Journal of Population and Social Studies, Volume 26 Number 4, October 2018: 262 - 280
DOI: 10.25133/JPSSv26n4.019

# Factors Influencing Adherence to Therapeutic Regimens among People with Type 2 Diabetes Mellitus in Yangon, Myanmar

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## Abstract

*Adherence to therapeutic regimens is a major challenge among people with Type 2 diabetes mellitus to achieve glycemic control. This study aimed to examine the factors influencing adherence to therapeutic regimens among 200 people with Type 2 diabetes at an Outpatient Department in two Yangon General Hospitals. Hierarchical multiple regression analysis showed the participants had good adherence to their therapeutic regimens. However, their adherence to specific diet, physical exercise, and blood glucose monitoring was lower than adherence to medication and foot care. The prevalence of poor glycemic control (71%) was significantly higher in this study. Analysis indicated patients with better family support, good patient-healthcare provider relationship, better self-efficacy and fewer comorbidities were better adhered to therapeutic regimens accounted for 71.9% of the variability in adherence behavior ($R2 = 0.719$, $F_{(1,194)} = 72.98$, $p < 0.001$). Therefore, the study recommends nurses and other healthcare providers consider five predictors to develop effective family-based interventions that empower people with Type 2 diabetes mellitus to improve their adherence to therapeutic regimens.*

## Keywords

*Adherence; therapeutic regimens; glycemic control; Type 2 diabetes mellitus*

## Introduction

Diabetes mellitus (DM) is a major worldwide public health problem because it involves high cost to control and treat its related complications. It is a major challenge to health system and society. There were 415 million adults suffering from diabetes worldwide and out of that 78.3 million adults with diabetes live in Southeast Asia (SEA) Region (International Diabetes Federation, 2015). Myanmar's diabetes population is placing a lot of strain and burden in the resources of this nation in SEA. In 2008, World Health Organization (WHO) estimated the prevalence of DM in Myanmar would increase to 3.2% in 2015. According to National Survey for non-communicable diseases conducted between 2013 and 2014, the prevalence of diabetes was 10.5% among the adult population aged between 25 and 65 years (Tint-Swe-Latt, Ko-Ko-Zaw, & Ko-Ko et al., 2015). However, the prevalence of diabetes is thought to be much higher than this.

The ultimate goal of any prescribed therapeutic regimens for people with diabetes is to achieve good glycemic control but majority of patients with Type 2 diabetes fail to control their glycemia (Tabasi, Madarshahian, Nikoo, Hassanabadi, & Mahmoudirad, 2014; WHO, 2003). In Myanmar, less than half of people with Type 2 diabetes achieve optimal glycemic control (Han-Win, et al. 2013; Sandhi-Wynn-Nyunt, Howteerakul, Suwannapong &

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Rajatanun, 2011). Therefore, poor glycemic control is a major challenge for people with Type 2 diabetes as well as health care professionals in Myanmar.

The achievement of glycemic control is determined to a great extent by patient's adherence to all recommended therapeutic regimens, including medication and lifestyle changes. Controlling diabetes and its complications can only be effective through adherence to the overall prescribed regimens (Garcia-Perez, Alvarez, Dilla, Gil-Guillen & Orozco-Beltran, 2013; Vermeire, Royen, Coenen, Wens, & Denekens, 2003). Koprulu et al (2014) pointed out that glycemic control could be improved through early identification of adherence behavior. Therefore, adherence is the cornerstone to achieve good glycemic control.

Diabetes therapies combine adherence to medications regimen and simultaneous changes to life style. Specifically, adherence to diabetes therapy includes taking oral hypoglycemic agents (OHAs) and/or insulin injections, self-monitoring of blood glucose (SMBG), following diets, physical activity, foot care, regular follow up and making several lifestyle changes corresponding with recommendations from a healthcare provider (Odegard & Capoccia, 2007; WHO, 2003). In the present study, medication, diet, physical exercise, SMBG and foot care were studied as diabetes therapeutic regimens.

Empirical evidence from international literature suggested that adherence rate for chronic illness regimens and lifestyle changes are lower than 50% in developing countries (WHO, 2003) and diabetes patients have a poor adherence record when compared with all non-communicable diseases (NCDs) (Rolnick et al., 2013). Although adherence is considered to be important in diabetes control, few diabetes patients adhere to recommended regimens and most do not reach optimal glycemic control. Han-Win, et al. (2013) and Sandhi-Wynn-Nyunt, Howteerakul, Suwannapong & Rajatanun (2011) found that more than half of Type 2 diabetes patients in Myanmar had poor adherence to medication and self-care. Consequently, they continue to suffer from serious diabetes complications which result in reduced quality of life, reduced productivity, premature mortality, and increased health care cost.

Only few studies have looked at the problem of DM, especially focusing on adherence to therapeutic regimens. Thus, it is important to understand the factors that have an impact on adherence to therapeutic regimens in order to design effective interventions to ultimately improve adherence rate of diabetes patients in Myanmar. Currently, there is no published literature regarding adherence to therapeutic regimen among Type 2 diabetes patients in Myanmar. This paper, therefore, focuses on the factors influencing adherence to therapeutic regimens among Type 2 diabetes patients in Yangon, Myanmar.

## Literature Review

The WHO describes adherence as a complex behavioral process which is simultaneously influenced by several factors that affect patient behavior and capacity to adhere to treatments. Adherence is defined as behavior related to consuming medication on time, following medical advice and adopting a healthy diet and making lifestyle changes consistent with recommendations from a health care provider (WHO, 2003). The WHO developed the World Health Organization Multidimensional Adherence Model (WHOMAM) to guide research and a goal standard for comprehensive understanding of multidimensional factors that influence patients' adherence to long-term therapy and to develop strategies to improve adherence behavior (WHO, 2003). This study adopted WHOMAM as a framework where the factors influencing adherence were categorized into five dimensions: patient-related factors, condition-related factors, therapy-related factors, social/economic factors, and healthcare team and health system-related (WHO, 2003).

Patient's knowledge about disease and treatment regimens is essential to elicit their full cooperation for treatment. Diabetes patients who have better knowledge have better attitude and better practice to adhere to diet, exercise, medication, foot care and blood glucose monitoring and regular follow up (Worku, Abebe, & Wassie, 2015; Ebrahim, Villier, & Ahmed, 2014; Mandpe, Pandit, Dawane, & Patel, 2014; Parajuli, Saleh, Thapa, & Ali, 2014; Sweilch et al., 2014; Campbell, 2012). Ei-Sandar-Oo (2012) found that awareness of diabetes is still low in Myanmar. Based on WHOMAM framework, knowledge is one of the patient-related factors that influenced adherence. In fact, diabetes knowledge may influence adherence behavior in Myanmar.

Based on literature, self-efficacy is the most important and constant predictor of adherence to therapeutic regimens (Ebrahim, Villier & Ahmed, 2014; Sonsona, 2014; Tovar, 2013). Most diabetes patients in Myanmar take a passive role in management of their disease and they are likely to depend on health care providers and family members. Therefore, self-efficacy plays an important role in adherence.

Regarding belief, patient's beliefs about effectiveness of diabetes treatment motivates them to achieve higher adherence rate (NiMhurchadha & Sayers, 2014). Specifically, beliefs about effectiveness of medication, diet, exercise, foot care and self-monitoring of blood sugar to control diabetes may affect patient's adherence behavior. Therefore, factors such as diabetes knowledge, self-efficacy, and belief in effectiveness of treatment were seen as patient related.

In Type 2 diabetes, there is often an absence of symptom because of the quiet nature of the diabetes and in fact many patients do not really feel sick. Consequently, they may believe that they are cured and eventually they stop adherence to regimens. Patients who suffer greatly from symptoms of the disease are more motivated to take medication and adhere to life style changes instructions (Chen, Tsa& Chou, 2011). However, the presence of symptoms is not a constant and significant predictor of adherence based on previous studies.

People with Type 2 diabetes often struggle with their comorbid conditions which can have serious effects on their ability to manage their illness and pose significant barrier to regimen adherence (Teklay, Hussien & Tesfaye, 2013; WHO, 2003). However, some studies found that it is not a significant predictor of adherence (Albuquerque, Correia& Ferreira, 2014; Tiv et al. 2012). Based on inconclusive findings of the previous studies, symptoms and comorbidity were studied as condition-related factors in explaining adherence.

Therapeutic regimens are likely to become more complex if the patient has been suffering with Type 2 diabetes for a long time. As a consequence of progressive conditions, oral therapies fail to control blood glucose level over time leading to most patients finally resorting to injectable regimens and hence, adherence becomes poor (Cooke, Lee, Tong & Haines, 2010). Complexity of treatment complexity may be very challenging for the patient and unable to cope, it may in turn negatively influence the latter's motivation to follow recommended regimens. Thus, complexity of treatment was considered as treatment-related factor.

Support from the family may positively or negatively affect adherence to therapeutic regimens (Mayberry & Osborn, 2012). The people of Myanmar value intimacy and rely on their family for support and care when they fall ill. Family support provides opportunity to the diabetes patients to express their feelings and concerns, which can increase their optimism of managing the disease and in turn, boost their commitment to adhere to their treatment. Hence, family support was selected as a predictor of adherence behavior in this study.

Adherence in this context is based the relationship between patients' and health care providers' respect and mutual cooperation (Rafii, Fatemi, Danielson, Johnsson, & Modoloo, 2014). Jin, Sklar, Oh & Li (2008) found good relationship is a vital issue for adherence because

it helps patients understand their condition and therapy, increases trust and mutual collaboration in treatment plan and increase motivation towards adherence. The culture of the people meant most patients adopt a passive role in communicating with their providers. Therefore, patient and healthcare provider relationship was chosen as healthcare team and health system-related factors of adherence.

Empirical studies have suggested adherence to medication and self-care practices were positively associated with good glycemic control (Al-Qazaz, et al., 2011; Wabe, Angamo, & Hussein, 2011). If diabetes patients do not adhere to a diabetes-friendly diet, they become resistant to the action of insulin or cannot produce insulin rapidly enough to reduce glucose in the blood. As a result, they are unable to control their glucose level (Aziz, Durmais & Barbe, 2013).

Regular physical exercise combined with a low-calorie diet are known to be effective in weight reduction in addition to improving insulin sensitivity to achieve glycemic control. Additionally, adherence to prescribed medication increases insulin secretion and decreases glucose production which in turn reduces HbA1c and prevents or delays progression of diabetes. The SMBG provides information about blood glucose level and guide for appropriate treatment and helps to determine the safety and efficacy of treatment to improve glycemic control (American Diabetes Association, 2014). For these reasons, adherence to therapeutic regimen is crucial in glycemic control.

The association between diabetes adherence behaviors and glycemic control, and the factors influencing adherence to therapeutic regimens have not been investigated among people with Type 2 diabetes in Myanmar. Therefore, this study aimed to explore the rate of adherence to therapeutic regimens and level of glycemic control, investigate the association between adherence to therapeutic regimens and glycemic control (HbA1c), and explore the factors influencing adherence to therapeutic regimens in people with Type 2 diabetes in Myanmar. The research framework is adopted from WHOMAM (2003) as shown in Figure 1.

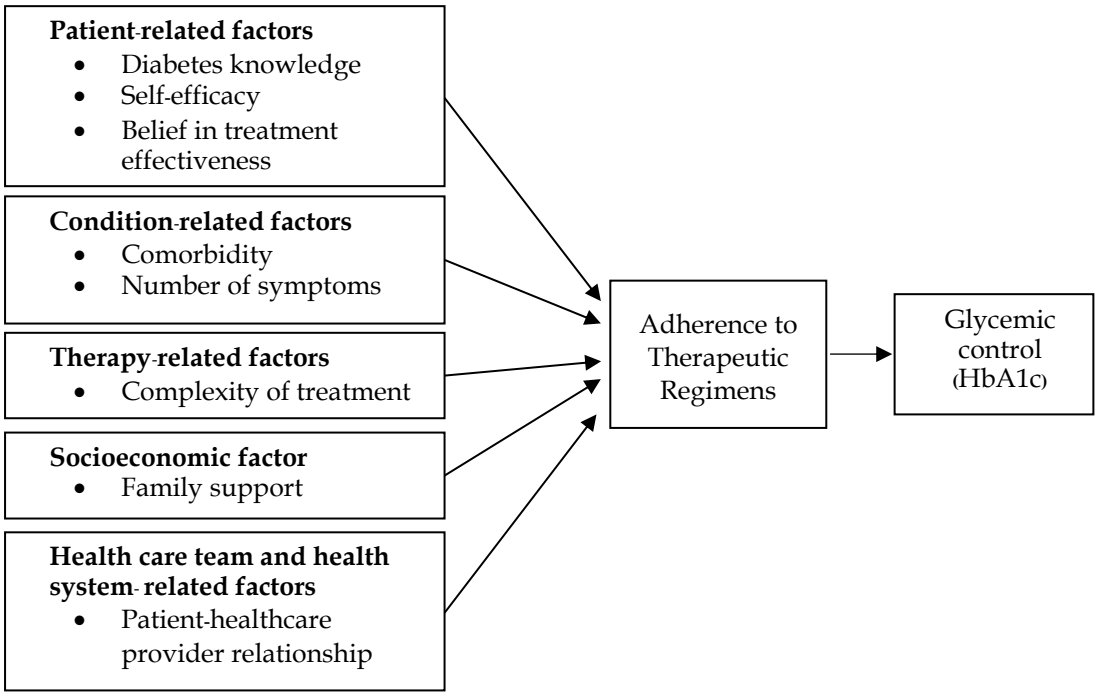


**Figure 1:** Research Framework

## Materials and Methods

A descriptive correlational research design was used to examine factors influencing adherence to therapeutic regimens in a sample of 200 people with Type 2 diabetes who sought treatment at a diabetic clinic at Outpatient Department in Yangon General Hospital and West Yangon General Hospital. The patients were aged ≥ 18 years, diagnosed with diabetes for ≥ 6 months and able to read and write in Myanmar language. Patients who suffered from acute physical illness, cognitive impairment, psychiatric disorder, and admitted to the hospital were excluded.

Sample size for this study was calculated based on Cohen's power analysis using G *Power program (Faul et al., 2009). The required sample-size for predictability of the multiple regression analysis with eight predictors at α =.05, power of the statistical test (1-β) =80, and the average effect size in terms of f2 from three previous studies equaled to 0.10 (Boas, Foss, Freitas & Pace, 2012; Villiers & Halabi, 2015; Nyunt, Howteerakul, Suwannapong & Rajatanun, 2010). In this study, approximately 20% sample was added for the demographic variables to ensure the statistical power for the study and produce accurate results. Therefore, the estimated total sample size was 200 subjects. Data was collected using convenience sampling method during November 2016 and February 2017.

Data collection started after receiving approval from the Institutional Review Board (IRB) of the Faculty of Nursing, Mahidol University and the Ethical and Research Committee, Department of Medical Research, Yangon. Prior to data collection, the investigator asked the permission from the responsible persons of respective areas and contacted with the head nurses and staff nurses at the Outpatient Departments to facilitate recruitment. The participants who met the inclusion criteria were identified and recruited. Patients who were willing to participate voluntarily in the study were asked to provide a written consent form, with 12 patients refusing to participate in this study. Data was kept confidential without specification of names or addresses. Code numbers were used instead of participants' name to maintain anonymities. Questionnaires took between 45 and 60 minutes to be completed and in cases, where the participants encountered problems in completing the questionnaire, such as inability to read or having poor eyesight, the investigator read and helped them answer each question and recorded their responses.

The researcher also screened the cognitive function of participants because diabetes is more likely to be associated with poor glycemic control, which can damage vessels in the brain that leads to cognitive impairment. In order to obtain accurate data, cognitive function was assessed in all participants with Type 2-Diabetes using GPCOG Questionnaire (Brodaty et al., 2002). The 10 participants who had cognitive problems were excluded and referred to the doctor for appropriate treatment. Data was also obtained from medical records of patients for comorbidity, treatment and HbA1c value.

## Study Variables

There were eight research instruments used in this study. Backward translation and monolingual test as per Maneesriwongul and Dixon (2000) were done. Lynn's (1986) formula was used to evaluate content validity index (CVI) whereby five experts, including endocrinologist and four senior nurses, were employed to assess content validity of the instrument. The investigator reviewed and revised the items as suggested by the experts. The CVI of every research instrument was more than .8. The instruments were also tested for their reliability with Cronbach's alpha coefficient with 30 diabetes patients in the pilot study. The reliability of instruments was acceptable at ≥ .7 (except Chalson's Comorbidity Index α = .67).

Nine variables were included in the regression model in this study. Diabetes knowledge, self-efficacy, belief in treatment effectiveness, number of symptoms, comorbidity, complexity of treatment, family support, and patient-healthcare provider relationship were the independent variables, and adherence to therapeutic regimens was the dependent variable in this study.

**Baseline information:** The baseline information included age, gender, marital status, educational level, BMI, HbA1c, duration of diabetes, presence of symptoms, types of treatment, complexity of treatment, and self-management education.

**Diabetes knowledge**: The 24-items version of Diabetes Knowledge Questionnaire (Garcia, Villagomez, Brown, Kouzikanani & Hanis, 2001) was used to measure diabetes knowledge including general diabetes knowledge (9 items), therapeutic regimens (9 items), symptoms of hypoglycemia and hyperglycemia (2 items), and complications of diabetes (4 items). This questionnaire consists of 'Yes', 'No' or 'I don't know' questions with one correct choice for each question. The knowledge score is determined by giving 1 for each correct answer, 0 for the wrong answer and I don't know response. For example, "A fasting blood sugar level of 210 mg/dl or 12% is too high." The scoring range was 0-24 points. The higher the score, the greater the level of diabetes knowledge among the participants.

**Self-efficacy**: The Diabetes Management Self-efficacy Scale (DMSES UK) was used to assess the patient's self-efficacy (Sturt, Hearnshaw, & Wakelin, 2010). The scale covered the patient's confidence in adhering to self-monitoring of blood glucose (1 item), correcting blood sugar level (2 items), food choice, and adherence to a healthy diet (7 items), exercise and weight control (2 items), medication (2 items) and foot care (1 item). The original DMSES UK scale included 15 items with 11-point Likert scale. In the current study, according to the experts' suggestions, 5-point Likert-scale from 0 (can't do at all), to 4 (certainly can do) was used to assess the participant's response (eg. "I am able to check my blood/urine sugar if necessary", "I am able to follow a healthy eating pattern when I am away from home.") The score ranged from 0 to 60 with higher scores indicating participant's higher perceived self-efficacy in adhering to therapeutic regimens.

**Belief in treatment effectiveness**: The Belief in Treatment Effectiveness Scale developed by Xu (2005) was used to measure the respondents' belief about the importance of diet, exercise, medications/insulin, self-monitoring blood glucose level and foot care in controlling diabetes (4 items) and preventing long term diabetes complications (5 items). For example, "How important do you believe exercise is for controlling blood glucose level?" The response was measured based on a 5-point Likert scale from 1 (not important) to 5 (extremely important) and the score ranged from 9 to 45 with higher scores indicating the participants' greater perception on the effectiveness of adherence to therapeutic regimens in controlling diabetes and preventing diabetes complications.

**Number of symptoms**: This refers to the number of common diabetes symptoms Type 2 diabetic patients suffered in the study. The participants were asked about the presence of eight common diabetes symptoms including frequent urination, feeling very thirsty, feeling very hungry even though one is eating regularly, extreme fatigue, blurred vision, cuts/bruises that are slow to heal, weight loss, and tingling, pain, or numbness in the hands/feet (American Diabetes Association, 2015).

**Comorbidity:** Charlson Comorbidity Index (CCI) was used to assess the presence of comorbid conditions among Type 2 diabetes patients (Charlson, Pompei, Ales, et al., 1987). It contained 19 comorbidities taking into account the number and seriousness of comorbid conditions. The range of the score was 0 –37 further was classified into four grades: Nil (0), mild (2), moderate (3-4), and severe (≥5).

**Complexity of treatment:** Complexity of treatment is considered by the number, dose and types of medication taken. Patients who take only one or two types of drugs once or twice daily will be categorized as receiving simple treatment and those who take more than two types of drugs more than twice daily or those who take only insulin injection, or take both oral hypoglycemic agents and insulin will be considered as receiving complex treatment.

**Family support**: The Family Support Scale developed by Xu (2005), was used to measure the perception of the participants regarding received emotional support (2 items), tangible aids (3 items) and appraisal support (1 item) from their family in the prior 3 months. For example, "Over the past 3 months, how often did your family listens carefully to what you have to say about your diabetes?" Responses were measured using 5-point Likert scale from 1(not at all) to 5 (a great deal) and the score ranged from 6 to 30. Higher scores indicated greater support from family members.

**Patient-healthcare provider relationship:** The Patient Reaction Assessment (PRA) scale (Galassi, Schanberg & Ware, 1992) was used to measure patient-healthcare provider relationship in this study. It is composed of 15 items with 7-point Likert's scale ranging from 1 (very strongly disagree) to 7 (very strongly agree) for measuring the perceived quality of the information (5 items), the ability to initiate communication (5 items), and affective behaviors of healthcare providers (5 items). For example, "My provider makes sure I understand treatment side effects". The score ranged from 15 to 105 with higher scores indicating patients' perceived better relationship with their healthcare providers.

**Adherence to therapeutic regimens**: The Summary of Diabetes Self-care Activity Measure was originally developed by Toobert, Hampson & Glasgow (2001) and modified Myanmar version (Sandhi-Wynn-Nyunt, Howteerakul, Suwannapong & Rajatanun, 2011) was used to assess various adherence behaviors within the following six domains: general diet (3 items), specific diet (4 items), exercise (3 items), glucose monitoring (2 items), foot care (3 items), and medication (2 items). Using a numerical scale ranging from 0–7, the scoring of each item was based on the number of days of the week that the behavior was performed. If the patient adhered to regimen only one day, the score mark is 1 and if the patient adhered to regimen everyday over the past week, the score was given 7. The score range of general diet was 0 to 21, for specific diet was 0–28, for exercise was 0-21, glucose monitoring was 0-14, foot care was 0-21 and medication was 0-14. Therefore, the total score ranged from 0-119 with higher scores indicating better adherence to therapeutic regimens. The example items of questionnaire for each dimension were: "On how many of the last SEVEN DAYS did you eat any sweetened food?", "Conducting physical activity for more than 30 minutes around the house in your leisure time during the last seven days?", "On how many of the last SEVEN DAYS did you take hypoglycemic drug or insulin precisely recommended by doctors?", "On how many of the last SEVEN DAYS did you test your blood sugar?" and "On how many of the last SEVEN DAYS did you wash your feet as part of foot care?"

**Glycated hemoglobin:** (HbA1c) was used as an indicator of glycemic control and HbA1c value < 7% was defined as good glycemic control following the criteria of American Diabetes Association (2014).

## Data Analysis

Data obtained from self-report questionnaires were examined to ensure it is complete using the SPSS for windows, version 18. Descriptive statistics was used to generate baseline information of the respondents and examine the distribution properties of the variables with frequency, percentage, mean, standard deviation, and range. Hierarchical regression analysis

was used to examine the predictive power of the variables on adherence to therapeutic regimens based on five sets of predicting variables according to the WHO Multidimensional Adherence Model, with significant level set at $p < .05$.

Prior to conducting the multiple regression analysis, the assumptions were tested. The normality of the error distribution evaluated using Kolmogorov-Smirnov test revealed z statistic is equal to .499 at $p > .05$ ($p = .964$). The linear relationship tested by the Pearson's product moment correlation showed the correlation coefficient ranging from .077 to .709. The scatter plot diagrams used to reveal the presence of homoscedasticity showed no extreme outliers because of the standardized residuals ranging between + 3.0 and – 3.0 (Tabachnick & Fidell, 2007). The multicollinearity was unlikely to be a problem with the tolerance values ranging from 0. 66 to 0.96 and the variance inflation factors (VIF) values ranging between 1.03 and 1.51 (Hair, et al., 2010). The value of Durbin-Watson was 2.007, and therefore, there was no violation in assumption testing.

Hierarchical multiple regression was conducted to examine the effect of the five sets of predicting variables (patient-related factors, condition-related factors, therapy-related factor, social/economic factor and health care team and system-related factor) on adherence to therapeutic regimens. Regression analysis was performed with controlled variables and according to the predictive power of independent variables and inconclusive findings in the previous studies. In previous studies, the patient was a primary concern in providing health care and patient-related factors are the stronger predictors. Therefore, patient-related factors (diabetes knowledge, self-efficacy, and belief in treatment effectiveness) was regressed in the first step. In the second step, a set condition-related factors, comorbidity and number of symptoms, were regressed after controlling patient-related factors because people with diabetes often struggle with their conditions which have serious effects on their ability to manage their disease and pose barriers to adherence. In the third step, therapy-related factor (treatment complexity) was regressed after controlling for patient-related factors and condition-related factors as it was considered a strong predictor that positively or negatively influence motivation to follow regimens; however, the findings were inconsistent. Social/economic factor (family support) was also viewed as an important factor in adherence but it showed inconclusive findings in the previous studies. Thus, social/economic factor was added in the fourth step after controlling patient- related factors, condition-related factors and therapy-related factor. In the final step, health care team and system-related factor (patient-patient provider relationship) were regressed after controlling for patient-related factors, condition-related factors, therapy-related factor and socio/economic factor.

# Findings

## Characteristics of the respondents

The mean age of the respondents was 56 years (Range 19-82 years) and the majority of them were females (77.5%) and married (71.5%). More than half had low level of education and only 13.5% of participants were university graduates. Regarding clinical characteristics, nearly half of the respondents had suffered from diabetes for 1-5 years, and nearly half of them were overweighed and obese, and half of them had high waist circumference. The majority of the respondents (74.5%) took only oral medication. Most respondents (80.5%) had received self-management education (Table 1).

**Table 1:** Demographic and clinical characteristics of the study participants

| Demographic and clinical characteristics | Frequency | Percentage |
|---|---|---|
| Gender | | |
| Male | 45 | 22.5 |
| Female | 155 | 77.5 |
| Age (year) (Min =19; Max=82; Range = 63; Mean = 55.9; SD = 10.3; Median = 56.5) | | |
| 18-34 | 3 | 1.5 |
| 35-44 | 24 | 12.0 |
| 45-54 | 63 | 31.5 |
| 55-64 | 67 | 33.5 |
| Above 64 | 43 | 21.5 |
| Educational level | | |
| Primary School | 93 | 46.5 |
| Middle school | 35 | 17.5 |
| High School | 45 | 22.5 |
| University | 2 | 1.0 |
| Graduate | 25 | 12.5 |
| Marital status | | |
| Single | 21 | 10.5 |
| Married | 143 | 71.5 |
| Separated | 2 | 1.0 |
| Duration of diabetes | | |
| 6 months – < 1 year | 19 | 9.5 |
| 1- 5 years | 83 | 41.5 |
| 6 - 10 years | 43 | 21.5 |
| Over 10 years | 55 | 27.5 |
| Glycated hemoglobin (Min = 4.5 %; Max = 15.0 %; Range = 10.5; Mean = 8.2; SD = 2.1) | | |
| Good glycemic control (HbA1c < 7%) | 57 | 29.0 |
| Poor glycemic control (HbA1c ≥ 7%) | 143 | 71.0 |
| Body Mass Index (Min = 14.7 kg/m2; Max = 42.7 kg/m2; Range = 28.0; Mean = 24.5; SD = 4.1) | | |
| Underweight (BMI < 18.5 kg/m2) | 12 | 6.0 |
| Normal (BMI 18.5 - 24.9 kg/m2) | 103 | 51.5 |
| Overweight (BMI 25 - 29.9 kg/m2) | 65 | 32.5 |
| Obese (BMI ≥30 kg/m2) | 20 | 10.0 |
| Waist circumference (Min = 65 cm; Max = 118 cm; Range = 53.0; Mean = 89.9; SD = 9.7) (IDF, 2008) | | |
| Healthy waist circumference (≤ 90 cm in men and ≤80 cm in women) | 90 | 45.0 |
| High risk (> 90 cm in men and > 80 cm in women) | 110 | 55.0 |
| Type of treatment received | | |
| Diet only | 2 | 1.0 |
| Oral medication | 149 | 74.5 |
| Insulin | 17 | 8.5 |
| Oral medication and insulin | 31 | 15.5 |
| Oral medication, insulin and traditional medicine | 1 | 0.5 |
| Self-management education | | |
| Received | 161 | 80.5 |
| Not received | 39 | 19.5 |

## Outcome variables

### *Prevalence of glycemic control and adherence to therapeutic regimens*

In this study, only 29% of participants had good glycemic control (Table 1). The majority had adhered well to overall therapeutic regimens in general (mean ± SD = 85.51 ± 15.20). However, when considering adherence in each domain of therapeutic regimens, the respondents' good adherence to general diet for 6.2 days per week (SD = 1.2), prescribed medication for 6.8 days per week (SD = 0.6) and foot care for 6.3 days per week (SD = 1.5). The participants moderately adhered to specific diet for 3.9 days per week, blood glucose monitoring for 3.9 days per week (SD = 2.4) and moderately engaged in physical exercise (>30 minutes) for 3.3 days per week (SD = 2.9).

### *Predictor variables*

The majority of respondents had moderate level of diabetes knowledge (mean ± SD = 13.99 ± 2.99), moderate level of self-efficacy (mean ± SD = 39.23 ± 7.25), strong belief in treatment effectiveness (mean ± SD = 36.27 ± 3.60), good family support (mean ± SD = 23.33 ± 5.67) and good patient-healthcare provider relationship (mean ± SD = 70.90 ± 8.57) in this study (Table 2).

Almost all of the respondents (93%) had suffered from comorbid conditions and 28% had severe comorbidity (≥ 5 points). The common comorbid diseases found in this study were hypertension (71%), DM with complications (50%), cardiovascular disease (20%) and 34.5% were taking aspirin as an anticoagulant to prevent cardiovascular disease (Table 2).

Most of them (95%) had suffered from diabetes symptoms, such as tingling and numbness **(**75.5%), blurred vision (68.5%), frequent urination (62%) and feeling thirsty (52%) that may be associated with high blood sugar and diabetes complications. Most respondents (84**.5%)** had received complex treatment (Table 2).

**Table 2:** Characteristics of the study variables

| Study variables | Frequency | Percentage | Mean | SD |
|---|---|---|---|---|
| Adherence to therapeutic regimens | | | 85.5 | 15.2 |
| Diabetes knowledge | | | 13.9 | 2.9 |
| Self-efficacy | | | 39.2 | 7.2 |
| Belief in diabetes treatment effectiveness | | | 36.2 | 3.6 |
| Family Support | | | 23.3 | 5.6 |
| Patient-healthcare provider relationship | | | 70.9 | 8.5 |
| Comorbidity | | | 3.2 | 1.8 |
| Absence of comorbidity (Nil) | 14 | 7.0 | | |
| 1-2 (Mild) | 63 | 31.5 | | |
| 3-4 (Moderate) | 67 | 33.5 | | |
| ≥5 (Severe) | 56 | 28.0 | | |
| Number of Symptoms | | | 3.9 | 2.0 |
| Absence of symptoms | 10 | 5.0 | | |
| Presence of symptoms | 190 | 95.0 | | |
| Complexity of treatment | | | | |
| Simple (Diet control or Take OHA with only one or two types of drug once or twice daily) | 31 | 15.5 | | |
| Complex (Take OHA with more than two types of drug more than twice daily or insulin injection) | 169 | 84.5 | | |

**OHA -Oral hypoglycemic Agent**

### *Factors influencing adherence to therapeutic regimens*

Five steps hierarchical multiple regression were conducted to examine effects of the five sets of predicting variables on adherence to therapeutic regimens. The eight predictive variables accounted for 71.9% of the total variance of adherence to therapeutic regimens (Table 3). In model 1, patient-related factors (diabetes knowledge, self-efficacy, and belief in treatment effectiveness) accounted for 28% of the variance in adherence (F change $_{(1,198)}$ = 77.00, $p$ < .001). Among them, self-efficacy was the only significant predictor of adherence (β = 0.53, t = 8.78, $p$ < .001). In model 2, with the entrance of condition-related factors (number of symptoms and comorbidity), the explaining variance increased to 43.2%. The variance in predicting level of adherence ($F_{(1,197)}$ = 52.65, $p$ < .001) and number of symptoms (β = .40, t = 7.26, $p$ < .001) were significantly associated with adherence. In model 3, adding therapy-related factors (treatment complexity) increased the explaining variance to 44.9%. The variance in adherence ($F_{(1,196)}$ = 5.91, $p$ < .05), comorbidity (β = -.14, t = -2.43, $p$ < .05) was significantly associated with adherence. In model 4, adding social/economic factor (family support) contributed to an additional 16.5% of variance in adherence ($F_{(1,195)}$ = 83.09, $p$ < .05), and family support (β = .49, t = 9.12, $p$ < .001) was significantly associated with adherence. In the final model, health care team and system-related factor (patient-healthcare provider relationship) was added after controlling for four related factors, which could additionally explain 10.6% of the variance in adherence ($F_{(1,194)}$= 72.98, $p$ < .001) and patient-healthcare provider relationship (β = 0.34, t = 8.54, $p$ < .001), was significantly associated with adherence to therapeutic regimens (Table 3 and table 4). The findings showed people with Type 2 diabetes who received good family support, had good relationship with their healthcare provider, had high self-efficacy, had suffered from more diabetes symptoms and had less severe comorbidity had good adherence to therapeutic regimens.

**Table 3:** Model Summary of Hierarchical Multiple Regression

| Model | R | $R^2$ | Adjusted $R^2$ | R Square Change | F Change | df1 | df2 | Sig. F Change |
|---|---|---|---|---|---|---|---|---|
| 1 | .529[a] | .280 | .276 | .280 | 77.007 | 1 | 198 | .000 |
| 2 | .657[b] | .432 | .426 | .152 | 52.652 | 1 | 197 | .000 |
| 3 | .670[c] | .449 | .440 | .017 | 5.914 | 1 | 196 | .016 |
| 4 | .783[d] | .613 | .605 | .165 | 83.093 | 1 | 195 | .000 |
| 5 | .848[e] | .719 | .712 | .106 | 72.980 | 1 | 194 | .000 |

*a. Predictors: (Constant), Self-efficacy*
*b. Predictors: (Constant), Self-efficacy, Symptoms*
*c. Predictors: (Constant), Self-efficacy, Symptoms, Comorbidity*
*d. Predictors: (Constant), Self-efficacy, Symptoms, Comorbidity, Family support*
*e. Predictors: (Constant), Self-efficacy, Symptoms, Comorbidity, Family support, Patient-healthcare provider relationship*
*f. Dependent Variable: Adherence to therapeutic regimens*

**Table 4:** Results of hierarchical regression analysis of factors predicting adherence to therapeutic regimens

| Model | Predictors | B | Std. Error | Beta | t | Sig | Tolerance | VIF |
|---|---|---|---|---|---|---|---|---|
| 1 | (Constant) | 42.000 | 5.042 | | 8.329 | .000 | | |
| | Self-efficacy | 1.109 | .126 | .529 | 8.775 | .000 | 1.000 | 1.000 |
| 2 | (Constant) | 39.390 | 4.505 | | 8.744 | .000 | | |
| | Self-efficacy | .898 | .116 | .428 | 7.725 | .000 | .937 | 1.067 |
| | Symptoms | 3.029 | .417 | .402 | 7.256 | .000 | .937 | 1.067 |
| 3 | (Constant) | 41.818 | 4.561 | | 9.170 | .000 | | |
| | Self-efficacy | .890 | .115 | .424 | 7.743 | .000 | .937 | 1.068 |
| | Symptoms | 3.455 | .448 | .459 | 7.712 | .000 | .794 | 1.259 |
| | Comorbidity | -1.126 | .463 | -.141 | -2.432 | .016 | .843 | 1.187 |
| 4 | (Constant) | 32.701 | 3.957 | | 8.264 | .000 | | |
| | Self-efficacy | .410 | .110 | .196 | 3.732 | .000 | .722 | 1.385 |
| | Symptoms | 2.429 | .393 | .323 | 6.187 | .000 | .729 | 1.372 |
| | Comorbidity | -.999 | .389 | -.125 | -2.569 | .011 | .842 | 1.188 |
| | Family support | 1.338 | .147 | .499 | 9.116 | .000 | .661 | 1.513 |
| 5 | (Constant) | -3.228 | 5.397 | | -.598 | .550 | | |
| | Self-efficacy | .264 | .095 | .126 | 2.769 | .006 | .699 | 1.431 |
| | Symptoms | 2.011 | .339 | .267 | 5.930 | .000 | .714 | 1.401 |
| | Comorbidity | -.696 | .334 | -.087 | -2.082 | .039 | .832 | 1.202 |
| | Family support | 1.306 | .125 | .488 | 10.411 | .000 | .660 | 1.515 |
| | Patient-healthcare provider relationship | .605 | .071 | .341 | 8.543 | .000 | .909 | 1.101 |

*Dependent variable: adherence to therapeutic regimens*

### *Association between adherence to therapeutic regimens and glycated hemoglobin*

Prior to conducting the correlation analysis, the assumption of normality was tested using Kolmogorov-Smirnov test and found to be in violation of study assumptions. Therefore, Spearman's rho and Kendall's tau_b correlation coefficient analyses were performed to determine actual correlation between adherence to therapeutic regimens and glycemic control **(**HbA1c**).** The results showed that adherence to therapeutic regimens was negatively associated with HbA1c **(**$r_s$ = -.409, $p$ < **.**01**)** and **(**$r_{Kendall'stau\_b}$ = **-.**295, $p$ < **.**01**)** respectively, meaning the participants who better adhered to therapeutic regimens had lower value of glycated hemoglobin (HbA1c) in this study (Table 5).

Adherence to diet, exercise, foot care and medication were moderately and negatively associated with glycemic control (rs = -.455, $p$ < .01 or rKendall's tau_b = -.326, $p$ < .01; rs = -.230, $p$ < .01 or rKendall's tau_b = -.169, $p$ < .01; rs = -.177, $p$ < .05 or rKendall's tau_b = -.134, $p$ < .05; rs = -.149 or rKendall's tau_b = -.1*20, $p$ < .05) respectively. However, adherence to self-monitoring of blood glucose (SMBG) was not significantly associated with glycemic control. The finding suggested people with diabetes who had better adherence to diet, exercise, medication and foot care, except adherence to SMBG, had lower value of glycated hemoglobin (HbA1c) Adherence to diet was most significantly associated with glycemic control in this study (Table 5).

**Table 5:** The association between adherence to therapeutic regimens and Glycated hemoglobin

| Variables | HbA1c | |
|---|---|---|
| | Spearman's rho | Kendall's tau_b |
| Adherence to overall therapeutic regimens | -.409** | -.295** |
| Adherence to diet | -.455** | -.326** |
| Adherence to medication | -.149* | -.120* |
| Adherence to exercise | -.230** | -.169** |
| Adherence to SMBG | -.103 | -.072 |
| Adherence to foot care | -.177* | -.134* |

*$p<0.05$ ** $p<0.01$

## Discussion

In the present study, adherence to therapeutic regimens was moderately associated with glycemic control. Although the participants had good adherence to therapeutic regimens, most of them had poor glycemic control. In Myanmar, patients who had poor glycemic control are referred to the hospital for effective treatment and since they already know about their condition, they may try to control their poor glycemic condition by adhering to their therapeutic regimens. A study showed nearly half of the participants were overweight and obese, and most were middle aged women premenopausal women which meant obesity and hormones may have caused insulin resistance (Lin, et al., 2006). Thus, gender and BMI are necessary to consider as predictor in the future study.

When considering the association between adherence to each domain of regimen and HbA1c, adherence to diet, exercise, footcare, and medication were negatively significant associated with HbA1c except SMBG**.** This result is in line with previous studies (Charity, et al., 2016; Shrestha, Shakya, Karmacharya & Thapa, 2013). In this study, majority of the participants were urged to measure their blood glucose level once a day 3-4 times a week. Some of the participants did not measure blood glucose level as recommended because of financial problems. Therefore, it may have an impact on the analysis of association between SMBG and glycemic control. According to the result, adherence to diet and exercise is most significantly associated with glycemic control. Therefore, healthcare providers should pay greater attention to adherence to diet and exercise and establish successful interventions to achieve diabetes control in Myanmar.

Family support was the strongest predictor of adherence in this study. Respondents who have good family support have good adherence rate to therapeutic regimens (Brundisini et al., 2015; Nwaokoro et al., 2014; Garcıa-Perez, lvarez, Dilla, Gil-Guille & Orozco-Beltra, 2013; Boas, Foss, Freitas, & Pace, 2012; Mayberry & Osborn, 2012). Like many other Asian countries, Myanmar people rely on family support as a primary resource to care for the ill and aged. Majority of the diabetes patient are from the low income group which meant family intervention is crucial for good health. Therefore, it is recommended health care providers strengthen family-based interventions in which family members are included in the treatment plan and participate in clinical decision-making.

In the current study, patient-healthcare provider relationship was the second strong significant predictor of adherence. This finding supports that of previous studies (Brundisini et al., 2015; Garcıa-Perez, lvarez, Dilla, Gil-Guille & Orozco-Beltra, 2013; Jin, Sklar, Oh & Li, 2008). It however contradicted Mandewo et al.'s findings (2014). Diabetes patients in Myanmar have good confidence and believe in treatment, and they usually rely on their

healthcare provider. Thus, nurses and other health care providers should establish effective therapeutic relationship between patients and healthcare providers.

In this study, number of symptoms was the third significant predictor. These results were in line with previous studies (NíMhurchadha & Sayers, 2014; Kardas, Lewek, & Matyjaszczyk, 2013; Ali & Jusoff, 2009; Delamater, 2006). The finding suggested that diabetes patient who suffered from greater diabetes symptoms may feel actually ill and thus, it motivates them to more adhere to regimens. It looks like that the patients who had no or fewer symptoms had poorer adherence rate. Accordingly, nurses should make sure patients understand the importance of persistent adherence and motivation especially those who had a few or no symptoms to improve adherence behavior.

Self-efficacy was the fourth significant predictor in this study. Like previous studies, the finding showed self-efficacy was constant predictor of adherence behavior (Ebrahim, Villier, & Ahmed, 2014; Sonsona, 2014; Sandhi-Wynn-Nyunt, Howteerakul, Suwannapong & Rajatanun, 2011). The participants who perceived they had high self-efficacy in taking medication, providing foot care, keeping weight under control, correcting blood sugar level, maintaining a healthy eating pattern, had better adherence to their therapeutic regimens in this study. Indeed, nurses and other healthcare providers should develop effective intervention program to empower and motivate the patients in order to improve their self-efficacy.

Comorbidity was the last significant predictor in this study**.** This finding was supported by the previous studies (Koprulu, Bader, Hassan, Alduelkarem & Mahmood, 2014; Teklay, Hussien, & Tesfaye, 2013). In contrast, the finding did not agree with other studies (Albuquerque, Correia, & Ferreira, 2014; Tiv et al., 2012). Comorbidities may have serious effects on the participants' ability to manage their illness, and pose barriers to adherence. This finding provides good information to healthcare providers to pay attention to patients who suffer from comorbidity and support them to deal with their difficulties in managing comorbid diseases and help them adhere to their therapeutic regimens.

Complexity of treatment was not a significant predictor of adherence in this study**.** The result of the study was in line with the previous one by Mandewo et al (2014). However, this finding was inconsistent with that of previous studies (Roy, Sajith & Bansode, 2017; Jackson, Adibe, Okonta, & Ukwe, 2015; Garcıa-Perez, lvarez, Dilla, Gil-Guille, & Orozco-Beltra, 2013). This inconsistency might be due to the fact that the previous studies focused only on medication adherence while this study focused upon adherence to overall therapeutic regimens (diet, exercise, SMBG, and foot care). In addition, the complexity of treatment in those previous studies was measured only by the complexity of medications consumed intake. Therefore, the complexity of medications intake might not directly influence overall adherence to diet, exercise, SMBG, medication and foot care. Moreover, the meaning of treatment complexity is different in this study.

Diabetes knowledge was not a significant predictor in this study which showed that diabetes knowledge alone may not influence adherence behavior. This finding was consistent with that of previous studies (Sanal, Nair & Adhikari, 2011) though it was inconsistent with some earlier previous studies, (Worku, Abebe & Wassie, 2015; Mandpe, Pandit, Dawane & Patel, 2014; Parajuli, Saleh, Thapa &Ali, 2014) because they used different research instruments and different characteristics of sample. Moreover, most participants had primary education level and are from the low-income group. Although patients understand that adherence to recommended therapy will control their diabetes, they often do not adhere to regimens because of their effort especially income, as a result, knowledge cannot transfer to practice

and there have the gaps between knowing and doing. Thus, the education level and income may influence the rate of adherence.

Surprisingly, although the participants had strong belief in treatment effectiveness, it could not predict adherence to therapeutic regimens in this study**.** This finding was similar to that of deVries et al. (2014) and Pourghaznein, Ghaffari, Hasanzadeh, & Chamanzari (2013), but it was not in line with other previous studies (Albuquerque, Correia, & Ferreira, 2014; Xu, 2010). Although the respondents believed the importance of therapeutic regimens, they were unable to adhere to their treatment because they may lack capacity or resources. Consequently, they might unintentionally not adhere to regimens. The healthcare provider should ensure patients have the capacity to meet their health challenges.

In summary, the finding showed that the WHOMAM can explain the major factors influencing adherence to therapeutic regiments and provide more comprehensive understanding the multidimensional factors that influence adherence behavior among Type 2 diabetes mellitus patients in Myanmar.

## Conclusion

Adherence is vital to improve glycemic control and an important indicator of health system to predict health outcomes. The findings of this study have provided evidence diabetes patients in Myanmar who have better family support, good patient-healthcare provider relationship, more diabetes symptoms, perceived higher self-efficacy and with few or no comorbidity showed greater adherence to regimens. Nurses and other healthcare providers should pay greater attention on these five predictors to design effective interventions to improve diabetes care services in Myanmar.

Future research can be a longitudinal study to investigate adherence behavior over time in addition to examining other variables within the WHOMAM. Qualitative research should be conducted to explore in depth the reasons for adherence and non-adherence to understand patient feelings, perception, difficulties, and barriers in their daily life.

The current study has both strengths and limitations. To the best of the researchers' knowledge, this is the first study that identified the factors influencing adherence to overall therapeutic regimens among Type 2 diabetes patients in Myanmar. The findings of this study contribute to knowledge about multidimensional factors and their influences on the adherence behaviors that can be used as fundamental and valuable evidence for further intervention research and develop effective intervention program to improve adherence behaviors. This is, however, a hospital-based study and with restricted geographical area (only two hospitals), and thus its findings cannot be generalized to other settings.

## Acknowledgements

The researcher would like to thank Capacity Building in Myanmar–Nowegian Scholarship Program for their support giving me a chance to study in Mahidol University, Bangkok, Thailand. The researcher would like to express deep gratitude to major advisor and co-advisors for valuable guidance and support. The researcher would also like to thank the respondents for their sacrificing their valuable time to participate and to all those who supported in this study.

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