

# Medication Adherence Among Patients with Multimorbidity in the United Arab Emirates

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**Background:** Multimorbidity, defined as having two or more chronic diseases, has a major impact on public health and Sustainable Development Goals (SDG). This study aims to assess the prevalence of medication adherence and associated factors among patients with multimorbidity.

**Methods:** A questionnaire-based, cross-sectional survey was conducted by a trained interviewer across patients with multimorbidity attending outpatient clinics in two tertiary referral hospitals in the United Arab Emirates (UAE). Demographic and social variables and the outcome (self-reported adherence to long-term medication) were measured using the General Medication Adherence Scale (GMAS). Multiple logistic regression was used to assess medication adherence and associated factors.

**Results:** From a total of 630 participants included in this study, the estimated prevalence of high medication adherence is 78.57% ( $\pm 1.63478$ ) with a 95% confidence interval (CI) [75.19, 81.61]. The odds of high medication adherence increased with age. The odds of high medication adherence for patients aged 66 years and older than those aged 19–35 years is adjusted odds ratio (AOR) = 3.880, with a 95% CI [1.124, 13.390]. Patients with income more than 50,000 had the odds, AOR = 5.169 with a 95% CI [1.282, 20.843], compared to those earning less than 10,000 Dirhams (AED). Patients aged 36–65 with health insurance coverage had higher medication adherence than groups on the other end. The number of current medications is significantly ( $p$ -value = 0.027) associated with high medication adherence with the odds of high medication adherence, AOR = 4.529 with a 95% CI [1.184, 17.326], the highest for those currently taking four medications.

**Conclusion:** This study highlights younger population having multimorbidity in the context of an increasing life expectancy and suboptimal therapeutic outcomes. Furthermore, the study highlights multimorbidity is associated with low medication adherence and out-of-pocket payment, and non-availability of insurance is a major hindrance to medication adherence.

**Keywords:** multimorbidity, medication adherence, United Arab Emirates, sustainable development goals, global burden of disease

## Introduction

Multimorbidity refers to the co-occurrence of two or more chronic conditions in an individual.<sup>1</sup> Recent systematic reviews suggest that the prevalence of multimorbidity is in the range of 23–33%, and prevalence further increases with age, estimated to be 75% or higher at the age of 70 years. As average life expectancy rises, the numbers are bound to substantially increase by 2035.<sup>2–4</sup> Those 65 years or older are expected to live with four or more chronic diseases by 2035.<sup>5</sup> Patients with multimorbidity are associated with increased healthcare and social services utilization,<sup>6</sup> increased healthcare costs,<sup>7</sup> poorer clinical outcomes,<sup>8</sup> and increased disability and mortality.<sup>3</sup> Thus, multimorbidity has been highlighted as a significant challenge to both the patients and healthcare providers.

Patients with multimorbidity require complex clinical care, including treatment with multiple medications (polypharmacy).<sup>9–11</sup> Medication adherence, defined as patients taking their medications as prescribed, is essential to achieve optimal disease control.<sup>12</sup> Non-adherence to medications includes poor initiation, implementation, and non-persistence to continue with prescribed treatment.<sup>13,14</sup> Recent evidence-based guidelines have emphasized that medication adherence is the cornerstone for managing and preventing long-term complications in multimorbidity patients.<sup>15</sup> Research has documented that low adherence to medications is multifactorial and multidimensional related to patients, physicians, and healthcare systems.<sup>10,11</sup> Furthermore, the current pandemic has had a negative effect and several constrains on the patients, public and the healthcare system.<sup>16–19</sup> Though the expenses are due to increased medication costs, there is evidence that there is a reduction in overall health care with medication adherence costs.<sup>20</sup> Evidence from several studies suggests that higher adherence with medications was associated with decreased complications.<sup>12,21</sup> Furthermore, evidence suggests a 26% improvement in health outcomes comparing patients between high and low medication adherence.<sup>22</sup> In another study, 38% decreased cardiovascular disease events compared with lower medication adherence.<sup>21</sup> In contrast, non-adherence to medications is associated with higher mortality. In the United States (US) alone, medication non-adherence amounts to an excess of \$100 billion (about \$310 per person in the US) in annual healthcare expenditure.<sup>23</sup>

Rapid economic and demographic transitions due to the discovery of oil have led the United Arab Emirates (UAE) to transform into a wealthy country adopting western lifestyles.<sup>24</sup> UAE has a younger population, witnessed rapid industrial growth and modernizations, which have contributed to an increase in trends in the prevalence of non-communicable diseases (NCD) such as diabetes, hypertension, obesity, and cardiovascular disease.<sup>18,19</sup> World Health Organization estimates that the burden of chronic diseases increases rapidly in the UAE, with one in four deaths contributing to cardiovascular disease.<sup>24</sup> Furthermore, one in six people in the United Arab Emirates has Diabetes.<sup>25</sup> Literature evidence suggests a higher rate of non-compliance with medications in patients with Diabetes<sup>26</sup> and Hypertension.<sup>27</sup> Medication compliance issues could lead to increased morbidity, mortality, and economic burden through hospitalization and increased costs due to chronic disease complications.

In 2015, United Nations member states adopted 17 Sustainable Development Goals (SDGs) and 169 target indicators as a global development agenda to achieve by 2030.<sup>28</sup> Reducing the burden due to multimorbidity (NCD) is a critical global health and well-being agenda.<sup>29</sup> One of the key SDG –3 targets is to reduce premature deaths due to NCDs by one-third by 2030. Furthermore, multimorbidity is associated with employment losses and poverty, creating inequity both within and across the globe. Several studies have shown improved survival and decreased morbidity in patients with multimorbidity.<sup>30,31</sup> However, it is evident that poor adherence to medications can further increase the mortality and morbidity associated with multimorbidity.<sup>32</sup> Hence, multimorbidity associated with poor medication adherence has a significant negative impact on health, economic, and social SDGs that contribute to a significant burden on the person, public, and society.

As the prevalence of multimorbidity rises, reflecting the unhealthy lifestyles and ageing in the UAE, patients with multimorbidity constitute a significant challenge to the healthcare system. Hence, there is a need to measure the relationship between multimorbidity and medication adherence. However, there is a paucity of literature regarding multimorbidity and medication adherence in the UAE. The study's primary objective is to quantify medication adherence among patients with multimorbidity. Furthermore, we aim to evaluate the factors associated with multimorbidity and medication adherence in the United Arab Emirates population.

## Methods

### Study Design and Participants

A cross-sectional survey design was used. Only people with more than one chronic disease and who consented to participate completed the questionnaire through a structured interview by a trained clinical researcher. Participants were recruited from visitors attending outpatient clinics in two hospitals, namely, Dubai and Rashid Hospital. Dubai and Rashid hospital are one of the major tertiary referral hospitals in the UAE. Patients from different geographical locations from the UAE visit these two hospitals to manage complex chronic diseases. After piloting the questionnaire on 36

participants the survey questionnaire was reviewed and adjusted for minor grammatical changes. Data collection took place between February 2021 – September 2021.

## Sample Size

Sample size was calculated to be 563 with a 5% level of significance and 80% power to detect a minimum of 5% difference. To substantiate missing data and other human factors, we have added 10% contingency in the collection of data resulting in 620 patients, and fortunately, we were able to recruit 630 patients.

## Inclusion and Exclusion Criteria

All patients having two or more diseases and on medications, aged  $\geq 18$  years, and attending a hospital-based outpatient service in Dubai Hospital and Rashid Hospital, Dubai, during February 2021 – September 2021 were included in the study. Patients with multimorbidity that limited their communications were excluded.

## Ethical Approval

Ethical approval was obtained before the commencement of the study from the Dubai Scientific research ethics committee, United Arab Emirates (Approval Number DSREC-01/2021\_20). Study was conducted anonymously in accordance with Declaration of Helsinki guidelines.

## Measurements

The survey tool comprises the following sections:

1. A Demographic section that included age, gender, height, weight, employment status, and ethnicity,
2. General Medication Adherence Scale (GMAS) which is an 11-item questionnaire that provides a convenient and affordable way of tracking compliance by an indirect approach. The GMAS adopted a combination of subjective and objective measures. The 11 items are subdivided into (1) Non-adherence due to patient behavior (Five items) (2) Pill burden and additional disease (four items), and (3) payment-related non-adherence (two items). We used the GMAS survey because of its studied results, which yielded values related to validation aspects. The GMAS instrument has been validated in several studies with different chronic diseases with good psychometric properties.<sup>33–36</sup>

Each item in the General Medication Adherence Scale (GMAS) has four Likert scores, and the maximum score for adherence that could be achieved is 33, with a minimum score of 0 and a maximum score of 3. The sum of all items yields a final score used to form the two categories of the outcome variable, medication adherence, as “Low adherence” if GMAS score  $\leq 26$  and “High Adherence” if GMAS score  $\geq 27$ .<sup>37</sup> In this study, GMAS had a good reliability, Cronbach’s alpha ( $\alpha = 0.8492$ ).

3. The Self-Administered Co-Questionnaire (SCQ) is a short, detailed survey that includes 12 medical conditions to determine a patient’s comorbidities.<sup>38</sup> This survey tool provides an alternative that constitutes an alternative method for comorbidity measurements to traditional methods that are often based mainly on information from the health record or administrative details. This questionnaire provides an advantage over other methods of comorbidity assessments by avoiding drawbacks such as incomplete medical records and low reporting consistency. The SCQ is a reproducible comorbidity measure with a meaningful relationship with a traditional hospital record-based comorbidity measure.<sup>38,39</sup>

To reduce risk of bias during the interview, study was not conducted during the month of Ramadan as during the month, people who fast from dawn to dusk, take the medications thrice and there is a chance to miss or change in routine to take the pills causing a bias in our study. Clinical researcher is a medically trained postgraduate doctor who is bilingual in Arabic and English. The survey questions were both available in English and Arabic to reduce any bias.

## Data Analysis

Descriptive statistics including mean and standard deviation (SD) for quantitative variables and percentages for categorical variables were used. We performed multiple logistic regression to evaluate factors associated with medication adherence (Table 1). Covariates were included in the multiple logistic regression model based on the literature and knowledge in the area. These analyses were performed using Stata software, version 16.0 (StataCorp LLC, College Station, TX)<sup>40</sup> with a two-tailed level of statistical significance set at  $p\text{-value} \leq 0.05$ .

**Table 1** Logistic Regression Examining Factors Associated with Medication Adherence of Patients with Morbidity

Variables		AOR	Std. Err.	z-Statistic	p-value	[95% Conf. Int.]	
Number of children		0.915	0.069	-1.180	0.239	0.789	1.061
Age (19–35) <sup>†</sup>	36–50	2.506	1.191	1.930	0.053*	0.987	6.362
	51–65	2.504	1.327	1.730	0.083*	0.886	7.074
	≥ 66	3.880	2.452	2.150	0.032**	1.124	13.390
Sex (Female)	Male	0.985	0.306	-0.050	0.962	0.536	1.810
Marital status (Divorced)	Married	1.912	1.333	0.930	0.352	0.488	7.496
	Single	1.978	1.655	0.810	0.415	0.384	10.197
	Widowed	1.146	1.038	0.150	0.880	0.194	6.764
Educational level (Primary)	Secondary	1.359	0.507	0.820	0.411	0.654	2.823
	Tertiary	1.165	0.428	0.410	0.679	0.566	2.394
Income (Less than 10,000)	10,001–20,000	0.741	0.228	-0.970	0.331	0.406	1.356
	20,001–30,000	2.153	0.870	1.900	0.058*	0.975	4.753
	30,001–40,000	1.267	0.652	0.460	0.645	0.462	3.474
	40,001–50,000	1.736	1.265	0.760	0.449	0.416	7.240
	> 50,000	5.169	3.677	2.310	0.021**	1.282	20.843
Smoke (Current Smoker)	Ex-smoker	0.997	0.430	-0.010	0.995	0.428	2.323
	Non-smoker	1.438	0.501	1.040	0.297	0.727	2.845
Alcohol (No)	Yes	0.690	0.377	-0.680	0.496	0.236	2.011
Insurance (No)	Yes	0.652	0.266	-1.050	0.295	0.293	1.452
Limit on insurance (No)	Yes	0.776	0.231	-0.850	0.394	0.433	1.390
Number of medical condition(2)	3	0.813	0.298	-0.560	0.573	0.397	1.668
	4	1.157	0.582	0.290	0.772	0.432	3.102
	5	2.874	2.298	1.320	0.187	0.600	13.775
	>6	2.599	2.033	1.220	0.222	0.561	12.038
Number of current medication(1)	2	2.320	1.454	1.340	0.179	0.679	7.926
	3	2.462	1.543	1.440	0.151	0.721	8.412
	4	4.529	3.100	2.210	0.027**	1.184	17.326
	5	3.271	2.350	1.650	0.099*	0.800	13.369
	>6	2.018	1.305	1.090	0.278	0.568	7.165
Herbal Medications (No)	Yes	0.593	0.262	-1.180	0.236	0.250	1.408

(Continued)

**Table 1** (Continued).

Variables		AOR	Std. Err.	z-Statistic	p-value	[95% Conf. Int.]	
Medication from(Both)	Overseas	1.270	1.342	0.230	0.821	0.160	10.073
	UAE	2.453	1.764	1.250	0.212	0.599	10.046
Heart disease (No)	Yes	0.990	0.331	-0.030	0.976	0.514	1.905
High blood pressure(No)	Yes	1.626	0.486	1.630	0.104	0.905	2.920
High cholesterol(No)	Yes	0.941	0.278	-0.210	0.837	0.528	1.678
Lung disease (No)	Yes	3.567	2.209	2.050	0.040**	1.060	12.006
Diabetes (No)	Yes	1.665	0.482	1.760	0.078*	0.944	2.936
Ulcer or stomach disease(No)	Yes	0.716	0.282	-0.850	0.396	0.331	1.548
Kidney disease (No)	Yes	0.828	0.342	-0.460	0.647	0.368	1.860
Liver disease(No)	Yes	1.208	0.934	0.250	0.806	0.266	5.494
Other blood disease (No)	Yes	0.407	0.163	-2.240	0.025**	0.186	0.894
Cancer (No)	Yes	0.258	0.161	-2.170	0.030**	0.076	0.877
Depression (No)	Yes	0.573	0.403	-0.790	0.429	0.144	2.276
Osteoarthritis(No)	Yes	0.376	0.144	-2.560	0.010**	0.178	0.795
Back pain(No)	Yes	0.908	0.343	-0.260	0.797	0.433	1.903
Rheumatoid arthritis(No)	Yes	0.899	0.504	-0.190	0.849	0.300	2.695

**Notes:** †The values in the bracket represent the reference group, \* and \*\* significant at 10% and 5% level of significances.

**Abbreviation:** AOR: adjusted odds ratio.

## Results

### Adherence to Medication

A total of 630 participants were included in this study. The prevalence of high medication adherence is estimated to be 78.57% ( $\pm 1.63478$ ) with a 95% CI of [75.19, 81.61]. The age composition of participants ranges from 19 to 97 years old, with the average age of the participants being 53.82 ( $\pm 0.5285$ ) years and a 95% CI [52.78, 54.86].

### Patients' Sociodemographic Characteristics and Clinical Characteristics

Though the proportion of patients with medication adherence increases with age, age is not significantly associated with medication adherence (Table 2). About 80% of males were adherent, whereas 75.62% for females. A statistically significant association is observed between medication adherence and nationality. The medication adherence for UAE nationals is significantly ( $p$ -value < 0.001) higher than that of expatriates. Although most (95%) of the patients do not drink alcohol, about 81% of those who drink alcohol were adherent to medication. Adding to that, there is no statistically significant difference in the prevalence of high medication adherence among teetotalers compared to those who drink alcohol. Household income is significantly ( $p$ -value < 0.001) associated with medication adherence. Of those patients whose income is less than 10,000 a month, about 75% were adherent to medication; whereas 95% of those who earn 40,001–50,000 were adherent to medication. Occupation of the patients also has a significant ( $p$ -value = 0.029) association with high medication adherence. Among the retired patients, about 86% had high adherence to medication.

Almost 70% of the patients have health insurance coverage, among which 77.5% were adherent to medication. Limit on health insurance is statistically significantly ( $p$ -value = 0.002) associated with high medication adherence. On the other hand, about a quarter of the patients who had a limit on health insurance coverage were found to have low medication adherence.

**Table 2** Sociodemographic Characteristics and Clinical Characteristics of Patients

	Total	Medication Adherence		p-value
		Low Adherence	High Adherence	
Variables	Count (%)	Count (%)	Count (%)	
<b>Age</b>				0.153
19–35	55(8.76)	17(30.91)	38(69.09)	
36–50	205(32.64)	48(23.41)	157(76.59)	
51–65	251(39.97)	49(19.52)	202(80.48)	
≥ 66	117(18.63)	20(17.09)	97(82.91)	
<b>Sex</b>				0.154
Female	242(38.41)	59(24.38)	183(75.62)	
Male	388(61.59)	76(19.59)	312(80.41)	
<b>Marital status</b>				0.776
Divorced	19(3.02)	5(26.32)	14(73.68)	
Married	532(84.44)	115(21.62)	417(78.38)	
Single	54(8.57)	9(16.67)	45(83.33)	
Widowed	25(3.97)	6(24.00)	19(76.00)	
<b>Number of children</b>				0.193
0	76(12.06)	16(21.05)	60(78.95)	
1–2	121(19.21)	28(23.14)	93(76.86)	
3–5	238(37.78)	59(24.79)	179(75.21)	
> 5	195(30.95)	32(16.41)	163(83.59)	
<b>Educational level</b>				0.991
Primary or below	154(24.44)	32(20.78)	122(79.22)	
Secondary	197(31.27)	41(20.81)	156(79.19)	
Tertiary	279(44.29)	62(22.22)	217(77.78)	
<b>Nationality</b>				< 0.001
Expatriate	299(47.46)	86(28.76)	213(71.24)	
UAE	331(52.54)	49(14.80)	282(85.20)	
<b>Occupation</b>				0.029
Employed	266(42.29)	67(25.19)	199(74.81)	
Home Maker/Housewife	147(23.37)	31(21.09)	116(78.91)	
Retired	165(26.23)	23(13.94)	142(86.06)	
Self - Employed	41(6.52)	10(24.39)	31(75.61)	
Others	10(1.59)	4(40.00)	6(60.00)	
<b>Household head income</b>				0.001
Less than 10,000	252(40.00)	66(26.19)	186(73.81)	
10,001–20,000	147(23.33)	40(27.21)	107(72.79)	
20,001–30,000	98(15.56)	9(18.37)	40(81.63)	
30,001–40,000	49(7.78)	3(12.50)	21(87.50)	
40,001–50,000	24(3.81)	3(5.00)	57(95.00)	
More than 50,000	60(9.52)	66(26.19)	186(73.81)	
<b>Smoking status</b>				0.349
Current Smoker	114(18.10)	30(26.32)	84(73.68)	
Ex-smoker	92(14.60)	20(21.74)	72(78.26)	
Non-smoker	424(67.30)	85(20.05)	339(79.95)	

(Continued)

**Table 2** (Continued).

	Total	Medication Adherence		p-value
		Low Adherence	High Adherence	
<b>Drinking Alcohol</b>				0.705
No	598(94.92)	129(21.57)	469(78.43)	
Yes	32(5.08)	6(18.75)	26(81.25)	
<b>Health Insurance</b>				0.319
No	190(30.16)	36(18.95)	154(81.05)	
Yes	440(69.84)	99(22.50)	341(77.50)	
<b>Limit on health insurance</b>				0.002
No	275(51.69)	44(16.00)	231(84.00)	
Yes	257(48.31)	69(26.85)	188(73.15)	
<b>Number of medical conditions</b>				0.267
2	268(42.54)	64(23.88)	204(76.12)	
3	154(24.44)	34(22.08)	120(77.92)	
4	114(18.10)	18(15.79)	96(84.21)	
5	33(5.24)	4(12.12)	29(87.88)	
>6	61(9.68)	15(24.59)	46(75.41)	
<b>Number of current medications</b>				0.1370
1	24(3.81)	10(41.67)	14(58.33)	
2	95(15.08)	22(23.16)	73(76.84)	
3	102(16.19)	25(24.51)	77(75.49)	
4	72(11.43)	15(20.83)	57(79.17)	
5	56(8.89)	9(16.07)	47(83.93)	
>6	281(44.60)	54(19.22)	227(80.78)	

Overall, the median number of current medications increased with age. The median number of current medications for patients with high medication adherence in the age group 19–35 is higher for females compared to males, and the same is true for patients in the age group 36–50 (Figure 1).

Among patients with a family history of hypertension, a significantly ( $p$ -value = 0.001) higher proportion (about 78%) of them were adherent to medication. A majority (78%) of patients with type 2 diabetes were adherent to medication. About three in four patients from a family with a heart disease history were adherent to medication. More than three-fourths of patients with a family history of dyslipidemia were adherent to medication (Table 3).

It is evident from Figure 2 that the percentage of patients with health insurance coverage is higher among the highly adherent group across all age categories. Moreover, high medication adherent patients in the age range from 36 to 65 were found to have higher health insurance coverage compared to the others.

## Co-Morbidity

As presented in Table 4, about one-quarter of the patients have heart disease, of which 80.13% were able to control its effect. A majority (90%) of the patients reported anemia or other blood-related diseases, of which 90% had received treatment. Among patients who have a blood pressure problem, almost 5% reported limiting their activities. Only a few, close to 3% of the patients, have reported depression. Although most of the patients reported that they had received the treatment, the majority reported that they could not control the disease.

## Factors Associated with Medication Adherence

Patients' age is significantly associated with medication adherence after accounting for other factors. For patients in the age group 36–50, the odds of medication adherence are more than two-fold compared to those in the age group 19–35, the same

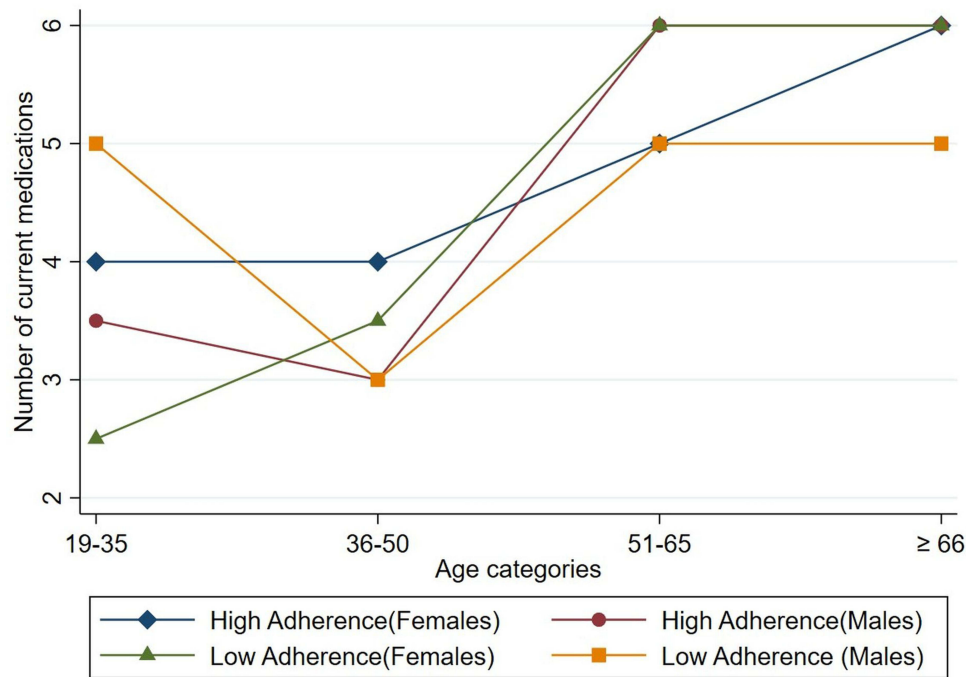


Figure 1 Median number of current medications by gender, age, and medication adherence.

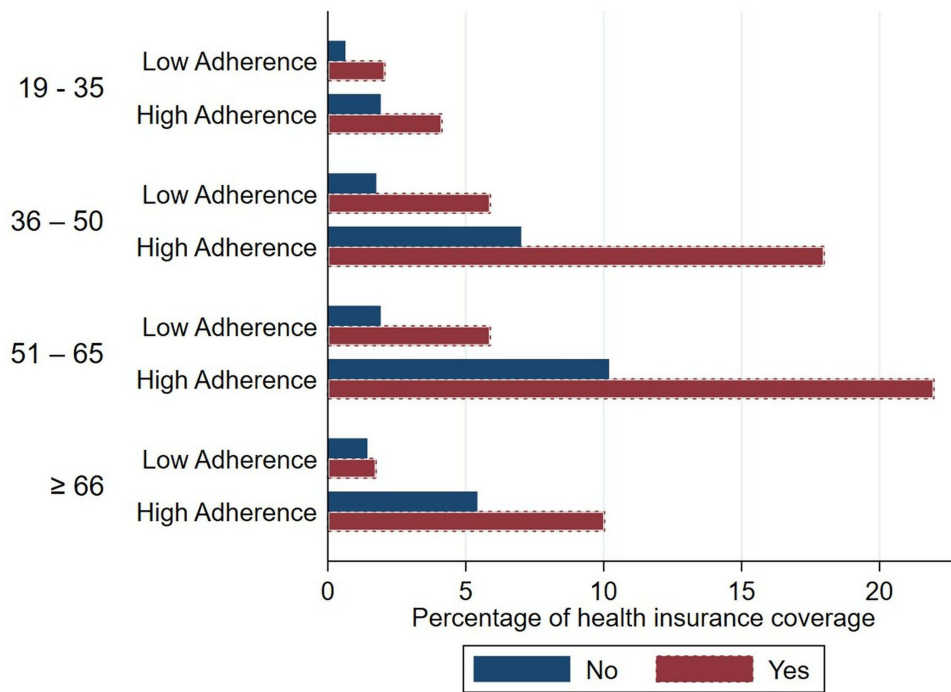
holds for the higher age groups. The odds of medication adherence for patients who are 66 years and older is about fourfold compared to those aged 19–35 years. Although the odds of adherence to medication for male patients is lower by about 1%, compared to female patients, the difference is not statistically significant. For patients who earn more than 50,000, the odds, AOR = 5.169 with a 95% CI [1.282, 20.843], of medication adherence, are significantly (p-value = 0.021) higher by more than fivefold than those earning less than 10,000. Non-smoking patients have higher odds of medication adherence than current smokers, although the association is not statistically significant.

The odds of medication adherence for non-smokers is lower by almost 30%, compared to smokers. For both patients with health insurance coverage and limit on health insurance, the odds of medication adherence are lower than their counterparts.

Table 3 Prevalence of Adherence to Medication by Family History

Variables		Total		Adherence		p-value
				Low Adherence	High Adherence	
		Count	%	Count (%)	Count (%)	
Hypertension	Yes	345	100	77(22.32)	268(77.68)	< 0.001
Heart failure/ischemic heart disease	Yes	154	100	36(23.38)	118(76.62)	< 0.001
Type 2 diabetes	No	1	0.28	1(100.00)	0(0.00)	< 0.001
	Yes	355	99.72	78(21.97)	277(78.03)	
Dyslipidemia	No	2	0.93	2(100.00)	0(0.00)	< 0.001
	Yes	213	99.07	50(23.47)	163(76.53)	
Stroke	No	2	10.00	2(100.00)	0(0.00)	0.4806
	Yes	18	90.00	7(38.89)	11(61.11)	





**Figure 2** Percentage of medication adherence by insurance coverage and age categories.

The number of current medications has a quadratic relationship with the odds of medication adherence. The odds ratio, AOR = 4.529 with a 95% CI [1.184, 17.326], was the highest for those currently taking four medications. The odds of medication adherence are significantly (p-value = 0.027) higher by more than fourfold than those taking one medication.

**Table 4** Specific Co-Morbidity (The Self - Administered Co-Morbidity Questionnaire)

Co-Morbidity	Do You Have Medical Condition		Do You Receive Treatment for It		Does It Limit Your Activities		Is It Controlled	
	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)
Heart disease	156 (24.76)	474 (75.24)	151 (96.79)	5 (3.21)	33 (21.15)	123 (78.85)	125 (80.13)	31 (19.87)
High Blood pressure	397 (63.02)	233 (36.98)	384 (96.73)	13 (3.27)	20 (5.04)	377 (94.96)	338 (85.14)	59 (14.86)
Cholesterol	360 (57.14)	270 (42.86)	332 (92.22)	28 (7.78)	12 (3.33)	348 (96.67)	309 (85.83)	51 (14.17)
Lung disease	51 (8.10)	579 (91.90)	42 (82.35)	9 (17.65)	3 (5.88)	48 (94.12)	40 (78.43)	11 (21.57)
Diabetes	377 (59.84)	253 (40.16)	364 (96.55)	13 (3.45)	43 (11.41)	334 (88.59)	309 (81.96)	68 (18.04)
Ulcer or stomach disease	76 (12.06)	554 (87.94)	67 (88.16)	9 (11.84)	5 (6.58)	71 (93.42)	57 (75.00)	19 (25.00)
Kidney disease	72 (11.43)	558 (88.57)	67 (93.06)	5 (6.94)	18 (25.00)	54 (75.00)	55 (76.39)	17 (23.61)
Liver disease	21 (3.33)	609 (96.67)	21 (100)	0 (0.00)	2 (9.52)	19 (90.48)	16 (76.19)	5 (23.81)
Anemia or other blood disease	64 (10.16)	566 (89.84)	58 (90.63)	6 (9.38)	8 (12.5)	56 (87.50)	53 (82.81)	11 (17.19)
Cancer	21 (3.33)	609 (96.67)	16 (76.19)	5 (23.81)	6 (28.57)	15 (71.43)	11 (52.38)	10 (47.62)
Depression	18 (2.86)	612 (97.14)	13 (72.22)	5 (27.78)	3 (16.67)	15 (83.33)	11 (61.11)	7 (38.89)
Osteoarthritis or degenerative arthritis	101 (16.03)	529 (83.97)	70 (69.31)	31 (30.69)	51 (49.50)	50 (50.50)	46 (45.54)	55 (54.46)
Back pain	97 (15.40)	533 (84.60)	61 (62.89)	36 (37.11)	36 (37.11)	61 (62.89)	42 (43.30)	55 (56.70)
Rheumatoid Arthritis	35 (5.56)	595 (94.44)	30 (85.71)	5 (14.29)	14 (40.00)	21 (60.00)	25 (71.43)	10 (28.57)

Patients with lung disease or diabetes had higher medication adherence odds than those who do not have those diseases. Cancer patients had significantly ( $p$ -value = 0.030) lower odds, AOR = 0.258, CI [0.076, 0.877], of medication adherence compared to their counterpart. Patients with osteoarthritis had significantly ( $p$ -value = 0.010) lower odds, AOR = 0.376 with a 95% CI [0.178, 0.795], of medication adherence, compared to those who did not have the condition.

## Discussion

In this study, the prevalence of medication adherence was estimated to be 78.57%. We have explored the factors associated with multimorbidity and medication adherence in the UAE Nationality, household income and occupation were found to significantly influence higher medication adherence among patients with multi-morbidities. High adherence increased with age and with increased limit to health insurance.

The challenge of ensuring that patients adhere to lifelong therapy for chronic conditions has seen many different interventions implemented over the past few decades. Chronic conditions currently dominate the burden of illness in our society, and poor medication adherence affects the potential of effective treatments to improve patients' health and quality of life. Patients and patient factors were primarily thought to be the main reason for the failure of medication adherence. Research has documented that low adherence to medications is multifactorial and multidimensional related to patients, physicians, and healthcare systems. In this study, medication adherence was around 79% compared to developed countries (50%)<sup>41</sup> while results on medication adherence obtained from Spain was 55.5%,<sup>42</sup> China at 53%<sup>43</sup> and 48% among American patients was much higher.<sup>42</sup> There may be many explanations for this outcome in our study, but it should not be confused with therapeutic control for these illnesses. Although just a speculation our high medication adherence may be related to a positive doctor–patient relationship. In a study conducted by Svensson et al adherence to antihypertensive medication was related to faith in the physician, which suggests that the quality of the provider–patient relationship was also an important determinant.<sup>44</sup>

Some of the sociodemographic factors that were statistically significant were nationality, occupation, household income (those earning > AED 50000, the AOR = 5.169, 95% CI [1.282–20.843]), and health insurance. After adjustment for several variables, we found age, income, and the number of current medications as independent factors for adherence. Other studies have different factors depending on the outcome variables measured. In the Spanish study (2019), older age, lower number of pharmacies used for medication refills, having received complete treatment information, having adequate knowledge about the medication regimen, and self-perception of a good quality of life were independent factors associated with adherence.<sup>42</sup> A study conducted in Saudi Arabia among patients with diabetes was positively associated with age and education.<sup>45</sup> These differing results demonstrate the diversity among the determinants for non-adherence to medications.

In 2015, 901 million persons were 60 years and older globally, most living in developing countries. It is expected that by 2050, 20% of the total population, ie, 1802 million, will be above 60 years.<sup>46</sup> The average life expectancy from 2010 to 2015 in developing countries was 68 years and 78 years in the developed countries,<sup>47</sup> while according to the World Data Atlas, the life expectancy in 1971 in the UAE increased from 62.1 years to 78.12 years by 2020 with an average annual growth of 0.47%.<sup>48,49</sup> The average age of the participants with multimorbidity in this study was 54 years old and, together with the increasing life expectancy, gives a picture of increasing longevity leading to long-term individual health consequences as well as for the health system and economy. As expected older patients are more likely to have comorbidities. Thus, medication adherence was associated with increasing age which was supported by a regional study.<sup>45</sup> While a recent study found partial-to-poor adherence in patients on medications for comorbidity<sup>45</sup> interestingly. This study showed those that were 66 years and older are four times more likely to adhere to their medications (AOR = 3.880 95% CI [1.124–13.390]) which is a welcoming outcome in the UAE behind a backdrop of a plethora of research showing that patients' non-adherent to medications have increased visits, in some instances four times higher, to the emergency rooms, inpatient and outpatient departments.<sup>30</sup> In a systematic review this could be supported with that age having a concave relation to adherence, ie, adherence is lowest in very young and very old people, which may explain our findings.<sup>50</sup>

It was predicted that non-communicable diseases (NCD) would account for 80% of the world's public health burden.<sup>51,52</sup> Recent systematic reviews suggest that the prevalence of multimorbidity is in the range of 23%–33%.<sup>2–4</sup> Persons 65 years or older are expected to live with four or more chronic diseases by 2035.<sup>5</sup> The highest percentages with non-communicable diseases in this study were hypertension, diabetes mellitus, hyperlipidemia, and cardiovascular

disease with 63%, 60%, 57%, and 25% with self-reported illness control of 15%, 82%, 86%, and 80%, respectively. Unfortunately, most studies outlined medication adherence to a single medical illness and less on medications for multimorbidity. In this study, 78.03% of patients were adherent to their anti-diabetic medication, and despite this, only 50.95% say that their diabetes mellitus is controlled. In a regional study, Saudi Arabia documented only 35.8% adhering to their anti-diabetic medication. The CODE-2 study (Cost of Diabetes in Europe – Type 2) conducted in Europe reported that only 28% of patients treated for diabetes had achieved good glycemic control which is much lower than recorded here.<sup>53</sup> In a recent study conducted in the UAE among patients with hypertension, the overall adherence to antihypertensive treatment was 42% while we documented a higher rate at 78% with 85% at suboptimal hypertension control.<sup>27</sup> The UAE has an incidence for major CVD is 12.7 per 1000 person-years,<sup>54</sup> with 25% of this cohort positively affirming CVD. Almost all of this cohort are being treated (97%) at least 80% have indicated that their CVD event is controlled. In a study assessing the impact of medication adherence on CVD outcomes, the non-adherent patients had double the risk of a major CVD event<sup>30</sup> Results from studies show a disconnect between medication adherence and therapeutic outcomes. This confirms the complexity of managing multimorbidity patients and the problems related to poor medication adherence. Treatment plans in patients with multimorbidity are complex and are often compromised by many barriers and challenges. These include socio-economic causes, healthcare professionals, health systems, disease characteristics and therapies, and patient factors. Such challenges have been magnified with the current pandemic.<sup>16,19</sup> Addressing these problems will assist in improving medication adherence.

## Strengths and Limitations

To our knowledge, this is the first study conducted among multimorbidity patients in the UAE with a large sample from tertiary referral hospitals. The study further estimated the prevalence estimates of medication adherence while controlling for other variables. WHO and United Nations associated SDGs recognize multimorbidity and poor adherence to medications as a significant challenge for public health. Our results call for implementing a tool such as surveys to improve patient-related outcome measures due to improved adherence. There are some limitations to this study. First, in self-reported surveys, patients may overestimate their adherence to medications due to social desirability bias. Nevertheless to mitigate such effect in our study a well-trained interviewer and a robust validated questionnaire with identified options to questions would have reduced such bias.<sup>55</sup> Second, a bias due to self-reported measures can affect the results. Third, we recruited participants from two large referral hospitals from the Emirates of Dubai. Though our study was multi – centre and many participants were from different UAE geographical locations, it may not be an accurate representative sample. Hence, a large systematic multi-centric study across in different regions of the UAE would be required for generalizability of the results. Furthermore, WHO has categorized potential reasons for medication nonadherence into five dimensions which include patient, condition, therapy, socioeconomic, and health system–related factors.<sup>56</sup> Thus, adding a qualitative methodology for future research will enrich and improve the robustness in understanding the multidimensional factors related to medication adherence.

## Implications for Practice

Medication and lifestyle adherence are the most important modifiable factors that compromise even the best treatment outcomes. Clinical interventions should encompass assessment tools and strategies to promote behavior change as suggested in a study that training programs can increase clinicians' awareness of factors impacting on medication adherence.<sup>10</sup> In a meta-analysis conducted by Roter et al, interventions that combined cognitive, behavioral, and affective components were most effective.<sup>57</sup> It is well-documented that the doctor–patient relationship is the cornerstone to improved health outcomes and central to this is physician compassion and empathy.<sup>58,59</sup> Our study highlights the relationship between medication adherence and multimorbidity with many SDGs goals and targets, particularly SDG 3 (Good Health and Well-being), SDG 8 (Decent Work and Economic Growth), SDG 15 (Reduced Inequality) and SDG17 (Partnerships to achieve the Goal). By implementing appropriate evidence-based policies and guidelines, key policy-makers can influence medication adherence, better health outcomes, and quality of life. Policymakers can address variables that include the availability and accessibility of services, support for patient education, data and information management, community support to patients, and adequate training provided to health service providers.<sup>60</sup> Furthermore,

our study calls on policymakers for Universal Health Coverage to provide health system financial options and service patterns to patients with multimorbidity.<sup>61</sup> Such cost-effective economic interventions with insurance and policies are needed to achieve the SDG targets. Sustainable investments by the policymakers to achieve such goals will add more benefit in averting premature deaths and significant health catastrophes such as stroke and ischemic heart disease and strengthen the national income through employment and increased productivity.<sup>62</sup>

Our findings highlight the need for further studies on patients with multimorbidity and their associated needs who may be associated with higher clinical care. Furthermore, it would be imperative to analyse through cost-effective analysis and modelling the economic costs involved with lack of medical insurance cover and how cost-effective measures can be implemented to prevent any disastrous consequences on the health and economy due to poor adherence.

## Conclusion

This study highlighted a young population having multimorbidity in increasing life expectancy and suboptimal therapeutic outcomes. Furthermore, the study highlights that out-of-pocket payment and non-availability of insurance are major hindrances to medication adherence. Medication non-adherence is a significant public health crisis, and by increasing the effectiveness of adherence interventions, the health of populations will be more positively impacted than any specific medical treatment could achieve. Such improvement can further be achieved by wise investments by policymakers in multimorbidity prevention and treatment with a vision to obtain a return on investment by achieving SDG.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work.

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The authors report no conflicts of interest for this work and declare that there are no financial and commercial conflicts of interest that could be perceived as prejudicing the impartiality of this study.

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