Clinical Journal of Diabetes Care and Control
ISSN: 2642-0872

Research Article *Volume 3 Issue 2*

Predictors of Pre -Diabetes among Adults above 18 Years in Myanmar: A Community Based Cross-Sectional Study

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Received Date: September 24, 2020; **Published Date:** October 17, 2020

Abstract

Introduction: The epidemic of prediabetes is one of the most devastating public health challenges in 21st century, especially for lower and middle-income countries. The world health organization (WHO) reported that, impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) are intermediate conditions in the transition between normality and diabetes. People with IGT or IFG are at high risk of progressing to type 2 diabetes.

Objective: The objective of the study was to estimate the prevalence of pre-diabetes and to examine their predictors among adults over 18 years in Myanmar.

Method: The study is a population-based cross-sectional study. The multi-stage sampling design was used with the design effect and set at 1.5 and the nonresponse rate was assumed at 10% and a total of 660 samples were included in the study.

Results and conclusions: The current study results indicate that the overall prevalence of prediabetes in the study area was 14.7%, where higher prevalence was reported among female respondents (17.5%) compared to male respondents (7.3%). The study found relatively a lower prevalence rate of prediabetes when compared with earlier study conducted in Myanmar which might be as result of different interventions to tackle the increasing prevalence of prediabetes in Myanmar. Therefore, the findings in this study, may contribute to expand community-based screening and prevention of diabetes. In the present scenario, for further improvements, it is highly recommended to improve and expand a set of community-based intervention programs that focused on health education, counseling regarding its risk factors, modifying them along with surveillance, encouragement, and proper monitoring should be performed.

Keywords: Prediabetes; Diabetes Mellitus; Daily tobacco use; Daily alcohol use

Abbreviations: WHO: World Health Organization; IGT: Impaired Glucose Tolerance; IFG: Impaired Fasting Glycaemia; RBS: Random Blood Sugar.

Introduction

Background and Problem Statement

The epidemic of prediabetes is one of the most devastating public health challenges in 21st century, especially for lower and middle-income countries. Pre-diabetes can be defined as a chronic metabolic condition where blood glucose levels are above the normal blood glucose but below the threshold for a diagnosis of diabetes. Since there are no clear symptoms for prediabetes, the only way that individual find out that they have prediabetes when being tested for diabetes, where as some people with prediabetes may have some of the symptoms of diabetes or even problems from diabetes already. The world health organization (WHO) reported that, impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) are intermediate conditions in the transition

between normality and diabetes. People with IGT or IFG are at high risk of progressing to type 2 diabetes [1-4]. Prediabetes is predisposing individuals to a high probability of progression to diabetes [2], where the number of people with diabetes rose from 108 million to 422 million between 1980 and 2014 and the global prevalence of diabetes among adults over 18 years of age rose from 4.7% to 8.5% in the same period. According to George Institute of Global health, having higher than normal blood glucose levels but not enough to be classified as having diabetes, is associated with an increased risk of cardiovascular disease (CVD) and death [4,5].

Regarding prevalence of prediabetes, there is very limited compressive evidences globally and the available literatures also reported vary greatly, which might be the reflection of the methods used to define the condition and the study population. According to George institution for global health, the difference on how to define diabetes and screening criteria between guidelines developed by different organizations, resulting in estimations of prevalence that can vary widely from one another [5]. On the other hand, despite these differences, the available evidence makes clear that the prevalence of prediabetes is increasing very rapidly, and significant percentage of the population are attracting prediabetes both in developed and developing countries. For example, only in USA 88 million people aged 18 years and above have prediabetes (34.5% of the adult US population) [1]. Similarly, significant proportion of the people in developing countries also have prediabetes. According to WHO global report on diabetes (2016) [6], the percentage of deaths related to high blood glucose that occurs prior to age 70 is higher in low- and middle-income countries when compared with high income countries. The study conducted in Bangladesh was reported that around 23% the population had prediabetes [7]. Another study conducted in Saudi Arabia was also reported higher prevalence of prediabetes, where 27.6% of the population reported to having prediabetes. Similarly, previous study conducted in Myanmar was also reported high prevalence of prediabetes, where the overall prevalence of prediabetes was 19.7% and even higher among the female population (23% among female against 16.5% among Male) [8]. The prevalence of prediabetes is increasing rapidly, and it is estimated over 470 Million of people will develop prediabetes by 2020, where 70% of them will advance to diabetes [5]. Even though early detection and proper treatment can have enormous benefits, many millions of people who are unaware they have either condition or do not act early enough are advancing to type 2 diabetes. Therefore, the prevalence of prediabetes is increasing rapidly in all parts of the world and action is required to halt this increase, and to avoid the future diabetes epidemic. Regarding prediabetes risk factors, numerous studies reported different factors contributing for prediabetes including socioeconomic status, access to healthcare services, education status, disease exposure, public health awareness among the others [2, 5].

These behavioral risk factors cause metabolic and physiological changes in the body that lead to elevated blood glucose, and obesity (WHO: 2018). All population groups are vulnerable to behavioral risk factors that contribute to prediabetes, whether from unhealthy diets, physical inactivity, tobacco use, or harmful use of alcohol [9]. The global population aging may also bring a higher prevalence of prediabetes complimenting with change of lifestyle trending toward obesity, unbalanced diets, physical inactivity, and others risk factors, especially in developing countries. With the current fast speed of urbanization in low-income countries complimented with underdeveloped infrastructure, the risk factors associated with prediabetes became higher and higher. In Myanmar, where there is limited evidence that systematically measured and reported the national prevalence of prediabetes, there is a significant gaps between rural and urban in accessing the services, where services do not always reach the poor and disadvantaged groups. Therefore, estimates of the current and future burden of diabetes are essential to appropriately allocate resources, drive health-promoting policies, and encourage action to prevent diabetes in future generations.

Objective

The objective of the study was to estimate the prevalence of pre-diabetes and to examine their predictors among adults over 18 years in Myanmar. The findings of this study will guide program decisions and for informing NCD public health policy decisions.

Methodology

Study Design

The study is a population-based cross-sectional study.

Settings: The study was carried out in Yangon, Mandalay and Ayeyarwaddy region over the month of January and first week of February 2020.

Sample size and sampling technique: Sample size calculation
To obtain the minimum required sample size, multistage sampling method was applied using the following formula.

$$n = z^2_{1-a/2}\frac{1-P}{\varepsilon^2 P}$$

Where: n= the desired sample size. Z= critical values of normal distribution at 95% to be 1.96. P= the proportion of

the target population estimated at 20% to have pre-diabetes. d=estimated margin of error 5%. For the current study participants P is estimated at 20% for those who have been diagnosed as pre-diabetes or diabetes according to STEP 2014 report and relative precision error (ε) is set at 20%. Therefore

$$n = (1.96)2 * (0.8) / [(0.2)2 (0.2)] = 385$$

The multi-stage sampling design was used with the design effect and set at 1.5 and the nonresponse rate was assumed at 10%. Therefore, the minimum required sample size was.
n = 385*1.5/ (1-0.1) = 642 ~ 660

Materials/Instruments: For data collection, eleven trained health professionals (one medical doctor, two nurses and eight health assistants) interviewed respondents using a questionnaire. The questionnaire being used was grounded on a review of the evidence published in prior sources. The following information was collected: the first part included demographics (such as age, sex, education, occupation, and marital status), the second part included behavioral measurement including tobacco smoking, alcohol consumption, active life style and healthy eating).

Random blood sugar (RBS) test: Random blood sugar was collected from each participant by one trained nurse and one health assistant. All participants completed an interviewer administered questionnaire, followed by a Random blood test by one trained nurse and one health assistant. Among 660 total samples, 8 respondents were denied testing Random Blood Sugar and so, blood sugar test was conducted among 592 respondents.

Methodology for random blood sugar test: With finger-prick blood, random blood glucose was measured using glucometer (ACCU-CHEK). Participant's hand was washed or cleaned with alcohol to remove any residue before blood glucose test. Then participant's hand was dried thoroughly as excess water or rubbing alcohol can dilute blood sample, affecting the reading. Squeezing or rubbing participant's fingers was avoided while taking blood sample. A test strip was inserted into meter and used lancing device on the side of participant's fingertip to get a drop of blood. The edge of the test strip was touched and held to the drop of blood and wait for the result.

Prediabetes definition: In the current study, prediabetes was defined using RBS cutoff level at 140 mg/dl to 199 mg/dlas as it was defined by American Diabetes Association (ADA:2019). Any subject who reported that he /she was a diabetic and on treatment (or not) was considered as self-reported diabetic. All random blood sugar level greater than or equal to 200 mg/dl was confirmed by testing HbA1c. The test was done at a convenient place, to where all the respondents with high blood sugar level (≥ 200 mg/dl) will be referred for HbA1c measurement.

Result	RBS
Normal	less than 140 mg/dl
Prediabetes	140 mg/dl to 199 mg/dl
Diabetes	200 mg/dl or higher

Table 1: Classification and diagnosis of diabetes.
Source: American Diabetic Association. 2019. Diagnosis of diabetes. Available at: https://www.diabetes.org/a1c/diagnosis.

Data analysis: The baseline characteristics of prediabetic individuals were reported using mean (standard deviation) for continuous variables and frequency and percentages for categorical variables. Data were analyzed using the Software for Statistics and Data Science (STATA). Data were expressed as mean value ± standard deviations (SD) for continuous variables. Frequencies (n) and proportions (%) were reported for categorical variables. The statistical association was reported using p-value 0.05 at 95%CI.

Results

Background Characteristics of Study Participants

Out of the total 660 respondents scheduled to participate in the study, all the respondents (100%) participated on the interviewer administered questionnaire, where female respondents made up 70% of the study population. More than one-third of male respondents (34.1%) were in the age group 60-69 years while 33.7 percent of females were aged between 50-59 years. Nearly, two-third (61.5 %) of the respondents were living in rural areas.

Background Characteristics	Male			Female			Total		
	n	%	CI 95%	n	%	CI 95%	n	%	CI 95%
Age (years)									
40 – 49	34	19.0	13.5-25.5	140	29.1	25.1-33.4	174	26.4	23.0-29.9
50 – 59	48	26.8	20.5-33.9	162	33.7	29.5-38.1	210	31.8	28.3-35.5
60 – 69	61	34.1	27.2-41.5	119	24.7	20.9-28.8	180	27.3	23.9-30.8

≥70	36	20.1	14.5-26.7	60	12.5	9.7-15.8	96	14.5	11.9-17.5
Mean (years)	59.9		58.4-61.6	56.6		55.7-57.3	57.5		56.7-58.3
Residence									
Urban	57	31.8	25.1-39.2	197	41.0	36.5-45.5	254	38.5	34.8-42.3
Rural	122	68.2	60.8-74.9	284	59.0	54.5-63.5	406	61.5	57.7-65.2
Educational level									
No formal schooling	33	18.4	13.0-24.9	132	27.5	23.5-31.7	165	25.0	21.7-28.5
Primary	67	37.5	30.3-45.0	218	45.3	40.8-49.9	285	43.2	39.4-47.1
Secondary	51	28.5	22.0-35.7	85	17.7	14.4-21.4	136	20.6	17.6-23.9
High School	19	10.6	6.5-16.1	33	6.9	4.8-9.5	52	7.9	5.9-10.2
College/university	9	5.0	2.3-9.3	12	2.5	1.3-4.3	21	3.2	2.0-4.8
Refused	-	-	-	1	0.2	0.0-1.2	1	0.2	0.0-0.8
Marital status									
Never married	7	3.9	1.6-7.9	20	4.2	2.6-6.3	27	4.1	2.7-5.9
Currently married	152	84.9	78.8-89.8	318	66.1	61.7-70.3	470	71.2	67.6-74.6
Divorced/ widowed	20	11.2	7.0-16.7	141	29.3	25.3-33.6	161	24.4	21.2-27.9
Refused	-	-	-	2	0.4	0.1-1.5	2	0.3	0.0-1.1
Occupation									
Employed/ self employed	116	64.8	57.3-71.8	221	46.0	41.4-50.5	337	51.1	47.2-54.9
Unpaid/homemaker	9	5.0	2.3-9.3	155	32.2	28.1-36.6	164	24.8	21.6-28.3
Unemployed(retired)	54	30.2	23.5-37.5	105	21.8	18.2-25.8	159	24.1	20.9-27.5
Average family monthly income (kyats)									
≤90000	16	8.9	5.2-14.1	37	7.7	5.4-10.4	53	8.0	6.1-10.4
90001-150000	40	22.4	16.5-29.2	89	18.5	15.1-22.2	129	19.5	16.6-22.8
150001-250000	21	11.7	7.4-17.4	62	12.9	10.0-16.2	83	12.6	10.1-15.3
250001-400000	29	16.2	11.1-22.4	72	15.0	11.9-18.5	101	15.3	12.6-18.3
≥ 400001	17	9.5	5.6-14.7	64	13.3	10.4-16.7	81	12.3	9.9-15.0
Refused	56	31.3	24.6-38.6	157	32.6	28.5-37.0	213	32.3	28.7-36.0
Mean (Kyats)	274935		219398-330473	296125		264081-328169	290294		262510-318078
Total	**179**	**100.0**		481	100.0		660	100.0	

Table 2: Socio-demographic characteristics of the study respondents.

Prevalence of Prediabetes

To assess prevalence of prediabetes, Random blood sugar test was used in the current study. Random blood sugar was collected from each participant by one trained nurse and one health assistant. All participants completed an interviewer administered questionnaire, followed by a Random blood sugar (RBS) test. Among a total of 660 respondents, 8 respondents were denied testing RBS test making the response rate for RBS test 92%. The overall prevalence of prediabetes among study sample was 14.7%. The prevalence of prediabetes much higher among female respondents (17.5%) when compared with their male counter parts (7.3%). The prevalence of prediabetes was almost 2times higher among those reside in urban areas (20.6%) when compared with their rural counterparts (11.1%). When, disaggregated by age, the highest prevalence was registered among the people with age of 70 years old and above(16.8%) followed by people with age of 50-59 years old (15.9%) whereas the lowest prevalence was registered among people

with age of 40-49 years old(13.5%). Similar speaking, the highest prevalence of prediabetes was registered among those who completed high school (19.2%) followed who graduated from university/ college (18.8%) whereas the lowest prevalence was registered among those with no formal schooling (10.9%).

When the prevalence of prediabetes was disaggregated against the income of the study sample, the highest prevalence of prediabetes was registered among those with highest income category (21.0%) followed by the lowest income category (14.9%) and the lowest prevalence of prediabetes were registered among those with middle income category (8.4%). Regarding the marital status, the highest prevalence of prediabetes was registered among divorced (50%), followed by widowed (17.8%), where the lowest prevalence was registered among those separated (7.1%).

Background characteristics	Respondents blood sugar measurement status (N=652)					
	less than 140 mg/dl		140 mg/dl to 199 mg/dl		200 mg/dl or higher	
	Frequency(N)	Percent (%)	Frequency(N)	Percent (%)	Frequency(N)	Percent (%)
Age(years)						
40 – 49	126	73.7%	23	13.5%	22	12.9%
50 – 59	147	70.7%	33	15.9%	28	13.5%
60 – 69	129	72.5%	24	13.5%	25	14.0%
≥70	71	74.7%	16	16.8%	8	8.4%
Gender						
Female	326	68.6%	83	17.5%	66	13.9%
Male	147	83.1%	13	7.3%	17	9.6%
Residence						
Rural	327	80.9%	45	11.1%	32	7.9%
Urban	146	58.9%	51	20.6%	51	20.6%
Educational level						
No formal schooling	136	82.4%	18	10.9%	11	6.7%
Primary	198	71.0%	43	15.4%	38	13.6%
Secondary	84	62.7%	22	16.4%	28	20.9%
High School	39	75.5%	10	19.2%	3	5.8%
College/university	10	62.5%	3	18.8%	3	18.8%
Marital status						
Never married	23	85.2%	3	11.1%	1	3.7%
Currently married	332	71.2%	64	13.7%	70	15.0%
Divorced	3	37.5%	4	50.0%	1	12.5%
Widowed	101	74.8%	24	17.8%	10	7.4%
Occupation						
Employed/govt.	2	40.0%	2	40.0%	1	20.0%
Employed/ Non govt.	12	75.0%	4	25.0%	0	0%
self employed	250	79.6%	37	11.8%	27	8.6%
Homemaker	82	65.1%	18	14.3%	26	20.6%
Unemployed (able to work)	27	64.3%	6	14.3%	9	21.4%
Unemployed/unable to work	63	73.3%	12	14.0%	11	12.8%

Retired	19	65.5%	5	17.2%	5	17.2%
Average Monthly income (KS)						
≤90000	76	75.2%	15	14.9%	10	9.9%
90001-150000	96	76.8%	15	12.0%	14	11.2%
150001-250000	65	78.3%	7	8.4%	11	13.3%
250001-400000	76	76.0%	12	12.0%	12	12.0%
≥ 400001	52	64.2%	17	21.0%	12	14.8%
Currently tobacco smoking						
yes	358	69.6%	79	15.4%	77	15.0%
No	473	72.6%	96	14.7%	83	12.7%
Ever consumed alcohol						
No	432	71.8%	93	15.4%	77	12.8%
Yes	41	82.0%	3	6.0%	6	12.0%
Overall prediabetes prevalence	473	72.6%	96	14.7%	83	12.7%

Table 3: Respondents blood sugar measurement status (N=652).

Prevalence of Risk Factors for Prediabetes Among Study Respondents

In the current study, the prevalence of risk factors such as tobacco smoking, alcohol consumption, physical inactivity and inadequate dietary practices of the study respondents were assessed.

Tobacco smoking: Tobacco smoking is associated with a wide range of diseases, including several types of cancers and heart and lung diseases, diabetes, eye disease, and rheumatoid arthritis. The tobacco epidemic is one of the biggest public health threats the world has ever faced, killing more than 8 million people a year. More than 7 million of those deaths are the result of direct tobacco use while around 1.2 million are the result of non-smokers being exposed to passive smoking [10]. In the current study, around one-fifth (21.2%) of the respondents reported that they are currently smoking tobacco products, where significant difference was reported among male and female (37.4% of male and 15.2% of female). The significant majority (87.9%) of the current tobacco product users uses in a daily basis. The study reported that more than half of male (55.2%) and more than one-third of female (37.4%) were started smoking below 20 years of age. The highest prevalence of daily smoking tobacco products was reported among male respondents belonging to the 50-59 years (39.6 %) followed by age of 60-69 years old (37.7%).

The current study also reported that 42.4 % of males with no formal schooling smoked tobacco daily basis, whereas only 11.1% of male among college/university educated uses in a daily basis. Similarly, nearly one-fourth of females (23.5%) having no formal education reported daily smoking as compared to 12.8% among females that were primary educated. More than three-quarters of male (77.6%) and 84.9 % of female smokers reported smoking cigars, cheroots, other products, where slightly more than one-tenth of both male and female smokers reported smoking hand rolled cigarettes. Regarding smokeless tobacco use, nearly half of the male (50.8%) and around one-third (34.5%) the female reported using smokeless tobacco products, where the use of betel quid among the respondents that used smokeless tobacco products was universal.

Tobacco consumption	Male			Female			Total		
	n	%	CI 95%	n	%	CI 95%	n	%	CI 95%
Currently smoking tobacco products	67	37.4	30.3-45.0	73	15.2	12.1-18.7	140	21.2	18.2-24.5
Total (n)	179			481			660		
Smoking tobacco products daily*	60	89.6	79.7-95.7	63	86.3	76.2-93.2	123	87.9	81.3-92.8
Total (n)	67			73			140		

Age at which daily smokers started smoking (years)**									
≤ 14	13	19.4	10.8-30.9	7	9.7	4.0-19.0	20	14.4	9.0-21.3
15-19	24	35.8	24.5-48.5	20	27.8	17.9-39.6	44	31.6	24.0-40.1
20-24	17	25.4	15.5-37.5	8	11.1	4.9-20.7	25	18.0	12.0-25.4
≥ 25	13	19.4	10.8-30.9	37	51.4	39.3-63.3	50	36.0	28.0-44.5
Mean (years)	20.2		17.9-22.6	25.2		22.4-28.0	22.8		20.9-24.7
Total (n)	67			72			139		
Type of tobacco product smoked* #									
Manufactured Cigarettes	9	13.4	6.3-24.0	2	2.7	0.3-9.5	11	7.9	4.0-13.6
Hand-rolled Cigarettes	7	10.4	4.3-20.3	8	10.9	4.9-20.5	15	10.7	6.1-17.1
Pipes with tobacco	2	3.0	0.4-10.4	1	1.4	0.0-7.4	3	2.1	0.4-6.1
Cigars, cheroots, cigarillos & Others	52	77.6	65.8-86.9	62	84.9	74.6-92.2	114	81.4	74.0-87.5
Total (n)	67			73			140		
Currently using smokeless tobacco products	91	50.8	43.3-58.4	166	34.5	30.3-38.9	257	38.9	35.2-42.8
Total (n)	179			481			660		
Using betel quid $	91	100.0		166	100.0		257	100.0	
Total (n)	91			166			257		

Table 4: Gender wise distribution of respondents by tobacco consumption.
* Calculated from respondents that was currently smoking,
# Multiple responses possible, total may exceed 100%.
** Calculated from respondents that reported smoking daily and were aware of age at starting smoking (1 female missing)
$ Calculated from those respondents that were currently using smokeless tobacco products

Alcohol consumption: The harmful use of alcohol causes several diseases, social and economic burden in communities [4]. Alcohol-related harm is determined by the volume of alcohol consumed, the pattern of drinking, and the quality of alcohol consumed. According to world health organization report [11], the harmful use of alcohol is a component cause of more than 200 disease and injury conditions in individuals, most notably alcohol dependence, liver cirrhosis, cancers, and injuries. In the current study, majority of the respondents (88.5%) were consumed alcohol in the last 12 months at the time of the study, where 78.8% reported alcohol consumption in the last 30 days at the time of the study. Regarding frequency of alcohol consumption, one-in four (24.4%) of the respondents were reported drinking daily. According WHO 2018 report, harmful use of alcohol causes more than 5% of the global disease burden where more than three million people died because of damaging use of alcohol in 2016 [9].

Alcohol consumption	Male			Female			Total		
	n	%	CI95%	n	%	CI95%	n	%	CI95%
Ever consumed alcohol	47	26.3	20.0-33.3	5	1.0	0.3-2.4	52	7.9	5.9-10.2
Total (n)	179			481			660		
Consumed alcohol during past 12 months*	41	87.2	74.3-95.2	5	100.0	-	46	88.5	76.6-95.6
Consumed alcohol during past 30 days*	39	83.0	69.2-92.4	2	40.0	5.3-85.3	41	78.8	65.3-88.9
Total (n)	47			5			52		

Frequency of consuming alcohol (≥1 drink) **									
Daily	10	24.4	12.4-40.3				10	21.7	10.9-36.4
5-6 times a week	2	4.9	0.6-16.5				2	4.3	0.5-14.8
1-4 times a week	1	2.4	0.1-12.9				1	2.2	0.1-11.5
1-3 times a week	5	12.2	4.1-26.2	4	80.0	28.4-99.5	9	19.6	9.4-33.9
Less than once a month	23	56.1	39.7-71.5	1	20.0	0.5-71.6	24	52.2	36.9-67.1
Total (n)	41			5			46		

Table 5: Alcohol consumption status amongst male and female respondents.

Physical inactivity: A lifestyle factor such as physical inactivity is reported to be heavily correlated with the development of many chronic diseases [12]. Physical inactivity for the purpose of this study is defined as undertaking no physical activity or less than 150 minutes of physical activity per week. In the current study, 42.2% of the total respondents reported physical inactivity, where higher physical inactivity (44.7%) were reported among female respondents compared to their male counterparts (36.3%) (See the following table).

Background Characteristics	n	Male			n	Female			n	Total		
		n	%	CI 95%		N	%	CI 95%		n	%	CI 95%
Age (years)												
40 – 49	34	12	35.3	19.7-53.5	140	59	42.1	33.9-50.8	174	71	40.8	33.4-48.5
50 – 59	48	17	35.4	22.2-50.5	162	61	37.7	30.2-45.6	210	78	37.1	30.6-44.1
60 – 69	61	18	29.5	18.5-42.6	119	54	45.4	36.2-54.8	180	72	40.0	32.8-47.6
≥ 70	36	18	50.0	32.9-67.1	60	41	68.3	55.0-79.7	96	59	61.5	51.0-71.2
Residence												
Urban	57	24	42.1	29.1-55.9	197	105	53.3	46.1-60.4	254	129	50.8	44.4-57.1
Rural	122	41	33.6	25.3-42.7	284	110	38.7	33.0-44.7	406	151	37.2	32.5-42.1
Educational level												
No formal schooling	33	13	39.4	22.9-57.9	132	64	48.5	39.7-57.3	165	77	46.7	38.9-54.6
Primary	67	25	37.3	25.8-50.0	218	89	40.8	34.2-47.7	285	114	40.0	34.3-45.9
Secondary	51	21	41.2	27.6-55.8	85	34	40.0	29.5-51.2	136	55	40.4	32.1-49.2
High School	19	5	26.3	9.1-51.2	33	20	60.6	42.1-77.1	52	25	48.1	34.0-62.4
College/university	9	1	11.1	0.3-48.2	12	7	58.3	27.7-84.8	21	8	38.1	18.1-61.6
Refused					1	1	100.0		1	1	100.0	
Marital status												
Never married	7	1	14.3	0.4-57.9	20	8	40.0	19.1-63.9	27	9	33.3	16.5-54.0
Currently married	152	53	34.9	27.3-43.0	318	140	44.03	38.5-49.7	470	193	41.1	36.6-45.7
Separated/divorced widowed	20	11	55.0	31.5-76.9	141	65	46.1	37.7-54.7	161	76	47.2	39.3-55.2
Refused					2	2	100.0		2	2	100.0	
Occupation												
Employed/self employed	116	33	28.5	20.5-37.6	221	68	30.8	24.8-37.3	337	101	30.0	25.1-35.2
Unpaid including homemaker	9	5	55.6	21.2-86.3	155	71	45.8	37.8-54.0	164	76	46.3	38.5-54.3

Unemployed(retired)	54	27	50.0	36.1-63.9	105	76	72.4	62.8-80.7	159	103	64.8	56.8-72.1
Average monthly family Income												
≤90000	16	7	43.8	19.8-70.1	37	10	27.0	13.8-44.1	53	17	32.1	19.9-46.3
90001-150000	40	10	25.0	12.7-41.2	89	35	39.3	29.1-50.3	129	45	34.9	26.7-43.8
150001-250000	21	8	38.1	18.1-61.6	62	26	41.9	29.5-55.2	83	34	41.0	30.3-52.3
250001-400000	29	9	31.0	15.3-50.8	72	26	36.1	25.1-48.3	101	35	34.7	25.5-44.8
≥ 400001	17	2	11.8	1.5-36.4	64	32	50.0	37.2-62.8	81	34	42.0	31.1-53.5
Refused	56	29	51.8	38.0-65.3	157	86	54.8	46.6-62.7	213	115	54.0	47.0-60.8
Total	**179**	**65**	**36.3**	**29.3-43.8**	**481**	**215**	**44.7**	**40.2-49.3**	**660**	**280**	**42.2**	**38.6-46.3**

Table 6: Status of physical inactivity among study respondents.

Inadequate dietary practices: Fruits and vegetables are important components of a healthy diet, where reduced fruit and vegetable consumption is linked to poor health and increased risk of no communicable diseases [13]. According to the above source (WHO: 2014), including fruits and vegetables as part of the daily diet may reduce the risk of some NCDs including cardiovascular diseases and certain types of cancer. According to another WHO report [9], an estimated 3.9 million deaths worldwide were attributable to inadequate fruit and vegetable consumption in 2017. In the current study respondents were probed for their pattern and frequency of consuming vegetables and fruits. They were also asked about the type of oil or fat that they used for meal preparation. The study found that the vast majority of the study respondents (84.4%) were reported inadequate diet, where the highest prevalence of inadequate diet intake was reported among male 60-69 years of age (91.8%) followed by male age of 70 and above (83.3%) and relatively the lowest prevalence of inadequate diet intake was reported among male of age 40-49 years old (73.5%). Similarly, 90.0% of female with age of 70 and above reported inadequate diet intake compared to 81.4% among study respondents of 40-49 years old.

Background Characteristics	n	Male			n	Female			n	Total		
		n	%	CI 95%		N	%	CI 95%		n	%	CI 95%
Age(years)												
40-49	34	25	73.5	55.6-87.1	140	114	81.4	74.0-87.5	174	139	79.9	73.2-85.6
50-59	48	40	83.3	69.8-92.5	162	138	85.2	78.8-90.3	210	178	84.8	79.2-89.3
60-69	61	56	91.8	81.9-97.3	119	100	84	76.2-90.1	180	156	86.7	80.8-91.3
≥ 70	36	30	83.3	67.2-93.6	60	54	90	79.5-96.2	96	84	87.5	79.2-93.4
Residence												
Urban	57	48	84.2	72.1-92.5	197	170	86.3	80.7-90.8	254	218	85.8	80.9-89.9
Rural	122	103	84.4	76.8-90.4	284	236	83.1	78.2-87.3	406	339	83.5	79.5-87.0
Educational level												
No formal schooling	33	29	87.9	71.8-96.6	132	109	82.6	75.0-88.6	165	138	83.6	77.1-88.9
Primary	67	56	83.6	72.5-91.5	218	184	84.4	78.9-89.0	285	240	84.2	79.4-88.2
Secondary	51	42	82.4	69.1-91.6	85	72	84.7	75.3-91.6	136	114	83.8	76.5-89.6
High School	19	17	89.5	66.9-98.7	33	29	87.9	71.8-96.6	52	46	88.5	76.6-95.6
College/ university	9	7	77.8	40.0-97.2	12	11	91.7	61.5-99.8	21	18	85.7	63.7-97.0
Refused					1	0	0		1	0	0	
Marital status												

Never married	7	6	85.7	42.1-99.6	20	17	85	62.1-96.8	27	23	85.2	66.3-95.8
Currently married	152	127	83.6	76.7-89.1	318	271	85.2	80.8-88.9	470	398	84.7	81.1-87.8
Separated/ divorced widowed	20	18	90	68.3-98.8	141	116	82.3	74.9-88.2	161	134	83.2	76.5-88.6
Refused					2	2	100		2	2	100	
Occupation												
Employed/ self employed	116	94	81	72.7-87.7	221	183	82.8	77.2-87.5	337	277	82.2	77.7-86.1
Unpaid including homemaker	9	7	77.8	40.0-97.2	155	130	83.9	77.1-89.3	164	137	83.5	77.0-88.9
Unemployed (retired)	54	50	92.6	82.1-97.9	105	93	88.6	80.9-94.0	159	143	89.9	84.2-94.1
Average monthly family Income *												
≤90000 (kyats)	16	15	93.8	69.8-99.8	37	33	89.2	74.6-97.0	53	48	90.6	79.3-96.9
90001-150000	40	31	77.5	61.5-89.2	89	70	78.7	68.7-86.6	129	101	78.3	70.2-85.1
15000-250000	21	17	81	58.1-94.6	62	54	87.1	76.1-94.3	83	71	85.5	76.1-92.3
250001-400000	29	26	89.7	72.6-97.8	72	60	83.3	72.7-91.1	101	86	85.2	76.7-91.4
≥ 400001	17	13	76.5	50.1-93.2	64	56	87.5	76.8-94.4	81	69	85.2	75.6-92.1
Refused	56	49	87.5	75.9-94.8	157	133	84.7	78.1-90.0	213	182	85.5	80.0-90.0
Total	**179**	**151**	**84.4**	**78.2-89.3**	**481**	**406**	**84.4**	**80.9-7.5**	**660**	**557**	84.4	81.4-87.1

Table 7: Gender wise distribution of inadequate diet intake among study respondents.

Knowledge of Complications of Prediabetes and Diabetes Among Study Respondents

In the current study the knowledge level of study respondents regarding complication of diabetes were assessed. The assessment includes knowledge of risk factors for prediabetes, knowledge of symptoms and Knowledge of complications. In addition, their awareness that diabetes can be prevented, and diabetes can cause premature death were also assessed. The study reported that the respondent's knowledge levels of complications of diabetes were significantly lower than the knowledge of level risk factors and symptoms of diabetes. Overall, around 36.2 % of the respondents had good knowledge of complications of diabetes while 48.5% had moderate knowledge. Gender wise differences in knowledge of complications were not marked (See the following table).

Knowledge Level	Diabetes								
	Male			Female			Total		
	n	%	CI 95%	n	%	CI 95%	n	%	CI 95%
Knowledge of risk factors									
Good knowledge	89	49.7	42.2-57.3	228	47.4	42.9-52.0	317	48.0	44.2-51.9
Average/moderate knowledge	62	34.6	27.7-42.1	169	35.1	30.9-39.6	231	35.0	31.4-38.8
Poor/inadequate knowledge	18	10.1	6.1-15.4	53	11.0	8.4-14.2	71	10.8	8.5-13.4
No Knowledge	10	5.6	2.7-10.0	31	6.4	4.4-9.0	41	6.2	4.5-8.3
Knowledge of symptoms									
Good knowledge	92	51.4	43.8-58.9	297	61.7	57.2-66.1	389	58.9	55.1-62.7

Average/moderate knowledge	53	29.6	23.0-36.9	108	22.5	18.8-26.4	161	24.4	21.2-27.9
Poor/inadequate knowledge	13	7.3	3.9-12.1	21	4.4	2.7-6.6	34	5.2	3.6-7.1
No Knowledge	21	11.7	7.4-17.4	55	11.4	8.7-14.6	76	11.5	9.2-14.2
Awareness that diabetes can be prevented	137	76.5	69.6-82.5	354	73.6	69.4-77.5	491	74.4	70.9-77.7
Awareness that diabetes can cause premature death	144	80.4	73.9 – 86.0	399	83.0	79.3-86.2	543	82.3	79.1-85.1
Total n	**179**			**481**			**660**		

Table 8: Gender wise distribution of knowledge of risk factors, symptoms, and complications of diabetes.

Factors Statistically Associated with Prevalence of Prediabetes Among Study Respondents

Under this sub-topic, the association of socio-demographic and risk factors variables with prediabetes was assessed. Accordingly, socio-demographic variables including age, sex, marital status, residence job and income were analyzed using multinomial logistic regressions. In addition, behavioral risk factors including alcohol consumption, tobacco use, and daily tobacco use was assessed at multinomial logic regression. Finally, female gender [P=0.0.039; (0.103-0.946)], currently married [p= 0.010; (0.063-0.692)], no formal education [p=0.047; (1.015-9.632)] and residence [p=0.000; (2.0226-8.674)] were significantly associated with prediabetes in the study area.

Variables	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
			Lower Bound	Upper Bound
Intercept	0.004			
Gender				
Female	0.039	0.312	0.103	0.946
Male	.	.	.	.
Age category				
40-49	0.796	1.28	0.198	8.284
50-59	0.627	0.643	0.109	3.809
60-69	0.444	0.506	0.088	2.898
>70	.	.	.	.
Educational status				
College/University Graduate	0.527	1.77	0.301	10.401
High school level	0.012	15.466	1.838	130.126
No formal schooling	0.047	3.126	1.015	9.632
Primary school level	0.234	1.582	0.743	3.367
Secondary school level	.	.	.	.
Marital status				
Currently married	0.01	0.209	0.063	0.692
Never married	0.769	0.694	0.06	7.969
Separated	0.992	126084.146	0	.c
Widowed	.	.	.	.
Employment status				
Government employee	0.475	0.37	0.024	5.666
Homemaker	0.112	0.553	0.266	1.148

Non-government employee	0.985	485256.695	0	.c
Retired	0.279	0.435	0.096	1.961
Self-employed	.	.	.	.
Residence				
Rural	0	4.226	2.058	8.674
Urban	.	.	.	.
Monthly income (Ks)				
<900000	0.632	0.768	0.261	2.259
900000-150000	0.687	0.813	0.297	2.226
150001-250000	0.818	1.128	0.405	3.142
250001-400000	0.96	1.026	0.373	2.826
≥ 400001	.	.	.	.
Alcohol consumption				
Alcohol_ever=no	0.145	2.969	0.687	12.833
Alcohol_ever=yes	.	.	.	.
Tobacco use				
Tobaco_sm =no	0.009	0.176	0.047	0.65
Tobaco_sm_=yes	.	.	.	.

Table 9: Factors associated with prediabetes in the study area.

a. The reference category is: 3.00.
b. This parameter is set to zero because it is redundant.
c. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

Similar study conducted in Myanmar in 2014 was reported similar findings, where female gender, older age groups, urban residence was significantly associated with prediabetes [8]. The study conducted in Saudi-Arabia was also reported similar findings where marital status and education level were significantly associated with prediabetes in the study area ($p < 0.0001$). Another study conducted in Nigeria was also reported similar findings, where marital status and lower level of education were reported as predictors for prediabetes. On the other hand, in the current study, alcohol consumption and tobacco use were not significantly associated. Similar result was reported in another study conducted in Malappuram, Kerala, where alcohol consumption and smoking were not significantly associated with the prevalence of diabetes in the study population ($p>0.05$) [14-16]. This might be because of the study enrolled few participants and association of pre-diabetes with proposed risk factors would have been difficult to establish.

Conclusion and Recommendation

The current study results indicate that the overall prevalence of prediabetes in the study area was 14.7%, where higher prevalence was reported among female respondents (17.5%) compared to male respondents (7.3%). The study found relatively a lower prevalence rate of prediabetes when compared with earlier study conducted in Myanmar which might be as result of different interventions to tackle the increasing prevalence of prediabetes in Myanmar. Therefore, the findings in this study, may contribute to expand community-based screening and prevention of diabetes [17]. In the present scenario, for further improvements, it is highly recommended to improve and expand a set of community-based intervention programs that focused on health education, counseling regarding its risk factors, modifying them along with surveillance, encouragement, and proper monitoring should be performed.

Limitations of the Study

The study enrolled few participants and association of pre-diabetes with proposed risk factors would have been difficult to establish. Since most of the men were at work, few who were at home was enrolled for the study, which brought over-represented females who were most of the time at home [18]. The study enrolled few participants, and this would have affected the proportions of prediabetes. However, the results show a trend which can guide further studies to establish both the prevalence and associated risk factors.

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