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Household Food Insecurity in Urban Slums: A Case Study of Dhaka City, Bangladesh

Submitted by

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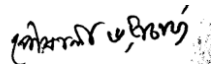
Declaration

I, Poushali Bhattacharjee, declare that the thesis is the outcome of my original effort. The analysis presented here has not been published anywhere else before. All the literatures and secondary source used in the study have been cited and referenced.



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Zásady pro vypracování

According to the Slum Census 2014, 2.3 million people in Bangladesh are now living in a basic need deprived condition in the slums. The capital city of Dhaka alone is enduring the enormous pressure of 3,360 slums with 25% of the total slum population due to lucrative emergent informal employment opportunities. The Bangladesh Bureau of Statistics (BBS) has set the minimum calories at 2,122kcal / captain / as the food poverty line (FPL). Results from the 2013 Bangladesh Urban Slum Survey (BUSS) indicate that half of the households in Dhaka's slums fell below the FPL. In this alarming situation, it is very important to go deeper into household factors that affect food insecurity in urban slums for effective policy formulation. Till now, most of the studies have focused on rural food insecurity with an emphasis on agricultural productivity gain. But the factors determining food insecurity in urban slums are very different from rural areas because of the difference in land ownership, lack of social insurance, unhygienic utilities and the top of that polluted urban environment. My study will aim to identify the food insecure households (HHs) in urban slums of Dhaka city at first. This will be based on several processes to validate each other through the Food Consumption Score, the Dietary Diversity Score, the Food expenditure and the Calorie Intake Gap. In order to identify HHs under the minimum food intake (FPL), the adult equivalent ratio will be used according to the composition of the household. The optimum calorie need for each HH will be different due to their composition and occupation pattern. The calorie intake standard provided by the Bangladesh Institute for Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) under the National Food Policy Capacity Strengthening Program will be used for this purpose. The calorie intake will be calculated from the daily food consumption table using the methodology of the World Bank and FAO from their report „Analyzing Food Security Using Household Survey Data" (2014). Later, the HH factors that affect the calorie intake gap will be assessed through a hierarchical regression analysis based on the „Framework for the Analysis of the Links between the Individual Food and Nutrition Security Pillars". From the literature, the size of the HH, the dependency ratio, the gender ratio, the HH income, the length of living, the slum, the recipient of government food aid, the condition of water, sanitation and care behavior and asset ownership are some factors those generally have an impact on HH food insecurity. All factors need to be tested through regression analysis to understand their significance. The asset ownership factor will be translated into the wealth index through the Principal Component Analysis (PCA) in the regression. Dataset: Bangladesh – Urban Informal Settlements Survey 2016, The World Bank Sample: 3,360 Urban slums have been classified into three different strata – small size slums (5-10 HHs); medium size slums (11-200 HHs); and large size slums (over 200 HHs) (2014 BBS Census of Slums and Floating Population). From stratum one, 6 slums and 30HHs, from stratum two, 27 slums and 270 HHs and from stratum three, 30 slums and 300 HHs were selected. So, a total of 600 households were randomly selected proportionally to HHs number in each stratum.

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Seznam doporučené literatury:

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Abstract

Bangladesh is the 10th most densely populated country in the world which put stress on its ability to secure the equal right to food for all group of people irrespective of socioeconomic condition. The National Food Policy of the country declared slum households as one of the most distressed groups in terms of fulfilling the nutritional need. The capital city Dhaka alone is the living place of humongous number (1.06 million) of slum population. The study conducted on 580 households of Dhaka City Corporation area has identified 75.52% of the households as food insecure by comparing their calorie intake with the energy requirement threshold for Bangladesh (2430 Kcal/AE/Day). The majority share of the calorie in their everyday diet plan came mostly from cereals, sugar, oil, and outside meal, which showcased a poor quality of diet. The households spent the lion's share of their monthly expenditure (72.77%) only on food consumption, which compelled to cut off essential nonfood expenditure.

The Inverse Hyperbolic Sine transformed Double Hurdle model has been applied, to analyze the determinants of the presence and depth of food insecurity among households, as it accommodates the heteroskedastic, correlated and not normally distributed error. The Per capita monthly income; percentage of food expenditure; diet diversity; household size; sex of household head; number of the female wage earner, children under five years and unemployed person within 15 to 64 years; proportion of adult female member and location of the slum were significant factors determining the food security status of households. Whereas, while exploring the determinants of the depth in food calorie gap among food insecure households, some other factors like wealth index, source of drinking water, overall HH security and migration of HH head from abroad came out as important factors along with the previous factor list except for the sex of the household head. To improve the situation of the slum dwellers, the government should concentrate on more coverage of social safety net programs, legal service provision of water and sanitation and human capital development-oriented program and training primarily focusing the women.

Key Words: Slum, food insecurity, indicators, determinants, DH model, IHS transformation

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List of Abbreviations

AE: Adult Equivalent

BBS: Bangladesh Bureau of Statistics

BUISBS: Bangladesh - Urban Informal Settlements Baseline Survey

DCC: Dhaka city corporation

DDS: Diet Diversity Score

DH: Double Hurdle

DNCC: Dhaka North City Corporation

DSCC: Dhaka South City Corporation

DWASA: Dhaka Water Supply and Sewerage Authority

FAO: Food and Agricultural Organization of the United Nations

FANTA: Food and Nutrition Technical Assistance III Project

FCS: Food Consumption score

FGT: Foster-Greer-Thorbecke

FSM: Fecal Sludge Management

HCES: Household consumption and expenditure Survey

HFIAS: Household Food Insecurity Access Scale

HH: Household

HIES: Household Income and Expenditure Survey

IFPRI: International Food Policy Research Institute

IHS: Inverse Hyperbolic Sine

LDV: Limited Dependent Variable

ME: Monthly Expenditure

MoFDM: Ministry of Food and Disaster Management

MLE: Maximum Likelihood Estimation

NFP: National Food Policy

PDS: Public distribution system

SSNP: Social Safety Net Programs

UNICEF: The United Nations Children's Fund

WASH: Water Sanitation and Hygiene

WFP: World Food Programme

WB: The World Bank

Chapter 01

INTRODUCTION

1.1 Urbanization trend in Bangladesh

The new global trend of development in developing countries is mainly conceptualized by the rate of urbanization. Urbanization is the most dominant demographic process which can be defined as the shift in the population from rural to urban settlements (Mcgranahan & Satterthwaite, 2014; United Nations, 2014). Bangladesh is no exception when it comes to following the global trend. According to the World Bank (WB), the percentage of the urban population in Bangladesh has increased from 5% to 36% between 1950 to 2017, and it will cross rural population by 2040 as per prediction (Worldometers,2019). The uncontrollable migration from the village and the haphazard city development are tuning the urban areas into death pocket, especially for the low-income people and they are ending up living in the slums (Islam, 2018; WFP, 2015).

The Bangladesh Bureau of Statistics (BBS) (2015) defines a "slum as a cluster of compact settlements of five or more households (HHs) which generally grows very unsystematically and haphazardly in an unhealthy condition and atmosphere on government and private vacant land. Slums are characterized by very poor housing; high population density and room crowding; poor environmental services (water and sanitation); low socio-economic status and lack of security of tenure". The Census of Slum Areas and Floating Population conducted by BBS on 2014 stated that 2.23 million people, 6.33% of the country urban population, live across 13935 slums in Bangladesh, whereas Dhaka alone is bearing the pressure of 1.06 million slum dwellers (BBS, 2015). Dhaka has fallen as the primary victim because of being the economic growth center with numerous informal employment opportunities and having high median hourly wages (Islam, 2018).

1.2 Food insecurity and urban slums

Food insecurity is a condition when availability, access, and utilization of food is limited and not stable over time. According to the FAO (2010), it is "*a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and*

development and active, healthy life." Though the right to food and adequate nutrition are among the basic needs of human being, roughly half of Bangladeshis are unable to access sufficient food to meet their dietary needs (USAID, 2019). In 2014, almost 40 million people suffered from food insecurity, where 11 million experienced acute hunger (Osmani et al., 2016). According to the global hunger index, Bangladesh ranked 86th out of 119 countries in the world in 2018 (Welthungerhilfe, 2018).

The anthropometric indicator of food security, the stunting rate in Bangladesh is even higher than Sub Saharan Africa, in spite of being in a better position in the economic indicators. Though the country did put a good fight against poverty, and there has been an increase in the real wage, the economic improvement did not translate into the nutritional security proportionally (Osmani et al., 2016). The high prevalence of malnutrition exerts a negative intergenerational impact on physical and mental development. Moreover, it reduces the overall productivity of the working force, which can be translated into the present monetary loss of around $1 billion (Howlader et al. 2012).

Bangladesh has adopted agricultural innovation and food production to cope up with the pressure of the exponential population increase. Overall, the country has achieved substantial food self-sufficiency, where only some items like wheat, pulses, and edible oil are imported to meet up the high domestic demand. Despite making impressive progress in local food production, balanced diets are still beyond the reach of the urban poor and rural landless (Osman et al., 2016; MoFDM, 2006). Most of the development projects in the country focused on rural poor or relatively high-tech urban development with minimal interest in the urban poor (IFPRI, 2007). As a result, by comparing the World Food Programme (WFP) survey results of 2006 and 2013, it was observed that the food security situation in the urban slums has not materially improved over the time in Bangladesh (IFPRI, 2007; WFP, 2015). According to the Multiple Indicator Cluster Survey (MICS), the rates of stunting and wasting of children under five years, in slums were 44% and 16% respectively in 2013 which was higher than the rate found in all non-slum urban areas of the country (WFP, 2015).

The slum is a residential block with unique features than rural and non-slum urban due to high dependency on cash income; less reliance on agriculture and natural resources; low wages from informal jobs, higher participation of women in the labor market; insecure land and housing tenure; inadequate access to safe water, sanitation and health services; and weak social networks (WFP, 2002; Ruel et al., 1998). In Bangladesh, Government's Poverty Reduction

Strategy, National Food Policy (2006) and Plan of Action (2008-2015) all the programs emphasized ensuring stable supply of safe and nutritious food by intensifying agricultural research on crop diversification; improving rural people access to market and asset; and expanding the coverage of social safety net programs (SSNP) (Food Security Portal facilitated by IFPRI, 2012). But there is no mention of specific measures adopted for urban poor accommodating their unique features. Moreover, due to living illegally on public land, government SSNP are not targeted for the slum HHs in the large cities (WFP,2002).

To design effective policy and programs for improving the food security status of the slum HHs, it is mandatory to understand the factors which contribute to increasing the severity of food insecurity. Some researchers have been conducted to understand the determinants of the presence of food insecurity among slum HHs, which did not focus on the determinant analysis of the depth of hunger among food insecure HHs. This research used the rich dataset of "Bangladesh - Urban Informal Settlements Baseline Survey (BUISBS) 2016 conducted by the World Bank, to identify the food insecure slum HHs in the Dhaka city based on their calorie intake. After that, the determinants of both the presence and depth of food insecurity were analyzed through Inverse Hyperbolic Sine (IHS) transformed Double Hurdle (DH) model. In the 1st step, per capita monthly expenditure; percentage of food expenditure; diet diversity; HH size; sex of HH head; number of female wage earner, children under five years and unemployed person within 15 to 64 years; proportion of adult female member and location of the slum, were identified as the significant factors determining whether a HH is food insecure or not. Whereas, the food gap among food insecure HHs was affected by some additional considerations: wealth index, source of drinking water, overall HH security and migration of HH head from abroad along with the factors of the 1st step. The outcome of the analysis can be used further by the government to adopt proper intervention to improve the food security condition of the different group of slum HHs based on their food insecurity severity.

1.3 Objectives of the Study

General Objective:

To explore the determinants of HH food insecurity among urban slum HHs of Dhaka city, Bangladesh

Specific Objectives:

1) To measure HH food insecurity in terms of diet quantity, diet quality, and economic vulnerability

2) To observe the demographic and socio-economic status of food secure and food insecure HHs

3) To explore the factors determining the presence and extent of food calorie gap among food insecure HHs

4) To propose policy and programs suitable to improve the food security status of the urban slum HHs

1.4 Rationale of the study

From the 1980s, the focus of food security analysis came down to HH level, as sufficient food supply per capita in global or national level does not ensure food security among all HHs and individual (Maxwell, 1996; Maxwell 2001). So the unit of food security analysis in this study has been chosen as the HH level. A HH is formed with one or more persons who live together, make common provision of cooking food, and took a meal together (BBS, 2015).

In Bangladesh, the undernutrition rates are higher among the urban slums and rural landless HHs, and they are identified as the most distressed population ((MoFDM, 2006). As already several research and programs were conducted in the rural area (IFPRI, 2007), this study focuses on the slum HHs of the Dhaka city. Dhaka was chosen as a study area, as it is burdened with the highest number of slums and slum population (BBS, 2015). Besides, the food security status has not improved in Dhaka from 2006 to 2013. The percentage of SSNP was also deficient among the slum HHs of Dhaka. The higher food prices and life expenditure have worsened the situation for the urban poor living there (WFP,2015).

In 2006, BBS conducted a survey and formulated a conceptual framework to analyze food insecurity determinants of the slum HHs in Dhaka, Chittagong, Khulna, and Rajshahi. The analysis was performed by OLS and logistic model with no focus on the depth of hunger among food insecure people (IFPRI, 2007). In 2013, the survey report on food insecurity among the urban slum HHs of Bangladesh focused on detail gender disaggregated profile of slum dwellers on livelihoods, dietary intake, water and sanitation, education, women's labor, and child-care

practices with no further food insecurity determinants analysis (WFP, 2015). Except for these two extensive studies, there has been lacking prominent research work done on the slum HHs food insecurity in Dhaka city. Besides, worldwide, most of the studies analyzing the urban slum HH food insecurity determinants analysis used the discrete choice logit model to investigate the factors which decide whether a HH is food insecure or not. But it loses information on the depth or extent of food insecurity, which is very important to understand while introducing an exclusive program with effective targeting to improve food security status of the heterogeneous slum HHs. So this study aims to intervene in this untapped area of research to understand the factors contributing to the presence and extent of food insecurity among slum HHs in the Dhaka city.

1.5 Scope and limitation of the study

The study aims to investigate the food security status of HHs in the slum area of the Dhaka city based on the secondary data consists of 580 samples. It used the latest food consumption table expressing the calorie of the local food item and adult equivalent (AE) number for Bangladesh while computing the HH calorie intake. The threshold energy requirement (2430 Kcal/AE/Day) recommended by FAO for Bangladesh has been used to identify the food insecure HHs. Whereas, the previous studies of slum HHs food insecurity, under the survey project of WFP, used 2122 Kcal/person/Day as the threshold which underestimated the food insecure HHs number. In this study, food insecurity was measured by five different indicators and FGT index not to miss any dimension of it. In the first stage, the factors determining food security status (food secure or not) were analyzed. The food gap varied a lot with a range from 25 to 1566 kcal/AE/Day for the food insecure HHs. So, in the second stage, the study even went further to check the factors which affecting the food gap among only the food insecure HHs. The factors and their effects were very different between these two stages. But the study results cannot be generalized; it only applicable for a particular slum area of Dhaka city and specific time 2016. The data set did not capture the individual food intake, and so the study failed to capture the true food consumption. The data was collected at a stretch for 14 days by overlooking the seasonal variation in HH consumption.

1.6 Organization of the study

The thesis consists of five chapters in total. **Chapter 1** focuses on the current situation of food security among urban slum in Bangladesh, the objective, scopes, and limitation and the justification of this research. **Chapter 2** contains detail review of literature on different food security indicators, empirical studies conducted on the determinant analysis of HH food insecurity, the use of Limited Dependent Variable (LDV) models in food security analysis and application of IHS transformed DH model in the related sector. **Chapter 3** formulates a conceptual framework for the urban slum HHs food insecurity determinant analysis. It elaborated the survey design, detail methodology of the measurement of the food security indicators, and the chosen econometric model with proper justification of using it. **Chapter 4** highlighted the results and discussion attained by applying the methodology stated in chapter 3 on the secondary dataset used in this study. **Chapter 5** proposed some recommendations which are based on the findings of chapter 4 and compatible with the country context.

Chapter 02

LITERATURE REVIEW

This chapter has provided an overview of the 1) different HH food security indicators, 2) some selected studies on the determinants of urban slum HH food insecurity in developing countries, where the selection was made on the basis of the compatibility with the study area context; 3)studies conducted in Bangladesh on the urban slum HH food insecurity; 4) the research gap in the food insecurity determinant analysis of the urban slum HHs; and 5)use of the LDV models to analyze the presence and depth of food insecurity and 6)application of Inverse Hyperbolic Sine (IHS) transformed LDV models in related fields.

2.1 Different HH food security indicators

Food security is a multidimensional concept which is difficult to capture through one single valid, reliable, and comparable indicator (Coates & Maxwell, 2012). To explore the food security status in HH level, per AE calorie intake is preferred as a standard indicator (Hoddinott & Yohannes 2002; Coates et al. 2007). Some other proxy indicators are also developed to capture different dimensions of food security (Maxwell et al., 2013). The quality of diet is measured by the indicators Diet Diversity Score (DDS) and Food Consumption Score (FCS). FCS was developed by WFP, which computes the number of consumed food groups and their frequency of consumption by HHs in the last seven days (WFO, 2008). DDS is a qualitative measure of the diet which checks the consumption of 12 different food groups with a 24 hours' recall period (FANTA, 2006). The percentage of income or expenditure spent on food consumption is also taken as a measure of food insecurity. Another indicator is the Coping Strategy Index (CSI), where HH can undertake strategy from a given list, in case of inadequate money and food availability (Maxwell & Caldwell 2008). HH Food Insecurity Access Scale (HFIAS) is one of the most widely used indicators which combines behavioral pattern and psychological anxiety for availing sufficient food (Swindale & Bilinsky, 2006). Derived from the HFIAS, the Household Hunger Score (HHS) is mainly adopted to measure food security in the area with severe hunger (Ballard et al., 2011).

2.2 Determinants of urban slum HHs food insecurity

The conducted empirical studies on urban slum HH food insecurity analysis is very scarce and limited. In this section, from some context relevant studies, the effort was put to highlight the adopted methodology of analyzing determinants of food insecurity among urban slum HHs and nature of the association between considered food security indicator and its determinants.

At first, the studies conducted on the slum HHs of the Vellore city, Northern part and New Delhi of India were reviewed. In these studies, the Household Food Security Survey (HFSS) questionnaire or experiential household food insecurity (HFI) was used to transform the dependent variable into a dichotomous variable as the food secure (0) and food insecure (1, for mild food insecure, moderately food insecure and severely food insecure) HHs. Multivariate logistic regression was adopted to calculate the odd ratio to see the association between factors and food security status. (Dharmaraju et al., 2018; Joshi et al., 2019; Chinnakali et al., 2014; Agarwal et al., 2009).

Dharmaraju et al. (2018) found out that, in the Vellore city, the significant determinants of HH food insecurity from logistic regression were socio-economic class, utilization of public distribution system (PDS), family size, and family type. The HHs were divided into "Upper," "Upper middle," "Lower middle," "Upper lower," and "Lower" socio-economic class by computing Socio-economic status (SES) score using objective scoring system of Kuppuswamy scale (2012) (Bairwa et al., 2013; Sharma &Saini, 2014). Food security status improved along with the higher SES score. HHs with high food insecurity was under the burden of debt, borrowed from the informal moneylender with interest rate even more than 100% in the absence of access to formal credit or loan.

In the urban slum of New Delhi, Joshi et al. (2019) identified the predictors (based on SDGs) of the HH food insecurity through the SMAART (S-Sustainable, M-Multisector, A-Accessible, A-Affordable, R-Reimbursable, T-Tailored) framework. The ANOVA and t-test were conducted for bivariate analysis to see the relation between average food insecurity score and independent categorical and continuous variable. Chi-square tests of significance were performed to analyze the difference between food insecure groups. Without any absolute quasi causal claim, the logistic regression identified that the highest level of education attained in HH (SDG4), healthcare coverage(SDG3), Water Sanitation and Hygiene (WASH) practice (SDG6), electricity needs (SDG7), employment needs (SDG8), HH size, presence of disable

member and general safety of women were significantly associated with food insecurity of the slum HHs.

In another study of Agarwal et al. (2016) in the New Delhi slums, two variables: unemployed to employed family members' ratio and low standard of living came out as the significant factors affecting experiential HFI. The Standard of living index (SLI) was computed by summing up the score of drinking water, types of house, source of lighting, fuel for cooking, toilet facilities and ownership of items: fan, radio/transistor, sewing machine, television, bicycle, motorcycle, car, tractor. Cronbach's alpha and Rasch model-based item fit statistics were calculated to ascertain the reliability and internal validity of HFI measure. Independent variables which had been taken into consideration in the beginning were: religion, family size, respondent's literacy level, the literacy level of HH head, unemployed to employed ratio, monthly income, HH Monthly Per Capita Expenditure (MPCE) on food and SLI. Univariate descriptive statistics, bivariate associations of food insecurity with all these variables were observed to select variables to be finally put in the regression.

While choosing independent variables for food security determinant analysis of the slum HHs in northern India, Chinnakali et al. (2014) put each variable alone to regress with the dependent variable and those having p-value at least 0.25 were taken into consideration to include in the logistic regression. The higher education level of adult women, monthly per capita income and the number of earning member had lowered the odds of being food insecure HHs. Though 53.2% of the respondents had a ration card, they denied being the recipient of the PDS due to inadequate quantity and inferior quality of the food items. Half of the monthly income of the food insecure HHs was dedicated only for food consumption. Their diet consisted of a high proportion of cheap carbohydrate with an insufficient amount of pulse and fruits.

Like in India, Akinloye et al. (2016) also analyzed the food insecurity determinants of the poor HHs, in the Atteridgeville, Soshanguve, and Tembisa area of the Tshwane city in South Africa, by applying the logistic regression and using the HFIAS as an indicator of food security. From the result, it was evident that the HHs with better income, higher education, and formal employment of HH head were more likely to be food secure. The high HH size, child proportion (below age five) and dependency ratio resulted in the higher odds of being food insecure.

In Ghana, Tuholske, et al. (2018) measured the food security among the low and middle income HHs by three indices: HFIAS, Household Food Insecurity Access Prevalence (HFIAP), and

FCS. But high correlation was not found among these indicators. FCS captured only 2% HHs as food insecure, whereas through HFIAP, almost 70% HHs were identified as food insecure. Through applying general linear models for each index, HH education, assets, and dwelling characteristics were identified as significant determinants of food security.

Gebre (2012) calculated the per AE per day calorie intake and compared it with national threshold 2200 kcal/AE/day to identify the food insecure, poor HHs in the Addis Ababa city of Ethiopia. Moreover, by using the Foster-Greer-Thorbecke (FGT) index, the depth and extent of food insecurity were assessed. The logistic regression was applied to conclude that low HH size; higher education and asset possession; better access to credit; employment and income opportunities were effective factors to improve food security.

Hall (2014) prepared a survey report conducted in the Afghan cities. From the result of computed HFIAS, it was clear that the anxiety about food availability and compromising with hunger were common features among the urban poor. The internally displaced people living in the informal settlement were found to be more vulnerable than others. Lack of male wage earner, non-diversified income source, informal nature of employment, presence of the addicted member, disability of a member, and lower level of education came out as contributing factors of food insecurity. Besides, low-quality sanitation, lack of awareness about hygiene and unsafe food preparation raised the risk of food insecurity of the children under five years.

2.3 Determinants of urban slum HHs food insecurity in Bangladesh

BBS surveyed 1,900 slums HHs in Dhaka, Chittagong, Khulna and Rajshahi in 2006 to analyze urban slum HHs food insecurity. To serve the purpose, four food security indicators were regressed with different models, against the same set of dependent variables. The 1st food security indicator, calorie consumption sufficiency ratio for HH with threshold value 2,122 Kcal/person/day, was a continuous variable, and OLS regression was used for this. The 2nd, 3rd, and 4th indicators were binary variable: calorie consumption sufficiency tercile, DDS, and HFIAS for which logistic regression was preferred. Large HH size and higher dependency ratio contributed to increasing the odds of food insecurity. The food secure and food insecure HHs did not vary in type of employment of HH head. Instead, they differed in the average hourly wage rate. The possession of asset and reliance on neighbors and relatives worked as a buffer against food insecurity during economic shocks (IFPRI, 2007).

With this continuation, WFP conducted a follow-up survey in 2013 in the slums of Dhaka, Barisal, and Sirajganj to see the change in the food security status of the HHs from 2006. Using the same calorie threshold value, still, almost 50% of slum HHs remained food insecure. Access and nature of participation in the labor market played major role in determining the food security status. But in the labor market, women faced massive inequality in wage and work hour. The price hike was a shock on food security in all the slums of three cities, which was worsened further due to the very limited SSNPs in the urban area (WFP, 2015).

In the slums of Rajshahi city corporation, Jakaria et al. (2015) identified the 87% food insecure HHs based on the HFIAS and analyzed the food security status by different socio-economic characteristics of the HHs using descriptive statistics. The study recommended introducing special SSNPs and income generating activities for the slum HHs to improve their food security status.

2.4 Research gap in food insecurity determinant analysis studies of slum HHs

In almost all the studies conducted on food insecurity determinants among urban slum HHs, mostly discrete choice logistic model has been used to examine the variables. But the logistic model only defines whether the HHs are food secure or not. The factor determining the depth of food insecurity among food insecure HHs, which is one of the objectives of this research, is not a well-explored area. Very few research works used LDV models (mostly Tobit, DH and Heckman), through which it was possible to explore the presence and intensity of the food insecurity among HHs. But in the context of urban slums HHs, the use of LDV model is almost negligible. Besides, two-stage LDV models assume the bivariate normal distribution of the error terms. If this assumption is violated, the estimation will be inconsistent. Yen and Jones (1997) introduced the IHS transformation of the dependent variable in the DH model to relax the restrictive assumption. Though this solution has been highly adopted in the field of food consumption and willingness to pay (WTP) related studies, its usage in the area of food security determinant analysis is mostly missing. To tap into this unexplored zone, this study has applied at first general DH model, and finally, IHS transformed DH model to understand the factors determining the depth of food insecurity among the food insecure urban slum HHs of Dhaka city.

2.5 Use of LDV model in food insecurity determinants analysis

Chileshe (2013) explored the determinants of existence and extent of rural HHs food insecurity by using DH model on a sample of 6,556 HHs in Zambia. Food insecure HHs were identified by comparing actual calorie intake to threshold calorie intake 2100 Kcal/AE/day. The DH model with 1st tier probit and 2nd tier truncated regression had been applied to determine whether a HH was food insecure or not (a dichotomous choice); and the factors affecting the extent of food insecurity (a continuous variable) among food insecure HHs respectively. From the 1st tier, HH size, education level, and age of HH head, off-farm income, access to extension services, and dependency ratio emerged as significant factors. Whereas, in the 2nd tier, the considerable factor list came down to only HH size, education level of HH heads, off-farm income, and access to farm inputs. Besides, the FGT index was calculated to express headcount ratio, food insecurity gap, and severity of HHs.

Kamau et al. (2011) analyzed the prevalence and depth of food insecurity among the HHs in Nairobi, Kenya, by using Heckman model. The HHs consuming less than 1,600 Kcal/person/Day were selected as food insecure. At first logistic model was applied to explore factors affecting food security status. It was evident that male-headed, single parent, large HHs with low per capita expenditure had higher odds to become food insecure. The factors determining the depth of hunger among food insecure HHs was assessed through subset sampling of only food insecure HHs. To correct the sampling bias, Heckman two-step estimation was applied, and the inverse mills ratio (IMR) was introduced. For this stage, a reduction in per capita food expenditure was selected as a proxy indicator of food insecurity. The increasing number of dependent adults decreased the food expenditure, whereas, the high infant ratio increased the food expenditure due to consuming more dairy products.

Sani and Kemaw (2019) used Tobit model to find out the determinants affecting the calorie intake among food insecure HHs of the Assosa zone in western Ethiopia. The dependent variable was the calorie intake (Kcal/AE/Day), and it was censored by imposing the upper limit of energy requirement threshold (2100 kcal/AE/day) to exclude the food secure HHs. The considered factors in the Tobit model were sex, age and education level of the HH head, HH size, dependency ratio, livestock holdings, cultivated land, access to irrigation and training, farm and non-farm income, access to credit, remittances and distance to market. The study also

calculated the FGT index to conclude that on an average, each HH needed 353.64Kcal/AE/day to gain the food secure status.

2.6 Application of IHS transformed LDV models in various field of research

Yen and Jones (1997) introduced IHS transformation of the dependent variable in DH model in the study of analyzing the determinant of cheese consumption among food stamp recipient and non-recipient USA citizen which helped to allow the heteroskedastic and non-normal distributed errors without any biases in estimation. Chen et al. (2018) also applied an IHS transformed DH model to explore the climatic, regional, and ethnic determinants of mutton consumption in the urban area of China.

Chiwaula et al. (2018) examined the gender difference in willingness to pay (WTP) for group-owned fish solar tent dryer (FSTD) using DH model. At first, the Tobit model was considered and the dependent variable (WTP) was censored with lower limit zero. Then Tobit model was compared with the DH model through the log likelihood test (Lin & Schmidt 1984; Martínez-Espiñeira, 2006). The tests allowed to select the DH model as the better one. The problem of the presence of heteroscedasticity and non-normality of error terms was overcome by the IHS transformation of the dependent variable (Newman et al., 2003; Sinnig, 2011).

The implication of the IHS transformation of the dependent variable can increase the robustness of the LDV model if the model violates the assumptions of homoscedasticity and normality of errors.

Chapter 3

METHODOLOGY

This chapter is divided into four main parts namely; 1) **conceptual framework** which described the context of urban slum HHs and prepared a framework of the food insecurity determinants analysis for them; 2) **survey design and data** which highlighted the sampling technique and the critical features of the secondary data; 3) **food security indicators and variable selection** which elaborated detail methods of computing different food security indicators and choosing the dependent and independent variables for HH food insecurity determinant analysis; and 4) **the econometric model** which emphasized the strength and justification of choosing the adopted model in step by step.

3.1 Conceptual Framework

To assess the presence and depth of food insecurity in the HH level, a conceptual framework is required based on which some indicators can be selected and measured.

3.1.1 Food security and its dimensions

According to the FAO (2002), "*Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*." The definition of food security emphasized on the main four distinctive dimensions:

The 1st dimension is the availability of food for all individual consistently in terms of quantity (energy) and quality (diversity of diet) which is free of toxic elements and meets up to the taste and preference of each individual (FAO,2008).

The 2nd dimension refers to physical, economic, and social access to a sufficient amount of food. Physical access depends on the proximity to the food market, infrastructure and storage facility, security, political, and legal stability (FAO-FSAU, 2005). Economic access defines whether the HH has enough resource to acquire the food demanded or not via their assets, wage level, and employment (USAID, 2012). Finally, when different ethnicity, religion, and political affiliation offers equal access to food, it ensures social access to food (FAO, 2002).

The 3rd dimension is the utilization of food through proper biological use so that the food intake can serve as the best way to provide sufficient energy and nutrients. Knowledge of food preparation, nutrition, and storage; care behavior, especially for children; quality of potable water and sanitation are some essential factors to determine the level of food utilization (Sassi, 2017).

The 4th dimension is the stability of food supply throughout the year. For HHs, both in the rural and urban area, seasonal variation is a prominent difficulty to deal with through coping mechanism and adaptive strategies (FIVIMS, 2003; WFP, 2002).

In this study, the factors determining the urban slum HHs food insecurity have been chosen based on these pillars of food security.

3.1.2 Household (HH) level food security

Food security can be analyzed in global, national, HH, and individual level. The study mainly focuses on the HH level analysis. According to Sassi (2017), "*Food security at the household level is reached when the household's entitlements are greater than or equal to its food needs in terms of energy requirements*." The entitlement concept was given birth by Amartya Sen (1981) as "*the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces*." The precise definition of energy requirement has been stated as "*the level of energy intake that will balance energy expenditure when an individual has a body size and composition and level of physical activity, consistent with long-term good health; and that will allow for the maintenance of economically necessary and socially desirable physical activity. In children and pregnant or lactating women, the energy requirement includes the energy needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health*" (FAO/WHO/UNU, 1995).

3.1.3 Food security indicators from HH Expenditure Survey (HES)

In this study, food security indicators have been calculated following the guideline of measuring food security from HH expenditure surveys (HES), provided by WFP (Mathiassen et al., 2017). According to this guideline, the food security indicators fall into three broad categories:

- Diet quantity measured by individual daily calorie intake and food energy deficiency of HH
- Diet quality measured by Diet Diversity Score (DDS) and Staple Share (SS)
- Economic vulnerability measured by food expenditure share and poverty line

Food security indicators have been measured for the HHs covering all three broad categories to get a comprehensive picture of the situation. The steps have been detailed out in **section 3.3**.

3.1.4 Conceptual framework of food security determinants for urban slum HHs

The conceptual framework is based on the three pillars of food security: food availability, food access, and food utilization. The secondary data used for this study was collected only for 14 days of the reference period. So the study could not take the 4th dimension 'stability' into consideration. The framework was designed based on the conceptual framework prepared for urban poor HH food security determinants in Bangladesh (IFPRI, 2007) and the framework linking fundamental pillars of food and nutrition security at the HH and individual level (Sassi, 2017). In the **figure (1) of Annex 1**, the boxes with a dotted outline are those variables, which could not be included in the analysis due to their absence in the secondary data.

The slums take shape according to the historical development of a city and its linkage with the rural area; land tenure system; and the existence of employment opportunity along with the presence of informal and formal safety nets. Urban slum HHs hold some distinctive characteristics. The slum HH size is challenging to understand due to the presence of seasonal relatives from the rural area and non-family member engaged in home-based business (WFP,2002). The community of slum also cannot be defined only by geographical proximity because of the heterogeneity and inequality in the economic status of HHs within the same neighborhood (Ruel et al., 1998). So while formulating the conceptual framework, the uniqueness of the urban slum HHs was kept in mind.

- **Food sources and diet pattern**

Almost 90% of the food of urban HH is purchased from the market, unlike rural HHs who mostly produce their own food (Maxwell et al. 1998). Urban agriculture is challenging for the city with huge density due to scarcity and high price of land. The urban poor neighborhood has limited access to commercial food store due to the lack of aggregate demand and purchasing power of the poor (Ruel et al.,1998; WFP,2002). In 2006, only 4.5% of urban slum HHs of Bangladesh was reported for receiving any benefits from social safety net food assistance

programs (IFPRI, 2007). The slum and squatter dwellers are mostly living illegally in the public land, moving in nature due to overnight eviction and not registered in the municipality. Government tends to discourage this illegal set up by not targeting them for any social assistance. Informal safety nets prevail among urban poor in the form of food sharing, barter, and money lending. In hard times, the undertaken strategies by slum HHs include diversifying income source, utilization of all female labor, selling assets, consuming cheaper and less nutritious food, migration, buffering nonfood expense and so on (Leslie& Paolisso 1989; Aguirre 1994). The diet pattern of the urban area is quite different than rural diets due to the presence of a high number of cheap substitute goods and time-saving readymade street foods (Ruel et al.,1998).

- **Income and employment**

The employment of urban poor is highly dependent on utilizing the labor in the informal sector, which is seasonally variated and poorly remunerated. The dependency on informal sector employment makes the HHs more susceptible to food insecurity. One remarkable difference between the slum and other types of HH, is the extremely high participation of women in the labor market with low wage and as freely used family labor (WFP, 2002; Ruel et al.,1998).

- **Health, caregiving, and Water, Sanitation and Hygiene (WASH) practices**

The high rate of maternal employment in the slum HHs results in a compromise in the quality of child care like lower breastfeeding, buying unhealthy readymade food, less attention on the child's growth, etc. But in some cases, the extra income earning of women can contribute to afford high-quality food and health care. (Ruel et al., 1998). The urban slums are built upon the waste ground with the low endowment of natural resources and low-quality public service. Lacking standard public water, sanitation, drainage, and sewerage system on these sites, contribute highly for food contamination and health deterioration (WFP, 2002). This is why the conceptual framework put detail emphasis on WASH practices.

Alongside the factors based on the three food security dimensions, some widely used HH factors like sex and age of HH head, HH size and number of children; have been considered in the conceptual framework.

3.2 Survey Design and Data

The study has used the secondary data collected by the World Bank titled "Bangladesh - Urban Informal Settlements Baseline Survey (BUISBS) 2016". The study area profile and adopted sampling technique by the world bank for BUISBS survey (Pagans,2017), are shortly described below.

3.2.1 Sample Selection

- **Target Population**

The target population of the BUISBS was the slum HHs in the Dhaka city corporation (DCC) area, identified from the BBS slum census 2014. There is a total of 3,360 slum communities with more than five HHs in the DCC area, which has been considered as Primary Sampling Unit (PSU). The sampling frame was also prepared based on the outcome of BBS slum census 2014 (BBS,2015).

- **Study Area**

The Dhaka city corporation (DCC) precisely defines the urban area which comprises of two parts, namely Dhaka north (DNCC) with 56 wards and Dhaka south (DSCC) with 36 wards (**figure 2 of Annex 1**). Dhaka city accounts for the largest share economy of the whole country and flooded with the high number of readymade garments (RMG), national and multinational industrial establishment. The city is the most unequal place of the country for being the home of the highest number of the richest and the poorest people together at the same time with disproportionate land use distribution and ownership; service and infrastructure, housing, health, transportation and safety (Ahmed et al., 2018).

Table 3.1: Study area profile (DCC area)

Variable	Description
Area	191.881sq. km.; DNCC: 82.63 sq. km. and DSCC: 109.251 sq. km (2018)
Population	7.85 million; DNCC: 3.88 million and DSCC: 3.97 million; density 40,911/ sq. km (2018)
Below poverty line	34% of total population (2013)
Language	Bengali
Religion	90% Shunni Muslim, Hindu the 2nd practiced religion and very negligible number of Christians and Buddhists
Literacy rate	74.6 % (2011)
Unemployment rate	4.81% (2017)
Life Expectancy (at birth)	72 years (2017)

Source: DNCC,2017; DSCC, 2018; The Daily Star,2017; The Daily Star; 2018; World Population Review, 2019

- **Sample Size**

The slums of DCC were divided into three strata: 1) Strata one: small size slums having 5-10 HHs; 2) Strata two: medium size slums having 11-200 HHs; and 3) Strata three: large size slums having more than 200 HHs. Then, in total, 600 slums HHs were selected, where ten slum HHs were taken from each 57 medium and large size slum communities, and five slum HHs from each six small size slum communities. But after collecting the data, finally, 588 HHs were retained with proper information. The study used 580 sample HHs for all analysis, as the other 8 HHs were identified as an outlier in calorie consumption with an exceptionally high level of calorie intake, especially in the context of the slum. When investigated further, these HHs responses showed more presence of 'others' than the exact food item name and quantity, which hampered the precise calculation of calorie intake for them.

Table 3.2: Number of Slum Communities and HHs in the CSAFP by BBS and the BUISBS sample

Stratum		BBS Slums Census				BUISBS sample		
		Slums		Households		Number		
ID	No. households	Number*	Share	Number*	Share	Slums	Households**	Cluster size
1	5-10	1,011	30.1%	7,801	4.4%	6	30	5
2	11-200	2,205	65.6%	70,481	40.1%	27	270	10
3	201-plus	144	4.3%	97,610	55.5%	30	300	10
	Total:	3,360	100.0%	175,892	100.0%	63	600	-

Source: Pagans, 2017

- **Sampling Technique**

Total 3360 PSUs were allocated across strata using Probability Proportional to Size (PPS) technique, where the number of the slum HHs was used as the measure of the size and accounted for determining cluster size of 10 HHs per PSU for medium size slum communities and five slum HHs per PSU for small slum communities. In the first stage, the slum communities from each stratum were selected with a replacement ratio of 2:1, 1:2 and 1:3 for slum communities of stratum one, two and three respectively. In the second stage, if the selected slum community of stratum one has only five HHs, all of them were surveyed. In case of more than five HHs in stratum one, systematic equal probability (SEP) sampling was used to select 5 HHs. For slum communities of stratum two, 10 HHs from each were chosen again with SEP sampling. In stratum three, there are blocks of around 200-250 slum HHs in each slum community. From the slum community, a block was randomly chosen and from that block, 10 HHs were selected through SEP sampling.

3.2.2 Description of Data

To assess food security indicators and its determinants, the primary need is a good quality and reliable data set. The BUISBS has followed the methodology used by the BBS to collect detailed HH consumption data using the structure of HH Income and Expenditure Survey (HIES). The data set is a multipurpose data concentrating on various aspects like general HH information; housing characteristics; utility facilities; Water Sanitation and Hygiene (WASH) practice; detailed food and nonfood consumption and expenditure; and possession of durable goods. The unit of recording food consumption data was at HH level which included food item, food quantity (in gram, millimeter, number, and cup), monetary value (in BDT) and source (purchase, wage in kind, gift, self-production). Some features describing the strength and weakness of the food consumption and expenditure data is discussed below, as this part of the data set is the primary concern of our study.

- **List of food items used in the questionnaire**

The food consumption list in the questionnaire comprised of a very detail list of foods with 148 items under 17 groups (**table 1 in Annex 1**) which make up the country's usual diet. It also included the option ‘others' for each food group, not to miss any food item. The list took into

consideration the readymade food while dining outside. The list collected food intake data of a HH on that specific day as a whole, not categorized according to the meal (breakfast, lunch, dinner).

- **Recall and reference period of data collection**

FAO and The World Bank guideline suggested maximum of seven days' recall period for HHs consumption and Expenditure Survey (HCES) in low and middle-income countries (FAO & WB, 2018). The BUISBS collected food consumption data of 14 days by enumerator based on a small recall period of two-days by visiting each HH seven times. Generally, to obtain the accurate HH food consumption data, maintaining a food diary is considered as the gold standard. But as the survey was conducted in low-income slums, where the majority was supposed to be illiterate, recall interview is preferred in such case over food diary (FAO &WB, 2018).

- **Seasonality**

As mentioned earlier, the data was collected at a stretch of 14 days; it failed to take into account the seasonal variation in food consumption. But urban area food insecurity also has a seasonal dimension based on different factors than the rural area, which should be taken into consideration (WFP, 2002).

- **Food acquisition and consumption**

The data set has followed the systematic approach and structure of HCES where data reflects the quantity of food acquired by the HHs, not the real consumption. For capturing the true food consumption, food intake data of each for both HH and non-HH member who take a meal together should be collected.

3.3 Food Security indicators and variable selection

3.3.1 Measuring Food Security Indicators

Based on section 3.1.3 of the conceptual framework, the detailed methodology of calculating different food security indicators measuring diet quality, diet quantity, and economic vulnerability of HH have been described here. Further, to understand the extent and depth of food insecurity, the Foster-Greer-Thorbecke (FGT) index has been computed for the sample (Chileshe, 2013; Sani & Kemaw, 2019). In most of the food insecurity determinants studies on

the urban slum, HFIAS or FCS or calorie intake was considered as a single indicator of food security which does not give the whole picture. It is recommended by WFP to observe correlations among different food security indicators to validate food security measurement (WFP, 2008). The study attempted to compute all possible food security indicators from the HIES dataset, which enabled to visualize a whole scenario of food security among the slum HHs in respect with different dimensions.

3.3.1.1 Indicator for measuring diet quantity

The diet quantity was expressed by the value of daily calorie intake per AE per day for each HH. To identify the food secure HH, the observed calorie intake was compared with the threshold energy requirement for Bangladesh, which is 2430 Kcal/AE/Day (FAO & WHO, 2014). Moreover, the food gap per AE for each HH was also determined by subtracting the observed calorie intake from the energy requirement. The steps of calculating Kcal/AE/Day for each HH, were adopted from the guideline of "Analyzing Food Security Using Household Survey Data" by the WB and FAO (Moltedo et al.,2014). The steps are briefly described below:

Step 01: Standardization of the food quantities into grams or milliliters equivalent

The latest food consumption table for Bangladesh was produced in 2013, by the University of Dhaka under National Food Policy Capacity Strengthening Programme. In this table, the calorie of each food item is presented per 100 g edible portion of fresh weight (Shaheen et al., 2013). Therefore, the first important step was to convert all food quantities into grams. For the unit of measurements like cup or number, standard weight in gram for each cup or number of that food item has been considered. To convert from milliliter (ml) to gram, the formula was applied:

Food quantity (gm)= Food quantity (ml) *density (g/ml)……..(1)

For example, the density of milk is 1.026 g/ml. So for 100 ml milk, the quantity in gram will be 100 ml*1.026= 100.026 gm.

Step 02: Adjustment of Food Quantities for Nonedible Portions

In the survey, HHs responded about the food quantity as the purchased quantity. But this quantity incorporates some nonedible portions comprising of peels, skin, bones, seeds and so on. So the amount reported for each food item (i) was transformed in edible quantity by using the edible coefficient from the food consumption table for Bangladesh.

(Edible Food Quantity) $_i$ **= (Reported Food Quantity)** $_i$ *** (Edible Coefficient)** $_i$ ……(2)

Step03: Calculating calorie for each item

The calorie intake (in Kcal) of HHs from each food item (i) was calculated for 14 days by the formula:

Food calorie $_i$ **(Kcal) = {(Edible Food Quantity)**$_i$ *** Calorie of food item i per 100 gm edible portion}/ 100** ……(3)

For some small number of the readymade non-local food item, the food consumption table for Bangladesh does not contain the energy value. The "fatsecret India" calorie sheet has been used to measure the calorie for those items, as Bangladesh shares a homogenous food preparation style mostly with India than any other country (fatsecret, 2019). Precisely, in total, 5.79% responses fell under the category named ‘others' from each food group. For ensuring the lowest dispersion in calorie calculation, this study has replaced each ‘others' from a food group, by the mean calorie acquired by the HH from that particular food group.

Step04: Estimation of Kcal/AE/Day

The adult equivalent for each HH was calculated based on age, the gender of HH member, mean body weight for a particular age in Bangladesh and a moderate level of physical activity by using the study of Waid et al. (2017). Finally, the mean calorie intake (Kcal) of 14 days was divided by total AE for each HH to get the Kcal/AE/Day.

3.3.1.2 Indicator for measuring diet quality

Calorie intake sufficiency is not enough to ensure food security. A healthy, nutritious, and balanced diet is vital to achieve food secure status. The diet quality has been measured by two indicators DDS/HH/Day and SS.

- **Diet Diversity Score (DDS)**

The DDS, a qualitative measure, reflects the HH's access to a variety of food groups as a proxy of their nutritional adequacy. According to the FAO guideline, 12 food groups are used for HH level DDS calculation. These 12 food groups are cereals; white root and tubers; vegetable; fruits; meat; eggs; milk and milk products; fish and seafoods; legumes, nuts and seeds; oil and fats; spices, condiments, and beverages. All food groups have the same relative weight of 1

and the same score '1'. The number of each food groups consumed by the HH during the reference period is counted. The DDS per day ranges from 0 to 12, and the mean has been used as the cut-off for determining low dietary diverse HH (FAO, 2011).

- **Staple share (SS)**

The SS represents the percentage of calorie consumed from staple food groups (cereals, roots, and tuber) by HHs over a reference period. It was calculated by dividing the total calories consumption of each HH from food grains and roots by the total calories consumption of each HH from all 17 food groups. The higher the value of SS express lower diversified diet of HHs. According to IFPRI, if the HH fulfills its calorie need mostly from the cheap food grains, it mainly consumes a high level of carbohydrate and suffers from protein and micronutrient deficiency (Smith & Subandoro, 2007).

Table 3.3: IFPRI suggested threshold of SS

% of food energy from staple	Diet Quality
75+	Very high (Very Poor Diet Quality)
60-75	High
40-60	Medium
<40	Low

Source: Mathiassen et al., 2017

3.3.1.3 Indicator for measuring economic vulnerability

The survey questionnaire included the price in local currency (BDT) of each food item consumed by the HHs in 14 days. It also recorded all the monthly and yearly nonfood consumption and expenditure in a very detailed manner. One highlighting fact is that the non-purchased food and nonfood items acquired by HHs were converted into monetary value transactions. The food expenditure share estimated the percentage of total expenditure which was spent on food by each HH on a monthly basis (Mathiassen et al., 2017). HH can be divided into the different levels of economic vulnerability based on the percentage share spend on monthly food expenditure:

Table 3.4: IFPRI guidance for interpreting food expenditure relative to total expenditure

% of Food Expenditure	Food expenditure share group
75+	Very high economically vulnerable
65-75	High
50-65	Medium
<50	Low

Source: Mathiassen et al., 2017

3.3.2 Foster, Greer and Thorbecke (FGT) Index

The FGT index was introduced to analyze headcount ratio, depth, and severity of food insecurity in comparison with energy requirement threshold (Chileshe, 2013; Sani and Kemaw, 2019). Through this index, three separate indicators can be obtained which are: 1) the number of slum households below the food security line 2430 Kcal/AE/day (headcount), 2) the extent of the shortfall of the Kcal of the food insecure from the food security line (food insecurity gap) and 3) the exact pattern of distribution of the kilocalorie of the food insecure households (squared food insecurity gap)

$$F(\alpha) = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{(m - y_i)}{m}\right]^{\alpha} \quad \text{.....(4)}$$

n= number of slum households (sample)

yi= calculated Kcal/AE/day of the ith household

m= food poverty line (2430 Kcal/AE/day)

q= number of food-insecure households

a = weight attached to the severity of food insecurity; if a=0, F(0) is Headcount ratio ; if a=1, F(1) is food insecurity gap and if a=2, F(2) is squared food insecurity gap

3.3.3 Selection of variables

- **Dependent Variable (Y)**

In the HH level, food security analysis, calorie intake (Kcal/AE/Day) has been considered as "gold standard for food security measurement (Hoddinott and Yohannes 2002). So, among three types of calculated food security indicators, the calorie intake gap (Kcal/AE/Day) has been used as the dependent variable (Y). The Y variable is a continuous variable ranging from -1816.502 to 1564.628 Kcal/AE/Day with a mean of 319.57 Kcal/AE/Day, where positive values denote food insecure HHs.

- **Independent Variables (X)**

In the first stage, the independent variables (X) were mainly selected in combination with empirical literature reviews and the conceptual framework (figure 3.1). The variables were organized based on the three pillars of food security: food availability, food access, and food utilization.

In the second stage, each considered X variable was regressed against the Y variable one by one alone (Chinnakali et al., 2014). Any X variable with p-value higher than 0.25 were excluded in this round. But before removing any categorical X variable, ANOVA test was performed to observe the significance in the association between Y and X variable. To be entirely sure before removing any categorical X variable, the further association between Y variable and all possible combination between categories of that X variable was observed through the command "pwmean Yvariable, over (Xvariable) mcompare (tukey) effects" in STATA. If any combination of categories of the X variable failed to show a significant effect, the variable was removed from further analysis.

The high correlation among X variables can cause the problem of multicollinearity, which generates bias coefficients of X variables. To avoid this problem, the correlation among all numeric X variables were observed through the correlation matrix. Any X variable having a correlation value more than 0.5 was excluded from further analysis. As a complementary tool to diagnosis the multicollinearity among continuous variable, the Variance Inflation Factor (VIF) test was conducted after running linear regression between Y and X variables. The VIF

value with more than 10 expresses the presence of strong multicollinearity (Yoo et al., 2014). In the case of categorical X variable, the chi-square test has been performed among the related group of variables with 95% confidence level to observe their association between each other. After completing all the stages, finally, the X variables were selected to include in the final analysis of food insecurity determinants, which has been described in detail in Chapter 4. Only detail methodology of one X variable 'wealth index' has been described below:

- **Formulation of Wealth Index (WI)**

WI has been identified as a reliable measure of living standard and long term economic condition, especially for HHs from low-income group. Because the poor HHs are engaged in the informal activity, lacks a fixed income over the year, involved in barter, gift or wage in-kind type of transaction for food consumption and invest once in a year in durable asset spending. So a snapshot of income or expenditure of them fails to express their actual living standard (Moser & Filton, 2007). Principal component analysis (PCA) is the most widely used tool to combine different binary asset indicator and impose accurate weights to form a relative wealth index. It is a variable reduction process which removes redundancy or duplication from a set of correlated variables and develop a smaller set of 'principal component' variables.

But now a better technique polychoric PCA is being used instead of general PCA, as it is more flexible by allowing ordinal categorical variables which reduce the loss of information by turning all variables into binary ones. It also gives more accurate estimated coefficients of ordinal variables than regular PCA (Kolenikov & Angeles, 2004). The steps to formulate WI through polychoric PCA are described below based on the steps defined by the WFP (Hjelm et al., 2017):

1) Select variables

At first, all the possible variables were identified from the dataset and incorporated in the WI formulation representing three categories: productive assets, nonproductive assets, housing condition, and utilities.

2) Basic Cleaning of data

WI mainly expresses the relative wealth among HHs. So, if any asset variable is present or absent in almost all of the HHs, that asset variable will not create any relative difference in HH wealth. This kind of variable must be excluded from index formulation. For example, in our study, only three HHs owned washing machine among 580 HHs. So it is clear that possession of washing machine must be eliminated from the analysis. Generally, the thumb rule is that if one asset is possessed or not possessed by 95% of respondents, that variable should not be included (Hjelm et al., 2017).

Table 3.5: Selection of variables for WI

Productive Asset	Non Productive Asset	Housing condition and Utilities
Sewing Machine	Radio	**Housing Condition:**
Boat	**TV**	
Rickshaw/Pushcart	**Fridge**	**Home ownership**
Computer	Bicycle	**Type of house**
Agricultural Land	Motorbike	**Number of room**
	Cassette player	**Drawing room furniture**
	VCR/DVD	Bedroom furniture
	Camera	**Dining room furniture**
	Fans	**Floor Material**
	Washing Machine	**Wall material**
	Heater	Roof material
	Dish antenna	**Utilities:**
	Pressure lamps	Source of water supply (drinking)
	Carpet	Type of toilet
	Kitchen Items Cutlery	Type of cooking fuel
	Kitchen items crockery	Source of light
	Micro oven/Kitchen Items-Cooking	Type of cooking stove
	Watch/wrist watch	**Sharing of toilet**
	Mobile	**Sharing of water source**
		Sharing of kitchen

Source: BUISBS,2016

*** The variables in the bold style were chosen finally in the formulation of WI*

3) Recoding the variables

Following the polychoric PCA methodology, all the categorical variables were recorded in ordinal numbers where higher value expressed wealthier HHs. For example, if one HH possesses a fridge, the response value will be 1 and 0 otherwise. In case of roof material, the bamboo/wood response has been recoded as 1, tin as 2 and cement/brick as 3, which means the better the quality of material, the higher is the value of the response.

4) Checking the quality of selected variables and justification of using polychoric PCA

To find out the correlation among ordinal variables, the polychoric correlation was performed. Generally, the correlation value (r) among retained variables should be within 0.1 to 0.7 range.

Factor test was also conducted to decide whether the retained variables are correlated enough to run factor analysis or not. The result of the factor test confirmed the appropriateness in terms of correlation among the retained variables. Moreover, the computed Kaiser-Meyer-Olkin (KMO) value for the dataset was 0.755 which perfectly justified the use of polychoric PCA to formulate the WI, as the preferred minimum KMO value is 0.6 (Hjelm et al., 2017).

5) Determining the number of factors

The factors having eigenvalue more than one were kept for index formation and visualized through scree plot. In the analysis, the first four factors having eigenvalue more than 1, explained 73.13% variance in the wealth of the HHs.

6) Predicting wealth index and formulating wealth quantiles

The polychoric PCA attaches coefficients along with all the variables used to formulate the WI. The coefficient can be positive, negative, and zero. The higher the value of coefficient, the more the variable provides information on explaining the wealth of HHs. The predicted WI is a continuous number which can be turned into an ordinal variable by creating wealth quantiles.

3.4 Econometric model

The study has adopted the LDV model, namely, the double hurdle (DH) model with IHS transformed Y variable, to determine the factors affecting the presence and depth of food insecurity among food insecure HHs. The justification of using the selected model is described in step by step below:

- **Justification of choosing LDV model over ordinary least square (OLS) model**

This study intended to focus on the depth of food calorie gap among the food insecure slum HHs. In the study75.52%, slum HHs were identified as food insecure HHs. If the focus needs to put only in this 75.52% of HH, subset sampling should be applied. So, OLS will produce biased estimator, as the sample will not be any more random. To focus only on the food calorie gap of food insecure HH, the Y variable need to be censored with a lower limit of 0. When the Y variable needs to be censored with some threshold value, the LDV model must be applied instead of OLS (Woodridge, 2003; Kamau et al.,2011; Katchova, 2013).

- **Justification of choosing Double Hurdle (DH) LDV model over Tobit LDV model**

Among various LDV models, most commonly used one in social science is the censored normal regression or Tobit model developed by Tobin in 1958 (Smith & Brame, 2003). In this study also, at first Tobit model was considered through left censoring the Y variable at 0 to consider only the positive food gap (food insecure HHs). So, the Y variable became the incompletely observed value of the latent dependent variable y* (Katchova, 2013).

$$Y = y^*, \ \& \ y^* > L \ L, \ \& \ y^* \leq L \quad \ldots\ldots(5)$$

$$y = \max(y^*, 0)$$

$$\text{Lower limit } (L) = 0$$

Tobit model is a combination of two models: the probit and truncated regression. The probit model analyses the variable determining the probability of Y variable being zero or positive and truncated regression analyses the variables contributing the increase or decrease of the positive continuous values of Y variable by imposing a lower limit 0 on Y.

Probit: $\text{Prob}(Y>0) = \Phi(\acute{x}\beta)$ ……………………………………………………………….(6)

Truncated: $E(Y|Y>0) = \acute{x}\beta + \lambda\sigma(\acute{x}\beta/\sigma)$…………………………………………………………… (7)

Φ= standard normal cumulative distribution function (cdf)

Y= Dependent variable

$\acute{x}$= Independent variable

β= Coefficients of the independent variable

σ= standard deviation

But this model is restrictive, as the independent variables $\acute{x}$ and the coefficients β are bounded to be the same in both probit and truncated regression model. Cragg proposed the alternative to this model, flexible Cragg's or DH model in 1971 (Lin & Schmidt, 1984; Smith & Brame, 2003). DH model can be expressed as:

Probit: $\text{Prob}(y>0) = \Phi(\acute{x}\gamma)$………………………………………………………………….(8)

Truncated: $E(y|y>0) = \acute{z}\beta + \lambda\sigma(\acute{x}\beta/\sigma)$……………………………………………………………….(9)

Unlike eq (6) and (7), DH model increases the flexibility by accommodating a different set of variables ($\acute{x}$ and $\acute{z}$) and coefficients (γ and β) for each stage. In our study, it is not guaranteed that the significant variable and their coefficient (both value and direction) would be the same

determining the presence and extent of food insecurity among HHs. So DH model was preferred over Tobit due to its flexible nature.

Statistical test to select DH model over Tobit model: The log-likelihood test was performed to choose between Tobit and DH model.

LR Statistics= -2 [lnLtobit – (lnLprobit +lnLtruncated)]~ χ2k ……..(10)

Here, lnLtobit is the log likelihood for the Tobit model, lnLprobit is the log likelihood for the probit model, Llntruncated is the log likelihood for the truncated regression. The test follows a chi-square distribution where the null hypothesis is "the Tobit model is correct," and k is the number of independent variables in the equations. (Lin & Schmidt 1984; Martínez-Espiñeira, 2006). In the study, the LR statistic value crossed the critical value of chi-square distribution. So the null hypothesis was rejected, and DH was accepted as the better model.

- **Justification for choosing IHS transformed double hurdle LDV model**

From the study of Chen et al. (2018), in the first stage of the DH model, a participation equation of HH i in food insecure group is presented as :

$$y^*1i = \acute{x}1i + \beta1 + \mu1i \text{……..(11)}$$

where y*1i denotes the latent participation indicator; ẋ1i is a vector of explained variables of the determinants of HH food insecurity; β1 is a vector of parameters to be evaluated, and µ1i is the error term.

The depth of food insecurity equation of food insecure HH i for the second stage is given as

$$y^*2i = \acute{x}2i + \beta2 + \mu2i \text{…….(12)}$$

Generally, the DH model is estimated by a maximum likelihood estimation (MLE), based on the assumption of bivariate normal distribution and non-correlation of the error terms µ1i and µ2i from eq (11) and (12).

$$\begin{pmatrix}\mu1i\\ \mu2i\end{pmatrix} \sim BVN(0;\sum), \quad \sum = \begin{bmatrix}1 & \rho\sigma\\ \rho\sigma & 1\end{bmatrix} \text{……(13)}$$

$\rho\sigma$ is the covariates between μ_1i and μ_2i

However, once this assumption is violated, the MLE is inconsistent. To make the used DH model robust, these assumptions were tested, and the error terms were found to be negatively correlated (-0.51) with violation of normal distribution like the study of Chen et al. (2018). The study intended to go further to solve this problem by introducing the IHS transformation of the Y variable, which was introduced by Yen &Jones (1997). The proposed solution allows flexible parameterization and accommodates dependence, heteroscedasticity, and non-normality of error terms. If the dependent variable is yi, after IHS transformation, it becomes:

yT= [ln {ϴ yi + (ϴ2 yi2+1)1/2}]/ ϴ……………………………….(14)

= sinh-1 (ϴ yi)/ ϴ

Here, θ is an unknown parameter that can be estimated from the data, and if the value is near 0, eq (14) becomes linear in form. Generally, the value is assumed to unity in most cases (Chiwaula, 2018; Chen et al. 2018; Sinning 2011). The sample likelihood function of the IHS transformed double-hurdle equations formulated from (12) and (13) can be expressed as:

$$L=\prod_{i=1}^{n}[1-\Psi(x_{1i}^{'}\beta_1,\frac{x_{2i}^{'}\beta_2}{\sigma},\rho)]^{1-d_i}\times\left\{(1+\theta^2 y_i^{2})^{-1/2}\times\frac{1}{\sigma}\phi(\frac{y^T-x_{2i}{'}\beta_2}{\sigma})\Phi\left[\frac{x_{1i}{'}\beta_1+\frac{\rho}{\sigma}(y^T-x_{2i}{'}\beta_2)}{\sqrt{1-\rho^2}}\right]\right\}^{d}$$

Ψ =bivariate standard normal cumulative density function with a covariance of ρσ

φ= univariate standard normal probability density function

Φ = cumulative density function, respectively, and

di = dichotomous index, which is equal to 1 if yi > 0, and 0 otherwise (Yen and Jones, 1997)

By following all the steps mentioned above, the study attempted to construct a robust econometric model for food insecurity depth analysis which was not commonly used in the previous researches performed on the urban slum HH food security analysis.

Chapter 4

Results and Discussion

This chapter briefly discusses **1) Sample Characteristics, 2) Food security status of HHs**, **3) Extent of HH food insecurity by FGT index and 4) Determinants of food insecurity among HHs**, after applying the methodology described in **chapter 3**.

4.1 Sample Characteristics

Descriptive statistics and ttest have been performed on variables related to HH characteristics, socio-economic profile and WASH practices, to understand the sample characteristics and observe the difference in variables among food secure and food insecure HHs.

- **HH Characteristics**

The male-female ratio among the slum HHs was 1:0.95, which was almost equal. But 85.69% of the HHs had a male HH head. Among the only 14.31% of HHs having a female household head, the majority of them were widowed (48.19%). Out of 580 HHs, 89.14% HH head were married at the time survey. 19.48% of HH head got married for the first time before at the age of legal age 18 years. In the urban poor community, generally, the child to adult ratio is high (WFP,2002). The slum HH age structure also showed the more prevalence of children and youth, as 39.83% of them were below 18 years. The mean age of the HH head was 40.16 years, where 60.17% of the HH head were in between 18 to 45 years range. This study observed a mean dependency ratio of 0.34. Out of 580 HHs, 90.17% of them had a family size ranging from 1 to 6 with an average of 4 people. By performing ttest at 95% confidence level, it was concluded that the HH size and age of HH head were higher in food insecure HHs than the food secure HHs. Only 3.82% of respondents were found to be disabled among all the HH members.

- **Educational level**

32.56% of the respondents of the selected HHs never attended school with only 18.47% completing the primary level and 6.7% crossing the Secondary School Certificate (S.S.C) level. Among the HH head also, 47.49% never attended school. The situation is worse for female members, as the higher percentage of them did not attend school than the male counterpart.

Majority of the respondents (60.57%) studied in the government educational institute, as it is the most affordable option and free of the tuition fee in general. 53.72% of the HH member responded positively to be able to write a letter which proved their minimum literacy level.

- **Occupational characteristics**

Almost half (48.21%) of the slum HH members were engaged in earning activity. Urban slums are characterized by high participation of women in income generating activities (WFP, 2002). This statement is justified totally by the presence of the female wage earner in 63% HHs. Unfortunately, 38 children, aged less than 14 years old, were identified as wage earner, which indicated the evidence of child labor by the International Labor Organization (Edmonds, 2008). Occupation of employed HH head was mainly rickshaw pulling, day labor, engagement in business and service; working in transport, construction and garment sector. Only 6.03% of HH heads were not engaged in any occupation.

- **Expenditure Pattern**

The mean monthly expenditure (ME), including for both food and nonfood items, of HH, was 11887.55bdt. 45.69% of HH had ME below 10,000bdt, and 47.59% of them had ME between 10,000 to 20,000 bdt. Only 6.72% HH had ME above 20,000bdt. The food secure HHs had significantly much higher ME than the food insecure HHs. The poorer section of society usually expends a very higher percentage of their income on food consumption (Ruel et al., 1997; WFP, 2002). In the sample HHs also, a higher share of the ME was spent on food expenditure. The mean percentage of food and nonfood expenditure of the HHs were 72.8% and 27.2% respectively.

- **Housing Characteristics and utility facilities**

Majority of the slum HHs (72.11%) lived in a rented home, and the structure of the house was mostly tin-shaded and kacha (57.99%). The slum dwellers generally use homogenous utility facilities, as these facilities are set up by community effort for sharing among a large number of HHs. 96.43% of the HHs used electricity connection as a source of power. For cooking, mainly gas and wood were used as a source of cooking fuel for almost 60% and 31.29% HHs respectively. Nearly 80% of the HH used the improved pit latrine with slab and ventilated pit latrine, which are considered as improved sanitation facility by UNICEF and WHO (Hjelm et al., 2017). 84.48% of the HHs responded that the woman felt safe while using the toilet at night.

In the case of 96.38% HHs, separate place for hand wash was observed by the surveyor. In the rest of the HH, the hand wash place was not adjacent to the dwelling unit. Water for hand wash was available in 94.48% observed handwash place., whereas any cleaning agent like ash, soap, etc. was missing in 56.35% HHs.

Almost 95% of the HHs used pipe water and public tap as a source of drinking water, which are considered as improved drinking water source according to UNICEF and WHO (Hjelm et al., 2017). The source of the cooking and the drinking water were almost the same, as they were collected from the same place. Mainly the adult woman (91.03%) in the HH was responsible for collecting water to drink and cook. For almost 90% HH, it did not take more than 15 minutes to collect water from the source. One serious drawback was noticed that 72.6% HHs did not perform any water treatment process before drinking it. But the water provided by the Dhaka Water Supply and Sewerage Authority (DWASA) in Bangladesh was reported by people not being able to drink directly, due to its poor quality (Rahman, 2019).

4.2 Food security status of HHs

For the 580 samples HHs, the average calorie intake was 2164.87 Kcal /AE/Day, which is below than the energy requirement level (2430 Kcal/AE/Day).

Table 4.1: Food security indicators and WI of food secure and food insecure HHs

Variable	Observation	Mean	Minimum	Maximum	Food Secure	Food Insecure
Food calorie intake (Kcal/AE/Day)	580	2164.87	889.0486	4406.216	2971.674	1903.3
Food calorie gap (Kcal/AE/Day)	580	319.5682	-1816.502	1564.628	-463.89	573.5667
DDS/HH/Day	580	7.34	2.28	11.14	8.05	7.1
Food Expenditure share	580	72.77%	24.32%	93.16%	74.43%	72.23%
Staple Share (SS)	580	46.45%	2.4%	73.42%	41.25%	48.15%
Wealth Index	580	-0.007	-1.95	5.01	0.24	-0.088

Source: BUISBS, 2016

The mean DDS/HH/Day was 7.34, and 46.55% of the total HHs scored less than the mean DDS value. So they are identified as HHs with low dietary diversity. The average SS among HHs was 46.47% and 58.8% of the HHs had the medium quality of diet with SS 40-60%. But if we look at the calorie share from all food groups (**Annex 2 table 1**), after cereal, there is pure

dominance of oil, sugar, and outside meal in the diet plan. The presence of sugar and oil in the everyday diet plan of the poor people was observed as a prominent problem, as it overestimates the DDS (Mathiassen et al., 2017). Street vendor selling raw and readymade food is considered as a prime and cheap source of food for urban poor (Tinker, 1997). It is a convenient option for working women in poor HHs to choose readymade street food, as it saves time and cost. But there is no formal quality assurance procedure applied to this street food (Ruel et al.,1998). So the low SS percentage did not ensure that HHs had a quality diet with more nutritious food; instead the calorie has come mostly from oil, sugar, and outside readymade food.

43.45% of the HHs were exposed to high economic vulnerable condition, because of spending more than 75% of their total monthly expenditure on food. The average percentage of food expenditure was also extremely high (72.77%). The uncertainty of fixed income and limited storage facility compels the poor to buy a smaller quantity of food at once. The traditional cereals are sold in higher price urban area than the rural market (Ruel et al.,1998). These factors contribute to the increase in food price for the urban poor, and so they end up paying approximately 30% or even more for the same food than the rural HHs (Argenti, 2000).

The HHs were identified as food secure and insecure based on their calorie intake. But This measure can be validated by observing the high mean DDS and low mean SS value for the food secure HHs. One striking fact is that the food expenditure share is higher for the food secure HHs. One possible explanation could be, among the slum HHs, the total monthly expenditure did not vary with a vast range. Almost 83% of HHs had monthly expenditure within the range between 5,000 bdt to 20,000 bdt. So in this situation, the HHs who spent more on food from that limited and low level of monthly expenditure, they were able to fulfill the calorie need.

Table 4.2: Difference in Food Security Indicators among WI quantiles

Indicators	Wealth Index (WI)			
	1st Quantile	2nd Quantile	3rd Quantile	4th Quantile
Monthly Expenditure (bdt)	8652.6	10505.64	10986.12	17405.84
% of food expenditure	74.65	73.80	72.96	69.67
Staple share (%)	47.90	46.52	46.9	44.45
DDS/HH/Day	6.92	7.12	7.4	7.89
Calorie intake (Kcal/AE/day)	2083.2	2103.208	2014.853	2240.42

Source: BUISBS, 2016

The change in food security indicators along with the four WI quantiles was found exactly as the way it was as expected (table 4.2). The percentage of food expenditure has decreased, and

total monthly spending has increased with high wealth index. The wealthier HHs did not need to cut off nonfood expenditure to fulfill their calorie need. Maximum food secure HHs (almost 30%) also belonged from the highest WI quantile. Though the average calorie intake has been increased with higher WI, it failed to have a mean calorie intake value higher than the threshold energy requirement even for the most upper quantile. The high DDS and low SS value in the higher wealth quantiles indicated that, the wealthier HHs had a better quality diet.

4.3 Extent of HHs food insecurity by FGT index

The FGT index has computed the headcount ratio, depth of food insecurity, and squared food insecurity gap. The headcount ratio was measured from the total 580 HHs, whereas the depth and severity of food insecurity calculation were based on the food insecure sample (438 HHs). The headcount ratio expressed that among all the HHs, 75.52% HHs were identified as food insecure. The depth of food security showed that each food insecure HH needed 433.14Kcal/AE/day to bring them in food secure state. The squared food insecurity gap expressed that the severity of food insecurity is 5.8% among the urban slum HHs in the Dhaka.

4.4 Determinants of food insecurity among HHs

The factors affecting HH food insecurity were determined by general DH model and IHS transformed DH model using the MLE estimation method where p-value associated with wald statistic was 0.0000 in both cases. It indicated that the models fitted the data significantly and all the parameters were jointly significant at a 99% confidence level. The associations of variables were reported at 90% confidence level.

The significant factors and their estimated coefficients were different in the probit and truncated regression model. From the 1st tier of probit model, where 0 equals to food secure and 1 equals to food insecure HH, it was observed that per capita ME, percentage of food expenditure, DDS, HH size, sex of HH head, number of female wage earner, number of children under five years, unemployed person within 15 to 64 years, proportion of adult female member and location of the slum were the significant factors to determine whether the urban slum HHs were food insecure or not.

In the 2nd tier of truncated regression model, from the table of marginal effects (**Annex 2 table 2**) of general DH model, per capita ME, percentage of food expenditure, DDS, HH size, number of female wage earner, number of children under five years, unemployed person within 15 to

64 years, proportion of adult female member, migration of HH head from abroad, previous residence place of the HH head, overall HH security and location of the slum were identified as the significant factors to determine the food gap among the food insecure HHs. But in final IHS transformed DH model, wealth index and source of drinking water were also added as significant variables and previous residence of HH head and was excluded from the significant factor list.

4.4.1 HH factors

Sex of HH head: The female-headed HH had 37.5% less probability of being food insecure than the male-headed HH, as the female member in the HHs are more concerned and knowledgeable about food processing, preparation, and storage (Chinnakali et al., 2014). But it had no significant effect on determining the food gap among food insecure HHs.

Size of HH: Similar to the findings of Akinloye et al. (2016), Dharmaraju et al. (2018), Joshi et al. (2019), Gebre (2012) and Agarwal et al. (2009), in this study also the large HHs were more likely to be food insecure due to high food demand at HH level with limited income generation. If there is an increase of one member in food insecure HHs, their food gap will increase by 9.9%, keeping other variables constant.

The number of children under five years: In the food security determinant analysis, generally the age limit of children is set within five years (Hall, 2014; Akinloye et al., 2016; WFP, 2015). The HHs with a high number of children had higher odds to be food secure. With the increase of one child, the food gap decrease by 15.9%. The presence of a child in HHs creates more awareness about diet plan and hygiene. It also results in high consumption of diversified dairy and other food items, as children generally do not prefer to eat cheap cereal all the time (Kamau et al.,2011).

4.4.2 Factors of food access

DDS/AE/Day: Food access depends on the level of food consumption. By expressing the HHs access to different food groups, DDS/HH/Day indirectly determines the food consumption level of HH. From the probit model, it can be concluded that a unit increase in DDS significantly decreases the probability of a HH to be food insecure by 71.9%. From the IHS transformed DH model, it can be interpreted that 1-unit increase in the value of DSS/HH/Day

will significantly decrease the calorie gap by 22.19% for the food insecure HHs, keeping all other factors and variables constant.

Per capita monthly expenditure (ME) and % of food expenditure: For the low-income community, consumption expenditure is a better representation of purchasing power and wellbeing. The expenditure is less vulnerable to underreporting, seasonal bias, and recall error (Meyer & Sullivan, 2003). The per capita ME was highly significant in both the probit and truncated regression model. HHs with high ME had higher odds of being food secure and less food gap among the food insecure HHs. If a HH spends more on food, they tend to be in food secure state. The higher percentage of food expenditure would also significantly lessen the food gap among the food insecure HHs.

HH head lived in abroad: A dummy variable was generated where '1' was assigned for the HH head who was in abroad for more than 6 months during last five years, and '0' was for the HH head did not live in abroad. If the HH head lived in abroad, there is the possibility of receiving remittance previously which could be used at that time to enhance asset possession. This variable did not determine the HHs food security status in the probit model. Keeping all other factors constant, among the food insecure HHs, the HH with a head living in abroad in the past had significantly 87.5% less food gap than the HH who did not have a head who lived abroad.

Number of unemployed HH member within 15 to 64 years: In the slum, almost 63% HHs had the unemployed member(s) from the working age (15 to 64 years) group which lessened the income generation capacity of the HHs. The HHs with the high number of unemployed member from working age were more likely to be food insecure. If there is an increase of one unemployed member, the food gap among food insecure HHs will increase by 14.9%.

4.4.3 Factors of food availability

Wealth Index: The WI is a continuous compound variable which includes in total 14 variables. Through the higher value of the coefficients attached to the variables, it is evident that the possession of own house, fridge and drawing room furniture, better housing structure, the higher number of room, not sharing the toiler and water facility, contributed the most to create wealth difference among HHs. In general DH model, the WI was not a significant variable. But in the IHS transformed DH model, with each additional unit of wealth score, the food gap among food insecure HHs was expected to decrease by 11.36%.

Overall Security of HH: The response of HHs regarding the issue of the overall security of the family were taken into four categories: sufficient secure, moderately secure, insecure and very insecure. But under the very insecure category, there was only one response, and it was merged with the insecure group to have at least 5% of respondents in each category. From the marginal effect of IHS transformed DH model, it can be noticed that the food gap significantly increased by 25.72% for moderately secure HHs than the sufficient secure HHs among food insecure HHs. When there is a lack of feeling of security in the slums, there is distrust among neighbors, which limits the social reliance and informal safety nets (Zingel et al., 2010).

Location of the slum: The slums' locations were divided into eight large areas of the Dhaka city namely, Mirpur, Mohammadpur, Old Dhaka (Puran Dhaka), Airport, Karail, Basabo, Hatirjeel and Periphery of the city, based on the mouza or mohalla code of each slum. All the adjacent areas were grouped under each location category. The HHs in the slums near the airport area was more likely to be food secure than the Mirpur area, as the airport area has an excellent public transport network connecting the city to go to any workplace. In Basabo and Mohammadpur, the food gap was higher among food insecure HHs than Mirpur area, as these are mostly residential area with the low job opportunity and high housing rent.

4.4.4 Factors of food utilization

The proportion of adult female: The number of female aged 18 years and above in each HH was divided by the total member of HH to calculate the continuous variable proportion of adult female member in each HH. In this study, the HHs with high adult female member proportion had high odds to be food secure and low-calorie gap among food secure HHs. The adult female generally manages the daily HH diet plan and all the needed arrangements to prepare them. So their presence can improve the condition of HHs (WFP,2002).

The number of female wage earner: In the slum HHs, the high rate of female participation in the labor market does not bring any change in the childcare and household chores obligations for them. To manage time constraint, they end up compromising the caring behavior for the HH member, etc. (Ruel et al., 1998). So the HHs with higher number of female wage earner were more likely to be food insecure. The food insecure HHs with more female wage earner had higher food calorie gap intake.

Drinking source: The poor quality of drinking water can result in water-borne diseases which hamper the proper utilization of food. Following the study of IFPRI (2007), dummy variable

was generated where 0 indicated the HHs using a better source: pipe water into dwelling, yard and compound and 1 showed HHs not using pipe water (public tap, borehole, tubule, and others). The variable is not significant in general DH model. But in IHS transformed DH model, the variable showed that the food insecure HHs not using pipe water, had food gap 31.16% higher than those food insecure HHs who use pipe water as the drinking water source.

Some other variables age, educational level, occupation and previous place of living of HH head and duration of collecting were considered in the DH model but failed to have any significant effect on both probit and truncated regression model. The formulation of these variables are described briefly:

Occupation of HH head: The occupation type was a categorical variable where '1' was assigned for the HH heads who were not working, 2 for the HH heads engaged in own business and services and '3' for all type of employed work.

Previous place of living: This dummy variable was introduced where, 0 was for those HH heads, who came in the current slum from different districts (not slum) and one was for those HH heads who were born in the currently living slums or came from any other slum.

The education level of HH head: The education level of HH head was divided into two categories where 0 value refers to the HH head who never attended school and 1 for those HH head who has ever attended school.

Duration of collecting water: The duration (in minutes) of completing a full trip to collect water, was considered as a continuous variable to put in the analysis

From the analysis, it can be concluded that, the food security condition of HHs highly dependent on the presence and activity pattern of the female member; employment, monthly expenditure, wealth and composition of the HHs; overall security and utility facilities of the slum.

Chapter 05

Recommendations and conclusion

5.1 Recommendations

The National Food Policy (NFP), 2006 of Bangladesh has emphasized three main objectives: to ensure the adequate and stable supply of safe and nutritious food; to increase purchasing power and access to food of the people and to confirm proper nutrition of all individuals, especially women and children. (Ministry of Food and Disaster Management, 2006). This chapter tried to propose recommendations based on the findings of the study and in line with the NFP to improve the food security status among the slum HHs of the Dhaka city.

- **Introducing formal Social Safety Net Program**

In the NFP, the government of Bangladesh admitted the need of a well-targeted intervention program for the most distressed slums and rural landless HHs through food distribution and public works programs like vulnerable group feeding (VGF) and Food for Work (FFW) (MoFDM, 2006). But The VGF programs operated by NGO and other social safety net programs (SSNP) in the distress period were minimal among the slum dwellers of Dhaka (Zingel et al., 2010). In our study also, only 4.4% HHs responded to receive any relief and official help during the last year of the survey period. The HHs are still dependent on family, neighbors, and local shop to smoothen any consumption shock due to lack of access to formal credit. The responses targeting the emergency situation and seasonal variation are mostly concentrated in rural areas in the NFP. But the poor section of the urban area also gets affected due to emergency shock like a price hike (WFP,2015). The price hike of 2008 hit the slums of Dhaka city very severely. The food, especially rice, procured by the government was sold by the sells unit set up by the Bangladesh Riffles (BDR) with a subsidized price. But this public food distribution scheme attempt did not succeed to reach all the slum HHs, as they cannot afford to stand in a queue for hours to get 3 kg rice per person and loose working hours (Zingel et al., 2010). So, the SSNP for the urban slum HHs must be redesigned, as it is challenging to minimize the leakage to non-target HHs in urban slums and introduce public works suitable for the urban area (MoFDM, 2006; Jakaria et al.,2015).

- **Arrangement of training for the adult female member in HH**

Women are considered as capable vehicles for ensuring HHs wellbeing and food security (MoFDM, 2006). The study also ascertained that by the improvement in HH food security status due to the presence of the adult female member. So, it is necessary to initiate women-centered development programs to improve their access to productive resources and services and knowledge about care behavior. In more than half of the HHs, there was no practice to use a cleaning agent to wash the hands, and the water was not treated before drinking. Only in 4.5% HHs, the toilet contents were emptied directly through the pipe sewer system. In 44% of cases, the contents were overflowed in the drain. The calorie shares of cereals, oil, sugar, and outside meal were very high, where other nutritious food groups were in negligible percentage in the daily diet plan. All these evidence proved that there is an urgent need of training for the women on preparing healthy diet plan, care behavior, and WASH practices. The NFP also focuses on increasing the availability of the non-cereal nutritious food products and developing of a diet chart based on locally available nutritious food which can create a balanced diet at low cost (MoFDM, 2006).

- **Development of human capital**

The improvement in human capital plays a vital role in improving the food security status in the long term. The education level of HHs member is very low in the slums. Half of the HH head never even went to school. 40% of the unemployed members of HHs were under age group between 20 to 50 years, which is alarming. In this age they must be in the working force. For these unemployed people with no formal education, the public sector and NGOs can work for imparting a minimum level of financial literacy, vocational and skill-based training based on the market demand to secure an earning source for them. For the women participated in the labor market, enforcing the law of equal pay, the extension of maternity safety net schemes and leave policies are mandatory to increase the HHs income. Government and development partners must play a vital role to regulate the minimum standard of wage, working hour, and occupational health hazard in informal economic activities.

- **Improvement in water and sanitation facility**

The malnutrition among HHs occurs due to poor quality of water and sanitation. In the study, in 73.47 % cases, the water source of slum HHs was not tested. Even if they were tested, the result was not disseminated to the HHs. The fecal sludge management (FSM) service was not available, which affected the sustainability of the sanitation services. The toilet facility was less safe for women and children to use at night than the male member (OXFAM & ITN-BUET, n.d). The community leaders and landlord mostly managed the water and sanitation facility, not directly by the public service department. Landlords set up illegal connections of the water network and sell this water at high prices to slum HHs (Simavi, 2015). Policy intervention is needed to make the landlords accountable for providing adequate WASH services to the slum HHs. Any future initiative of entrepreneurship and FSM service should be welcomed in the slum with the cooperation of the Community Based Organizations (CBOs) to improve WASH services.

The slum settlements lack a strong regulatory framework for development. The interventions taken to improve food security among slum HHs were fragmented, not well designed, and targeted to solve the existing problem. To improve the food security condition of slum HHs, multidimensional policy framework must be formulated with association with different ministries and departments of the government in Bangladesh.

5.2 Conclusion

The sincere will of the government can only achieve the overall food security of the slum HHs. The improvement in the availability of the quality full cereal and non-cereal food products at a low price with easy access to food market should be ensured for the urban poor. To tackle the short term seasonal food price shock, the government should introduce SSNP suitable for the metropolitan area and target the slum HHs effectively to minimize leakages of the limited resource. For the attainment of long term food security status, development in economic condition, educational need, standard utility services, and care behavior knowledge of the slum HHs should be emphasized. The minimum level of education must be provided free of cost to the slum children to escape the intergenerational poverty trap, which results in chronic food insecurity. The slums are generally the primary source of cheap labor in a developing country. Utilization of this labor force in the proper channel to enhance the economic growth of the

country as well as the HHs, is a challenge for the government. The slums rely on some local leaders and influential person for the illegal and poor quality water and sanitation service, as the coverage of public service in slums is still meager. But only food availability and access cannot ensure food security if the government does not intervene in WASH services for proper utilization of food. For the most effective result, the women of the HHs should be integrated into the slum development plan, as they are the most concerned one about the HHs welfare and food consumption. The food security status among the slums in Dhaka did not improve over time even after undertaking some measures. So it is high time the government modified the NFP to focus on this vulnerable part of the society to ensure their fundamental right to food.

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ANNEX 01

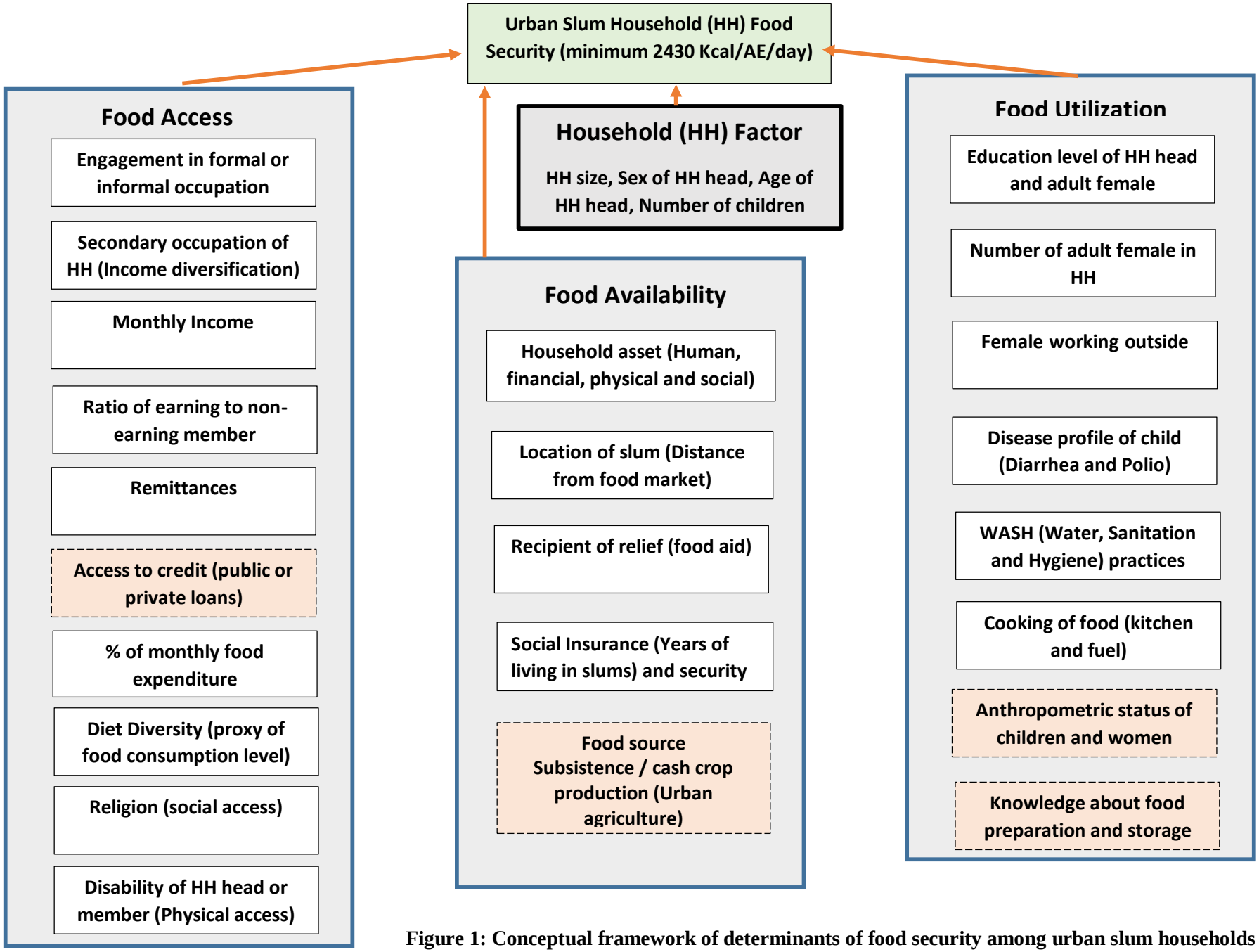

Figure 1: Conceptual framework of determinants of food security among urban slum households

Figure.2: Map of Dhaka City Corporation (DCC) Area
Source: MediaBangladesh.net

Table 1*: **List of food items in food consumption table used in questionnaire***

Sl no.	**Food Group**	**Number of food item**
01	Food grains	13
02	Pulse	6
03	Fish	17
04	Egg	3
05	Meat	7
06	Vegetable	16
07	Fruits	17
08	Milk	6
09	Sweetmeat	4
10	Oil	5
11	Drinks	6
12	Sugar and molasses	6
13	Miscellaneous	5
14	Food outside (dining out)	14
15	Tobacco products	4
16	Spices	12
17	Betel leaf and chew goods	7
	Total	**148**

Source: BUISBS, 2016

ANNEX 02

Table 1*: **Calorie and expenditure share for different food groups***

Food Group	Calorie Share (%)		Expenditure share (%)	
	Food security	Food insecure	Food secure	Food Insecure
Cereal	41.24	48.14	16.51	18.31
Pulse	2.38	2.50	2.80	2.83
Fish	2.97	2.99	11.99	11.78
Egg	1.89	1.04	3.34	3.03
Meat	1.99	1.46	8.26	6.63
Vegetable	2.63	2.78	6.58	7.37
Milk	.879	0.68	2.05	1.66
Fruit	2.44	2.29	9.16	8.36
Drink	0.48	0.318	1.74	1.08
Sugar and miscellaneous	5.831	4.062	3.57	2.64
Outside	19.9	15.34	16.71	17.84
Oil	14.17	14.9	3.56	3.69
Spice	3.2	3.5	5.66	6.44
Tobacco	0	0	8.07	8.34
Total	100	100	100	100

Source: BUISBS, 2016

Table 2: Marginal effects of the determinants of food insecurity of urban slum HHs

Variables	Tobit model (Marginal effect)	Probit model (1st tier)	Truncated model (2nd tier) (Marginal effect)	IHS DH model (Marginal effect)
Y variable: Food Calorie Gap				
HH factors				
Sex of HH head				
Male (Base Level)				
Female	-25.86	-.375*	1.39	-.084
HH size	40.753***	.203**	36.56**	.099**
Number of children (under 5 years)	-66.41***	-.216*	-113.76***	-.159*
Age of HH head				
18-30 years (Base level)				
31-40 years	46.81*	0.23	37.77	-.009
41-50 years	44.71	0.28	24.69	0.117
Above 50	43.77	0.37	14.53	0.156
Food Access				
DDS/HH/Day	-115.44***	-.719***	-98.13***	-.2219***
Monthly expenditure (ME)/Capita	-.109	-.00037***	-.217***	-.00028***
% of monthly HH food expenditure	-8.68***	-.042***	-10.002***	-.024***
Number of unemployed HH member within 15 to 64 years	41.08***	.252*	42.66*	.149***
HH head lived in abroad	-132.96***	-.355	-262.87***	-.875*
Occupation of HH head				
Not working (base level)				
Own business and service	-20.92	-.69	89.31	.1189
Engaged in Employed work	-66.217	-.61	-10.707	-.066
Food Utilization				
Proportion of adult female	-260.495***	-1.64***	-278.13***	-.6668**
Female wage earner/HH	40.63***	.363**	15.71	.1154**
Education level of HH head				
Never attended school (base level)				
Attended school	20.42	.19	1.02	-.0384

Variables	Tobit model (Marginal effect)	Probit model (1st tier)	Truncated model (2nd tier) (Marginal effect)	IHS DH model (Marginal effect)
Drinking water source				
Pipe water (Base level)				
Other source except pipe water	60.02	-.1218	78.71	.3116**
Duration (in min) to collect water	0.944	.0028	1.91	-.0018
Food Availability			-.003	-0.098**
Wealth Index	-16.55	-.027	-18.7	-.1136**
Previous Place of living				
Anywhere except slum (Base level)				
Slum	-14.41	-.005	-48.069*	-.0065
Security of HH				
Sufficiently Secure (Base level)				
Moderately secure	56.49**	.2407	75.25**	.2572**
Insecure	70.34	0.213	75.88	0.2307
Location of the slum				
Mirpur (Base level)				
Periphery	78.83	.303	85.94	.1930
Mohammadpur	9.63	-.215	56.77	.211*
Airport	-130.42**	-1.22***	-77.42	-.052
Puran Dhaka (Old Dhaka)	-26.558	-.1132	-79.62	-.258
Karail	39.093	-.179	122.81**	.0816
Basabo	49.409	-.097	127.709**	.2433 ***
Hatirjheel	36.4865	0.286	66.38	-0.325

Source: BUISBS, 2016

Here, * is significant at 90% confidence level, ** significant at 95% confidence level and *** significant at for 99% confidence level