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# Evaluation of medication adherence in Lebanese hypertensive patients

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**Abstract** Controlling hypertension is essential in cardiovascular diseases. Poor medication adherence is associated with poor disease outcomes, waste of healthcare resources, and contributes to reduced blood pressure control. This study evaluates treatment adherence to antihypertensive therapy in Lebanese hypertensive patients by estimating the proportion of adherent hypertensive patients using a validated tool and investigates what factors predict this behavior. A questionnaire-based cross-sectional study was conducted on a random sample of 210 hypertensive outpatients selected from clinics located in tertiary-care hospitals and from private cardiology clinics located in Beirut. Adherence level was measured using a validated 8-item Modified Morisky Medication Adherence Scale (MMMAS). Among 210 patients, 50.5% showed high adherence, 27.1% medium adherence, and 22.4% low adherence to medication. Mean MMMAS score was $6.59 \pm 2.0$. In bivariate analyses, having controlled blood pressure ($p = 0.003$) and taking a combination drug ($p = 0.023$) were predictors of high adherence. Forgetfulness ($p < 0.01$), complicated drug regimen ($p = 0.001$), and side effects ($p = 0.006$) were predictors of low adherence after multiple liner regression. Logistic regression results showed that calcium channel blockers ($p = 0.030$) were associated with increased adherence levels. In conclusion, developing multidisciplinary intervention programs to address the factors identified, in addition to educational strategies targeting healthcare providers, are necessary to enhance patient adherence.


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## 1. Introduction

Hypertension is a worldwide epidemic causing 7.1 million premature deaths each year and accounting for 13% of all deaths globally [1]. Kearney et al. [2] reported that overall prevalence of hypertension in 2000 was estimated to be 26.4% of the world population and predicted that the burden of hypertension would increase by 60% to approximately 1.56 billion in the year 2025. Also, hypertension results in an economic burden of $47.5 billion annually in direct medical expenses and $3.5 billion each year in lost productivity [3].

According to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7), hypertension is defined as a systolic blood pressure (SBP) of 140 mmHg or higher, or a diastolic blood pressure (DBP) of 90 mmHg or higher [1].

Hypertension is reported to be the leading cause of cardiovascular disease worldwide [4]. Additionally, uncontrolled blood pressure (BP) increases the risk of ischemic heart disease three- to fourfold [5] and overall cardiovascular risk by two-to threefold [6].

Among hypertensive patients who have poor BP control, poor drug adherence is one of the causes and accounts for an increasingly significant and substantial public health burden [7]. Only 29% of hypertensive patients in the United States achieve adequate control and even fewer have been reported in Canada and Europe (17% and $\leqslant$10%, respectively) [8].

The term ''adherence'' is defined by the World Health Organization (WHO) as the extent to which a person's behavior taking medication, following a diet, and/or executing lifestyle change corresponds with agreed recommendations from a health care provider [9]. The WHO describes poor adherence as the most important cause of uncontrolled blood pressure [9] and estimates that 50—70% of people do not take their antihypertensive medication as prescribed [10].

In a meta-analysis of literature on medication nonadherence rates in the elderly, it was shown that from 29% to 59% of outpatients do not take medications as prescribed [11]. In another study done on hypertensive patients in primary health care centers and hospitals in Saudi Arabia, 53% were found to be adherent and, consequently, the mean SBP and DSB were found to be significantly lower in adherent patients relative to those nonadherent [12].

Numerous factors influence treatment adherence, including demographic characteristics (gender, age, education, etc.), psychosocial factors (quality of life), socioeconomic status and disease severity, class of drug prescribed, patient understanding of disease and importance of treatment, co-morbid medical conditions, patient—healthcare provider relationship, drug cost, forgetfulness, and presence of psychological problems, specifically depression [13—16].

Based on this, our study objective is to evaluate treatment adherence to antihypertensive therapy in Lebanese hypertensive patients by estimating the proportion of adherent hypertensive patients using a validated tool and to investigate what factors predict this behavior.

## 2. Methods

### 2.1. Patients and methods

A cross-sectional design utilizing a convenient sample and a well-designed questionnaire was adopted to address the study objective. Patients recruited for this study were randomly selected from those visiting the external (outpatient) clinics located in tertiary care hospitals and from private cardiology clinics located in Beirut. In fact, interviewers visited the location on randomly selected dates and recruited all patients present in these clinics.

An oral informed consent was obtained from each patient. All patients interviewed agreed to participate in this study. The Institutional Review Board of the Lebanese University stated that approval was not necessary, since the study was an observational one and not experimental, clinical, or interventional.

### 2.2. Inclusion and exclusion criteria

Eligible patients were Lebanese adult outpatients ($\geqslant$18 years). They were diagnosed with essential (primary) hypertension by a cardiovascular physician and taking at least one antihypertensive medication. Patients with co-existing medical conditions were also included. Excluded subjects were those with secondary hypertension, pregnant women, or taking other drugs that could increase BP. Hypertensive patients taking no medication were also excluded.

### 2.3. Sample size

We used the following formula for sample size calculation: $n = \frac{Z^2.p(1-p)}{d^2}$, where $Z$ is a standard normal variate ($Z = 1.96$ when the confidence interval is 95%), $p$ is the expected proportion of outcome in

population based on other studies, and d is the absolute accuracy or precision [17]. Based on a previous study where 16% of the population were highly adherent (Morisky score of 8) [18], we calculated a minimal sample size of 207 that would be required to give a 95% probability of measuring the prevalence of high adherence with 5% accuracy.

## 2.4. Data collection

Data were collected using a structured questionnaire composed of different sections chosen and organized based on a thorough review of similar literature. The questionnaire was administered by trained interviewers in the Arabic language for ease of patient comprehension. The tool was pilot tested on 30 patients who were not included in the final study sample.

The questionnaire extracted information regarding sociodemographic characteristics, lifestyle characteristics, patient healthcare behaviors, patient disease status, patient—healthcare provider relationship, and patient medication adherence using an 8-item modified Morisky Medication Adherence Scale (8-MMMAS).

Trained investigators measured BP using aneroid sphygmomanometers and stethoscopes in all patients after they were in the resting state for 10 min and in a seated position with the right arm placed at the level of the heart. Controlled hypertension was defined as a BP reading <140 systolic or <90 diastolic mmHg at the time of data collection irrespective of measurements at other times. BP

**Table 1** Sociodemographic characteristics ($n$ = 210).

| Variables | Mean ± SD/$n$ (%) |
|---|---|
| Age | 59.33 ± 12.201 |
| *Gender* | |
| Males | 85 (40.5) |
| Females | 125 (59.5) |
| *Body mass index* | |
| Normal weight | 51 (24.3) |
| Overweight | 103 (49) |
| Obese | 56 (26.7) |
| *Marital status* | |
| Single | 11 (5.2) |
| Married | 170 (81) |
| Divorced/widowed | 29 (13.8) |
| *Education level* | |
| Illiterate | 30 (14.3) |
| Elementary | 66 (31.4) |
| Intermediate | 55 (26.2) |
| Secondary | 23 (11) |
| University | 36 (17.1) |
| *Employment status* | |
| Unemployed | 132 (62.9) |
| Employed/Self-employed | 57 (27.1) |
| Retired | 21 (10) |
| *Monthly income* | |
| 500,000—1,000,000 | 95(45.2) |
| 1,000,000—2,000,000 | 85 (40.5) |
| >2,000,000 | 30 (14.3) |
| *Working hours* | |
| 3—7 | 22 (10.5) |
| 8—16 | 35 (16.7) |
| Having care provider at home | 173 (82.4) |
| Having medical insurance | 132 (62.9) |

SD = standard deviation.

readings ⩾140 systolic or ⩾90 diastolic mmHg are referred to as uncontrolled hypertension [18].

### 2.5. The 8-MMMAS

The original 8-MMMAS was tested by Morisky et al. [18] on a sample of hypertensive patients, and the scale was reliable with good predictive validity and sensitivity. Sensitivity and specificity of the 8-item scale were 93% and 53%, respectively [18]. The scale is a widely used and validated method for assessing patient adherence/nonadherence to a drug regimen. Highly adherent patients were identified with a score of 8 on the scale, medium adherers with a score of 6 or <8, and low adherers with a score of <6 [18]. Using a cutoff of 6, its sensitivity in identifying low versus high adherers was estimated to be 93% and the specificity was 53% [18].

### 2.6. Statistical analysis

All data were analyzed using SPSS version 20 (IBM, Corp., Atlanta, GA, USA). Bivariate and multivariate (linear and logistic regressions) analyses were undertaken. The dependent variable for linear regression was the medication adherence score, which is a continuous variable ranging from 0 to 8, while for logistic regression it was the dichotomized adherence score (based on a cutoff point = 6). Only variables having $p < 0.2$ in bivariate analysis were included in multivariate analysis. We considered a 95% confidence interval and a value of $p < 0.05$ to be statistically significant.

## 3. Results

### 3.1. Socio-demographic and lifestyle characteristics

Two hundred and ten patients were approached, agreed to participate (100%), and were included in this study. Forty percent were males, with no significant ($p = 0.199$) age difference between males (60.65 ± 12.34) and females (58.44 ± 12.07). The majority of the study population was married (81%) and only 27.1% of the sample population is employed (Table 1). Forty percent are smokers and 69% of patients regularly measure their blood pressure (Table 2).

**Table 2** Lifestyle characteristics.

| Variables | Mean ± SD/*n* (%) |
|---|---|
| *Smoking status* | |
| Nonsmoker | 102 (48.6) |
| Smoker | 84 (40) |
| Ex-smoker | 24 (11.4) |
| Number of cigarettes/d | 9.904 ± 15.506 |
| *Regular sport* | |
| Yes | 67 (31.9) |
| No | 143 (68.1) |
| *Frequency of practicing sport/wk* | |
| 1—3 | 31 (14.8) |
| 4—7 | 36 (17.1) |
| *Doctor recommended a certain diet?* | |
| Yes | 197 (93.8) |
| No | 13 (6.2) |
| *Do you follow this diet?* | |
| No/sometimes | 92 (43.8) |
| Yes | 118 (56.2) |
| *Do you eat a lot of salt?* | |
| No | 137 (65.2) |
| Some | 34 (16.2) |
| Yes | 39 (18.6) |
| *Do you regularly measure your BP?* | |
| Yes | 145 (69) |
| No | 65 (31) |

BP = blood pressure; SD = standard deviation.

### 3.2. Health status and medication-related characteristics

The mean duration of hypertension was 7.65 ± 6.61 years and it was accompanied with other comorbidities in 71.9% of cases. The mean DBP was 82.92 ± 9.41 mmHg, the mean SBP was 139.40 ± 18.56 mmHg, and 62.9% of the cases were classified as having controlled BP. The average number of medications taken by patients was approximately four different medications/day (4.28 ± 2.71) and, specifically, the mean number of antihypertensive medications prescribed was 1.45 ± 0.68. Regarding pharmacological classes, the most widely prescribed type of antihypertensive medications was beta-blockers (BB) at 62.9% (Table 3).

### 3.3. Relationship with healthcare provider

When asked, 36.7% of patients admitted that they postpone physician appointments. Also, results showed that a high percentage (89.5%) of hypertensive patients know the normal BP reading (120/80 mmHg) and that the most commonly reported cause of stopping medication was forgetfulness at 21.4% (Table 4).

**Table 3** Health status and medication-related characteristics.

| Variables | Mean ± SD/*n* (%) |
|---|---|
| Systolic blood pressure | 139.404 ± 18.560 |
| Diastolic blood pressure | 82.928 ± 9.414 |
| Duration of hypertension (y) | 7.650 ± 6.617 |
| Uncontrolled BP | 78 (37.1) |
| Controlled BP | 132 (62.9) |
| *Family history of hypertension* | |
| Yes | 185 (88.1) |
| No | 25 (11.9) |
| *Presence of comorbidities* | |
| Yes | 185 (88.1) |
| No | 59 (28.1) |
| Number of comorbidities | 1.28 ± 1.077 |
| Total number of medications | 4.285 ± 2.711 |
| Number of antihypertensive medications | 1.457 ± 0.685 |
| *Pharmacological category of antihypertensive medications* | |
| Beta-blockers | 132 (62.9) |
| Calcium channel blockers | 48 (22.9) |
| ACEi/ARBs | 78 (37.1) |
| Diuretics | 36 (17.1) |
| Combination drug | 63 (30) |
| *Dosing frequency/d* | |
| Once daily | 77 (36.7) |
| Twice daily | 82 (39) |
| Three times daily | 51 (24.3) |
| *Do you experience any side effects related to antihypertensive medications?* | |
| Yes | 28(13,3) |
| No | 182(86,7) |
| *Do you experience any complications related to hypertension?* | |
| Yes | 67(31.9) |
| No | 143(68.1) |
| *Do you take any OTC medications?* | |
| Yes | 77 (36.7) |
| No | 133 (63.3) |

ACEi = angiotensin-converting-enzyme inhibitor; ARB = angiotensin II receptor blockers; BP = blood pressure; OTC = over-the-counter; SD = standard deviation.

### 3.4. Adherence patterns

The mean 8-MMMAS score was 6.59 ± 2.0, with minimum and maximum scores of 0 and 8, respectively. Following classification, 50.5% showed high adherence, 27.1% medium adherence, and 22.4% low adherence. These results were modified to 77.6% high adherence and 22.4% low adherence following dichotomization based on a cutoff point <6 (Table 5).

### 3.5. Factors associated with antihypertensive medication adherence

The association of different variables with adherence status was investigated using both bivariate and multivariate analyses. Variables that showed significant association in the bivariate analysis included following a recommended diet, adding salt to food, having a controlled/uncontrolled BP, taking BBs as an antihypertensive medication, taking any over-the-counter (OTC) medications, postponing medical appointments, understanding how to take medications, knowing normal BP value, facing different reasons to stop taking medications, value of SBP and DBP, and number of cigarettes/day (Table 6).

Linear regression results indicated that stopping medications due to forgetfulness has the greatest impact on adherence score (standardized $\beta = 0.481$), decreasing it by approximately 2 points ($p < 0.01$). Similarly, stopping medication due to feeling that the disease is under control ($p < 0.01$), the drug regimen is too complicated ($p < 0.01$), experiencing side effects ($p < 0.01$), or drug cost ($p < 0.01$) were associated with a decrease in adherence score by a range of approximately 1—3 points. Only understanding how to take medications ($p < 0.01$) and having a combination drug ($p < 0.023$) were shown to improve adherence score (Table 7). Results of logistic regression showed that patients taking calcium channel blockers (CCB) or knowing the normal BP value were three to five times more adherent than those taking other types of medication or not knowing the normal BP value (ORa = 3.08, 95% confidence interval [1.12; 8.50], $p = 0.030$ and ORa = 4.95, 95%

**Table 4** Relationship with healthcare provider.

| Variables | Mean ± SD/*n* (%) |
|---|---|
| *Do you consult a physician about your disease/treatment?* | |
| No | 27 (12.9) |
| Yes | 183 (87.1) |
| Frequency of physician visit (mo) | 6.490 ± 7.744 |
| *Do you postpone your doctor appointment?* | |
| No | 133 (63.3) |
| Yes | 77 (36.7) |
| *Does the doctor explain how to take medications?* | |
| No | 6 (2.9) |
| Yes | 204 (97.1) |
| *Do you understand how to take your medication?* | |
| No | 9 (4.3) |
| Yes | 201 (95.7) |
| *Does the doctor explain your disease?* | |
| No | 17 (8.1) |
| Yes | 193 (91.9) |
| *Do you know the normal BP value?* | |
| No | 22 (10.5) |
| Yes | 188 (89.5) |
| *Reason for stopping medication* | |
| Did not stop | 140 (66.7) |
| Forget | 45 (21.4) |
| Drug cost | 11 (5.2) |
| Complicated regimen | 3 (1.4) |
| Side effects | 3 (1.4) |
| Controlled BP | 8 (3.8) |

BP = blood pressure; SD = standard deviation.

**Table 5** Percentages of 8-MMMAS answers and adherence scores.

| Question | | | Yes (%) | No (%) |
|---|---|---|---|---|
| 1- Do you sometimes forget to take your pills? | | | 30.5 | 69.5 |
| 2- People sometimes miss taking their medication for reasons other than forgetting. Thinking over the past two weeks, were there any days when you did not take your medicine? | | | 16.7 | 83.3 |
| 3- Have you ever cut back or stopped taking your medication without telling your doctor, because you felt worse when you took it? | | | 11 | 89 |
| 4- When you travel or leave home, do you sometimes forget to bring along your medication? | | | 23.8 | 76.2 |
| 5- Did you take your medication yesterday? | | | 91.4 | 8.6 |
| 6- When you feel like your disease is under control, do you sometimes stop taking your medicine? | | | 11 | 89 |
| 7- Taking medication every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your treatment plan? | | | 12.9 | 87.1 |
| | | | Sometimes/often/always | Never/rarely |
| 8- How often do you have difficulty remembering to take all of your medication? | | | 26.2 | 73.8 |
| | **Mean** | **SD** | **Median** | **Range** (min—max) |
| 8-MMMAS Score | 6.595 | 2.005 | 8 | 0—8 |
| | **High adherence (=8)** | **Medium adherence (6—7)** | | **Low adherence (0—5)** |
| 8-MMMAS Classes (%) | 50.5 | 27.1 | | 22.4 |
| | **Adherent** | | **Nonadherent** | |
| Dichotomous 8-MMMAS (%) | 77.6 | | 22.4 | |

8-MMMAS = 8-items modified Morisky medication adherence scale; SD = standard deviation.

**Table 6** Variables associated with adherence score.

| Variables | Mean 8-MMMAS | *p* |
|---|---|---|
| *Do you follow the recommended diet?* | | |
| No/sometimes | 6.119 | 0.003 |
| Yes | 6.966 | |
| *Do you eat a lot of salt?* | | |
| No | 6.875 | <0.001 |
| Some | 7.294 | |
| Yes | 5 | |
| *Controlled BP* | | |
| Uncontrolled | 6.115 | 0.011 |
| Controlled | 6.878 | |
| Taking beta-blockers | 6.348 | 0.011 |
| Taking combination drug | 7 | 0.023 |
| *Do you take any OTC medications?* | | |
| No | 6.842 | 0.019 |
| Yes | 6.168 | |
| *Do you postpone your doctor appointment?* | | |
| No | 7.037 | <0.001 |
| Yes | 5.831 | |
| *Do you understand explanation about your medication provided by your doctor?* | | |
| No | 4.222 | 0.034 |
| Yes | 6.701 | |
| *Do you know the normal BP value?* | | |
| No | 5.727 | 0.032 |
| Yes | 6.696 | |
| *Reason for stopping taking the medications* | | |
| Did not stop | 7.471 | <0.001 |
| Forget | 4.777 | |
| Drug cost | 5.818 | |
| Complicated regimen | 4 | |
| Side effects | 5.666 | |
| Controlled BP | 3.875 | |
| Number of cigarettes/day | — | 0.005 |
| Systolic blood pressure | — | 0.006 |
| Diastolic blood pressure | — | <0.001 |

8-MMMAS = 8-items modified Morisky medication adherence scale; BP = blood pressure; OTC = over-the-counter.

confidence interval [1.52; 16.13], $p = 0.008$, respectively) (Table 8).

## 4. Discussion

The objective of our study was to estimate the prevalence of nonadherence to antihypertensive medication in Lebanese hypertensive patients and to evaluate what factors predict and constitute a barrier toward good medication adherence. The overall percentage of adherent hypertensive patients was 77.6%, greater than that reported by the WHO for other developing countries, such as Gambia (27%) [19], as well as Saudi Arabia (53%) [12] and China (65.1%) [7]. However, it is slightly greater than the adherence rate (71.6%) of patients in the Unites States according to 8-MMMAS [20]. Cultural factors, such as cultural health perception of hypertension, self-care behaviors, and social support, could explain variations in adherence rates among different populations.

Sociodemographic factors were not associated with any variation in adherence levels. This is similar to findings from a study from Brazil [21], while other studies have shown different results. Younger patients and males [22] were found to be less adherent, while another study showed the opposite [12]. Additionally, poor socioeconomic status,

**Table 7** Multivariate analysis and linear regression model.

| Variables | Unstandardized $\beta$ | 95% CI | $p$ |
|---|---|---|---|
| Forgot to take drugs[a] | −2.346 | −2.852; −1.841 | <0.001 |
| Feeling BP is controlled[a] | −3.338 | −4.378; −2.299 | <0.001 |
| DBP | −0.033 | −0.055; −0.012 | 0.003 |
| High drug cost[a] | −1.308 | −2.223; −0.394 | 0.005 |
| Complicated drug regimen[a] | −2.852 | −4.530; −1.174 | 0.001 |
| Understand how to take medications | 1.536 | 0.541; 2.531 | 0.003 |
| 1,000,000−2,000,000 | 0.547 | 0.137; 0.957 | 0.009 |
| Stop due to SE[a] | −2.386 | −4.068; −0.705 | 0.006 |
| Postpone physician appointments | −0.525 | −0952; −0.098 | 0.016 |
| Combination drug | 0.514 | 0.073; 0.956 | 0.023 |

BP = blood pressure; CI = confidence interval; DBP = diastolic blood pressure.Dependent variable: Morisky score.
Model statistics: adjusted $R^2$ = 0.513/$p$-value of the model ANOVA < 0.001.
[a] Reasons to stop medications (categorical variable).

**Table 8** Multivariate analyses and logistic regression model.

| Variables | Adjusted odds ratio (Exp $\beta$) | 95% CI | $p$ |
|---|---|---|---|
| Duration of cigarette smoking | 0.968 | 0.944; 0.992 | 0.010 |
| Salt (1)[a] | 2.282 | 0.593; 8.787 | 0.230 |
| Salt (2)[a] | 0.118 | 0.047; 0.297 | <0.001 |
| Taking CCB | 3.080 | 1.116; 8.501 | 0.030 |
| Postpone physician visits | 0.245 | 0.110; 0.543 | 0.001 |
| Know normal BP value | 4.948 | 1.517; 16.134 | 0.008 |

BP = blood pressure; CCB = calcium channel blockers; CI = confidence interval; DBP = diastolic blood pressure.Dependent variable: dichotomized Morisky score.Omnibus test $p$-value < 0.001/Hosmer−Lemeshow test $p$-value = 0.986.
Nagelkerke $R^2$ = 0.362/Overall predicted percentage = 83.7%.
[a] Salt amount (categorical variable)/reference group: no salt added.

illiteracy, and unemployment were estimated to be important risk factors for poor adherence [23].

Following a physician-recommended diet reflects an aspect of a management plan that all adherers complied with, in addition to taking medication. This perhaps indicates a level of awareness that hypertension management is an integrated plan, wherein pharmacological treatment is complementary to the nonpharmacological.

Several studies show a strong linkage between medication adherence and BP control. Controlled levels of SBP and DBP were most prominent among adherent patients according to studies done in Brazil [21] and the United States [18,20]. Our findings match these, wherein association between adherence levels and controlled BP and inverse correlation between adherence scores and both SBP and DBP affirm the cited results. This can be attributed to the mutual association between better outcomes of the treatment offering the patient satisfaction and creating strong motivation toward treatment and bad outcomes (uncontrolled BP) making the patient hopeless and lowering satisfaction, resulting in treatment termination. Better adherence to medication can consequently lead to improved clinical outcomes, one of which is controlled BP.

Surprisingly, the number of antihypertensive medications was not related to adherence behaviors. This is consistent with findings from China [7] and contrary to a study undertaken in France [24]. Our study demonstrated that taking a combination of antihypertensive drugs rather than multiple single drugs may improve adherence levels. However, the opposite is true when taking many OTC medications concurrently with hypertension medications. As a result, complicated drug regimens, commonly accepted as a reason for poor adherence [25,26], should be simplified by fewer daily doses of antihypertensive drugs, monotherapies (preferably combination dosages), and fewer changes in antihypertensive medications for better adherence outcomes.

In crude analyses, only patients on BBs were less adherent than others, possibly attributed to the fact that in Lebanon, most BBs are available in a single form and not in combinations. This is in addition to side effects associated with BBs, specifically hypotension and sexual impotence.

After adjustment for other factors in multivariate analyses, CCBs were found to improve adherence in hypertensive patients, similar to a study carried out in the Unites States using 8-MMMAS

[27]. Patients for whom CCBs are recommended are generally at high risk of coronary disease, diabetes, or have higher BP levels [1]. Thus, patients taking these drugs may have a more severe disease and comorbidities reinforcing the importance of medication adherence. Furthermore, significant improvements of depressive symptoms in patients randomized for dosages of verapamil versus atenolol suggest positive mood-related effects associated with this CCB [28], which may impact adherence. Finally, the reduced variation in SBP observed in patients taking CCBs [29] may result in more controlled BP levels over time and thus better adherence.

A good relationship between patients and their healthcare providers, as well as proper counseling, can affect adherence levels in hypertensive patients [18,20]. One of the aspects of a good patient—healthcare provider relationship is adhering to physician appointments and understanding counseling regarding treatment and disease, which can improve adherence outcomes. For example, our study demonstrated a strong association between adherence scores and patient knowledge of normal BP values, understanding physician explanations regarding treatment, and postponing physician visits. Patients attending medical appointments may positively impact drug treatment adherence, given that frequent patient attendance at the clinic may offer reduced BP levels by providing motivation and improving attitudes that contribute to reduction of arterial hypertension, better pressure-level monitoring, and increased access to information related to treatment and disease.

Forgetting to take drugs and drug cost were the most commonly reported barriers to medication adherence. Our findings are in line with those of a study from Pakistan [16]. Appropriate measures should be taken to enhance patient memory, including planning to take medications in conjunction with certain activities, such as eating meals, and recommending the use of pill boxes that organize the process of medication intake. Physicians can also prescribe generic medications when drug cost is a barrier to adherence.

To our knowledge, this is the first study carried out in Lebanon analyzing adherence to antihypertensive medications among Lebanese hypertensive patients. Many factors have been identified as possible barriers to adherence leading to poor treatment outcomes.

Several limitations to our study can be addressed here. As mentioned, given that patients having co-existing illnesses were not included, some of our results may not be purely indicative of the characteristics of all hypertensive patients. Hence, the extent of generalization is limited. Self-reporting was used as the only method of measuring adherence, which has potential disadvantages concerning recall bias and eliciting only socially-acceptable responses. Given these possibilities, adherence levels among participants may be overestimated. Additionally, single BP readings were used to classify patients into controlled and uncontrolled hypertension groups, which may increase classification bias. Also, we did not account for the ''white-coat'' effect while making these classifications. This implies that a subject demonstrating ''normal'' BP levels when measured outside of a physician office may exhibit levels in the hypertensive range when levels are measured within a physician office [30]. Similarly, we did not account for ''white-coat'' adherence, which is defined as improving medication-taking behavior shortly before and after an appointment with a healthcare provider [13]. Multiple comparisons may give rise to ''false'' positive associations so that a more skeptical assessment of the obtained associations is needed.

## 5. Conclusion

Our study highlights several factors that may impact adherence levels in Lebanese hypertensive patients either by improving adherence though understanding how to take medications, knowing normal BP value, or taking CCBs, or decreasing adherence through high drug costs, forgetfulness, or complicated drug regimens.

We recommended implementing educational campaigns to increase awareness about hypertension risk factors, complications, and treatment. Patient—healthcare provider factors, such as patient education and counseling, developing a good healthcare provider—patient relationship, and innovating new ways to help patients remember to take their medications should be emphasized.

## Conflicts of interest

There are no conflicts of interest to disclose.

## References

[1] Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo Jr JL, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension 2003;42:1206—52.

[2] Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet 2005;365:217—23.
[3] Heidenreich PA, Trogdon JG, Khavjou OA, Butler J, Dracup K, Ezekowitz MD, et al. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. Circulation 2011;123:933—44.
[4] Burt VL, Whelton P, Roccella EJ, Brown C, Cutler JA, Higgins M, et al. Prevalence of hypertension in the US adult population. Results from the Third National Health and Nutrition Examination Survey, 1988—1991. Hypertension 1995;25:305—13.
[5] Berenson GS, Srinivasan SR, Bao W, Newman WP, Tracy RE, Wattigney WA. The Bogalusa Heart Study. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. N Engl J Med 1998;338:1650—6.
[6] Thompson DW, Furlan AJ. Clinical epidemiology of stroke. Neurol Clin 1996;14:309—15.
[7] Lee GK, Wang HH, Liu KQ, Cheung Y, Morisky DE, Wong MC. Determinants of medication adherence to antihypertensive medications among a Chinese population using Morisky Medication Adherence Scale. PLoS One 2013;8:e62775.
[8] Wolf-Maier K, Cooper RS, Kramer H, Banegas JR, Giampaoli S, Joffres MR, et al. Hypertension treatment and control in five European Countries, Canada, and the United States. Hypertension 2004;43:10—7.
[9] Sabate E. Adherence to long-term therapies: evidence for action. Geneva: World Health Organization. http://www.who.int/chronic_conditions/en/adherence_report.pdf; 2003 (accessed March 1, 2014).
[10] Mant J, McManus RJ. Does it matter whether patients take their antihypertensive medication as prescribed? The complex relationship between adherence and blood pressure control. J Hum Hypertens 2006;20:551—3.
[11] Stewart RB, Caranasos GJ. Medication compliance in the elderly. Clin Pharmacol Ther 1989;73:1551—63.
[12] Khalil SA, Elzubier AG. Drug compliance among hypertensive patients in Tabuk, Saudi Arabia. J Hypertens 1997;15:561—5.
[13] Osterberg L, Blaschke T. Drug therapy: adherence to medication. N Engl J Med 2005;353:487—97.
[14] Payne KA, Esmond-White S. Observational studies of antihypertensive medication use and compliance. is drug choice a factor in treatment adherence? Curr Hypertens Rep 2000;2:515—24.
[15] Wang PS, Bohn RL, Knight E, Glynn RJ, Mogun H, Avorn J. Noncompliance with antihypertensive medications: the impact of depressive symptoms and psychosocial factors. J Gen Intern Med 2002;17:504—11.
[16] Almas A, Hameed A, Ahmed B, Islam M. Compliance to antihypertensive therapy. J Coll Physicians Surg Pak 2006;16:23—6.
[17] Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med 2013;35:121—6.
[18] Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. J Clin Hypertens (Greenwich) 2008;10:348—54.
[19] van der Sande MA, Milligan PJ, Nyan OA, Rowley JT, Banya WA, Ceesay SM, et al. Blood pressure patterns and cardiovascular risk factors in rural and urban Gambian communities. J Hum Hypertens 2000;14:489—96.
[20] Hyre AD, Krousel-Wood MA, Muntner P, Kawasaki L, DeSalvo KB. Prevalence and predictors of poor antihypertensive medication adherence in an urban health clinic setting. J Clin Hypertens (Greenwich) 2007;9:179—86.
[21] Oliveira-Filho AD, Barreto-Filho JA, Neves SJ, Neves DP. Association between the 8-item Morisky Medication Adherence Scale (MMAS-8) and blood pressure control. Arq Bras Cardiol 2012;99:649—58.
[22] Marentette MA, Gerth WC, Billings DK, Zarnke KB. Antihypertensive persistence and drug class. Can J Cardiol 2002;18:649—56.
[23] Saounatsou M, Patsi O, Fasoi G, Stylianou M, Kavga A, Economou O, et al. The influence of the hypertensive patient's education in compliance with their medication. Public Health Nurs 2001;18:436—42.
[24] Korb-Savoldelli V, Gillaizeau F, Pouchot J, Lenain E, Postel-Vinay N, Plouin PF, et al. Validation of a French version of the 8-item Morisky medication adherence scale in hypertensive adults. J Clin Hypertens (Greenwich) 2012;14:429—34.
[25] Iskedjian M, Einarson TR, MacKeigan LD, Shear N, Addis A, Mittmann N, et al. Relationship between daily dose frequency and adherence to antihypertensive pharmacotherapy evidence from a meta-analysis. Clin Ther 2002;24:302—16.
[26] George J, Phun YT, Bailey MJ, Kong DC, Stewart K. Development and validation of the medication regimen complexity index. Ann Pharmacother 2004;38:1369—76.
[27] Krousel-Wood M, Joyce C, Holt E, Muntner P, Webber LS, Morisky DE, et al. Predictors of decline in medication adherence: results from the cohort study of medication adherence among older adults. Hypertension 2011;58:804—10.
[28] Ried LD, Tueth MJ, Handberg E, Kupfer S, Pepine CJ. A Study of Antihypertensive Drugs and Depressive Symptoms (SADD-Sx) in patients treated with a calcium antagonist versus an atenolol hypertension Treatment Strategy in the International Verapamil SR-Trandolapril Study (INVEST). Psychosom Med 2005;67:398—406.
[29] Webb AJ, Fischer U, Mehta Z, Rothwell PM. Effects of antihypertensive-drug class on interindividual variation in blood pressure and risk of stroke: a systematic review and metaanalysis. Lancet 2010;375:906—15.
[30] Pickering TG, James JD, Boddie C, Harshfield GA, Blank S, Laragh JH. How common is white coat hypertension? JAMA 1988;259:225—8.