ORIGINAL RESEARCH

Factors Associated with Antihypertensive Medication Non-Adherence: A Cross-Sectional Study Among Lebanese Hypertensive Adults

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Background: Poor adherence to antihypertensives is associated with negative outcome of the disease as well as loss of health-care resources. Addressing the epidemic of poor adherence requires identifying factors associated with this behaviour. The aim of this study is to describe adherence to antihypertensive medication among Lebanese hypertensive patients and to evaluate the association between socio-economic, patient- and conditions-related factors and non-adherence.

Methods: A cross-sectional study was carried out on adherence to antihypertensive medications covering all governorates of Lebanon. This study was conducted between February 2018 and January 2019 on a random sample of 1497 hypertensive patients. A face-to-face questionnaire was used to assess adherence to antihypertensive medication and its determinants according to the five World Health Organization (WHO) main categories. Logistic regression analysis was performed to test the adjusted association between the multiple exposure factors, and drug adherence data were collected by trained interviewers.

Results: Adherence to antihypertensive medications was reported by 1253 (83.7%) of the patients. After multivariate analysis, patients who tried to control their stress level (OR = 0.77, 95% CI [0.38–0.95]), those who had normal BP readings (OR =0.49, 95% CI [0.18–0.97]), and those who believed in the effectiveness of their treatment (OR = 0.31, 95% CI [0.14–0.76]) had a significantly lower chance to exhibit non-adherence to their treatment. However, older patients (OR= 1.87, 95% CI [1.23–2.21]), divorced/separated patients (OR= 2.14, 95% CI [1.31–5.48]), married (OR=1.96, 95% CI [1.27–3.90]), widowed (OR=2.11, 95% CI [1.62–6.50]), obese patients (OR = 1.76, 95% CI [1.21–1.94]), and patients who smoked hookah and cigarettes (OR = 2.62, 95% CI [1.17–6.76]) were more likely to exhibit non-adherence.

Conclusion: Our study highlights the influence of factors such as old age, marital status, BMI and high level of emotional stress on non-adherence to medication in hypertensive patients. These determinants should be incorporated into adherence improving strategies.

Keywords: non-adherence, antihypertensive medications, patient-related factors, condition-related factor, Lebanon

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Introduction

The prevalence of hypertension (HT) is growing rapidly worldwide and is reaching epidemic proportions.[1] In Lebanon, a population-based study conducted in 2015 revealed that the prevalence rate of HT was 36.9%.[2] Antihypertensive medications are effective in lowering blood pressure (BP), preventing target organ damage, averting cardiovascular disease, and reducing mortality.[3] Despite the efficacy of

antihypertensive agents, non-adherence to these medications limits optimal clinical outcomes.[3]

Understanding adherence and developing interventions to improve adherence levels are difficult as several factors are associated with adherence levels. The World Health Organization (WHO) proposed to categorize these factors into five main categories: patient's socio-economic-, therapy-, health-care system-, conditions-, and patient's related factors.[4] In regard to conditions-related factors, stress has been reported to adversely affect the adherence to antihypertensive medication and causes poor BP control.[5–7] On the contrary, patients who are aware of the negative impact of stress show better adherence to treatment.[8] Other patient-related factors such as tobacco use and high body mass index (BMI) may negatively affect adherence to antihypertensive medication as well.[9,10] As for socioeconomic factors, a low social support may be a common risk factor for non-adherence in older patients.[11]

The 2014 Cochrane review of interventions aimed to promote medication adherence suggesting that it is possible that such interventions have been ineffective because the adherence problem is not sufficiently understood.[12] Despite the evidence supporting the efficacy of a range of promising interventions, gaps in knowledge persist.[9,10,13,14] Many factors that may affect antihypertensive adherence such as social support, stress, smoking, self-monitoring of BP, attitude toward treatment and weight disorder have never been evaluated in Lebanon. However they have been evaluated in other parts of the world such as the USA, the China, Greece, Italy, Ethiopia, UAE, Gambia and Seychelles who have different health-care systems, reimbursement rules or cultural attitudes to marriage or beliefs in medicine. Therefore, the objective of this study is to describe the antihypertensive medication adherence among Lebanese hypertensive adults' patients, and to evaluate the association between some socio-economic-, patient- and conditions-related factors and the non-adherence pattern to antihypertensives.

Methods
Source Population
This cross-sectional study was conducted from February 1, 2018 to January 31, 2019. Participants were randomly selected from outpatient clinics in Rafic-Hariri University hospital in Beirut, community pharmacies and cardiology clinics dispersed all over Lebanon.

Eligible participants were Lebanese, 18 years old or older, diagnosed with essential hypertension by a cardiovascular physician, and taking at least one antihypertensive medication such as diuretics, beta-blockers, ACE inhibitors, angiotensin II receptor blockers, calcium channel blockers, alpha blockers and alpha-2 receptor agonists.

Excluded from the study were patients who were not Lebanese, pregnant, under drugs that could increase blood pressure or had secondary HT. If no informed consent was given, participants were also excluded.

Data Collection
Permission letters were sent to 30 pharmacies across Lebanon in order to facilitate cooperation with field interviewers. The cardiologists were contacted by a telephone call in order to gain entry to their clinics and to meet hypertensive patients.

Data were collected through a structured questionnaire composed of different sections which were developed and organized by the researchers following extensive literature review and discussions with hypertensive patients and their treating physicians. The questionnaire was administered by trained interviewers via face-to-face interviews that lasted up to 45 mins. Arabic, the country's official language was used during interviews in order to enhance the patients' comprehension. The questionnaire was pilot tested on 45 patients not involved in the study in order to assess its legibility.

Study Measures
- Medication Adherence

Non-adherence to antihypertensive medications was self-reported. After clearly describing the WHO definition of medication adherence to participants, they were asked to indicate whether they took their antihypertensive medications as prescribed by their health-care providers or not.

- BP measurement

BP measurements were done based on the recommendations of the American Heart Association (AHA) guidelines for measuring BP.[15] BP was read with an automated BP machine (Omron HEM-RML 31) after participants rested for 10 mins in a seated position with the right arm placed at the level of the heart. Controlled HT was defined as a BP reading <140 systolic or <90 diastolic mmHg at the

time of data collection. BP readings >140 systolic and/or >90 diastolic mmHg were defined as uncontrolled HT. Standardized and identical automated BP machines were used by all trained interviewers.

- Patient-related factors

Age and sex were obtained through self-report. Height was measured by trained interviewers to the nearest 0.1 cm with a non-stretchable measuring tape. Participants' weight was measured to the nearest 0.1 kg with a digital scale (Omron HBF-500). Height and weight were measured with clothes on but no shoes. BMI was calculated for each participant by dividing weight in kilogram by height in meters squared.

Smoking and alcohol status were acquired via self-reported questions and smokers were defined as those currently smoking at the time of data collection. Ex-smokers were defined as those who had smoked greater than 100 cigarettes in their lifetime but had not smoked in the last 28 days.[16] Patients' belief in the effectiveness of the treatment was assessed via direct self-reported question: "Do you believe that your treatment is helpful?" and patients' awareness about medication adherence was assessed via the following question: "Do you think that non-adherence to medication will affect your health status?"

- Socio-economic Factors

Marital status, living status, educational level, occupation, monthly income, and the presence of health insurance were obtained through self-report.

- Condition-related factors

Stress was assessed via the following direct question: "Is reducing stress one of your primary goals to control BP?"

Ethical Statement

In order to complete the Institutional Review Boards (IRB) requirements, the interviewers passed an exam offered by the National Institute of Health (NIH) office for extramural research: "Protecting Human Research Participants". The study protocol was reviewed and approved by the IRB of the Lebanese University and the IRB of Rafic-Hariri University hospital. In accordance with the privacy rule of the Health Insurance Portability and Accountability Act

and the declaration of Helsinki, all patients who participated in the study gave written informed consent.

Statistical Analyses

The data on 1497 questionnaires was entered and analyzed by Statistical Package for the Social Sciences (SPSS) program version 20. As part of quality control, data entered into the computer was double-checked for its accuracy by random assessment of the survey responses and the data entered. Qualitative data were represented in frequency and percentage, while quantitative data, such as BP, weight and height, were represented by mean and standard deviation (SD).

Logistic regression analysis was performed to test the adjusted association between the multiple exposure factors and drug adherence. Odds ratios (OR) and their respective 95% confidence interval (CI) were reported, and p <0.05 was used to determine statistical significance. Based on clinical judgment and known confounders, adjustment included age, gender, educational level, marital status, monthly income and health insurance.

Results

A total of 1497 participants was included in this study (Figure 1). As shown in Table 1, 603 (40.2%) participants were recruited from community pharmacies, 498 (33.3%) from Rafic-Hariri University hospital and 396 (26.5%) from private cardiology clinics.

Patient-Related Factors

Baseline characteristics are shown in Table 1. Participants did not differ significantly in relation to gender. A larger number of women (n=773, 51.7%) than men (n=724, 48.3%) was part of this study. By age group, 200 (13.4%) were between 18 and 44, 392 (26.2%) were between 45 and 64, and 905 (60.4%) were above 65 years of age. Obesity (BMI $\geq$ 30 kg/m^2) was found in 33.0% of patients. Active smoking was reported by 724 (48.4%) participants. The study also showed that 1235 (82.5%) of the participants were aware that non-adherence may affect their health status, and 1226 (81.9%) believed that their treatment regimens were helpful.

Socio-Economic and Condition-Related Factors

As shown in Table 2, low monthly family income of less than USD 1000 was reported by 549 (36.7%). Low education level (less than high school) was reported by 744
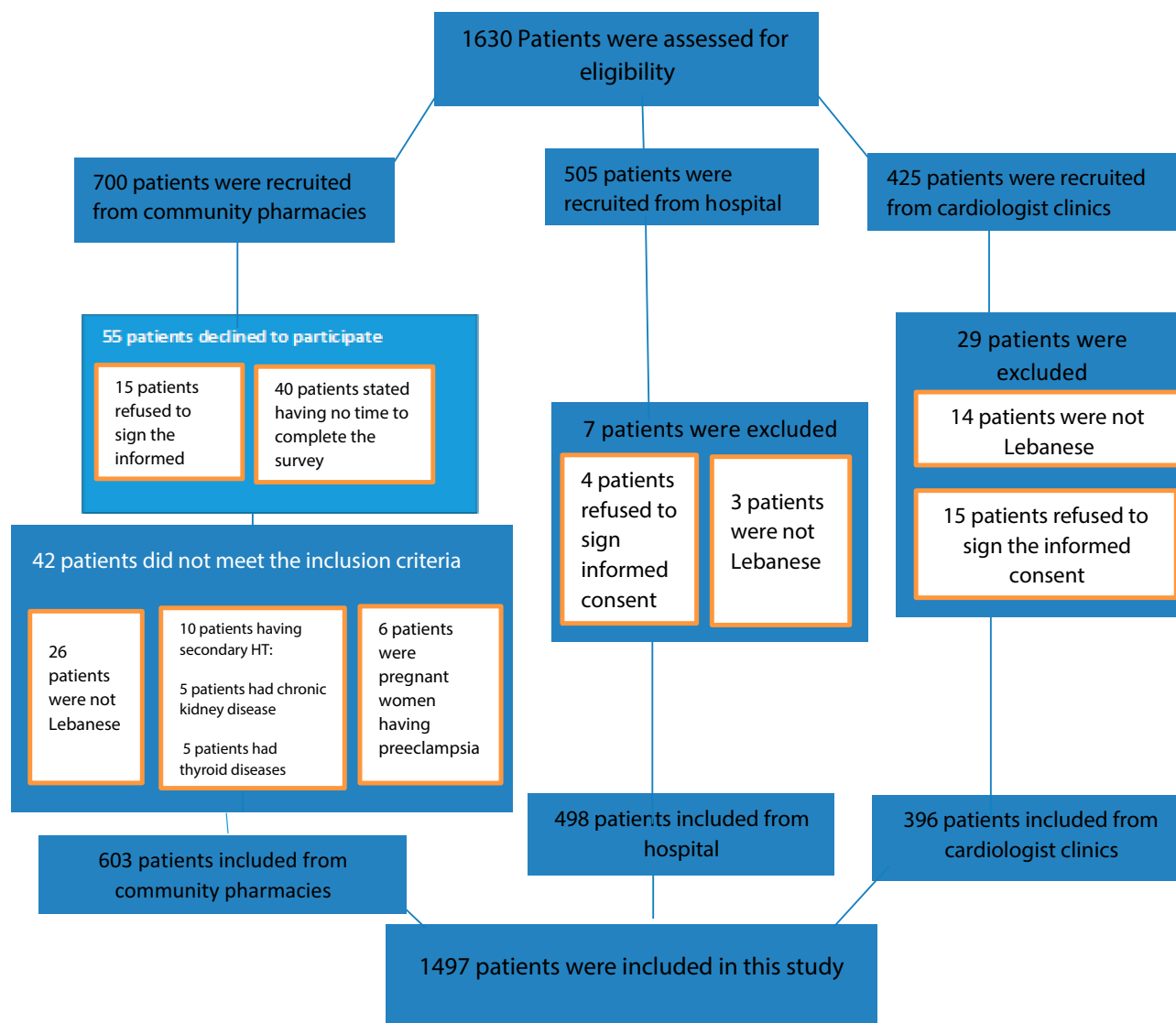
Figure 1 Flow chart of cohort creation.

(49.7%) and 1116 (74.6%) reported to be married. Living alone was reported by 206 (13.8%) of the participants and 1157 (77.3%) of participants were accompanied by a family member or friend when visiting their physicians. In addition, 838 (56.0%) aimed at reducing their stress level and 1171 (78.2%) participants were covered by health insurance.

Adherence Pattern and Blood Pressure Characteristic

With regards to non-adherence, 244 (16.3%) of the participants declared not taking their antihypertensive medications as prescribed by their doctors. Among these non-adherent participants, 153 (62.7%) related this

behaviour to mere forgetfulness. As shown in Table 3, 1031 (68.9%) checked their BP at home.

Factors Associated with Antihypertensive Medication Non-Adherence in Lebanese Adults

In Table 4, logistic regression analysis was used to evaluate predictors of non-adherence to antihypertensive medications. The variables included age, gender, marital status, living arrangements, BMI, smoking status, stress, education level, health insurance regular check-up of BP, normal BP reading, patients 'awareness about non-adherence and belief in the effectiveness of the treatment.

Table 1 Baseline Characteristic and Patient-Related Factors

Variables	Adherent Participants; N= 1253 (%)		Non-Adherent Participants; N=244 (%)		Total Participants, N=1497 (%)	
Location						
Community Pharmacies	504	(83.6)	99	(16.4)	603	(40.2)
Rafic-Hariri University hospital	372	(74.7)	126	(25.3)	498	(33.3)
Clinics	376	(94.9)	20	(5.1)	396	(26.5)
Patient-Related Factors						
Age						
18–44	180	(90.0)	20	(10.0)	200	(13.4)
45–64	297	(75.8)	95	(24.2)	392	(26.2)
≥65	776	(85.7)	129	(14.3)	905	(60.4)
Gender						
Male	598	(82.6)	126	(17.4)	724	(48.3)
Female	655	(84.7)	118	(15.3)	773	(51.7)
BMI (kg/m^2)						
<18.5	6	(66.7)	3	(33.3)	9	(0.6)
18.5–24.9	262	(82.4)	56	(17.6)	318	(21.4)
25–29.9	602	(89.2)	73	(10.8)	675	(45.0)
≥30	383	(77.4)	112	(22.6)	495	(33.0)
Lifestyle						
Smoking Status						
Smoking Cigarettes	355	(80.7)	85	(19.3)	440	(29.4)
Smoking Hookah	82	(59.4)	56	(40.6)	138	(9.2)
Smoking hookah and cigarette	73	(50.0)	73	(50.0)	146	(9.8)
Never smoked	479	(95.2)	24	(4.8)	503	(33.6)
Ex-smoker	264	(97.8)	6	(2.2)	270	(18.0)
Do you think that non-adherence to medication will affect your health status?						
Yes	1157	(93.7)	78	(6.3)	1235	(82.5)
No	96	(36.6)	166	(63.4)	262	(17.5)
Do you believe that your treatment is helpful?						
Yes	1151	(93.9)	75	(6.1)	1226	(81.9)
No	102	(37.6)	169	(62.4)	271	(18.1)

As shown in Table 4, when fully adjusted for the selected covariates such as age, gender, education level, marital status, monthly income and health insurance, the logistic regression showed that patients who tried to control their stress level (OR = 0.77, 95% CI [0.38–0.95]) were less likely to be non-adherent to their antihypertensive treatment. In addition to that, those who had normal BP readings (OR =0.49, 95% CI [0.18–0.97]), those who believed in the effectiveness of their treatment (OR = 0.31, 95% CI [0.14–0.76]) and those who self-measured their BP (OR = 0.67, 95% CI [0.32–0.91]) had a significantly lower chance of being non-adherent to their antihypertensive therapies.

On the other hand, older patients (OR= 1.87, 95% CI [1.23–2.21]), divorced/separated patients (OR= 2.14, 95% CI [1.31–5.48]), married (OR=1.96, 95% CI [1.27–3.90]), widowed (OR=2.11, 95% CI [1.62–6.50]), obese patients (OR = 1.76, 95% CI [1.21–1.94]), and patients who

Table 2 Socio-Economic and Condition-Related Factors

Variables	Adherent Participants; N= 1253 (%)		Non-Adherent Participants, N=244 (%)		Total Participants, N=1497 (%)	
Socio-economic factors						
Marital status						
Single	64	(41.8)	89	(58.2)	153	(10.2)
Married	1084	(97.1)	32	(2.9)	1116	(74.6)
Divorced	20	(29.0)	49	(71.0)	69	(4.6)
Widowed	85	(53.4)	74	(46.6)	159	(10.6)
Living alone						
Yes	10	(4.8)	196	(95.2)	206	(13.8)
No	1243	(96.3)	48	(3.7)	1291	(86.2)
Education level						
No formal education	198	(78.0)	56	(22.0)	254	(17.0)
Primary education	448	(91.4)	42	(8.6)	490	(32.7)
Secondary education	374	(85.4)	64	(14.6)	438	(29.3)
University studies	233	(74.0)	82	(26.0)	315	(21.0)
Does someone accompany you when visiting your physician						
Yes	995	(86.0)	162	(14.0)	1157	(77.3)
No	258	(75.9)	82	(24.1)	340	(22.7)
Monthly income						
Less than 1000$	500	(91.0)	49	(9.0)	549	(36.7)
1000 to 2000$	358	(86.5)	56	(13.5)	414	(27.7)
More than 2000$	81	(91.0)	8	(9.0)	89	(5.9)
No answer	314	(70.6)	131	(29.4)	445	(29.7)
Do you have a health insurance?						
Yes	1064	(90.9)	107	(9.1)	1171	(78.2)
No	189	(58.0)	137	(42.0)	326	(21.8)
Condition-related factor						
Is reducing stress one of your primary goals to control BP?"						
Yes	786	(93.8)	52	(6.2)	838	(56.0)
No	467	(70.9)	192	(29.1)	659	(44.0)

smoked hookah and cigarettes (OR = 2.62, 95% CI [1.17–6.76]) were more likely to exhibit non-adherence.

Discussion

The present study aimed to describe the antihypertensive medication adherence among Lebanese hypertensive adults' patients and to investigate the association between some socio-economic-, patient- and conditions-related factors and non-adherence pattern. In our study, 244 (16.3%) of the participants did not adhere to their antihypertensives, which was lower than the results found in the majority of other countries.[17–24] The result could be explained by the absence of one of the most common

barriers to medication adherence which is the cost factor, as 78.2% of the study group had a health insurance. The results were also supported by the increased awareness among the study participants as 81.9% of them were aware about the importance of adherence to treatment. In addition, variations in adherence rates could be explained by cultural factors, such as cultural health perception of HT, social support and self-care behaviours among different populations.

Our research on adherence to antihypertensive treatments has shown that patient's non-adherence to medication was mainly related to the following factors: Marital status, age, BMI, smoking pattern, controlling stress,

Table 3 Adherence Pattern and Blood Pressure Characteristics

Variables	Number of Participants; N=1497	Percentage (%)
Adherent	1253	83.7
Non-adherent	244	16.3
Main reason of non-adherence in non-adherent patients		
Side effects	22	9.0
High medication cost	22	9.0
Interaction with other medications	2	0.8
Simple forgetfulness	153	62.7
Do not need/Do not think about it	40	16.4
Others	5	2.1
Do you check your blood pressure at home?		
Yes	1031	68.9
No	466	31.1

having normal BP readings, self-measurement of BP and believing in the effectiveness of the therapy regimen, all with different effects on adherence level.

This study showed that married (OR=1.96, 95% CI [1.27–3.90]), widowed (OR=2.11, 95% CI [1.62–6.50]), divorced or separated patients (OR= 2.14, 95% CI [1.31–5.48]) were more likely to exhibit non-adherence as compared to single patients. To our knowledge, this is the first study in Lebanon that evaluates the impact of marital status on adherence to antihypertensives among Lebanese patients. Hu et al in their study in the Chinese community, found a positive association between family social support and adherence to medication. A 10-unit increase in family social support increased the odds ratio of taking medication by 1.39 (95% CI, 1.03–1.87).[12] A study by Osamor[25] in Nigeria showed that patients who had support from friends displayed better compliance to treatment than those who did not. Another study by Sayers et al demonstrated a positive effect of family support on adherence to treatment.[26] Maguire and colleagues also found that high level of social support were associated with high level of adherence.[27] Although marital status is considered a measure of social network, this factor alone could not always reflect the lack of family support since widowed, divorced or separated people may be well supported by their families. Nevertheless, this factor may affect the

emotional well-being of patients and it showed a significant impact on adherence to treatment.[28]

Age is a factor reported as affecting adherence, but inconsistently. This study has shown that adherence to treatment was negatively correlated with age, contrary to the findings of other studies which stated that young age leads to lower adherence.[17,29,30] However, the results of some reports were consistent with our findings.[31–33] A study showed that patients under 65 years of age achieved better adherence than elderly subjects (P=0.0005).[33] The lowest adherence was observed among old age pensioners (>65 years old).[34] These findings may be linked to the main cause of non-adherence determined by our study, especially the aspect of mere forgetfulness. Memory impairment and limited ability to absorb new information are usually observed in elder patients since people tend to forget more as they grow older.[35]

In this study, almost half of our participants reported to be active smokers. This population had a two-fold risk of being non-adherent to their antihypertensives compared to never smokers. To our knowledge, there are very few publications that show a link between the smoking pattern and adherence to antihypertensive treatments. Our findings support the results of the study conducted in the Midwestern United States which concludes that adherence to medications used for chronic conditions was significantly lower among smokers.[36] In support of this finding, another study showed the negative association between smoking water pipe and adherence to treatment.[36] Smoking less than three water pipes per week compared to no water pipe smoking was significantly associated with a decrease in the adherence score.[37] In other studies, no significant association between medication adherence and smoking was found.[34,38]

Other factors that could affect treatment adherence, include normal BP readings, self-monitoring of BP, and the belief in the effectiveness of the therapy regimen. In our study, those who had normal BP had a significantly lower chance of being non-adherent to their antihypertensive therapies. Studies conducted in Ethiopia and in Greece showed that controlling BP was associated with high adherence.[17,18] Also, the result of a study by Marquez-Contreras et al showed an improved adherence rate in patients who carried out self-monitoring in comparison with usual care.[39] In addition to that, in a randomized clinical trial by van Onzenoort et al, self-monitoring as an adjunct to office BP measurement resulted in higher adherence to treatment.[40] As mentioned previously, the belief in

Table 4 Factors Associated with Antihypertensive Medication Non-Adherence in Lebanese Adults

Factor	Number of Non-Adherent Patients (N=244), (%)		Crude OR (95% CI)	Age-Sex Adjusted OR (95% CI)	Fully Adjusted(a) OR (95% CI)
Patient-related					
Age (years)					
18–44	20	10.0	1	1	1
45–64	95	24.2	1.43 (1.11–1.72)	1.52 (1.16–1.76)	1.39 (1.13–1.67)
≥65	129	14.3	1. 67 (1.13–1.96)	1.95 (1.16–2.29)	1.87 (1.23–2.21)
Sex					
Male	126	17.4	1	1	1
Female	118	15.3	1.76 (0.42–2.41)*	1.74(0.51–2.40)*	1.49 (0.39–1.64)*
Lifestyle					
BMI (kg/m^2)					
<18.5	3	33.3	1.68(1.27–3.42)	1.43(1.14–1.87)	1.11 (1.02–1.27)
18.5–24.9	56	17.6	1	1	1
25–29.9	73	10.8	1.46(1.22–1.80)	1.23 (1.07–2.04)	1.54 (1.23–1.89)
≥30	112	22.6	1.71(1.41–1.94)	1.74 (1.34–1.95)	1.76 (1.21–1.94)
Smoking Status					
Smoking Cigarettes	85	19.3	1.45 (1.14–2.71)	1.77 (1.13–2.79)	1.87 (1.34–2.98)
Smoking Hookah	56	40.6	1.54 (1.26–1.97)	2.08 (1.12–3.87)	2.32 (1.35–4.97)
Smoking hookah and cigarette	73	50.0	2.36 (1.43–1.96)	2.43 (1.26–4.49)	2. 62 (1.17–6.76)
Never smoked	24	4.8	1	1	1
Ex-smoker	6	2.2	0.84 (0.45–2.61)*	1.16 (0.48–1.97)*	0.86 (0.43–1.05)*
Patients' Awareness About Importance of Medication Adherence					
Yes	78	6.3	0.24 (0.12–0.56)	0.20 (0.15–0.61)	0.22 (0.13–0.54)
No	166	63.4	1	1	1
Patients' belief in treatment					
Yes	75	6.1	0.29 (0.11–0.67)	0.33 (0.19–0.69)	0.31 (0.14–0.76)
No	169	62.4	1	1	1
Self-Measurement of BP					
Yes	60	24.6	0.51 (0.24–0.92)	0.63 (0.31–0.95)	0.67 (0.32–0.91)
no	184	75.4	1	1	1
Normal BP Reading					
Yes	43	17.6	0.58(0.21–0.96)	0.51 (0.14–0.93)	0.49 (0.18–0.97)
No	201	82.4	1	1	1
Social/Economic-Related					
Marital status					
Single	89	58.2	1	1	1
Married	32	2.9	1.84 (1.12–3.41)	1.91 (1.38–3.94)	1.96 (1.27–3.90)
Divorced/Separated	49	71.0	2.28 (1.30–4.40)	2.31 (1.21–4.81)	2.14 (1.31–5.48)
Widowed	74	46.6	2.51 (1.75–7.81)	2.63 (1.52–8.43)	2.11 (1.62–6.50)
Living Arrangements					
alone	196	95.2	1	1	1
With others	48	3.7	1.48 (1.26–2.14)	1.51 (1.24–2.54)	1.95 (1.19–2.68)

(*Continued*)

Table 4 (Continued).

Factor	Number of Non-Adherent Patients (N=244), (%)		Crude OR (95% CI)	Age-Sex Adjusted OR (95% CI)	Fully Adjusted(a) OR (95% CI)
Education Level					
No formal education	56	22.0	2.44 (0.81–3.96)*	2.53(0.45–4.10)*	2.23 (0.72–3.74)*
Primary education	42	8.6	1.46 (1.07–2.30)*	1.76 (0.27–3.06)*	1.31 (0.41–4.17)*
Secondary education	64	14.6	1.29 (0.45–1.32)*	1.67 (0.52–1.81)*	1.59 (0.54–1.89)*
University studies	82	26.0	1	1	1
Having a Health Insurance?					
Yes	107	9.1	1.07 (0.08–2.24)*	1.29 (1.10–1.85)	1.29 (1.11–1.74)
No	137	42.0	1	1	1
Condition-related factor					
Controlling stress					
Yes	52	6.2	0.62 (0.37–0.91)	0.53(0.23–0.94)	0.77 (0.38–0.95)
No	192	29.1	1	1	1

Notes: [a]Adjusted for the following covariates: age, gender, educational level, marital status, monthly income and health insurance. *Variables those were not significant during logistic regression analysis at P value < 0.05.

the effectiveness of treatment was reported by 1226 (81.9%) of the participants. Witnessing a positive outcome of the treatment makes patients feel more secure, satisfied and confident about the given treatment and this encourages them to continue their treatment.[18,39]

In this study, the logistic regression analysis showed that patients who tried to control their stress level were less likely to be non-adherent to their antihypertensive treatment (OR = 0.77, 95% CI [0.38–0.95]). This is consistent with findings from a Greek study.[17] Also, Kretchy et al (2014) stated that stress among patients increased their chances to be less adherent to antihypertensive medications.[41] The relationship between stress and non-adherence suggests the importance of recognizing stress as a risk factor for poor adherence to antihypertensives.

Most studies examined patients' weight following the advice of their physicians, but no study showed adherence to HT medications among obese and underweight patients.[42,43] In this study, both obese and underweight patients showed a higher chance of being non-adherent to HT medications. The low adherence of these patients could be related to the underlying causes behind the weight disorder such as mental disorders which contribute to this behaviour.[41] More research is recommended on the association between BMI and adherence to HT medications.

The large sample of the population and the wide geographical coverage of this study are considered

points of strength. This ensured the inclusion of participants of different socio-demographic characteristics. Moreover, several limitations of our study should be addressed. First, the data were collected using an interviewer-administered method. Although this method is less expensive and easily applicable, the study is prone to social desirability and recall bias. In this regard, participants were adequately informed about the relevance of this study and the importance of telling the truth. Secondly, single BP readings were used to classify BP as controlled or uncontrolled, which may increase classification bias. In addition to the above, we did not account for "white-coat" adherence, which is defined as improving medication-taking behaviour shortly before and after an appointment with a healthcare provider.

Conclusion

In summary, the present study confirmed that factors such as marital status, age, BMI, smoking habits, controlling stress level, having good BP readings, self-measurement of BP and believing in physician's treatment, were significantly associated with adherence to antihypertensive treatment. Future research should examine our findings and test whether managing these factors may contribute to better treatment adherence and improved BP control.

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