Behavioral Risk Factors Profile of People Living with Hypertension and Diabetes Comorbidity: A Cross-sectional Study in Chirirbandar Sub-district, Bangladesh

"Final Report of Summative Learning Project (SLP) Presented to the BRAC James P Grant School of Public Health, BRAC University."

Submitted by:
Sita Kumari
MPH Cohort: 20
Student ID: 24167019

Supervisor:
Prof. Dr. Malay Kanti Mridha
Deputy Dean, BRAC James P Grant School of Public Health; Director, Centre for non-Communicable Diseases and Nutrition
Email: malay.mridha@bracu.ac.bd

Co-Supervisor:
Mahbub A.H.M Latif
Professor
Institute of Statistical Research and Training (ISRT), University of Dhaka
Email: mlatif@isrt.ac.bd

Mentors

Dr. Tanmoy Sarker
Deputy Research Coordinator, Centre for non-Communicable Diseases and Nutrition
Email: tanmoy.sarker@bracu.ac.bd

Dr. Ali Ahsan
Deputy Research Coordinator, Centre for non-Communicable Diseases and Nutrition
Email: ali.ahsan@bracu.ac.bd

Fahmida Akter
Assistant Scientist, Centre for non-Communicable Diseases and Nutrition
Email: fahmida.akter@bracu.ac.bd

Sayma Islam Alin
Research Associate, (MPH)
BRAC James P Grant School of Public Health
Email: sayma.alin@bracu.ac.bd

Shahnaz Sharmin
Research Associate, Centre for non-Communicable Diseases and Nutrition
Email: shahnaz.sharmin@bracu.ac.bd

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ABSTRACT

Introduction: Non-Communicable Disease (NCDs) and their behavioral risk factors are rising worldwide. Moreover, co-occurrence of hypertension and diabetes is also rising among adults in low- and middle-income countries (LMICs) like Bangladesh. The study aims to assess the behavioral risk factors and to identify the factors associated with the clustering of behavioral risk factors (≥3 risk factors) among people living with hypertension and diabetes comorbidity in Chirirbandar sub-district of Bangladesh.

Methods: A cross-sectional study was conducted to assess behavioral risk factors among 387 participants from rural households of Chirirbandar sub-district. The data was conducted using WHO STEPs approach to chronic disease risk factor surveillance (STEPs) tools. Presence of three or more risk factors of NCDs was defined as the presence of clustering of NCDs risk factors. Multivariable logistic regression was conducted to identify the factors associated with clustering of behavioral risk factors.

Findings: This community-based study covered twelve community clinics of Chirirbandar sub-district of Bangladesh. In total, 387 (148 men and 239 women) were included in the study. The mean age of the respondent was 56.99 years, more than half of them were unemployed, currently married, and less than one third of them had secondary and higher level of education. The prevalence of tobacco use, insufficient fruits and vegetable intake and inadequate physical activity was higher among men, however exposure to indoor air pollution was higher among women. The prevalence of clustering of NCDs risk factors for zero risk factors, one risk factor, two risk factors, three risk factors, and four risk factors were 0.78%, 9.04%, 51.94%, 32.3%, and 5.94% respectively. Majority (61.76%) of the study participants had at most two risk factors and 38.24% of them had three or four risk factors of NCDs. Risk of three or more risk factors was higher among the respondents aged 60 and above (48.47%), and male participants (43.92%). Moreover, the clustering of risk factors was found significantly associated with increased age, and self-care management for hypertension, particularly those who frequently forget to take their medications.

Conclusion: The high prevalence of clustering of risk factors demands an integrated NCDs preventive strategies to reduce the burden of risk factors and relevant complications in the rural setting of the country.

CHAPTER 1: INTRODUCTION

1.1 Background

The rise of non-communicable diseases (NCDs) accounts for nearly three-quarters of deaths in the world (WHO, 2024). Hypertension and diabetes comorbidity represents a significant public health burden across the globe, with more than 40% people diagnosed with diabetes also suffering from hypertension (Kwakye et al., 2024). As a result, prevalence of the comorbidity of hypertension and diabetes is increasing (Alsaadon et al., 2022). Moreover, the cases of hypertension and diabetes among the adult population are relatively higher in lower-and-middle income countries (LMICs) (Long & Dagogo-Jack, 2011; Wallace et al., 2018). Thus, there is an alarming situation in the South Asian countries due to the fact that approximately 53.5% of hypertensive individuals also have diabetes (Feng, et al., 2019).

In Bangladesh, around 13.14 million people were diagnosed with diabetes in 2021, and nearly 20% of adults are affected by hypertension (Chowdhury et al., 2020). Some studies have shown a substantial increase in hypertension prevalence in Bangladesh from 38.7% to 61.4% in rural and 36% to 64% in urban areas from 2011 to 2018 (Pravin, et al, 2024). Similarly, the prevalence of diabetes has increased from 12.1% in 2011 to 14.4% in 2018 (Wetzel, et al, 2023). Additionally, the comorbidity of hypertension and diabetes increases the risk of cardiovascular disease synergistically and other NCDs such as kidney disease, stroke, renal failure and other complicated consequences (Balogun & Salako, 2011). Therefore, it is imperative to address the comorbidity of hypertension and diabetes.

In addition, the comorbidity of hypertension and diabetes increases the risk of cardiovascular disease synergistically and other non-communicable diseases such as kidney disease, stroke, renal failure and other complicated consequences (Balogun & Salako, 2011). Moreover, another study shows that the majority of the people with both hypertension and diabetes are from low socio-economic backgrounds, and among them 21.3% of them have smoking behavior, and 60.3% are physically inactive. (Pereira et al, 2017). Behavioral risk factors like unhealthy diet, inadequate physical activity, tobacco consumption, alcohol intake, exposure to indoor air pollution and other modifiable factors have significant contributions to the development and progression of these comorbid conditions (World Health Organization, 2018). Diabetes and hypertension often share overlapping risk factors. Behavioral risk factors like unhealthy diet,

inadequate physical activity, tobacco consumption, alcohol intake, exposure to indoor air pollution and other modifiable factors have significant contributions to the development and progression of these comorbid conditions (World Health Organization, 2018). While several studies have been done on the prevalence of risk factors that cause NCDs, and common comorbidities conditions among Bangladeshi adults, assessing behavioral risk factors among adults with comorbidity of hypertension and diabetes has not been explored (Banik et al., 2018; Bhuyan, 2022; Kundu et al., 2022). This study aims to identify and cluster the modifiable behavioral risk factors among the adults with comorbidity of hypertension and diabetes.

Moreover, studies have revealed that modifying the behavioral risk factors such as unhealthy diet, physical inactivity, tobacco use reduces the severity and complications of the disease condition and helps to delay or prevent the onset and progression of the disease**.** Furthermore, identifying the clustering of behavioral risk factors becomes imperative among the adults with comorbidity of hypertension and diabetes to prevent the severe complication. By this, there can be reduction in risk of complications and prevention of comorbidity onset and progression.

1.2 Rationale

This study is important to conduct because multiple studies have been conducted on prevalence of NCDs risk factors, and common comorbidities conditions among Bangladeshi adults in different regions of the country, while assessing behavioral risk factors among adults with comorbidity of hypertension and diabetes has not been addressed (Banik, et al., 2018; Kundu, et al, 2022; Bhuyan, et al., 2022). Therefore, the study aimed to identify the behavioral risk factors among the patients living with both hypertension and diabetes in Bangladesh.

1.3 Research Question

- What is the status of the behavioral risk factors among the adults living with hypertension and diabetes comorbidity in Chirirbandar sub-district of Dinajpur, Bangladesh?

1.4 Objectives

- To assess the status of the behavioral risk factors among patients living with hypertension and diabetes.
- To identify factors associated with the clustering of behavioral risk factors among people living with both hypertension and diabetes.

1.5 Conceptual Framework

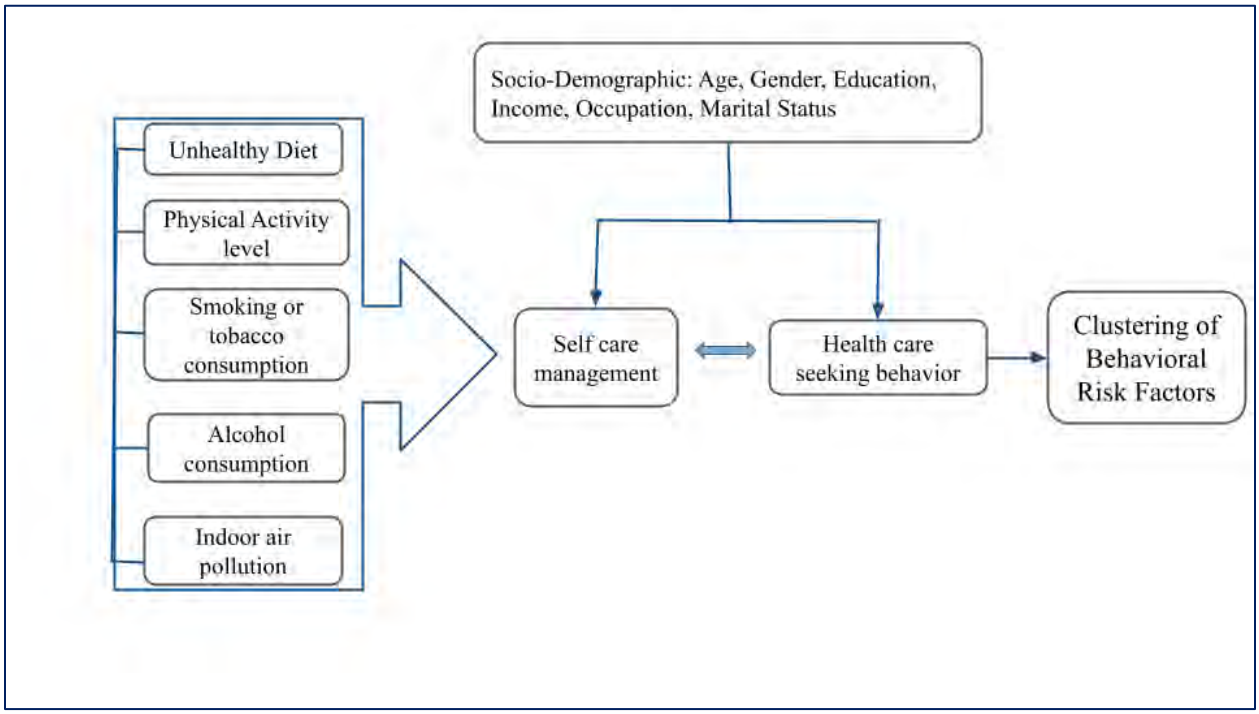

Figure 1: Conceptual framework on behavioral risk factors profile of people with hypertension and diabetes

CHAPTER 2: METHODOLOGY

2.1 Study design, setting and sampling

A cross-sectional study was conducted in Chirirbandar sub-district of Dinajpur, Bangladesh among the patients living with both hypertension and diabetes. This survey was conducted in Shinganagar, Ranipur, Dakshin Alokdihi, Joat Satnala, Boro Hashimpur, Noakhair, Dakshin Palashbari, Nanderai, Galahar, Chakmusa, Kherkati, and Burihat community clinics of Chirirbandar sub-district of Dinajpur, Bangladesh. The Chirirbandar sub-district was chosen for the study purposely as there is an established surveillance site for BRAC James P Grant School of Public Health (BRAC JPGSPH). Individuals who were above 18 years old and diagnosed with both hypertension and diabetes as per established surveillance system by BRAC JPGSPH were included for the study.

2.2 Sample size

Assuming prevalence rate of 50%, using a 95% confidence interval and5% margin of error, the sample size was:

n=384, using $n= (Z^2 p(1-p))/d^2$ formula,

Where, Z is the 0.975 quantile of the standard normal distribution, p is the prevalence, and d is the margin of error. After adjusting for a 20% non-response rate, the final sample size was 480. Among the 481 participants of the sampling frame, we achieved our sample size by recruiting 387 participants. An individual was the sampling unit, individuals who were above 18 years old and diagnosed with both hypertension and diabetes were included for the study. However, individuals with severe physical and psychological disabilities, with cancer or other critical illness, bed-ridden, had a life expectancy of less than a year, individuals under medications who had previously been diagnosed with psychological disorders, and women who were currently pregnant were excluded from the survey.

2.3 Data collection process

The data was collected during the months of November and December 2024, through face-to -face interviews, and using WHO STEPS survey questionnaires. The data collection team included four research team members, and three trained data collectors, one project officer. The data collectors

were exclusively trained prior to visiting the field regarding taking consent, mock interviews, instructions on using show cards, serving bowls, and demonstrations on using KoboToolbox. To ensure accurate and reliable data collection and data entry, KoboToolbox was used.

The questionnaire was adopted from WHO STEPs surveys and utilized the modified version of it (WHO, 2024). A Bangla version of the questionnaire of WHO STEPs with some minor changes with local terminology which was aligned with the context of the study site. Furthermore, we did pre-testing to validate the questionnaire, and to assess the data collectors' knowledge and competencies to conduct the surveys accurately. The questionnaire was reviewed thoroughly by the research team and the deputy research coordinator and feedback was incorporated prior to the data collection. Socio-demographic such as age, sex, religion, marital status, education, working status, and household wealth index was collected. The NCDs five behavioral risk factors including tobacco use, fruits and vegetables daily intake, low physical activity, alcohol intake and exposure to indoor air pollution was collected.

The data collectors administered the surveys under the supervision of the research team and the project officer. The collected data was further reviewed to identify non-response patterns or errors at the end of the day during the data collection period. Based on the performance after identifying any pattern or error, feedback was given to the data collectors prior to the next day of data collection. The surveys were carried out at their community clinics or at their household as per the convenience of the participants.

2.4 Outcome variables and their measurement

The outcome variable of this study was the clustering of behavioral risk factors of NCDs. The behavioral risk factors were smoking, insufficient fruits and vegetable intake, current alcohol consumption, and indoor air pollution.

Clustering of factor: A cluster of behavioral risk factors was defined as the co-existence of three or more risk factors associated with lifestyle which influence the onset and prognosis of non-communicable diseases (Leite et al., 2022).

The following variables of socio-demographic were included age, sex, religion, marital status, education, working status, and household wealth index (**Table 1**):

Table 1: List of study variables

Variable	Definition
Demographic	
Age (in years)	Participant's age in years (0=18-39, 1=40-49, 2=50-59, 3=60 and above)
Sex	Participant's sex (1 = male, 2=female)
Religion	1=Islam, 2 = Others (Akter et al., 2021)
Marital status	1= Currently married, 2= Others (Rawal et al., 2017)
Education	1=No education, 2= Incomplete primary education, 3= Complete primary education, 4 = Incomplete secondary education, 5 = Secondary and above
Working status	1 = Currently employed, 2 = Unemployed, 3= Retired (Khanal et al., 2018)
Household wealth index	1 = Poorest, 2 = Second, 3 = Middle, 4 = Richer, 5 = Richest (Haregu et al., 2018)

2.5 Operational definitions

Current smoking status: Current smoking status (yes; no), Current smoking was defined as smoked in the past 30 days of the survey. (Jain et al., 2020) This was to assess smoking status or smokeless tobacco consumption (any) by the respondents daily. While collecting data on smoking (bidis, cigarettes, cigars or pipes) and smokeless tobacco (snuff, chewing tobacco, tobacco, betel, sadapata, gul, khoinee) consumption, no. of sticks or the amount of tobacco products and days of consumption in a week was collected. Moreover, showcard showing common and local based tobacco products were used as recommended by WHO.

Insufficient daily fruits and vegetable intake: Participants took insufficient fruits and vegetables (yes; no), Insufficient fruits and vegetables were defined as intake less than 5 servings a day (1 serving = 80gm) (Nguyen, et al, 2018). The information recorded the average no. of days the respondents consume fruits and vegetables in a typical week, and the number of servings of fruits and vegetables on those days of the week. Pictorials showing various green vegetables, and serving bowls were used to explain the no. of servings of cooked vegetables and fruits if cooked and uncooked as per WHO recommendation.

Inadequate physical activity: Inadequate physical activity was defined as inadequate if the

moderate activity is <150 minutes of moderate intensity aerobic physical activity per week or <75 minutes of vigorous intensity aerobic activity per week (WHO, 2010) which is equivalent to <600 MET minutes per week. Physical activity was assessed using questionnaires and showcards with local context-based examples on how many days the participants were involved with various types of physical activity for at least 10 minutes on average in a day, the duration of those activities and how many days per week they were engaged with. The information on vigorous and moderate activities, walking or cycling, recreational activities during leisure time, and time spent sitting. Moreover, show-cards with culturally appropriate examples were used to assist the response to demonstrate the activities and the types. In combination, those who did not meet the recommended level of physical activity were categorized as inadequate physical activity (<600 MET minutes).

Current alcohol consumption: Current status of alcohol intake (1=Yes, 2 =No). Current alcohol Consumption was defined as use of alcohol in the last 30 days of the survey (Jain et al., 2020). To assess the current alcohol use, show-cards with various examples of alcoholic drinks and their different amount were used.

Indoor air pollution: Whether participants had exposure to harmful pollutants produced by fuel combustion such as firewood, agricultural residues, animal dung, coal and etc. in their household (WHO, 2024).

Dietary diversity: Dietary diversity score was defined as the consumption of at least 5 food groups out of a 10 essential and other optional food groups in the past 24 hours. The food groups included both essential and optional food groups. The survey included essential food groups were as follows: i) starch food or grains, ii) dark green leafy vegetables, iii) vitamin A rich fruits and vegetables, iv) pulses, v) meat, fish and poultry, vi) eggs, vii) dairy, viii) nuts and seeds, ix) others vegetables, x) other fruits. The other optional food groups included savory snacks, sweets and sugar beverages, other oil and fats, condiments, and other beverages and foods (Mridha et al., 2020; El Ahmad Mater, 2023). For the dietary assessment, information on the types of food and beverages consumed by the respondents were taken within the last 24 hours.

Self-care management: Self-care management is the naturalistic approach to address both prevention and disease management. In this study the self-care management included salt intake below 5gm per day, and medication adherence for hypertension and for diabetes, self-care

management constitutes adherence to medical adherence and maintained frequent visits to the health care provider (Riegel et al, 2017).

Healthcare seeking behavior: Health seeking behavior was defined as the "sequence of remedial actions that individuals undertake to rectify perceived ill-health." This included regular blood pressure and blood pressure check-ups, approaching the healthcare providers and facilities, type of healthcare providers (Mahmood et al, 2009).

2.6 Statistical analysis

Before data analysis, the data was cleaned and imported into STATA 17.0 version. A descriptive statistical analysis was performed to summarize the study population including their socio-demographic status, and behavioral risk factors. Key demographic variables like age, gender, income, education, marital status was summarized and presented as frequencies and percentage. To find the cluster of the behavioral risk factors, descriptive statistical analysis was used to categorize it into four: 1) no risk factor, 2) one risk factor, 3) 2 risk factors 4) 3 risk factors 5) 4 risk factors. Logistic regression was used to assess the association between the socio-demographic factors, self-care management, and healthcare seeking behavior and the presence of 2 or less risk factors and 3 and 4 risk factors of individuals.

2.6 Ethical consideration

The research covered all the ethical standards and obtained ethical clearance from the Institutional Review Board of BRAC James P Grant School of Public Health, Dhaka, Bangladesh (IRB protocol no: MPH-2024-007). Informed written consent was taken from participants after explaining the study objective, procedures and ethical considerations.

CHAPTER 3: RESULTS

Out of 481 individuals of the sampling frame, 387 (80.46%) participants were finally assessed for behavioral risk factors of NCDs.

3.1 Socio-demographic background

Table 2 presents the characteristics of the study population. The study population consisted of a higher proportion of female respondents (61.76%), than male respondents (38.24%). Out of total respondents, a higher proportion of respondents belonged to 60 and above age groups (42.12%), 7.75% of the respondents were 18 to 39 years old, where proportion of 40 to 49 and 50 to 59 years of age were 21.68% and 42.12% respectively. More than third-fourth of the respondents were currently married (85.79%) and 14.21% were others which included never married, divorced and widowed. More than half of the respondents were currently unemployed, where 32.30% were employed and 7.75% of them were retired. More than three fourth of the respondents were following Islam religion, where 11.11% of them were categorized as others which constituted Hindu, and Christians. Less than one third of the respondents had secondary and higher levels of education (30.49%), and 16.80%, 9.82%, 17.57%, 25.32% had incomplete secondary education, completed primary school, incomplete primary education, and no education respectively. The distribution of wealth in each quintile (lowest, second, middle, higher, and highest) was nearly equal. The proportion of lowest, lower, middle, higher and the highest quintile were 20.41%, 19.64%, 22.48%, 19.38%, and 18.09% respectively among the study population.

Table 2: Socio-demographic characteristics of the respondents (n=387)

Characteristics	Frequency (n)	Percentage (%)
Sex of the respondents		
Male	148	38.24
Female	239	61.76
Respondents' age (years)		
18 - 39	30	7.75
40 - 49	83	21.45
50-59	111	28.68
60 and above	163	42.12
Marital status		
Currently married	332	85.79

Characteristics	Frequency (n)	Percentage (%)
Others*	55	14.21
Employment		
Currently employed	125	32.30
Unemployed	232	59.95
Retired	30	7.75
Religion		
Islam	344	88.89
Others*	43	11.11
Education level		
No education†	98	25.32
Incomplete primary school‡	68	17.57
Completed primary school§	38	9.82
Incomplete Secondary School ¶	65	16.80
Secondary and above #	118	30.49
Household wealth index		
Lowest	79	20.41
Lower	76	19.64
Middle	8	22.48
Higher	75	19.38
Highest	70	18.09

*Others than Islam including Hindu and Christian
† Did not attend any formal education
‡ Completed education less than 5th
§ Completed education till 5th grade
¶ Completed education less than 12th grade
# Completed till 12th grade and higher

Table 3 illustrates the prevalence of consumption of essential and optional food groups among the study participants. The prevalence of minimum dietary diversity intake among the study participants was 52.45%. The most consumed food included grain with an overwhelming 100% of the study participants reporting grain consumption. The prevalence of dark green leafy vegetables intake, vitamin A rich fruits and vegetables, pulses, meat, fish and poultry, eggs, dairy products, nuts and seeds, other vegetables, and other fruits were 54.78%, 5.94%, 31.27%, 70.54%, 33.33%, 24.55%, 8.53%, 91.47%, and 27.65% respectively. Moreover, considering optional food groups intake, the prevalence of processed food intake, savory and fried snacks, processed food, and sweet beverages were 59.43%, 32.04%, 28.94%, and 28.17% respectively.

Table 3: Frequency distribution of respondents by consumption of foods from essential and optional food groups in the last 24 hours preceding the survey (n=387)

Variables	Frequency (n)	Percentage (%)
Minimum dietary diversity		
Inadequate**	203	52.45
Adequate	184	47.55
Essential food groups		
Starch/ Grains		
Yes	387	100
Dark green leafy vegetables		
Yes	212	54.78
Vitamin A rich fruits and vegetables		
Yes	23	5.94
Pulses		
Yes	121	31.27
Meat, fish and poultry		
Yes	273	70.54
Egg		
Yes	129	33.33
Dairy		
Yes	95	24.55
Nuts and seeds		
Yes	33	8.53
Other vegetables		
Yes	354	91.47
Other fruits		
Yes	107	27.65
Optional food groups		
Processed food intake (any)		
Yes	230	59.43

Variables	Frequency (n)	Percentage (%)
Savory and fried snacks intake		
Yes	124	32.04
Processed food		
Yes	112	28.94
Sweet beverages intake		
Yes	109	28.17

** less than 5 essential food groups intake a day

Figure 2 shows the prevalence of indoor air pollution, insufficient fruits and vegetables intake, physical inactivity, tobacco use, and alcohol consumption among male, female, and both study participants. Most of the respondents were found having exposure to unclean fuel (88.34%) for preparing their food which includes agricultural or crop residue or grass, firewood etc. A higher percentage of female participants were found using unclean fuel for cooking purpose than male respondents (83.0%), with an overall prevalence of 88.3%. The vast majority of the study population failed to maintain the daily recommended intake of fruits and vegetables (at least 5 servings a day), both male (93.9%) and female (90.4%) study participants were found having inadequate daily intake of fruits and vegetables and combined prevalence was found to be 91.73%. In addition, slightly less than one third (28.94%) of the respondents did not meet the recommended level of physical activity which included vigorous and moderate work, walking or cycling and recreational activities (**Annex Table 7**). Moreover, physical inactivity was more prevalent among male (31.1%) than female respondents (27.6%) with an overall prevalence of 28.9%. Among the respondents, 24.55% were currently tobacco users (including both smoking i.e. cigarette, hookah, bidi, cigar or pipes and smokeless including *zarda* with supari, betel quid with sadapata, pan masala with tobacco, *gul, khoinee*, and *gutkha*). In addition, tobacco use among male respondents was higher among male (32.4%) compared to females (19.7%) with an overall prevalence of tobacco use was 24.6%. Although alcohol consumption among both study participants was found to be extremely low, only 0.68% of male respondents and no female respondents reported consumption of alcohol within the last 12 months, this results in a combined prevalence of 0.26%.

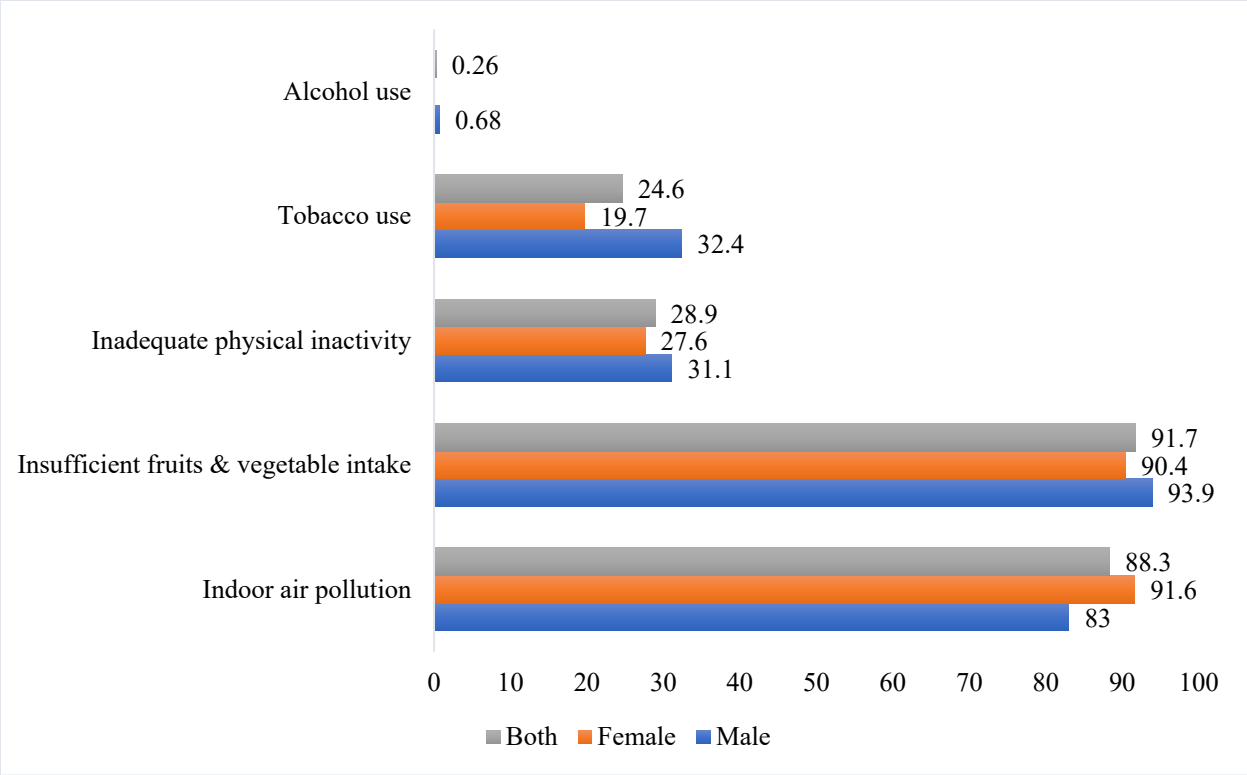

Figure 2: Prevalence of exposure to indoor air pollution, insufficient fruits and vegetables intake, inadequate physical activity, tobacco use and alcohol consumption among respondents by sex (n=397)

Table 4 shows the self-care management activities for both hypertension and diabetes by the study participants. For hypertension only, it was found that 52.45% of the respondents took more than one teaspoon of salt each day (5 gm per day), while 4.65% took the amount of salt sometimes and 42.89% of them always took the recommended amount of salt every day. In terms of forgetting to take medicine, 54.01% of the respondents never forgot to take their medicine, while 23.51% forgot sometimes and 22.48% of the study participants often forgot to take their medication.

For diabetes, half of the study participants were found to be highly adherent to their prescribed medicine (50.13%), while 10.08% of the participants were substantially adherent and 10.08% of them were partially adherent. It was also found that the 25.32% of the respondents frequently forgot to take their medication, while the prevalence of forgot to take medicine moderately, and occasionally were 5.17%, and 13.44% respectively. Additionally, the prevalence of maintaining doctor's visits regularly, moderately, occasionally were 17.57%, 11.11%, and 22.22% respectively.

Table 4: Frequency distribution of respondents by self-care management practices for hypertension and diabetes (n=387)

Variables	Frequency (n)	Percentage (%)
Hypertension only		
Salt intake below 1 teaspoon/day*		
Never	203	52.45
Sometimes	18	4.65
Always	166	42.89
Forget to take medicine		
Never	209	54.01
Sometimes	91	23.51
Always	87	22.48
Diabetes only		
Adherence to prescribed medicine		
Highly adherent	194	50.13
Substantial adherent	39	10.08
Partially adherent	24	10.08
Not applicable	130	33.59
Forget to take diabetic medicine		
Frequent	98	25.32
Moderately	20	5.17
Occasionally	52	13.44
Not applicable	217	56.07
Maintaining doctor's visit		
Regularly	68	17.57
Moderately	43	11.11

Variables	Frequency (n)	Percentage (%)
Occasionally	86	22.22
Not applicable	190	49.1

* 5 gm of salt per day

Table 5 illustrates the prevalence of health care seeking behavior of the study participants. Based on the timing based on the last blood pressure measurement, it was found that most of the study participants had their blood pressure within the last three months (70.80%), while 29.20% of them had their last measurement more than three months ago. The distribution of healthcare facilities where the respondents had their blood pressure measures, the study showed that most of them visited private dispensaries (58.91%). A small percentage of the study participants visited government facilities (12.66%), private chambers (9.82%), NGOs or private clinics (7.24%), while 11.37% of them measured blood pressure at home. The data based on who measured the blood pressure of the respondents, the largest group (35.66%) had their measurements taken by salesperson at pharmacy, and remaining of them got their blood pressure measured by rural medical practitioners (29.72%), MBBS doctor (12.92%), nurses (4.65%), CHCP or community health workers (5.68%), and others (11.37%).

Moreover, based on the timing based on the last blood sugar measurement, it was found that most of the study participants had their blood sugar within the last three months (62.53%), while 37.47% of them had their last measurement more than three months ago. The distribution of healthcare facilities where the respondents had their blood pressure measures, the study showed that most of them visited private dispensaries (46.51%). Remaining of them visited government facilities (15.50%), private clinics (16.54%), private chambers (7.75%), and 13.70% of them measured at home. The data based on who measured the blood sugar of the respondents, the largest group (29.46%) had their measurements taken by salesperson at pharmacy, and remaining of them got their blood pressure measured by MBBS doctor (17.83%), nurses (4.39%), CHCP or community health workers (6.98%), rural medical practitioners (22.84%), and others (18.86%).

Table 5: Percentage distribution of the respondents by health care seeking behavior for hypertension and diabetes (n=387)

Variables	Hypertension n (%)	Diabetes n (%)
Last blood pressure / sugar measured		
Within last 3 months	274 (70.80)	242 (62.53)
More than 3 months	113 (29.20)	145 (37.47)
Visit for BP / sugar measurement		
Govt. facility	49 (12.66)	60 (15.50)
NGO/private clinic	28 (7.24)	64 (16.54)
Private dispensary	228 (58.91)	180 (46.51)
Private practice/chamber	38 (9.82)	30 (7.75)
Home	44 (11.37)	53 (13.70)
Blood pressure / sugar measured by		
MBBS doctor	50 (12.92)	69 (17.83)
Nurse	18 (4.65)	17 (4.39)
CHCP/CHW	22 (5.68)	27 (6.98)
Rural medical practitioner	115 (29.72)	87 (22.48)
Salesperson at pharmacy	138 (35.66)	114 (29.46)
Others	44 (11.37)	73 (18.86)

The prevalence of one or multiple behavioral risk factors of NCDs among the study participants was assessed. This was observed that only 0.78% of the respondents showed no risk factors. The overall prevalence of one risk factor, two risk factors, three risk factors, and four risk factors were 9.04%, 51.94%, 32.3% and 5.94%. Respectively. Moreover, none of the respondents reported having five risk factors. Most of the participants have two risk factors (**Figure 3**).

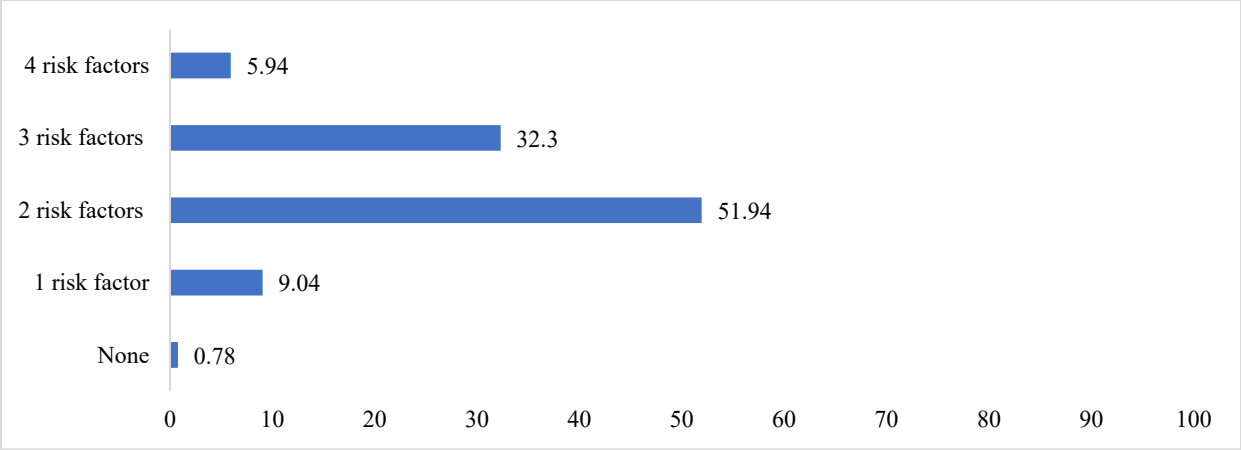

Figure 3: Prevalence of clustering risk factors for NCDs among respondents (n=387)

Table 6 shows the univariate and multivariate analysis results with 95% confidence interval (CI) of odds ratio (OR) (unadjusted and adjusted) for the association of socio-demographic factors (**Annex Table 8**), self-care management (**Annex Table 9**), and health care seeking behaviors (**Annex Table 10**) with co-existence of at least three risk factors. For the study participants aged 40-49 years old, both crude OR of 0.34 and the adjusted OR [aOR]: 0.32, 95% CI: 0.16, 0.62; p<0.001 were statistically significant. However, for the age group 50-59 years, they had the highest OR of 0.60; 95% CI: 0.37-0.98 was statistically significant but after adjusting the potential confounders, this was not statistically significant. For the working status of the study participants, the result shows that the working status was not statistically significant with the clustering of risk factors. Moreover, considering the education level of the study participants, none of the educational level was statistically significant with the clustering of NCD risk factors after the adjustment. Compared to the reference group (poorest household wealth index), for the study participants from the "poorer" category had OR of 0.47, 95% CI 0.24-0.90, p<0.023 which was statistically significant, however after adjusting the potential confounders, this was not statistically significant.

Additionally, for the self-care behaviors related to hypertension, compared to the reference group (never take extra salt), those who consume extra salt "sometimes" and "always" were found not statistically significant. However, for forgetting to take medicine, study participants who "always" forgot to take their medications have a significantly higher odds of having three or more risk factors with crude OR of 1.93; 95% CI 1.04, 3.57; p<0.037 and [aOR]: 2.01, 95% CI: 1.02, 3.

96; p<0.045 which were statistically significant. Furthermore, self-care management for diabetes, the frequency of doctor visits compared to the reference group (regularly), those who visited doctor moderately and occasionally were not statistically significant.

For the healthcare seeking behavior for hypertension, compared to the reference group (blood pressure measured within the last 03 months), the study participants who had measured their blood pressure more than 3 months ago were not statistically significant. Another, regarding visiting the healthcare facilities for BP measurement, compared to the reference group (home), those who visited govt. facilities, NGOs or private clinics, private dispensaries indicated no statistical significance between the cluster of NCD risk factors and the visits to healthcare facilities. In addition, healthcare seeking behavior for diabetes, compared with the reference group (Community Health Care Provider/Community Health Worker), the study participants who visited MBBS doctor, nurse, rural medical practitioner, salesperson at pharmacy or others to measure their blood sugar, the results suggested that none of them were statistically significant.

Table 6: Factor associated with the clustering of risk factors (≥3 risk factors) among respondents (n=387)

Characteristics	OR† [95% CI]	p-value	aOR‡ [95% CI]	p-value
Age (in years)				
18 - 39	0.46 [0.20-1.05]	0.066	0.48 [0.19 - 1.23]	0.125
40 - 49	0.34 [0.19-0.61]	<0.000	0.32 [0.16 - 0 .62]	0.001
50 - 59	0.60 [0.37-0.98]	0.042	0.61[0.35 - 1.05]	0.075
60 and above	Ref.		Ref.	
Working status				
Employed	Ref.		Ref.	
Unemployed	1.21 [0.77 - 1.90]	0.413	1.38 [0.82 - 2.31]	0.226
Retired	1.91 [0.85 - 4.27]	0.116	1.45 [0.58- 3.60]	0.426
Education				
No education	Ref.		Ref.	
Incomplete primary School	0.57 [0.30 - 1.07]	0.081	0.68 [0.34 - 1.39]	0.293
Complete primary School	0.48 [0.22 - 1.06]	0.069	0.56 [0.24 - 1.32]	0.186
Incomplete secondary	0.50 [0.26 - 0.96]	0.036	0.67 [0.31 - 1.42]	0.291
Secondary and above	0.60 [0.35 - 1.03]	0.064	0.80 [0.38 - 1.66]	0.542
Household wealth index				
Poorest	Ref.		Ref.	

Characteristics	OR† [95% CI]	p-value	aOR‡ [95% CI]	p-value
Poorer	0.47 [0.24 - 0.90]	0.023	0.52 [0.25 - 1.07]	0.078
Middle	0 .51 [0.26 - 0.97]	0.041	0.53 [0.25 - 1.11]	0.091
Richer	0.82 [0.45 - 1.47]	0.502	0.88 [0.44 - 1.76]	0.709
Richest	0.48 [0.23 - 1.01]	0.053	0.58 [0.24 - 1.38]	0.218
Self-care for hypertension				
Salt intake				
Never	Ref.		Ref.	
Sometimes	1.18 [0.44 -3.19]	0.739	1.06 [0.36 - 3.10]	0.914
Always	1.36 [0.89 - 2.07]	0.158	1.28 [0.79 - 2.08]	0.323
Forget to take medicine				
Never	1.53 [0.90 - 2.60]	0.115	1.43[0.80 - 2.57]	0.229
Sometimes	Ref.		Ref.	
Always	1.93 [1.04 - 3.57]	**0.037**	2.01 [1.02 - 3.96]	0.045
Self-care management for diabetes				
Regular doctor visit				
Regularly	Ref.		Ref.	
Moderately	1.24[0.56 - 2.76]	0.6	1.36 [0.57 - 3.24]	0.495
Occasionally	1.58 [0.81 - 3.07]	0.177	1.87 [0.87 - 4.00]	0.109
Not applicable	1.30 [0.73 - 2.34]	0.374	1.30 [0.64 - 2.64]	0.468
Health seeking behavior of hypertension				
Last blood pressure measured				
Within last 3 months	Ref		Ref.	
More than 3 months	1.43 [0.91- 2.23]	0.119	1.29 [0.77 - 2.16]	0.336
Visit for BP measurement				
Govt. facility	1.64 [0.69 -3.90]	0.258	2.71 [0.92 -7.95]	0.07
NGO/private clinic	1.79 [0.66 -4.81]	0.25	1.88 [0.58 - 6.08]	0.293
Private dispensary	1.42 [0.70- 2.86]	0.329	1.39 [0.59 - 3.26]	0.45
Private practice/chamber	2.15 [0.87- 5.32]	0.099	2.63 [0.92 -7.49]	0.07
Home	Ref.		Ref.	
Health seeking behavior of diabetes				
Blood sugar measured by				
MBBS doctor	1.84 [0.68 -4.93]	0.227	1.69 [0.55 - 5.16]	0.358
Nurse	1.56[0.42 - 5.81]	0.509	1.74 [0.41 - 7.41]	0.453
CHCP/CHW	Ref.		Ref.	
Rural medical practitioner	1.92[0.74 -5.03]	0.183	2.28 [0.73 - 7.13]	0.155
Salesperson at pharmacy	1.80 [0.70 - 4.60]	0.222	2.33 [0.77 - 7.06]	0.136
Others	1.88 [0.71 -5.02]	0.206	2.71 [0.86 - 8.54]	0.09

†Adjusted odd ratio

‡Unadjusted odd ratio

CHAPTER 4: DISCUSSION

4.1 Discussion

The study provides comprehensive insights on the behavioral risk factors of NCDs and factors associated with clustering of NCD risk factors among adults living with hypertension and diabetes comorbidity in the rural setting of Bangladesh. We observed that the prevalence of indoor air pollution, insufficient fruits and vegetables intake and inadequate physical activity was prevalent among the study participants. The prevalence of insufficient intake of fruits and vegetables and indoor air pollution were most common among both male and female participants within the regions. It was also observed that more than one third of the study participants had three or more behavioral risk factors. Study participant with increased age and those who forget to take their medication were found statistically significant.

In this study, we found that insufficient intake of fruits and vegetables and indoor air pollution were highly prevalent (91.7%). A systematic and meta-analysis by Jayawardena et al. reported that intake of fruits and vegetables is extremely low in South Asian countries, Bangladesh and Sri Lanka showed 0.43 servings/day of fruits consumption, India reported lowest intake of vegetables (0.9 servings per day), while Bangladesh showed the lowest fruits and vegetables (1.83 servings per day). (Jayawardena et al, 2020). Another recent study reported that insufficient intake of fruits and vegetables in both rural and urban Bangladesh is influenced by socio-economic factors, people with higher income and higher education are associated with increased fruits and vegetables intake (Mustafa et al, 2021). Although the availability of the fruits and vegetables in rural setting is not restricted, socio-economic factors and health literacy can play a role to reduce the consumption of daily recommended intake of fruits and vegetables.

In this study, most of the participants were exposed to indoor air pollution, where female participants were more exposed to indoor air pollution compared to male participants. Moreover, another study revealed that women and children were more likely to be exposed to indoor air pollution than men (Shakya et al, 2021). However, women participants showing higher prevalence of exposure of indoor air pollution than men are also somehow related to the culture, traditional gender roles and also needs to addressed from social and gender lens. This result is consistent with other LMICs such as Nepal, a recent study reported that more than 80% of the households reported indoor air pollution by using unclean fuel, not having separate kitchen or ventilation which is

associated with low socio-economic status (Ghimire et al, 2019). Moreover, the patients living with hypertension and diabetes comorbidity might increase the risk to more disease complications, particularly women.

Our study found that nearly one third of the study participants were found to be physically inactive where physical inactivity among women is higher than men. Study participants particularly women in rural areas are mostly occupied with their household chores, farming, and other activities which limit their sedentary time as well. However, a systematic review in South Asian countries including Bangladesh, India, Sri Lanka reported that the prevalence of physical inactivity within this region ranges from 11% to 88.4%, and some common factors which are associated with the female gender, older age, and high educational level (Ranasinghe et al, 2013, Ng et al, 2009). Moreover, physical activity level among women is also based on the context, and social and cultural norms.

The study also found that the prevalence of tobacco use was 24.4% among the study participants which was found lower than recent nationwide survey (43.7%) in Bangladesh. Similarly, studies reported tobacco use among over half of the hypertensive and diabetic patients in India and Africa, and the studies showed that the active smoking was higher among male than female participants (Kumar et al, 2022; Noubiap, et al, 2019). Another study supported that older age groups have significantly higher odds of using tobacco compared to the younger people (Lakew, et al, 2015). The tobacco use among the adults has been reduced however, tobacco use has become another public health issue which needs to addressed to reduce the future burden of the NCD risk factors.

Our study reported that the prevalence of clustering of three or more risk factors among the study participants was 38.24%. A similar study was conducted on national representatives of Bangladesh which found that low-income countries like Bangladesh, and Nigeria showed high prevalence of the risk factor clustering (Zaman et al, 2015, Alikor et al, 2018). Considering Bangladesh, 38% of the Bangladeshi adults showed at least three risk factors which were found to be associated with age, male gender, and socio-economic background (Zaman et al, 2015). Moreover, the existing behavioral risk factors also lead to other behavioral risk factors.

Our study showed that the NCD risk factors increase with age and forget to take the medicine category after the adjustment. These findings were found to be similar and consistent with the other studies done among different populations in Nepal. The NCD risk factors are more

likely to be among women aged 40-49 years old (Bista et al, 2020). Another study found that the age would be constantly associated with clustering of risk factors due to the presence of one risk may increase the probability of clustering of other risk factors while aging (Sarveswaran et al, 2020). This study observed that the multiple risk factors are relatively higher among men, however the co-existence of the multiple risk factors are prevalent among both men and women which needs to be addressed urgently.

4.2 Strengths and limitations

The strengths of the study were using validate comprehensive WHO STEPs questionnaires, unique study population and high responsiveness. The findings cannot be generalized among the same population in the country as it does not contain national representatives. However, this provides a snapshot of what is happening in these selected populations. Moreover, the collected data were self-reported which might have led to social desirability bias and recall bias. However, WHO STEPS validated tools were used to minimize the recall bias.

4.3 Conclusion

In conclusion, the study revealed that the clustering of behavioral risk factors was highly prevalent among the study participants, with high prevalence of insufficient fruits and vegetables intake, and exposure to indoor air pollution, particularly among people with increased age and inadequate self-care management. The findings also highlight the need for further national level research to inform intervention strategies and policy development. Additionally, an integrated approach to address NCD risk factors is required to reduce the NCDs burden and its complications.

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ANNEX

Table 7: Distribution and prevalence of physical activity level among respondents (n=387)

Variables	Frequency (n)	Percentage (%)
Vigorous intensity physical activity		
No	364	94.06
Yes	23	5.94
No. of days (mean ± SD)	4.09 (± 0.42)	
Duration (mean ± SD)	117.17 (± 23.02)	
Moderate intensity activity		
No	160	41.34
Yes	227	58.66
No. of days /week (mean ± SD)	6.53 (± 0.09)	
Duration (mean ± SD)	106.09 (± 6.64)	
Walk or cycling at least for 10 minutes		
No	247	63.82
Yes	140	36.18
No. of days / week (mean ± SD)	5.78 (± 0.17)	
Duration (mean ± SD)	51.69 (± 3.56)	
Vigorous intensity sports, fitness and recreational (n=3)		
No	384	99.22
Yes	3	0.78
No. of days / week (mean ± SD)	4.67 (±2.33)	
Duration (mean ± SD)	35(± 5)	
Moderate intensity sports, fitness and recreational (n=135)		
No	252	65.12
Yes	135	34.88
No. of days /week (mean ± SD)	6.13 (± 0.13)	
Duration (mean ± SD)	34 (±1.21)	
Sedentary time		

Variables	Frequency (n)	Percentage (%)
>4 hours	264	68.22
≤4 hours	123	31.78
Inadequate physical activity (per week)		
Inadequate ❖	112	28.94
Adequate	275	71.06

❖ less than 600 Metabolic Equivalent of Task (MET) minutes in a week

Table 8: Logistic regression of sociodemographic factors clustering of risk factors of NCDs (≥3 risk factors)

Characteristics	OR [95% CI]	p-value	aOR [95% CI]	p-value
Age (in years)				
18-39	0.46 [0.20-1.05]	0.066	0.70 [0.27 - 1.80]	0.458
40 - 49	0.34 [0.19-0.61]	0.000	0.42 [0.22 - 0.83]	0.012
50 - 59	0.60 [0.37-0.98]	0.042	0.72 [0.42 - 1.23]	0.229
60 and above	Ref.		Ref.	
Sex				
Male	1.47 [0.97 - 2.24]	0.071	3.33 [1.36 - 8.15]	0.008
Female	Ref.		Ref.	
Marital status				
Currently married	1.10 [0.61 - 1.99]	0.757	1.01 [0.52 - 1.97]	0.965
Others	Ref.		Ref.	
Working status				
Employed	Ref.		Ref.	
Unemployed	1.21 [0.77 - 1.90]	0.413	3.35 [1.42 - 7.92]	0.006
Retired	1.91 [0.85 - 4.27]	0.116	1.67 [0.68 - 4.06]	0.260
Religion				
Islam	1.09 [.56 - 2.14]	0.796	1.13 [0.55 - 2.32]	0.733
Other	Ref.		Ref.	

Characteristics	OR [95% CI]	p-value	aOR [95% CI]	p-value
Education				
No education	Ref.		Ref.	
Incomplete primary School	0.57 [0.30 - 1.07]	0.081	0.63 [0.32 - 1.26]	0.191
Complete primary School	0.48 [0.22 - 1.06]	0.069	0.52 [0.22 - 1.22]	0.130
Incomplete secondary	0.50 [0.26 - 0.96]	0.036	0.51 [0.24 - 1.06]	0.069
Secondary and above	0.60 [0.35 - 1.03]	0.064	0.63 [0.31 - 1.29]	0.211
Household wealth index				
Poorest	Ref.		Ref.	
Poorer	0.47 [0.24 - 0.90]	0.023	0.52 [0.25 - 1.04]	0.065
Middle	0 .51 [0.26 - 0.97]	0.041	0.59 [0.29 - 1.20]	0.144
Richer	0.82 [0.45 - 1.47]	0.502	0.84 [0.42 - 1.68]	0.628
Richest	0.48 [0.23 - 1.01]	0.053	0.48 [0.21 - 1.11]	0.086

Table 9: Logistic regression of self-care management influencing clustering of risk factors (≥3 risk factors) of hypertension and diabetes

Characteristics	OR [95% CI]	P-value	aOR [95% CI]	P-value
Hypertension only				
Salt intake				
Never	Ref.		Ref.	
Sometimes	1.18 [0.44 -3.19]	0.739	1.00 [0.36-2.74]	0.995
Always	1.36 [0.89 - 2.07]	0.158	1.41 [0.91-2.20]	0.125
Forget to take medicine				
Never	1.53 [0.90 - 2.60]	0.115	1.68 [0.96 - 2.95]	0.071
Sometimes	Ref		Ref	
Always	1.93 [1.04 - 3.57]	0.037	2.01[1.05 - 3.84]	0.035
Diabetes only				
Adherence to prescribed medicine				
Highly adherent	Ref.		Ref.	

Characteristics	OR [95% CI]	P-value	aOR [95% CI]	P-value
Substantial adherent	1.55 [0.78 - 3.11]	0.214	1.51 [0.71 -3.23]	0.284
Partially adherent	1.29 [0.55 - 3.07]	0.558	1.30 [0.50 - 3.36]	0.592
Not applicable	1.17 [0.74 - 1.85]	0.503	1.05[0.58 - 1.88]	0.873
Forget to take medicine				
Frequent	1.31 [0.80 - 2.13]	0.281	1.24[0.70 - 2.19]	0.455
Moderately	1.21 [0.47 - 3.09]	0.687	1.03[0.37 - 2.89]	0.960
Occasionally	1.33[0.72 -2.47]	0.360	1.28[0.65-2.52]	0.480
Not applicable	Ref.		Ref.	
Regular doctor visit				
Regularly	Ref.		Ref.	
Moderately	1.24[0.56 - 2.76]	0.600	1.17 [0.51 -2.68]	0.711
Occasionally	1.58 [0.81 - 3.07]	0.177	1.49[0.74 - 3.01]	0.269
Not applicable	1.30 [0.73 - 2.34]	0.374	1.19[0.61 -2.30]	0.606

Table 10: Logistic regression of health care seeking behavior influencing clustering of risk factors (≥3 risk factors) of hypertension and diabetes

Characteristics	OR [95% CI]	p-value	aOR [95% CI]	p-value
For hypertension				
Last blood pressure measured				
Within last 3 months	Ref.			
More than 3 months	1.43 [0.91- 2.23]	0.119	1.33[0.71 - 2.50]	0.373
Visit for BP measurement				
Govt. facility	1.64 [0.69 -3.90]	0.258	5.89[0.92 -37.65]	0.061
NGO/private clinic	1.79 [0.66 -4.81]	0.250	2.37[0.48 -11.73]	0.291
Private dispensary	1.42 [0.70- 2.86]	0.329	1.17 [0.28 -4.79]	0.830
Private practice/chamber	2.15 [0.87- 5.32]	0.099	2.67[0.54 -13.12]	0.226
Home	Ref.		Ref.	

Blood pressure measured by				
MBBS doctor	3.40 [1.09 -10.64]	0.036	7.97[1.19 -53.33]	0.032
Nurse	1.70[0.42 - 6.88]	0.457	2.7 [0.34 -21.82]	0.348
CHCP/CHW	Ref.		Ref.	
Rural medical practitioner	2.03[0.70 - 5.90]	0.193	5.61[0.65- 48.74]	0.118
Salesperson at pharmacy	2.19 [0.76 -6.27]	0.146	7.70[0.95 -62.49]	0.056
Others	1.76 [0.54 - 5.70]	0.347	5.88[0.69 -50.01]	0.105
For diabetes				
Last blood sugar measured				
Within last 03 months	Ref.		Ref.	
More than 3 months	1.24 [0.81- 1.88]	0.326	1.11 [0.60 - 2.05]	0.740
Visit for sugar measurement				
Govt. facility	Ref.			
NGO/private clinic	1.11 [0.54 -2.32]	0.772	1.56 [0.39 - 6.28]	0.534
Private dispensary	1.21[0.66 - 2.22]	0.540	2.43[0.40 -14.72]	0.334
Private practice/chamber	1.42 [0.58 -3.48]	0.443	1.44[0.21 - 9.86]	0.712
Home	1.04 [0.48 -2.25]	0.925	1.83[0.345 -9.56]	0.476
Blood sugar measured by				
MBBS doctor	1.84 [0.68 -4.93]	0.227	0.53 [0.09 -3.01]	0.471
Nurse	1.56 [0.42 -5.81]	0.509	0.75[0.10 - 5.39]	0.776
CHCP/CHW	Ref.		Ref.	
Rural medical practitioner	1.92 [0.74 -5.03]	0.183	0.71 [0.08 - 5.95]	0.752
Salesperson at pharmacy	1.80 [0.70 -4.60]	0.222	0.54 [0.07 - 4.38]	0.562
Others	1.88 [0.71 -5.02]	0.206	0.91[0.14 - 5.74]	0.916