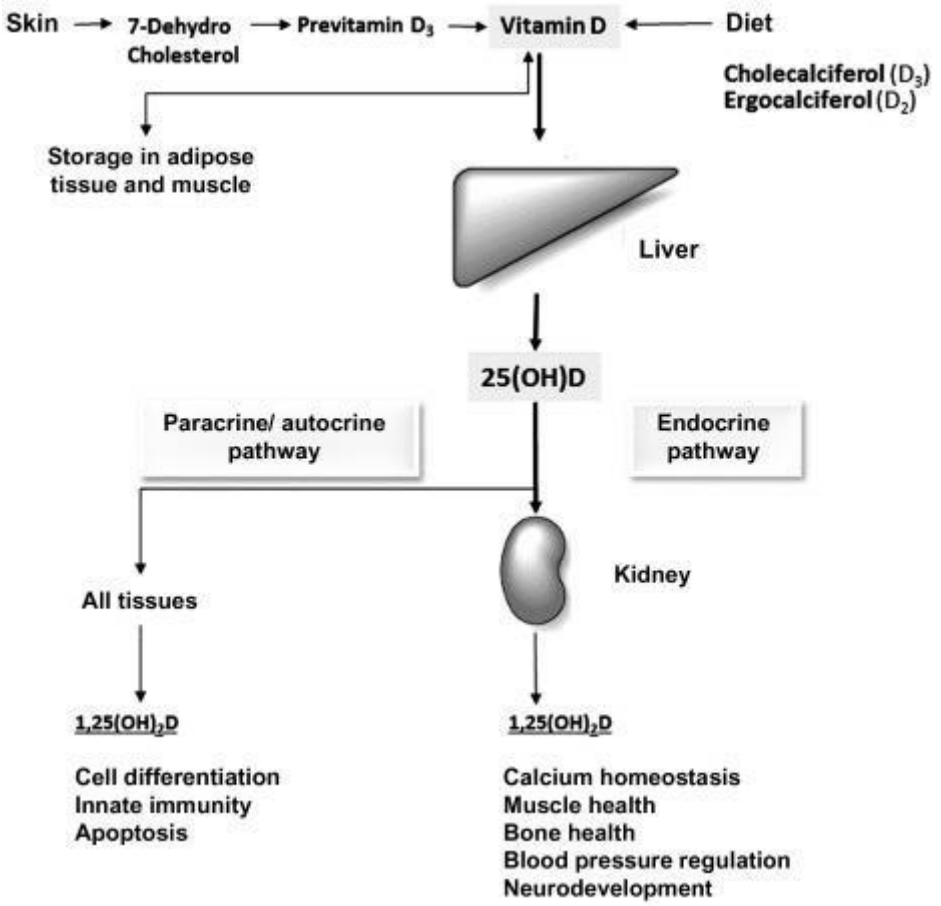


Figure 2 Schematic diagrams of vitamin D production and metabolism

THE SYMPTOMS AND EFFECTS OF VITAMIN D DEFICIENCY ON HEALTH

Table 1 illustrates the various disorders that might arise in different age groups and genders due to inadequate or deficient amounts of Vitamin D. Sunlight and rich foods fortified with vitamin D are both necessary for maintaining the body's healthy levels of vitamin D. Natural sources alone are insufficient.

Everyone face a greater risk of vitamin D deficiency as they get older. Their skin loses its ability to synthesize enough Vitamin D as they age. Additionally, they confine themselves indoors, receiving less sunlight and consuming less animal products in their diet. As a whole, this leads to weakening, osteoporosis, musculoskeletal pain, decreased mineral density, and a higher risk of fractures and falls [46]. A range of health issues, including Type-2 diabetes, sleep difficulties, cancer, fractures, cardiovascular ailments, muscle weakness, aching joints,

and asthma, as well as the mild to severe symptoms that go along with them, have been linked to an increase in the prevalence of this deficiency recently.

TABLE 1 EFFECTS OF VITAMIN D DEFICIENCY ON HEALTH

1.	Osteoporosis and Osteopenia	**12.**	Schizophrenia
2.	Reduced bone mass	**13.**	Multiple sclerosis
3.	Rickets	**14.**	Renal failure
4.	Osteomalacia	**15.**	Depression
5.	Osteoarthritis	**16.**	Tuberculosis
6.	Rheumatoid arthritis	**17.**	Lung disease
7.	Metabolic Syndrome and Diabetes	**18.**	Liver disease
8.	Autoimmune disease	**19.**	Heart Disease
9.	Asthma	**20.**	17 variates of cancer (including breast, prostate and colon)
10.	High blood pressure	**21.**	Parkinson's Disease
11.	Obesity	**22.**	Alzheimer's Disease

VARIABLES THAT AFFECT THE STATUS OF VITAMIN D

A lack of vitamin D is connected to various factors, including age, length of sun exposure, exposed skin area, time of day, latitude, geographic location, air pollution, season, gender, race, clothing, melanin pigmentation, use of sunscreen, use of supplements, dietary habits, genetic factors, outdoor activities lifestyle, and obesity, and so forth [6]. The following section discusses some causes of a lack of vitamin D:

1. People who spend long periods of time indoors or who wear clothes that covers a lot of skin are more probable to be vitamin D deficient due to a lack of sun exposure.
2. Vegetarians are more vulnerable to vitamin D deficiency shortage since animal products including fish, egg yolks, and fish oil are key sources of Vitamin D.
3. Those with darker skin tones and higher melanin levels have a decreased capacity to produce previtamin D3. Melanin inhibits the photolysis of provitamin D3 to generate previtamin D3, competing with it, much as sunlight exposure does.

4. Given that fat cells may easily absorb vitamin D from the bloodstream since it is fat-soluble, obesity is another important factor contributing to vitamin D insufficiency [47].

DIETARY PATTERNS

Fat-soluble vitamin D is created in the skin by ultraviolet B (UVB) light exposure and is present in diet. Technically speaking, vitamin D is a class of secosteroids with paracrine and endocrine properties rather than a true vitamin. Whenever exposed to ultraviolet B (UVB) radiation from solar (wavelength: 280 to 315 nm), pre-vitamin D3, which is produced by photo converting 7-dehydrocholesterol to vitamin D3, isomerizes to become vitamin D3. The main environmental elements that affect the body's ability to synthesise vitamin D are latitude, season, time of day, ozone and clouds, surface reflectivity, and personal factors like skin type, age, clothes, and use of sunscreen creams. The FAO/WHO expert panel reports that there is an abundance of sunshine in most places in the world that are located between latitudes 420N and 420S. This is the process by which the skin naturally produces vitamin D from 7-dehydrocholesterol found in subcutaneous fat.

There are several ways in which vitamin D is not like other vitamins. The biggest difference is that vitamin D in circulation does not originate primarily from food consumption. The truth is that vitamin D is found in very few foods, including egg yolks, sun-dried mushrooms, and oily salmon. Fortified foods and beverages, such as cereals, milk, fruit drinks, and breads contain trace amounts of vitamin D. Because of this, most individuals only get very little natural vitamin D from their diet and need to spend time in the sun in order to maintain adequate blood levels.

Instead of consuming specific nutrients separately, humans consume a variety of foods [48]. This means that the effects of consuming many nutrients and foods in combination may not be adequately taken into account by the single-nutrient method [49]. Furthermore, it is frequently challenging to investigate the particular effects of each nutrient independently due to the intricate interactions among several nutrients [50]. Additionally, a dietary pattern containing numerous nutrients may have significant, detectable impacts, but the effects of any one vitamin an illness might be too little to notice [51].

Dietary pattern analysis is an alternate strategy that gets around these drawbacks and is gaining popularity. This method looks at how food and nutrients are combined, based on eating habits, to uncover dietary patterns [51]. As dietary patterns are not directly measurable,

dietary patterns are inferred statistically using dietary intake assessment data that has been gathered [51].

A multivariate statistical technique called factor or principal component analysis uses data gathered from food frequency questionnaires (FFQs) or dietary notebooks. It finds commonalities (or patterns) in food intake and offers scores that let people rank each other according to how closely they match the overall pattern [51]. One of the main advantages of this technique, according to Jacques and Tucker's editorial [50], is its "ability to summarize behavior across several variables simultaneously into a small number of orthogonal variables." One restriction they mention in the same editorial is stating that "results can be sample precise and significantly affected by subjective analytic judgement." Notwithstanding these drawbacks, the results could prove to be a useful and educational means of understanding the connection between nutrition and illness, since factor analysis has been shown to be a reliable method of establishing dietary patterns [48] [52].

METHODS FOR DETERMINATION OF VITAMIN D STATUS

Numerous researches have revealed that it’s possible that vitamin D deficiency is more prevalent than it was and has grown to be an issue for public health globally. The increasing prevalence of vitamin D deficiency thus creates a growing requirement towards 25(OH)D detection. The growing need for the 25(OH)D test has compelled clinical laboratories to extend precise techniques that are suitable for everyday readings.

25(OH)D is the sole metabolite of vitamin D that may be used to measure a patient's vitamin D status. 25(OH)D, which has a half-life of about two to three weeks, is the main form of vitamin D in circulation. The sum of all vitamin D production 25(OH)D is obtained from sun exposure and vitamin D ingestion.

Currently, an assortment of techniques based on distinct measurement principles are used for the primary 25(OH) D detection methods. These techniques include HPLC-UV stands for high-performance liquid chromatography with ultraviolet detection, and LC-MS/MS for tandem mass spectrometry and various immunoassay methods. radioimmunoassay (RIA), enzyme-linked immunosorbent assay (ELISA), chemiluminescence immunoassay (CLIA), electrochemiluminescence immunoassay (ECLIA), automated biochemical analysis, and other techniques are examples of immunoassay procedures [53].

Radioimmunoassay (RIA), enzyme-linked immunosorbent assay, high-performance liquid chromatography (HPLC), liquid chromatography coupled with mass spectrometry (LC-MS), and automated assay employing chemiluminescence immunoassay (CLIA) are a few of the frequently used alternative assays.

The status of vitamin D can be determined using HPLC and immunoassays, which measure 1, 25 (OH)2D, and 25 (OH)D. The gold standard assay technique for determining 25(OH)D levels is reportedly HPLC.

RECOMMENDATIONS AND THE STATUS OF VITAMIN D

The optimal level of vitamin D status is not yet widely defined [39]. In the past, the Institute of Medicine (IOM) and the American Academy of Paediatrics both declared that newborns and young children with a blood 25(OH)D concentration of less than 11 ng/mL (≤27.5 nmol/L) indicated vitamin D deficiency [54]. The consensus states that the thresholds for vitamin D deficiency and insufficiency are ≤20 ng/mL (≤50 nmol/L), vitamin D sufficiency is >30 ng/mL (>75 nmol/L), and insufficiency is ≤30 ng/mL (≤75 nmol/L) [6] [55] [56] [57]. Based to the IOM's most recent definition, vitamin D deficiency was defined as ≤12 ng/mL (≤30 nmol/L) and sufficiency as >20 ng/mL (>50 nmol/L) [39, 54]. For children and adolescents, the Recommended Daily Allowance (RDA) and Estimated Average Requirement (EAR) for vitamin D are 400 IU/d and 600 IU/d, respectively [39]. The committee of IOM further declared when values above 50 ng/mL (125 nmol/L) may be reason for worry and because there isn't any reliable proof to link higher advantage when blood 25(OH) D levels are more than 30 ng/mL (>75 nmol/L) [39]. Then, in July 2011, the Endocrine Society published guidelines stating that in order to elevate blood 25(OH) D levels over 30 ng/mL; infants under the age of one should get at least 600 IU and maybe up to 1000 IU/d of vitamin D [58].

VITAMIN D DEFICIENCY: PREVENTION AND TREATMENT

Amongst the main sources of D-vitamine, sunlight helps the skin create enough of the nutrient that is normally needed for the creation and strengthening of bones, as well as reducing inflammation, boosting immunity, and protecting against skin cancer.

The generation of Vitamin D in the 10–3 PM without the use of sunscreen is greatly aided by two times a week; spend ten to thirty minutes in the sun each day. Those with fair skin should be out in the sun during the cooler months [59].

Since glass windows absorb UV B rays and prevent them from reaching the skin, people should sit outside in the open air to produce vitamin D from sunlight exposure.

Additionally, sunscreen use should be avoided for 10 to 30 minutes of direct sunlight since the sun protection component in sunscreen inhibits the skin's capacity to absorb UV B radiation, which will hinder vitamin D synthesis [60].

Several naturally occurring foods high in the vitamin D include pomegranates, blueberries, as well as raspberries. Yoghurt and cheese are two examples of milk goods with a lot of vitamin D. Almond milk, a nutritious substitute for cow's milk, contain 100 IU of vitamin D. Due to their high antioxidant and necessary fat content, these meals will strengthen skin cells and guard against sun damage to the skin. Among the sources of vitamin D2 that is produced by sunlight's UV B rays, are mushrooms. Certain fish, like eels, mackerel, salmon, trout, and tuna, are particularly high in vitamin D [61].

Taking cholecalciferol, which comes in injection, capsule, tablet, and oral solution forms, can help those who are deficient in vitamin D. People need a combination of food, supplements, solar exposure, and nutrition to maintain a suitable amount of Vitamin D throughout the year [62] [63].

CHAPTER –III

RESEARCH QUESTION AND OBJECTIVE

3.1 Research Question

"What is the vitamin D status of adolescent attending the outpatient department of selected tertiary hospitals in Bangladesh, and how is it associated with their dietary pattern and socio-demographic factors?"

3.2 Objectives

Primary Goal/Objective

To ascertain the vitamin-D status level among adolescent attending in the outpatient department of selected tertiary hospitals in Bangladesh.

Particular Goals/Objectives

a. To identify the socio-demographic traits of adolescents
b. To assess the levels of serum vitamin D among adolescents who attended an OPD of selected tertiary hospitals
c. To know the dietary history of the adolescents using FFQ (Food Frequency Questionnaire)
d. To investigate the frequency of vitamin D deficiency in among adolescents who attended an OPD of selected tertiary hospitals

CHAPTER –IV

METHODOLOGY

4. Methodology

Design of study

An investigation that was cross-sectional conducted for this research.

Settings of study

The study has been carried out at two selected tertiary hospitals, and data were collected from the outpatient department of two selected Hospitals.

Population of study

The selected study population was adolescents (10–19 years of age) who attended hospitals with minor symptoms in the outpatient department.

Duration of study

Data collection took place from February 1st, 2021, to June 31st, 2023.

Sample size

The sample's composition was established using following n=z2pq/d2 formula.

Where,

n=the preferred sample size.

z=Standard normal distribution value as specified by the significance (confidence) level; typically, 1.96 at the 95% Confidence Interval

p= Prevalence value (50%) [Using Cochran's method (Equation 1), the necessary sample size was determined to be 305, taking into account Bangladesh's 28% point prevalence of stunting among children under five.]

q = 1-p = 1-0.5 = 0.5

d = Study's acceptable error of 5% (0.05)

Hence desired sample size,

n is equal to $\{(1.96)^2 \times (0.5) \times (0.5)\} / (0.05)^2 = 384.6$.

So desired sample size was 384.

A non-response rate of 10% was considered. Thus, we had to approach a total of 422 participants for the study. Finally, a total of 384 participants were interviewed in the present study.

Sampling technique

A convenience sampling technique was employed to select participants from adolescents who came to attend the hospital in the study area.

C**riteria for Inclusion**

- The adolescent (10–19 years) who came to the outpatient department of two selected hospitals with minor symptoms like fever and cough, body ache, myalgia, arthritis, difficulty walking, loss of appetite, vomiting, etc. and
- In this study, those whose levels of vitamin D in their blood were examined were included.

Criteria for Exclusion

- Those who were critically ill
- Having a long-term illness or
- Who were taken Vitamin D supplementation and
- As well as those participants, parents, careers, or attendees who failed to respond to or finish the FFQ were not included in this study.

Development of study questionnaire

Development of socio-demographic questionnaire

Participants responded to a validated vitamin D questionnaire, which included socio-demographic questionnaire and Food Frequency Questionnaires (FFQ). Demographic questions included (15 items) age, sex, height, weight, living area, religion, mother and father's educational backgrounds, their occupations, and the total earnings of the family, etc. Many more questions were also structured as closed-ended questions. For example, selection options were given for reason behind attending hospitals, educational status, occupation status, etc.

Development of Food Frequency Questionnaire (FFQ)

The frequencies of consuming foods that were naturally or enriched with vitamin D were taken into account within the FFQ to assess the dietary patterns of adolescent. A questionnaire has been developed, examined, and approved. The food frequency questionnaire included a total of 71 food items, which contained both general food items and vitamin D-rich food items. Foods were grouped similarly to those used in previous studies and classified based on the vitamin D nutritional content or culinary application. Further 39 food items were focused on as they were rich sources of vitamin D. The food items were separated under 10 different food groups like was the cereal group, pulses group, meat group, fish group, egg group, milk and milk products group, oil group, nuts group, fruits and vegetables group, and miscellaneous group, following accordingly the Food Composition Table for Bangladesh. But in **Table 2** only vitamin D rich 8 food group are shown.

Participants were questioned about how often they ingested meals, and they responded per day, week, month, or never. The response for consumption pattern was as follows: never, once a month, twice a month, once a week, 2-4 times a week, 5–6 times a week, once a day, 2-3 times a day, 4-5 times a day, and 6+ times a day. Further, it was categorized as four labels for consumption frequency (**Table 3**). Major dietary patterns were identified based on how frequently each participant consumed each of these 10 food groups.

Table 2. List of Vitamin D rich food item

Food Group	**Food item**	
Meat	Beef	
Fatty Fish	Hilsa Pangash Catla Puti Mola Mrigal Rohu Salmon	Tuna Nile tilapia Prawn Rupchada Koi mach Gura mach (Sagor Ponna)
Egg	Chicken egg with yolk Duck egg with yolk Koel egg with yolk	
Dairy	Milk (cows) Yoghurt Cheese Butter Pasteurized/UHT milk Dairy desert (custard, pudding, Firni/Payesh) Ice cream Milk shake	

Fortified oil	Teer Fortified (Vit D) Soyabean Oil Bashundhara Fortified (Vit D) Soyabean Oil Cod liver oil
Nuts	Almonds Cashews
Fruits and vegetables	Dates Raisins Fortified Orange Juice Ripe Banana Spinach Brocoli Mushroom
Miscellaneous	Horlicks

Table 3. Consumption frequency

Frequent consumption	Daily (at least one time)/ 5-6 times per week
Occasionally	2-4 times a week or once every week
Rarely	Once a month or up to three times per month
Never	Never eaten

Data collection tools

Well-structured paper versions of the questionnaire were used for data collection and were filled out by the self, participants, mother, career, or attendee who was attending with adolescent. The questionnaire covered both socio-demographic characteristics and dietary habits (including vitamin D sources) by FFQ. Participants were interviewed in the out-patient departments (OPDs) of two selected tertiary hospital to gather information on the socio-demographic characteristics and dietary patterns of adolescent. Anthropometric measurements were also taken, including height and weight. Data collection consisted of direct interviews and collected vitamin D blood sample reports from the selected hospitals for later vitamin D level measurements. Strict protocols were put in place to protect participant anonymity and data confidentiality during the research process, and written agreement was also acquired from all participants, parents, careers, or attendees.

Assessment of vitamin D status: Blood samples were not directly collected from participants for the analysis of vitamin D levels. Instead, the sample 25(OH) D report was taken from two different laboratories in different hospitals and analyzed using the automated chemiluminescence microparticle immuneassay (CMIA) method. As per their techniques, to obtain blood samples from participants in the sample collection rooms of the hospitals, veins were punctured in accordance with normal techniques.

So, there are several ways to define or classify either sufficient or insufficient for circulation 25 (OH) D. Vitamin D sufficiency was classified by the IOM as >20 ng/mL (>50 nmol/L) and vitamin D deficiency as ≤12 ng/mL (≤30 nmol/L) **(Table 4)** [39]. In this investigation, it served as the cutoff value for circulating 25(OH) D. The recommended daily allowance and estimated average requirement for vitamin D in children and adolescents, respectively, are 600 IU/d and 400 IU/d, according to these guidelines [39].

Table 4.

Segmenting Vitamin D Status Based on Blood 25-Hydroxyvitamin D		
ng/mL	**nmol/L**	**Classification**
Less than 12 ng/mL	Less than 30 nmol/L	Deficient
More than 20 ng/mL	More than 50 nmol/L	Sufficient

Statistical Analysis

The IBM SPSS (version 25) was primarily used for data analysis. Different descriptive and inferential statistics were used based on data distribution. Chi-square statistics were reported for categorical variables. This non-parametric test was chosen to find out the association of different socio-demographic characteristics and dietary pattern with vitamin D status. Multinomial logistic regression model was fitted to explore the association of various socio demographic factors and dietary habits with vitamin D status. Level of vitamin D was dependent variable categorized as: deficient, insufficient, and normal status. Socio-demographic factors and dietary habits were independent variables.

CHAPTER V

RESULTS

5. Outcomes

The following was an analysis of the study's findings:

Table 5: General characteristics of the study subjects (n = 384)

Variable	n (%)
Age category	
10-14	224 (58.3)
15-19	160 (41.7)
Sex	
Male	138 (35.9)
Female	246 (64.1)
Religion	
Muslim	344 (89.6)
Hindu	35 (9.1)
Christian	5 (1.3)
Living area	
Slum	86 (22.4)
Non-slum	298 (77.6)

Table 4 shows that among 384 respondents, there were 58.3% of those in the 10–14 year age group and 41.7% of those in the 15–19 year age group, as well as females at 64.1% and males at 35.9%. 89.6% were Muslims, 9.1% were Hindus, and 1.3% was Christians by religion. According to the living area, 77.6% belongs to the non-slum area, and 22.4% belongs to the slum area.

Figure 3. Distribution of respondents by mother's educational level (n = 384)

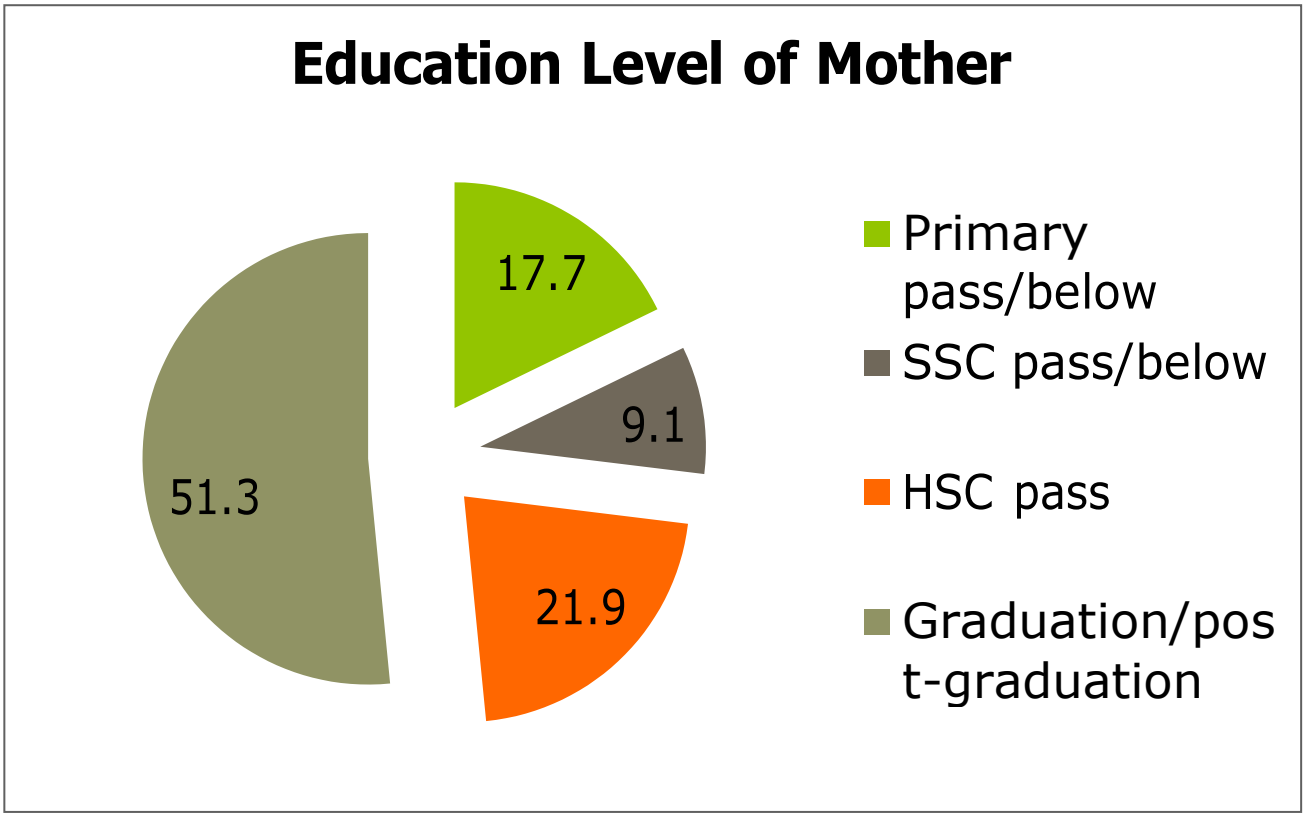


Figure 3 shows that among 384 respondents, by mother education level, 51.3% (n = 197) were graduated or post-graduated, 21.9% (n = 84) were HSC passed, 17.7% (n = 68) were primary pass/below, and 9.1% (n = 35) were SSC passed/below.

Figure 4. Distribution of respondents by father's educational level (n = 384)

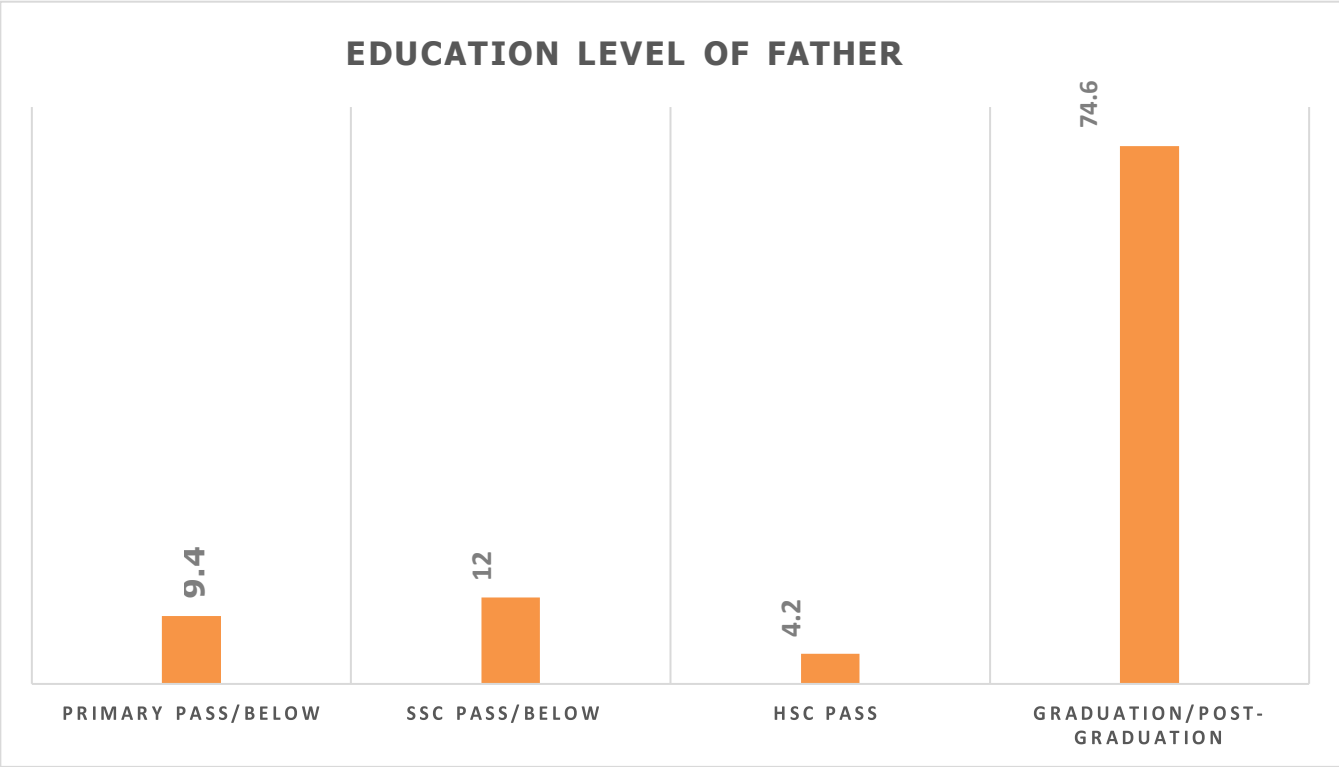


Figure 4 shows that according to father educational level, 74.6% (n = 286) were graduated or post-graduated, 12.0% (n = 46) were SSC passed or below, 9.4% (n = 36) were primary pass/below, and 4.2% (n = 16) were HSC passed.

Figure 5. Distribution of respondents by Occupation of mother (n = 384)

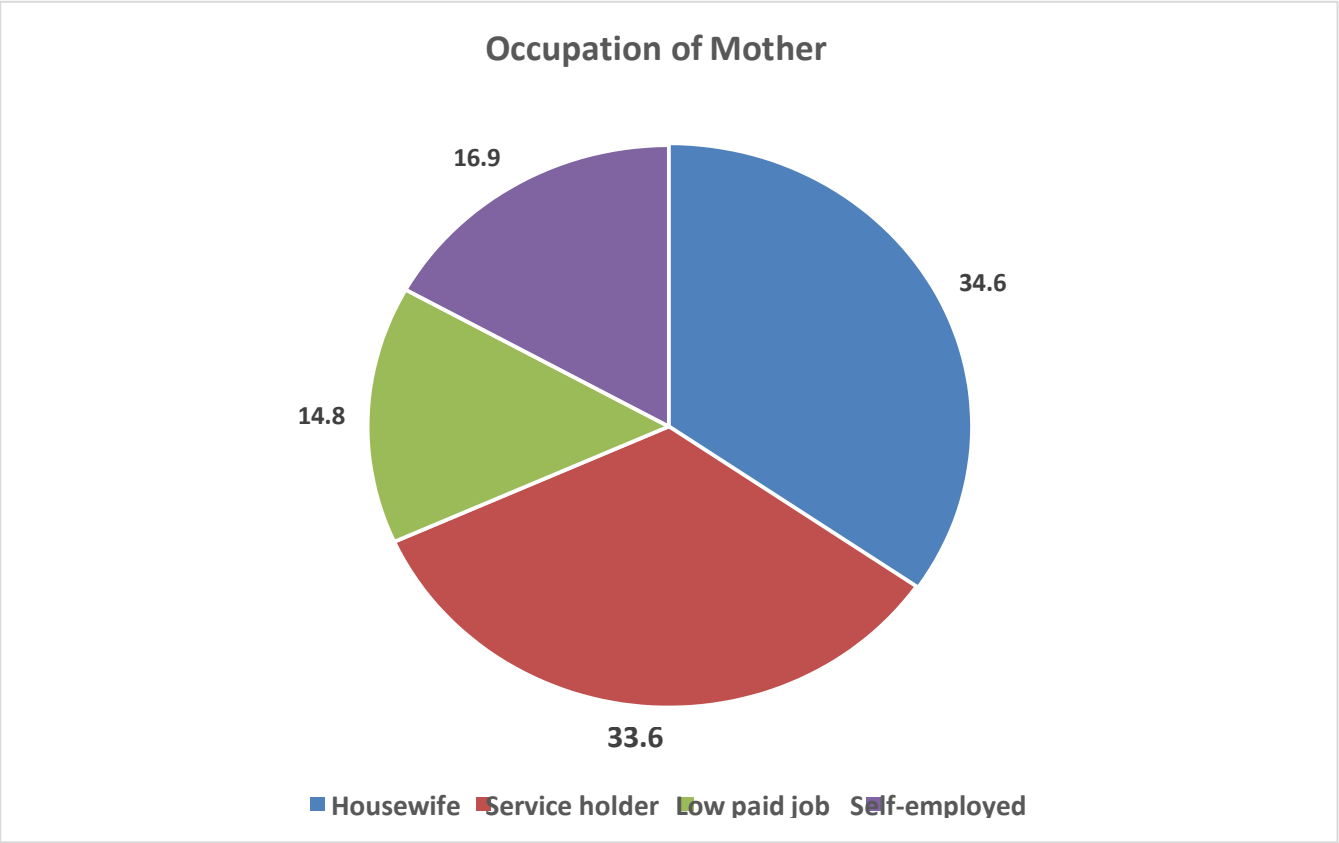


Figure 5 shows that among 384 respondents, by occupation of mother, 34.6% (n = 133) were housewives, 33.6% (n = 129) were service holders, 16.9% (n = 65) were self-employed, and 14.8% (n = 57) had a low-paid job like; Garments worker, Tailoring, Maid servant, etc.

Figure 6. Distribution of respondents by Occupation of father (n = 384)

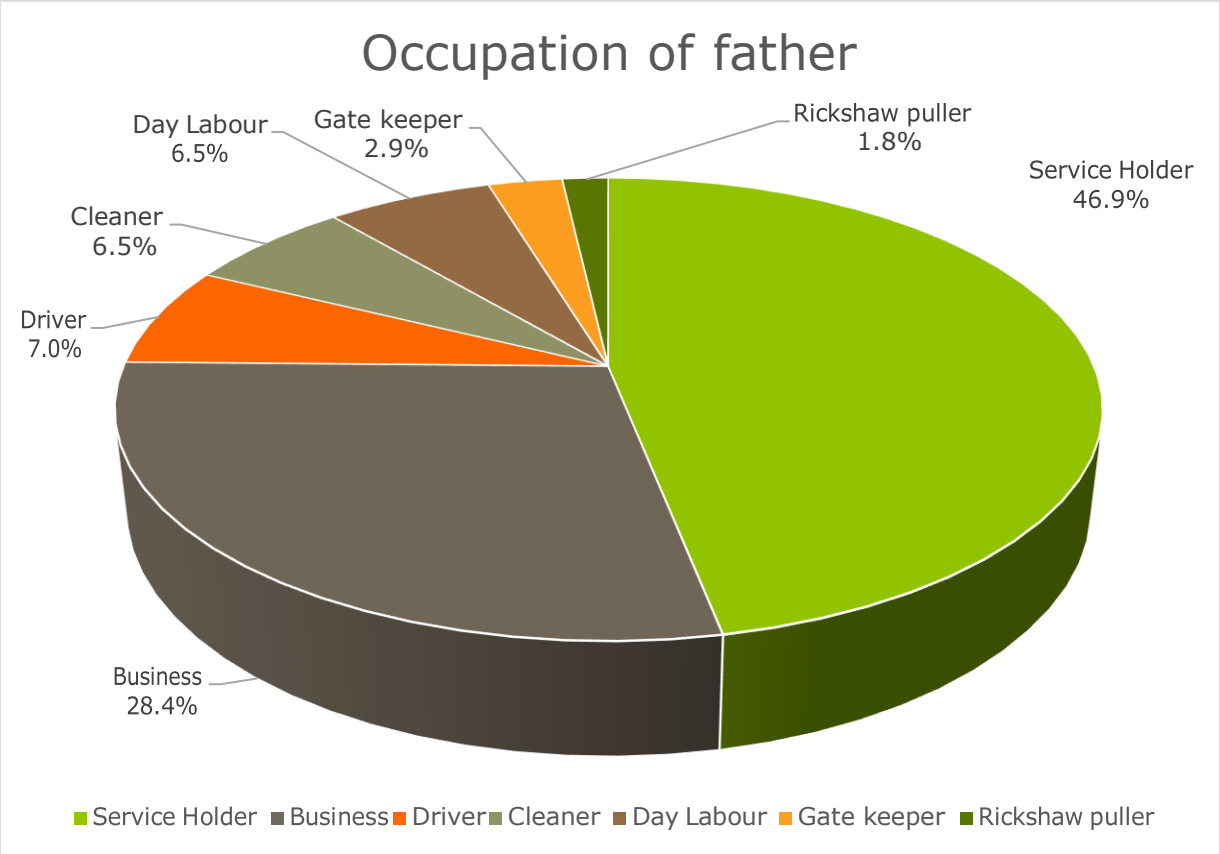


Figure 6 shows that according to father's occupation, 46.9% (n = 180) were service holders, 28.4% (n = 109) were businessmen, 7.0% (n = 27) were drivers, 6.5% (n = 25) were cleaners, 6.5% (n = 25) were day labourers, 2.9% (n = 11) were gatekeepers, and 1.8% (n = 7) were rickshaw pullers.

Figure 7 Distribution of respondents by family income (n = 384)

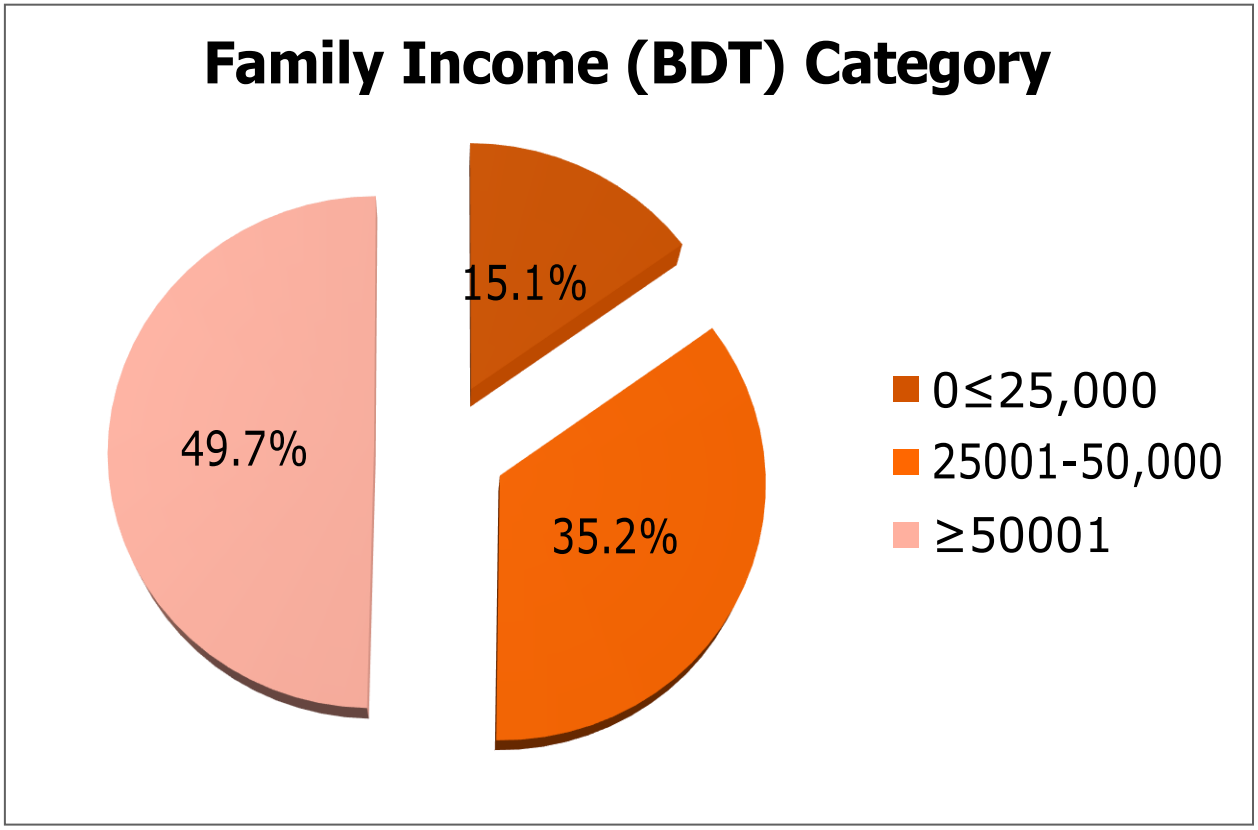


Figure 7 shows that among 384 respondents, by family income, 49.7% (n = 191) earned more than 500001 BDT, 35.2% (n = 135) earned between 250001 and 50,000 BDT, and 15.1% (n = 58) BDT earned less than 25,000 BDT taka.

Figure 8 Distribution of respondents by level of Vitamin D status (n=384)

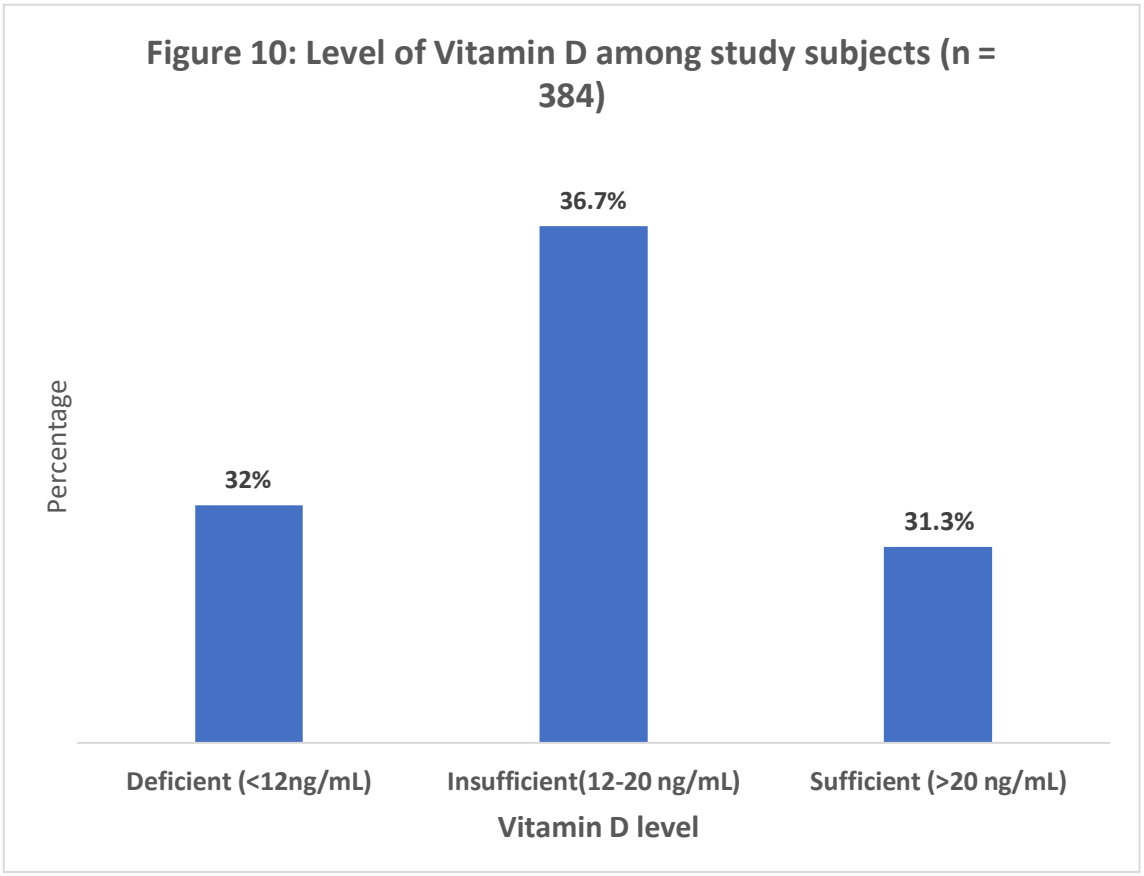


Figure 8 shows that among 384 respondents, 36.7% were insufficient, 32% were deficient, and 31.3% were sufficient in terms of vitamin D level.

Table 6: Relationship between vitamin D level and social and economic categories

Characteristics	Circulating 25OH vitamin D status			P value
	Deficient Below 12 ng/mL)	Insufficient (Between 12-20 ng/mL)	Sufficient (Above 20 ng/mL)	
Age category				
10-14	66 (29.5)	84 (37.5)	74 (33.0)	0.41
15-19	57 (35.6)	57 (35.6)	46 (28.7)	
Sex				
Male	34 (24.6)	49 (35.5)	55 (39.9)	0.012
Female	89 (36.2)	92 (37.4)	65 (26.4)	
Religion				
Muslim	116 (33.7)	121 (35.2)	107 (31.1)	0.12
Hindu	7 (20.0)	16 (45.7)	12 (34.3)	
Christian	0	4 (80.0)	1 (20.0)	
Living area				
Slum	75 (87.2)	10 (11.6)	1 (1.2)	<0.001
Non-slum	48 (16.1)	131 (44.0)	119 (39.9)	
Education level of mother				
Primary pass/below	63 (92.6)	5 (7.4)	0	<0.001
SSC pass/below	22 (62.9)	10 (28.6)	3 (8.6)	
HSC pass	15 (17.9)	52 (61.9)	17(20.2)	
Graduation/post-graduation	23 (11.7)	74 (37.6)	100 (50.8)	
Education level of father				
Primary pass/below	34 (94.4)	2 (5.6)	0	<0.001
SSC pass/below	42 (91.3)	4 (8.7)	0	
HSC pass	5 (31.3)	10 (62.5)	1 (6.3)	
Graduation/post-graduation	42 (14.7)	125 (43.7)	119 (41.6)	
Occupation of mother				
Housewife	46 (34.6)	57 (42.9)	30 (22.6)	<0.001
Service holder	9 (7.0)	57 (44.2)	63 (48.8)	
Low paid job	51 (89.5)	5 (8.8)	1 (1.8)	
Self-employed	17 (26.2)	22 (33.8)	26 (40.0)	
Occupation of father				
Service Holder	33 (18.3)	86 (47.8)	61 (33.9)	<0.001
Business	9 (8.3)	43 (39.4)	57 (52.3)	
Low paid job	81 (85.3)	12 (12.6)	2 (2.1)	
Family size				
≤3	5 (13.5)	10 (27.0)	22 (59.5)	<0.001
4	45 (23.2)	83 (42.8)	66 (34.0)	
≥5	73 (47.7)	48 (31.4)	32 (20.9)	
Family income category				
≤25,000	53 (91.4)	5 (8.6)	0	<0.001
25001-50,000	47 (34.8)	70 (51.9)	18 (13.3)	
≥50001	23 (12.0)	66 (34.6)	102 (53.4)	

* The Chi-square test's p value

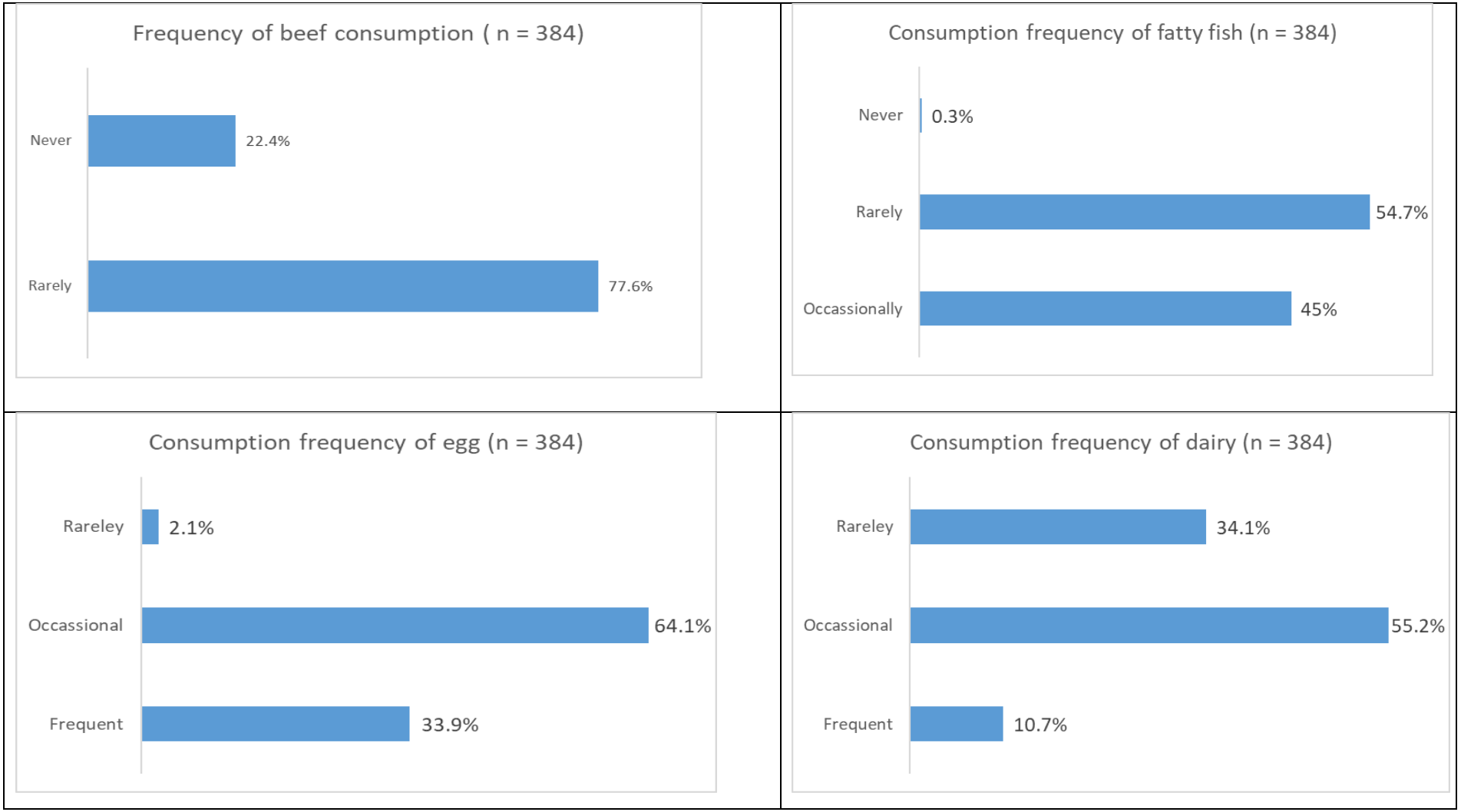
Table 6 shows the fact, among 15-19 age groups were vitamin D deficient by 35.6%, and 10-14 age groups, they were deficient by 29.5%, as the same 10-14 age groups had vitamin D sufficient by 33.0%, and 15-19 age groups were sufficient by 28.7%. Females were more deficient by 36.2% than males by 24.6%, and males had more vitamin D sufficiency by 39.9% than females by 26.4%. According to religion, Muslims were more vitamin D deficient by 33.7% than Hindus by 20.0%. In Hinduism, 34.3% had sufficient vitamin D, compared to Muslims by 31.1%. Among living areas, slum residences were more vitamin D deficient by 87.2% than non-slum residences by 16.1%, and non-slum residents had more vitamin D sufficient by 39.9% than slum residences by 1.2%.

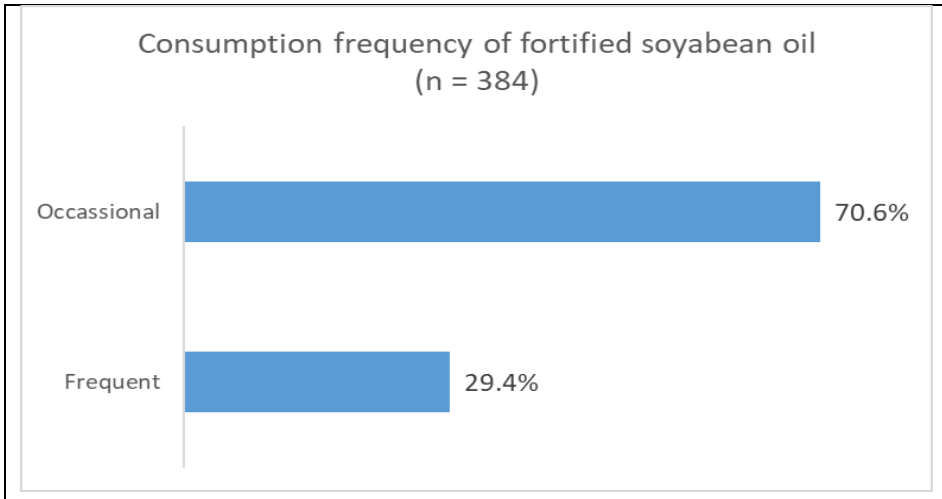
According to educational level, primary passed/below or no institutional education mothers had higher levels of vitamin D deficiency by 92.6%, 62.9% deficient in SSC passed/below mothers, 17.9% deficient in HSC passed mothers, and 11.7% deficient in graduated/post-graduated mothers, and by 50.8% had vitamin D sufficient in graduated/post-graduated mothers, 20.2% had sufficient in HSC passed mothers, and 8.6% had sufficient in SSC passed/below mothers. Among fathers who were primary passed/below no institutional education were discovered to be more vitamin D-deficient by 94.4%, 91.3% were deficient in SSC passed or below father, 31.3% were deficient in HSC passed father, 14.7% were deficient in graduated or post-graduated father, 41.6% had sufficient vitamin D in graduated or post-graduated father, and 6.3% in HSC passed father.

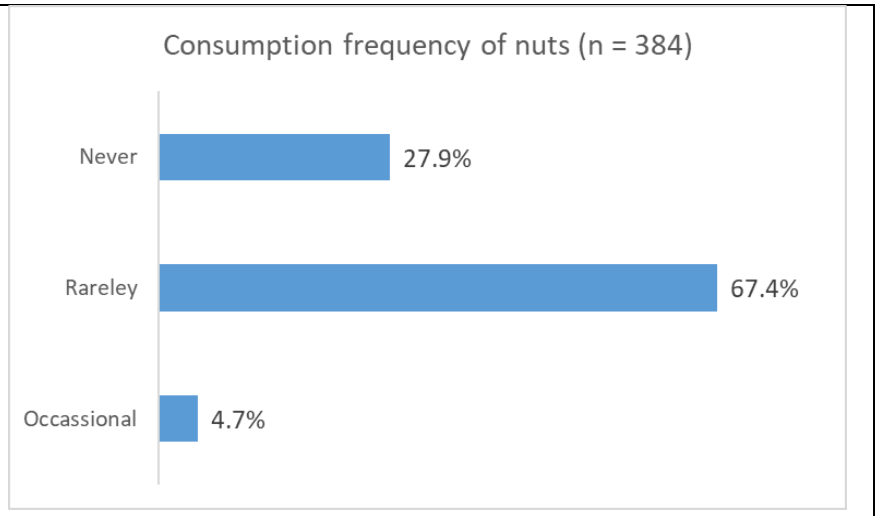
Among low-paid job mothers, 89.5% were deficient in vitamin D by occupation status; 34.6% were deficient in housewife mother; 26.2% were deficient in self-employed mother; 7.0% were deficient in service holder mother; 48.8% had sufficient vitamin D in service holder mother; 40.0% had sufficient in self-employed; 22.6% had sufficient in housewife; and 1.8%. Among low-paid job fathers, 85.3% were deficient in vitamin D, 18.3% were deficient in service-holder fathers, 8.3% were deficient in business fathers, 52.3% had sufficient vitamin D in business fathers, 33.9% had sufficient in service-holders, and 2.1% had sufficient in low-paid job fathers.

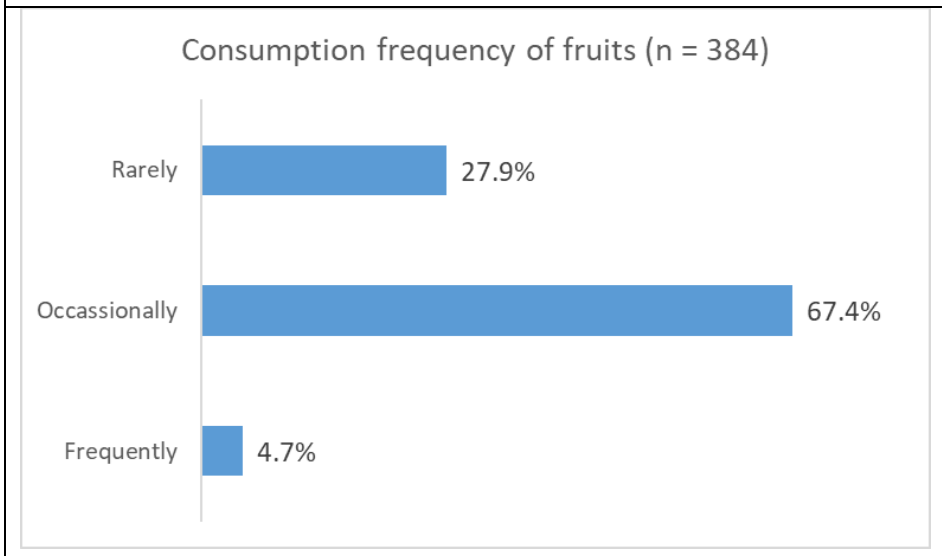
According to family income, 91.4% were vitamin D deficient and earned less than 25,000 taka per month; 34.8% were deficient and earned between 25,001 and 50,000 taka; 12% were deficient and earned more than 50,001 taka per month; 53.4% had sufficient vitamin D and earned more than 50,001 taka; and 13.3% had sufficient vitamin D and earned between 25001 and 50,000 taka per month.

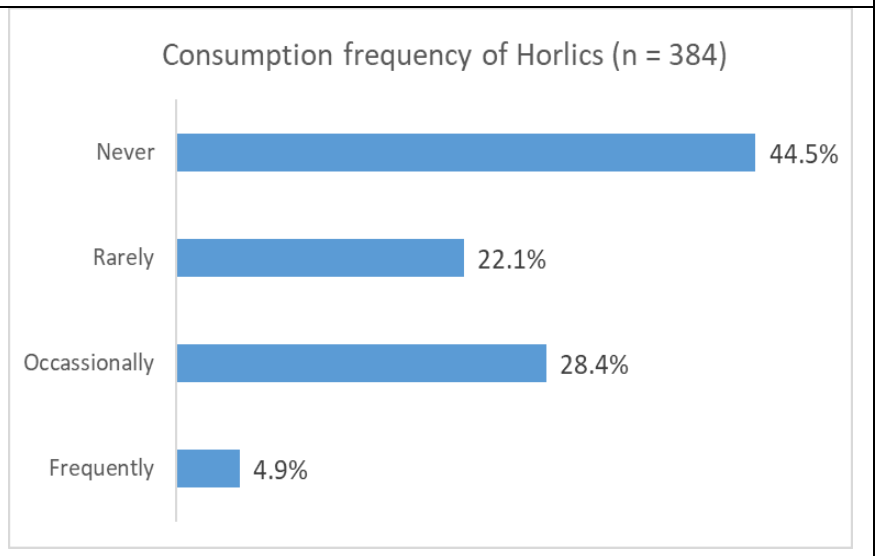
Figure 9: Frequency of Vitamin D rich food item consumption




Consumption frequency of fortified soyabean oil (n = 384)
Occassional
70.6%
Frequent
29.4%


Consumption frequency of nuts (n = 384)
Never
27.9%
Rareley
67.4%
Occassional
4.7%


Consumption frequency of fruits (n = 384)
Rarely
27.9%
Occassionally
67.4%
Frequently
4.7%


Consumption frequency of Horlics (n = 384)
Never
44.5%
Rarely
22.1%
Occassionally
28.4%
Frequently
4.9%

Out of 384 respondents, **Figure 9** reveals that 77.6% had eaten beef occasionally and 22.4% had never eaten it. Regarding fatty fish, 54.7% of respondents said they ate it rarely, 45% said they did it occasionally, and only 0.3% said they never did. Of those who ate eggs, 64.1% did so occasionally, 33.9% did so frequently, and only 2.1% did rarely. A little over 55.2% reported consuming dairy products occasionally, 34.1% reported doing it rarely, and 10.7% reported doing so frequently. Consumers of fortified soy oil reported using it frequently (29.4%) and occasionally (70.6%). Of the people who ate nuts, 67.4% consumed very rarely, 27.9% never did so, and only 4.7% had done so occasionally. With respect to fruits and vegetables, 67.4% of respondents said they ate them occasionally, 27.9% said they ate them rarely, and 4.7% said they ate them frequently. Of the Horlicks customers, 44.5% never ate Horlicks, 28.4% occasionally consumed Horlicks, 22.1% rarely consumed Horlicks, and 4.9% frequently consumed Horlicks.

Table 7: Relationship between food habits and vitamin D levels

Food item	Consumption frequency	Deficient (Less than 12 ng/mL)	Insufficient (Between 12-20 ng/mL)	Sufficient (More than 20 ng/mL)	p-value
Beef	Rarely Never	59 (19.9) 64 (74.4)	126 (42.3) 15 (17.4)	113 (37.9) 7 (8.1)	<0.001
Fatty fish	Occasionally Rarely Never	41 (23.7) 81 (30.1) 1 (100.0)	52 (30.1) 89 (42.4) 0	80 (46.2) 40 (19.0) 0	<0.001
Egg	Frequent Occasionally Rarely	15 (11.5) 100 (40.7) 8 (100.0)	37 (28.5) 104 (42.3) 0	78 (60.0) 42 (17.1) 0	<0.001
Dairy	Frequent Occasionally Rarely	4 (9.8) 46 (21.7) 73 (55.7)	2 (4.9) 89 (42.0) 50 (38.2)	35 (85.4) 77 (36.5) 8 (6.1)	<0.001
Oils	Frequent Occasionally	16 (14.2) 107 (39.6)	29 (25.6) 112 (41.3)	68 (60.2) 51 (19.2)	<0.001
Nuts	Occasionally Rarely Never	0 50 (19.3) 73 (68.2)	1 (5.6) 114 (44.0) 26 (24.3)	17 (94.4) 95 (36.7) 8 (7.5)	<0.001
Fruits and vegetables	Frequent Occasionally Rarely	13 (13.8) 57 (24.9) 53 (86.9)	20 (21.3) 114 (49.8) 7 (11.5)	61 (64.9) 58 (25.3) 1 (1.6)	<0.001
Horlicks	Frequent Occasionally Rarely Never	0 12 (11.0) 20 (23.5) 91 (53.2)	0 53 (48.3) 31 (36.5) 57 (33.3)	19 (100.0) 44 (40.4) 34 (40.0) 23 (13.5	<0.001

* The Chi-square test's p value

Table 7 demonstrates the facts 37.9% of respondents who rarely consumed beef had sufficient vitamin D, compared to 19.9% of respondents who rarely consumed beef; 8.1% of respondents who never consumed beef had sufficient vitamin D compared to 74.4% of respondents who had never consumed beef. A vitamin D deficiency of 100% was reported by those who never ate fatty fish, compared to 30.1% of those who did so rarely and 23.7% of those who did so occasionally as well as 46.2% of those who did occasionally, and 19.0% of those who did rarely had sufficient amounts of vitamin D.

Regarding how often people ate eggs, 100.0% had low vitamin D levels and rarely ate eggs, 40.7% had insufficient vitamin D levels and occasionally ate eggs also 11.5% had insufficient vitamin D levels and who frequently ate eggs, 60.0% had adequate vitamin D levels and

frequently ate eggs, and also 17.1% had a sufficient level of vitamin D and who occasionally ate eggs.

A total of 85.4% of respondents had sufficient vitamin D when they frequently consumed dairy, 36.5% had sufficient vitamin D when they occasionally consumed dairy, and also 6.1% had sufficient vitamin D when they rarely consumed dairy. Of the respondents, 55.7% were deficient when they rarely consumed dairy, 21.7% were deficient when they occasionally consumed dairy, and also 9.8% were deficient when they frequently consumed dairy.

Based on how often oil was consumed, 39.6% of people had insufficient vitamin D and occasionally consumed oil, also 14.2% had insufficient vitamin D and regularly consumed oil, 60.2% had sufficient vitamin D and frequently consumed oil, and also19.2% had sufficient vitamin D and occasionally consumed oil.

Among the individuals who ate nuts, 68.2% had never eaten any, 19.3% had eaten some rarely and were vitamin D deficient, 94.4% had sufficient amounts of vitamin D and occasionally ate nuts, 36.7% had sufficient vitamin D and rarely ate nuts, and also 7.5% had sufficient vitamin D and never ate nuts.

Of those surveyed, 86.9% said they were deficient in vitamin D when they rarely ate fruits and vegetables; 24.9% said they were deficient when they occasionally ate; 13.8% said they were deficient when they frequently ate fruits and vegetables; and 64.9% said they had sufficient amounts of vitamin D when they frequently ate fruits and vegetables; 25.3% said they had sufficient when they occasionally ate; and 1.6% said they had sufficient vitamin D when they rarely ate fruits and vegetables.

Of the respondents who consumed Horlicks; 53.2% of never consumed Horlicks; 23.5% consumed it rarely; 11% had consumed it occasionally and was vitamin D deficient; 100.0% of consumers had sufficient amounts of vitamin D when they frequently consumed Horlicks; 40.4% had sufficient vitamin D when they took it rarely; 40.0% had sufficient vitamin D when they consume it rarely; and also 13.5% had sufficient vitamin D when they did not consume it.

Table 8: Predictors of Lack of vitamin D (Multinomial logistic regression: The level of vitamin D was classified as deficient, insufficient and sufficient)

	Deficient		Insufficient	
Characteristics	**AoR (95 % CI)**	**p value**	**AoR (95 % CI)**	**p-value**
Sex				
Female	2.26 (0.973, 5.251)	0.058	2.226 (1.145, 4.	0.018
Male	1		327)	
			1	
Religion				
Other	1.009 (0.229, 4.441)	0.9	2.479 (0.751, 8.183)	0.13
Muslim	1		1	
Living area				
Slum	6.15 (0.072, 28.127)	0.9	7.40 (4.56, 10.01)	0.99
Non-slum	1		1	
Education level of mother				
	0.257 (0.001, 23.12)	0.99	0.15 (0.04, 0.781)	0.99
Primary pass/below	1.781 (0.163, 19.437)	0.636	0.372 (0.036, 3.81)	0.4
SSC pass/below	0.608 (0.161, 2.301)	0.464	2.352 (0.775, 7.139)	0.13
HSC pass	1		1	
Graduation/post-graduation				
Education level of father				
	1.631 (1.01, 3.435)	0.98	4.37 (2.32, 6.17)	0.8
Primary pass/below	5.98 (3.435, 12.345)	0.9	1.55 (1.1, 3.44)	0.9
SSC pass/below	1.51 (0.45, 7.98)	0.35	1.622 (1.235, 5.672)	0.9
HSC pass	1		1	
Graduation/post-graduation				
Occupation of mother				
Housewife	1.372 (0.372, 5.013)	0.63	1.073 (0.321, 3.592)	0.9
Service holder	0.17 (0.043, 0.678)	**0.012**	2.527 (0.877, 7.279)	0.086
Low paid job	7.13 (6.28, 24.29)	0.98	1.76 (1.341, 4.879)	0.9
Self-employed	1		1	
Occupation of father				
Service Holder	0.118 (0.001, 11.17)	0.36	2.259 (1.04, 4.875)	<0.001
Business	0.049 (0.001, 5.752)	0.19	-	
Low paid job	1		1	

Family size				
≤3	0.941 (0.181, 4.884)	0.94	0.628 (0.179, 2.204)	0.46
4	1.402 (0.487, 4.034)	0.53	0.666 (0.301, 1.474)	0.31
≥5	1		1	
Family income category				
≤25,000	1.209 (0.099, 14.71)	0.88	2.234 (1.173, 4.441)	0.54
25001-50,000	0.851 (0.294, 2.462)	0.76	3.943 (1.54, 10.096)	0.004
≥50001	1		1	
Beef consumption				
Rarely	0.085 (0.048, 0.149)	**0.007**	4.417 (0.705, 27.65)	0.11
Never	1		1	
Fatty Fish consumption	0.546 (0.21, 1.424)	0.21	0.557 (0.264, 1.174)	0.12
Occasionally	1		1	
Rarely				
Egg consumption				
Frequent	0.176 (0.097, 0.319)	0.34	0.45 (0.187, 1.083)	0.075
Occasionally/Rarely	1		1	
Dairy consumption				
Frequent	0.086 (0.029, 0.255)	**0.028**	0.022 (0.003, 0.179)	<0.001
Occasionally	0.22 (0.137, 0.354)	0.005	0.22 (0.072, 0.674)	0.008
Rarely	1		1	
Oil consumption				
Frequent	0.249 (0.139, 0.445)	**0.032**	0.649 (0.284, 1.481)	0.3
Occasionally	1		1	
Nuts consumption				
Occasionally/Rarely	0.103 (0.062, 0.171)	0.41	3.598 (0.952, 13.59)	0.059
Never	1		1	
Fruits and vegetables				
Frequent	0.132 (0.008, 2.255)	0.16	0.629 (0.05, 7.979)	0.72
Occasionally	0.336 (0.028, 3.981)	0.38	1.369 (0.131, 14.36)	0.79
Rarely	1		1	
Horlicks consumption				
Frequent/Occasionally	0.204 (0.05, 0.831)	**0.026**	4.646 (1.58, 13.661)	0.005
Rarely	0.178 (0.051, 0.62)	**0.007**	0.816 (0.322, 2.066)	0.66
Never	1		1	

*Abbreviation: OR (Odds ratio), AOR (Adjusted odds ratio)

Table 8 presents the factors associated with vitamin D level among the study subjects. Multinomial logistic regression model was fitted where a set of demographic factors were included as covariates along with consumption frequency of various food items rich with vitamin D. Significant predictors for vitamin D deficiency were occupation level of mother (service holder), consumption of beef, dairy, fortified oil and Horlicks. It has been found that odds of deficiency were lower among service holder mother than those with self-employment (AoR: 0.17, $p = 0.012$). This study also found a positive impact of consumption of certain vitamin D rich food items (beef, dairy, fortified oil and Horlicks) on vitamin D level. The likelihood of vitamin D deficiency was lower in adolescents who regularly consumed these types of food than those who did so infrequently or never at all.

CHAPTER VI

DISCUSSION

6. Discussion

The prevalence of vitamin D deficiency among adolescents is not well-documented, despite the fact that numerous papers have mentioned it in relation to children, adults, or any other group in Bangladesh.

In our study shows that, the age range of 10–14 years old comprised 58.3% of the 384 respondents. 77.6% of the living space is in non-slum areas. One of survey comprising 274 children revealed that 26.3% of them were between the ages of 10 and 14. 51.8 percent of those surveyed was urban dwellers [64]. Our study founds in mothers, 17.7% had completed primary school or less or had never attended an institution, 9.1% had completed SSC, 21.9% had completed HSC, and 51.3% had graduated or pursued post-graduation their education and in case of father, 9.4% had only completed primary school or less, or had never attended an institution, 12.0% had completed their SSC or less, 4.2% had completed their HSC, and 74.6% had completed their undergraduate degree or above. In other study shows that, 16.4% of the mothers had no schooling at all, 44.9% had completed primary school, 31.4% had completed high school (up to SSC), 4.7% had completed the HSC, and 2.6% had graduated. 14.2% of fathers had no schooling at all, 38.0% had completed primary school, 37.6% had completed high school (up to SSC), 5.5% had completed the HSC, and 4.7% had graduated [64]. In their findings also shows that, 76.3% of the mothers of their subjects were housewives, 8.8% had job holders, and 5.1% worked in the garment industry. The remaining 9.9% of mothers were employed in various occupations. Out of the fathers, 26.3% worked as service holders, 16.8% had engaged in businesses, 13.1% were drivers, 10.2% were cleaners, and 8.4% performed daily labour. Of them, 25.3% engaged across different professions. [64] as well as in comparison to our findings by profession, 34.6% of the mothers were housewives, 33.6% worked in service holders, 16.9% were self-employed or in other professions, and 14.8% were in the garment sector. 46.9% of the fathers employed in service, 28.4% engaged with businesses, 7.0% were drivers, 6.5% were cleaners, 6.5% engaged in daily labour and 4.7% were found to be in other occupations. In terms of family size, our study also shows, ≤3 members made up 9.6% of the family, 4 members made up 50.5%, and ≥5 members made up 39.8% in compare to other studies, 54.0% of them had up to four members, 41.6% had five to six members, and 4.4% had more than six members [64].

According to our study analysis, the vitamin D levels of 36.7% were insufficient, 32% were deficient and 31.3% were adequate. Age groups 10 to 14 had a 29.5% higher likelihood of vitamin D deficiency. Compared to male, female were more deficient by 36.2% against 24.6%. Compare to other studies, 40 percent of those surveyed had 25-OHD levels below 20 ng/mL overall, of which 110 of those surveyed (25%) had deficiencies and 66 of those surveyed (15%) had insufficiencies. Among the 10–16 age groups, they discovered an especially high frequency of low vitamin D status. When vitamin D levels were compared between age groups, older children showed a lower mean level of 25 (OH) D in the 10–16 age groups (18.7±11.5 ng/mL). Conversely, the blood vitamin D levels of 64.8% of teenage girls were less than 20 ng/mL. Girls had a greater probability of vitamin D deficiency [65].

In one more study of Dhaka, the prevalence of hypovitaminosis D in children aged 0 to 16 was investigated by Zaman et al, 2017 [63 34]. They demonstrated a rising trend of vitamin D insufficiency and deficiency with age, as well as a very high prevalence of hypovitaminosis D. The prevalence of vitamin D deficiency and insufficiency (S-25OHD <75 nmoL/L) was found to be 41.02% and 52.56%, respectively, in the 6–11 year old group and 46.75% and 51.95%, respectively, in the 12–16 year old group. According to their research, as children grow older, the prevalence of vitamin D deficiency rises because serum 25-hydroxyvitamin D levels in the pediatric population gradually decline as children age [63 34].

In our study, it was discovered that girls had a higher prevalence of vitamin D deficiency than boys by sex groups. Noticeably, with growing age, vitamin D deficiency may occur more frequently. Comparing to other studies, according to the Oren et al.; 2010 [66] study, females are more likely than boys to be vitaminD insufficient. 64.8% of adolescent girls between the ages of 10 and 16 had vitamin D levels < 20 ng/mL [66]. Depending on the season and socioeconomic status, the frequency of vitamin D deficiency in a group of Turkish girls aged 14–18 years was shown to range from 15.6% to 59.4% [67].

Hence, taking into account sex groups in our sample study also strongly discovered that the prevalence of vitamin D deficiency was higher in females.

In contrast of living areas our study shows, slum residences were more vitamin D deficient by 87.2% than non-slum residences by 16.1%, and non-slum residents had more vitamin D sufficient by 39.9% than slum residences by 1.2%. Comparing to other findings, according to the National Micronutrients Survey (NMS 2011–2012); [68], the prevalence of vitamin D deficiency in preschool- and school-aged children was 45.5% and 39.6%,

respectively. It was discovered that children residing in slum areas were particularly susceptible to vitamin D deficiency [68]. According to the NMS conducted in 2019–2020; [69], 21.9% of children had an overall vitamin D insufficiency. The likelihood of deficiency was slightly higher in girls (23.0%) than in boys (21.0%). In contrast to rural areas, 8.3% of urban areas had higher deficiencies. Comparing the NMS 2011–12 and NMS 2019–20 vitamin D deficiency, NMS 2019–20 has an 18% lower level, at 39.6% and 21.9%, respectively [69].

Few prior research have examined the connection between DP and serum vitamin D levels as well as food intake [70] [71]. A cross-sectional study revealed a favorable correlation between vitamin D intake and "dairy and fish DP," which is high in dairy products and fish [70]. In terms of eating fatty fish of our study, 54.7% of respondents stated they ate very rarely, 45% said they ate so occasionally, and only 0.3% said they ate it never. A little over 55.2% said they occasionally consumed dairy products, 34.1% said they did rarely, and 10.7% said they did so frequently. Adolescent who consumed dairy products on a regular basis had founda correlation between lower risks of vitamin D deficiency and food intake.

In sample 742 Greek, Grigoriou et al.; 2020 [71], identified three categories of healthier DPs: "healthy DP," "vegetables fruit DP," and "traditional DP"; three categories of unhealthier DPs: "sweets DP," "fast food DP," and "western DP." Serum 25(OH) D was shown to positively correlate with "healthy DP," which included a lot of non-refined breads, low-fat dairy products, low-fat cheese, and low-fat yoghurt. However, "traditional DP," which was defined by a high positive loading factor of full-fat yoghurt and milk, and "vegetables fruit DP," which was rich in fruits, vegetables, refined rice, and fish, were not linked to 25(OH) D levels. Despite the fact that dairy products constituted the majority of the vitamin D dietary intake, "traditional DP," with its high loading factor of full-fat milk and full fat yogurt, did not correlate with 25(OH) D levels [71].

Based on the results of our study, 67.4% of participants reported eating fruits and vegetables occasionally, 27.9% said they ate them rarely, and 4.7% said they ate them frequently. Of them, 86.9% found to be vitamin D deficient despite the fact that vegetables are a poor sourceof the vitamin D. Since devout vegetarians (those who abstain from animal-based foods like eggs and dairy products) frequently suffer from vitamin D deficiency, vegetables have a low vitamin D concentration [72].

According to our findings on educational level compared to vitamin D level, both the graduated/post-graduated father and mother had a lower risk of vitamin D deficiency, 11.7%

and 14.7%, respectively. 50.8% and 41.6% had sufficient vitamin D in both graduated or postgraduate fathers and mothers. But it had been found deficient by 92.6% and 94.4% of fathers and mothers with primary passed, below, or no institutional education at all. Other study findings also shows that, according to a Mullie et al.; 2010 [73] study, male Mediterranean diet scores, healthy DP, and higher Healthy Eating Index (HEI) were positively correlated with higher education levels [75]. In another study involving a large Iranian population, participants with a lesser degree of education consumed a higher quality of a "western DP" [74]. High educational attainment was taken into account as a predictor of a healthy DP in a systematic review [75]. This conclusion may indicate that educated people are more concerned about their health, depending on their knowledge of nutritional needs and general health [76].

CHAPTER VII

LIMITATION

7. Limitation of Study

- Because the study was cross-sectional in nature, causal relationship couldn't be established between vitamin D status and other variables.
- Since the study covered only two selected hospitals in Dhaka city, study findings couldn't be generalized to all the adolescent patients.
- Furthermore, we were unable to completely rule out recall bias while evaluating dietary habits.
- We also couldn't include other important factors that can contribute to vitamin D level e.g., sunlight exposure, latitude of subject's home, use of sunscreen lotions, and clothing habits, etc.

CHAPTER VIII

CONCLUSIONS and RECOMMENDATION

8. Conclusion

The study findings highlighted about one-third of the participants were deficient serum vitamin D level while more than one-third had insufficient level of vitamin D. There were gender disparities in vitamin D levels, with a higher prevalence of deficiency among females compare to males. This study also found a positive impact of consumption of certain vitamin D rich food items (beef, dairy, fortified oil and Horlicks) on vitamin D level. The likelihood of vitamin D deficiency was lower in adolescents who regularly consumed these types of food than those who did so infrequently or never at all. Thus, dietary and lifestyle choices made by Bangladeshi adolescents may pose a risk for vitamin D deficiency. Therefore, dietary and life style modification focusing on the consumption of vitamin D enriched foods might reduce the vitamin D deficiency/insufficiency rate among adolescents particularly females.

Recommendation

- The present study found a positive association between frequent consumption of vitamin D-rich food (either fortified or naturally rich in vitamin D). Hence, further research can be conducted to find the possibility and feasibility of fortification of other food items with vitamin D.

- The study found low consumption frequency of certain vitamin D rich food items. Therefore, the consumption of those foods should be increased.

A few more recommendations can be made to stop the common issue of vitamin D deficiency in adolescents from Bangladesh who are at risk.

- **Public awareness:** Public awareness of vitamin D's benefits and deficiency risks, especially since vitamin D deficiency is common in Bangladesh. Media campaigns and collaboration with health and government sectors can spread the message effectively.

- A key approach to combating vitamin D deficiency can be food fortification, using commonly available, affordable foods consumed year-round.

- Providing free supplements—like calcium, vitamin D, and micronutrients—through community clinics can benefit elderly, women, adolescents, and children most at risk.
- To gauge vitamin D deficiency in adolescents, large, long-term cohort studies are essential. A national health policy should support vitamin D screening and preventive measures, such as promoting outdoor activities, fortifying dairy, and providing supplements to ensure healthy growth.

CHAPTER IX

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ANNEXURE

ANNEXURE –I
CONSENT FORM (ENGLISH)

CONSENT OF RESPONDENT

Introductory statement
My name is Sanni Jaiswal. I am the regular student of MPhil (2nd part) course in the Institute of Nutrition and Food Science at University of Dhaka. I'm conducting a study to investigate **"The Vitamin-D status among adolescent attending in the Out Patient Department of Selected Tertiary Hospitals in Bangladesh".** For this purpose, you.....are selected as an informer. All of collected information's will be used only for academic purpose. The questions usually take about 30 minutes to answer. All of the answers you give will be confidential and will not be shared with anyone. I would like to request you heartily that please feel free disclose the needed information for this study purpose since your views are important. If I ask you any question that you don't want to answer, just let me know and I will go on to the next question or you can stop the interview at any time.

Why is the study being done?
The information I collect will help to investigate the vitamin- D status among adolescents in Bangladeshi population.

What is involved in the study?
You have been selected as a respondent in this study. I would like to ask you some questions about basic information.

What will you have to do if you agree to participate?
Since you have been selected as a respondent in this study, I shall be thankful if you provide your valuable response on certain issues. If some questions cause you embarrassment or make you feel uncomfortable, you can refuse to answer them.

What are the risks and benefits of this study?
By providing information you will not have any risk whatsoever, rather this will help the government and policy planners to evaluate, strengthen and refocus national effort to improve health issues to adolescents due to vitamin deficiencies.

Confidentiality:
Whatever information you provide will be kept strictly confidential. It will be used only for research purposes.

Is there any compensation for participating in the study?
Your participation in the study is voluntary and promises no financial benefit.

Right to refuse or withdraw:
Participation in this study is voluntary and you can choose not to answer any individual question or all of the questions. However, I hope that you will participate in this study since your views are important.

Who do you contact if you have a question or problem?
If you wish to know more about your rights as a participant in this study you may contact Sanni Jaiswal, Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000; Phone: 01622316152

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Signature of respondent Signature of interviewer

ANNEXURE - II

CONSENT FORM (BANGLA)

উত্তরদাতার সম্মতি

সূচনামূলক বিবৃতি

আমার নাম সান্নী জৈসয়াল আমি ঢাকা বিশ্ববিদ্যালয়ের পুষ্টি ও খাদ্য বিজ্ঞান ইনস্টিটিউটের এমফিল (২য় পর্ব) কোর্সের নিয়মিত শিক্ষার্থী। আমি একটি গবেষণা পরিচালনা করছি **"বাংলাদেশের নির্বাচিত টারশিয়ারি হাসপাতালের বর্হিঃ বিভাগের কিশোর-কিশোরী রোগীদের মধ্যে ভিটামিন-ডি'র মাত্র নির্ণয়"** এই উদ্দেশ্যে ..... কে একজন তথ্য প্রদানকারী হিসেবে নির্বাচিত করা হয়েছে। প্রদানকৃত তথ্য শুধুমাত্র শিক্ষামূলক উদ্দেশ্যে ব্যবহৃত হবে। প্রশ্নগুলির উত্তর প্রদানে সাধারণত প্রায় ৩০ মিনিট সময় লাগবে। আপনার দেওয়া সমস্ত উত্তর গোপনীয় হবে এবং এই তথ্যগুলো কাউকে দেওয়া হবে না। আমি আপনাকে আন্তরিকভাবে অনুরোধ করতে চাই যে, অনুগ্রহ করে অধ্যয়নের উদ্দেশ্যে প্রয়োজনীয় তথ্য নির্দ্বিধায় প্রকাশ করুন যেহেতু আপনার মতামত গুরুত্বপূর্ণ। যদি আমি আপনাকে এমন কোনো প্রশ্ন জিজ্ঞাসা করি যার উত্তর আপনি দিতে চান না, তাহলে আমাকে অবগত করুন। আমি পরবর্তী প্রশ্নে চলে যাব অথবা আপনি যে কোনো সময় সাক্ষাৎকার বন্ধ করতে পারেন।

কেন গবেষণা করা হচ্ছে?
আমরা যে তথ্য সংগ্রহ করি তা বাংলাদেশী জনসংখ্যার কিশোর-কিশোরীদের মধ্যে ভিটামিন-ডি'র মাত্রা নির্ণয় করতে সাহায্য করবে।

গবেষণার সাথে কী জড়িত?
আপনাকে এই গবেষণায় একজন উত্তরদাতা হিসেবে নির্বাচিত করা হয়েছে। আমি আপনাকে মৌলিক তথ্য সম্পর্কে কিছু প্রশ্ন জিজ্ঞাসা করতে চাই।

উত্তরদাতা হিসেবে অংশগ্রহণ করতে সম্মত হলে আপনাকে কি করতে হবে?
যেহেতু আপনি এই গবেষণায় একজন উত্তরদাতা হিসাবে নির্বাচিত হয়েছেন, জিজ্ঞাসিত বিষয়ে আপনার মূল্যবান তথ্য প্রদান করলে আমি আপনার নিকট কৃতজ্ঞ থাকব। যদি কোন প্রশ্ন আপনাকে বিব্রত করে বা আপনাকে অস্বস্তি বোধ করায় তবে আপনি উক্ত প্রশ্নের উত্তর প্রদান থেকে বিরত থাকতে পারবেন।

এই গবেষণার ঝুঁকি এবং সুবিধাগুলি কী কী?
তথ্য প্রদানের মাধ্যমে আপনার কোন ঝুঁকি থাকবে না, বরং এটি সরকার এবং নীতি পরিকল্পনাকারীদের ভিটামিন ডি সংক্রান্ত কিশোর-কিশোরীদের স্বাস্থ্য সমস্যাগুলির উন্নতির জন্য জাতীয় প্রচেষ্টাকে মূল্যায়ন, শক্তিশালী করতে এবং পুনরায় তুলে ধরতে সহায়তা করবে।

গোপনীয়তাঃ
আপনি যে তথ্য প্রদান করবেন তার গোপনীয়তা কঠোরভাবে রক্ষা করা হবে। এটি শুধুমাত্র গবেষণার উদ্দেশ্যে ব্যবহার করা হবে।

গবেষণায় অংশগ্রহণের জন্য কোন সম্মানী আছে কি?
গবেষণায় আপনার স্বেচ্ছায় অংশগ্রহণ হওয়ায় কোন আর্থিক সহায়তার প্রতিশ্রুতি দেওয়া হচ্ছে না।

প্রত্যাখ্যান বা প্রত্যাহার করার অধিকারঃ
যদিও এই গবেষণায় আপনার স্বেচ্ছায় অংশগ্রহণ তবুও আপনি যে কোনো পৃথক বা সকল প্রশ্নের উত্তর না দেওয়াকে বেছে নিতে পারেন। যাইহোক, আমি আশা করি আপনি এই গবেষণায় অংশগ্রহণ করবেন যেহেতু আপনার মতামত গুরুত্বপূর্ণ।

কোন প্রশ্ন বা সমস্যা থাকলে আপনি কার সাথে যোগাযোগ করবেন?
এই গবেষণায় অংশগ্রহণকারী হিসেবে আপনার অধিকার সম্পর্কে আরও তথ্য জানতে চাইলে আপনি সান্নী জৈসয়াল, পুষ্টি ও খাদ্য বিজ্ঞান ইনস্টিটিউট, ঢাকা বিশ্ববিদ্যালয়, ঢাকা-১০০০; ফোন: ০১৬২২৩১৬১৫২ এর সাথে যোগাযোগ করতে পারবেন।

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স্বাক্ষাৎকার প্রদানকারীর নাম / স্বাক্ষর **স্বাক্ষাৎকার গ্রহণকারীর স্বাক্ষর**

ANNEXURE -III

Institute of Nutrition and Food Science
University of Dhaka

QUESTIONNAIRE (ENGLISH)

Respected respondents, I am the regular student of MPhil (2nd part) course in the Institute of Nutrition and Food Science at University of Dhaka. I'm going to conduct as academic research on "Vitamin- D status among adolescent patients in the Out Patient Department of Selected Tertiary Hospitals in Bangladesh." For this purpose, I need some information from you. All of these information's will be used only for educational purpose. The confidentiality and anonymity will be strictly maintained. You have freedom to participate in an interview and you may abstain from answering any these questionnaires. I would like to request you heartily that please feel free disclose the need information for study purpose. So, I need your kind cooperation.

Tick (✔) on code no. near the answer that best reflect your personal details or you may specify in details.

SL. N.	Question	Answer	Code
	General Information		
1.	Name of patient	…….	
2.	Age	…….	
3.	Sex	Male	1
		Female	2
4.	Height	…….	
5.	Weight	…….	
6.	Religion	Muslim	1
		Hindu	2
		Buddhist	3
		Christian	4
		Others please specify…..…..……..	5
7.	Name of hospital	…….	
8.	What kind of physical problem brought you to the hospital?	Body ache	1
		Myalgia	2
		Athralgia	3
		Difficulty in walking	4
		Others please specify……..	5
9.	Living status	Slum	1
		Non Slum	2
10.	Educational status of mother	Never gone to school	1
		Class 1-4	2
		Primary Level (up to 5)	3

		Class 6-9	**4**
		Secondary level (up to SSS)	**5**
		Up to HSC Level	**6**
		Graduate/Degree	**7**
		Others please specify……..	**8**
11.	**Educational status of father**	**Never gone to school**	**1**
		Class 1-4	**2**
		Primary Level (up to 5)	**3**
		Class 6-9	**4**
		Secondary level (up to SSS)	**5**
		Up to HSC Level	**6**
		Graduate/Degree	**7**
		Others please specify……..	**8**
12.	**Mother's occupation**	**Housewife**	**1**
		Job Holder	**2**
		Garments Worker	**3**
		Others please specify……..	**4**
13.	**Father's occupation**	**Service Holder**	**1**
		Business	**2**
		Driver	**3**
		Cleaner	**4**
		Day Labour	**5**
		Other please specify……..….	**6**
14.	**How many total members are in your family?**	**Please specify…….……**	
15.	**Total HH monthly income**	**Please specify……..……**	

THANK YOU FOR HELP

ANNEXURE - IV

পুষ্টি ও খাদ্য বিজ্ঞান ইনস্টিটিউট

ঢাকা বিশ্ববিদ্যালয়

প্রশ্নাবলী (বাংলা)

সম্মানিত উত্তরদাতাগণ, আমি ঢাকা বিশ্ববিদ্যালয়ের পুষ্টি ও খাদ্য বিজ্ঞান ইনস্টিটিউটের এমফিল (২য় পর্ব) কোর্সের নিয়মিত শিক্ষার্থী। আমি **"বাংলাদেশের নির্বাচিত টারশিয়ারি হাসপাতালের বর্হিঃ বিভাগের কিশোর-কিশোরী রোগীদের মধ্যে ভিটামিন-ডি'র মাত্রা নির্ণয়"** উক্ত বিষয়ের উপর শিক্ষামূলক গবেষণা করতে যাচ্ছি। এই উদ্দেশ্যে, আমার আপনার কাছ থেকে কিছু তথ্য দরকার । এই সমস্ত তথ্য শুধুমাত্র শিক্ষামূলক উদ্দেশ্যে ব্যবহার করা হবে। গোপনীয়তা এবং পরিচয় কঠোরভাবে গোপন রাখা হবে। আপনার অংশগ্রহণের স্বাধীনতা আছে এবং আপনি চাইলে এই প্রশ্নাবলীর উত্তর দেওয়া থেকে বিরত থাকতে পারেন। আমি আপনাকে আন্তরিকভাবে অনুরোধ করতে চাই যে, অনুগ্রহ করে গবেষণার উদ্দেশ্যে প্রয়োজনীয় তথ্য নির্দ্বিধায় প্রকাশ করবেন। তাই আপনার সদয় সহযোগিতা চাই।

কোড নম্বরে (✓) টিক দিন। উত্তরের কাছাকাছি যা আপনার ব্যক্তিগত বিবরণকে সর্বোত্তমভাবে বর্ণনা করে বা আপনি বিশদভাবে উল্লেখ করতে পারেন।

সিরিয়াল নং	প্রশ্ন	উত্তর	কোড
	সাধারণ তথ্য		
১.	আপনি কি ভিটামিন ডি খেয়েছেন / নিয়েছেন ?	হ্যাঁ	১
		না	২
১. (ক)	কত মাস আগে খেয়েছেন / নিয়েছেন ?	উল্লেখ করুন	
১. (খ)	কত মাত্রায় খেয়েছেন / নিয়েছেন ?	উল্লেখ করুন	
২.	রোগীর নাম	.....	
৩.	বয়স	.....	
৪.	লিঙ্গ	পুরুষ	১
		মহিলা	২
৫.	উচ্চতা	.....	
৬.	ওজন	.....	
৭.	ধর্ম	মুসলিম	১
		হিন্দু	২
		বৌদ্ধ	৩
		খ্রিস্টান	৪
		অন্যান্য উল্লেখ করুন.....	৫
৮.	হাসপাতালের নাম	.....	
৯.	আপনি কি শারীরিক সমস্যা নিয়ে হাসপাতালে এসেছেন ?	শরীরে ব্যথা	১
		মায়ালজিয়া (মাংস পেশিতে ব্যথা)	২
		অ্যাথ্রালজিয়া (গীড়ায়-গীড়ায় ব্যথা)	৩
		হাটতে অসুবিধা	৪
		অন্যান্য উল্লেখ করুন.....	৫
১০.	বসবাসের অবস্থান	বস্তি	১
		বস্তি না	২
১১.	মায়ের শিক্ষাগত যোগ্যতা	কখনো স্কুলে যায়নি	১
		শ্রেণী ১-৪	২
		প্রাথমিক স্তর (৫ পর্যন্ত)	৩
		শ্রেণী ৬-৯	৪
		মাধ্যমিক স্তর (এস.এস.সি পর্যন্ত)	৫
		এইচ.এস.সি স্তর পর্যন্ত	৬
		স্নাতক /ডিগ্রী	৭
		অন্যান্য উল্লেখ করুন.....	৮

১২.	পিতার শিক্ষাগত যোগ্যতা	কখনো স্কুলে যায়নি	১
		শ্রেণী ১-৪	২
		প্রাথমিক স্তর (৫ পর্যন্ত)	৩
		ক্লাস ৬-৯	৪
		মাধ্যমিক স্তর (এস.এস.সি পর্যন্ত)	৫
		এইচ.এস.সি লেভেল পর্যন্ত	৬
		স্নাতক /ডিগ্রী	৭
		অন্যান্য উল্লেখ করুন.....	৮
১৩.	মায়ের পেশা	গৃহিণী	১
		চাকুরীজিবী	২
		গার্মেন্টস কর্মী	৩
		অন্যান্য উল্লেখ করুন.....	৪
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সাহায্য করার জন্য আপনাকে ধন্যবাদ

ANNEXURE V

Food Frequency Questionnaire (ENGLISH)

For each food item, indicate with a check mark the category that best describes the frequency with which you usually eat that particular food item

Groups of products	Food Items	Never	Once in a month	2-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
Cereals	Rice										
	Rotti/Parotha										
	Corn										
	Bread										
	Others (specify)										
Pulses	Red Lentils (Masoor Dal)										
	Green Gram (Moong Dal)										
	Chickpea/Bengal Gram (Chana Dal)										
	Black Gram (Urad dal)										
	Gram pulse/Chola Dal										
	Khesari Dal										
	Others (specify)										
Types of Meat	Beef										
	Mutton										
	Lamb										
	Chicken										
	Duck										
	Liver/Kidney										
	Others (specify)										
Flesh fatty fish	Hilsa										
	Pangash										
	Catla										
	Puti										
	Mola										
	Silver Carp										
	Mrigal										
	Rohu										
	Salmon										
	Tuna										
	Common item										
	Nile tilapia										
	Ayer mach (Long-whiskered Catfish)										
	Prawn										

Groups of products	Food Items	Never	Once in a month	2-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
	Magor (Catfish)										
	Rupchada										
	Shar puti										
	Koi mach										
	Shoal mach										
	Gura mach (Sagor Ponna)										
	Taki										
	Shing mach										
	Baila										
Egg	Chicken (with yolk/without yolk)										
	Duck (with yolk/without yolk)										
	Koel (with yolk/without yolk)										
Milk and Milk products	Milk (cows)										
	Yoghurt										
	Cheese										
	Butter										
	Pasteurized/UHT milk (Aarong, Milk vita/ Farm fresh)										
	Dairy desert (custard, pudding, Firni/Payesh)										
	Ice cream										
	Milk shake										
	Cake										
	Others (specify)										
Oils	Mustard oil										
	Teer Fortified (Vit D) Soyabean Oil										
	Bashundhara Fortified (Vit D) Soyabean Oil										
	Rupchanda Soyabean Oil										
	Fresh Soyabean Oil										
	Cod Liver oil										
	Dalda										
	Open oil										
Nuts	Almonds										
	Cashews										
	Pistachio nuts										
	Peanuts										

Groups of products	Food Items	Never	Once in a month	2-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
Miscellaneous	Horlicks										
	Fortified soy milk										
	Mushrooms										
	Orange Juice (Fortified)										
	Spinach										
	Ripe Banana										
	Dates										
	Raisins										
	Brocoli										
Enter other foods not listed that are eaten regularly											

Thank You for your help

ANNEXURE -VI
খাদ্য ফ্রিকোয়েন্সি প্রশ্নাবলী (বাংলা)

প্রতিটি খাদ্য আইটেমের জন্য, একটি চেক মার্ক দিয়ে নির্ধারণ করুন যাতে, বিভাগটি সর্বোত্তমভাবে বর্ণনা করে যে, ফ্রিকোয়েন্সিতে আপনি সাধারণত সেই নির্দিষ্ট খাবারটি খান

রোগীর আইডি নম্বর-

আইটেম সমুহ

পণ্যের গ্রুপ	খাদ্য তালিকা	কখনো না	মাসে একবার	প্রতি মাসে ২-৩ বার	সপ্তাহে একবার	প্রতি সপ্তাহে ২-৪ বার	প্রতি সপ্তাহে ৫-৬বার	দিনে একবার	প্রতিদিন ২-৩ বার	প্রতিদিন ৪-৫ বার	প্রতিদিন ৬বারের উপরে
খাদ্যশস্য	ভাত										
	রুটি/ পরোটা										
	ভুট্টা										
	পাউরুটি										
	অন্যান্য (উল্লেখ করুন)										
ডাল	মসুর ডাল										
	মুগ ডাল										
	ছোলা ডাল (চনার ডাল)										
	কালো ডাল (উড়দ ডাল)										
	বুটের ডাল										
	খেসারী ডাল										
	অন্যান্য (উল্লেখ করুন)										
মাংসের প্রকারভেদ ও অন্যান্য	গরুর মাংস										
	খাসির মাংস										
	ভেড়ার মাংস										
	মুরগী										
	হাঁস										
	গীলা /কলিজা										
	অন্যান্য (উল্লেখ করুন)										

পণ্যের গ্রুপ	খাদ্য তালিকা	কখনো না	মাসে একবার	প্রতি মাসে ২-৩ বার	সপ্তাহে একবার	প্রতি সপ্তাহে ২-৪ বার	প্রতি সপ্তাহে ৫-৬ বার	দিনে একবার	প্রতিদিন ২-৩ বার	প্রতিদিন ৪-৫ বার	প্রতিদিন ৬ বারের উপরে
চর্বিযুক্ত মাছ	ইলিশ										
	পাঙ্গাস										
	কাতল										
	পুটি মাছ										
	মলা মাছ										
	সিলভার কার্প										
	মৃগাল										
	রুই মাছ										
	স্যালমান মাছ										
	টুনা মাছ										
	সাধারণ আইটেম										
	তেলাপিয়া										
	আইড় মাছ										
	চিংড়ি										
	মাগুর মাছ										
	রূপচাদা										
	শরপুটি										
	কই মাছ										
	শোল মাছ										
	গুরামাছ (পোনা মাছ/ ছোট মাছ)										
	টাকি মাছ										
	শিংমাছ										
	বাইলা মাছ										
ডিম	মুরগীর ডিম (কুসুম সহ/ কুসুম ছাড়া)										
	হাঁসের ডিম (কুসুম সহ/ কুসুম ছাড়া)										

পণ্যের গ্রুপ	খাদ্য তালিকা	কখনো না	মাসে একবার	প্রতি মাসে ২-৩ বার	সপ্তাহে একবার	প্রতি সপ্তাহে ২-৪ বার	প্রতি সপ্তাহে ৫-৬ বার	দিনে একবার	প্রতিদিন ২-৩ বার	প্রতিদিন ৪-৫ বার	প্রতিদিন ৬ বারের উপরে
	কোয়েলের ডিম (কুসুম সহ/ কুসুম ছাড়া)										
দুধ ও দুগ্ধজাত পণ্য	গরুর দুধ										
	দই										
	পনির										
	মাখন										
	পাস্তুরিত / ইউএচটি দুধ (আড়ং/ মিল্ক ভিটা/ ফার্ম ফ্রেস)										
	দুধের তৈরি (কাস্টার্ড, পুডিং, ফিরনি/পায়েশ, চিজ কেক)										
	দুধজাতীয় আইসক্রিম										
	মিল্ক শেক										
	কেক										
	অন্যান্য (উল্লেখ করুন)										
তেল	সরিষা তেল										
	তীর **Fortified** /সুরক্ষিত (ভিটামিন ডি) সয়াবিন তেল										
	বসুন্ধরা **Fortified**/ সুরক্ষিত (ভিটামিন ডি) সয়াবিন তেল										
	রূপচাদা সয়াবিন তেল										
	ফ্রেস সয়াবিন তেল										
	কড লিভার অয়েল										
	ডালডা										
বাদাম	কাঠবাদাম										
	কাজুবাদাম										
	পেস্তাবাদাম										
	চিনা বাদাম										

পণ্যের গ্রুপ	খাদ্য তালিকা	কখনো না	মাসে একবার	প্রতি মাসে ২-৩ বার	সপ্তাহে একবার	প্রতি সপ্তাহে ২-৪ বার	প্রতি সপ্তাহে ৫-৬ বার	দিনে একবার	প্রতিদিন ২-৩ বার	প্রতিদিন ৪-৫ বার	প্রতিদিন ৬ বারের উপরে
বিবিধ	হরলিক্স										
	Fortified /সুরক্ষিত সয়া দুধ										
	মাশরুম										
	কমলার জুস **Fortified /**(সুরক্ষিত)										
	পালং শাক										
	পাকা কলা										
	খেজুর										
	কিসমিস										
	ব্রকলি										

তালিকাভুক্ত নয় এমন অন্যান্য খাবার লিখুন যা নিয়মিত খাওয়া হয়											

আপনার সাহায্যের জন্য ধন্যবাদ

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