

PREVALENCE OF DIABETES MELLITUS AMONG PATIENTS WITH ESSENTIAL ARTERIAL HYPERTENSION

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ABSTRACT • Objectives : This study evaluates the prevalence of diabetes mellitus (DM) among patients with arterial hypertension, and indirectly, the crucial impact of adopting screening for diabetes as a standard procedure for all patients diagnosed with arterial hypertension. **Materials & Methods :** This cross-sectional study was performed on a sample of hypertensive patients recruited from three different university hospitals in Lebanon. Blood pressure and glycemic blood measurements were determined in all subjects. In addition, a complete clinical history and physical exam were performed. Data was entered and analyzed using SPSS 19.0. Frequencies for the different variables were calculated, and the chi-square and independent sample t-tests were conducted. **Results :** This study included 294 patients. Prevalence of diabetes was 27%, and 23% of diabetic patients were newly diagnosed. More than half of the subjects suffering from DM had uncontrolled blood pressure, contrasted with only one third of the non-diabetic subjects with uncontrolled hypertension. **Conclusion :** The prevalence of DM in patients with essential hypertension was more than double that of the general population. Therefore, major recommendations would be to adopt strictly the diabetes screening requirements and aggressive management among hypertensive patients to minimize both the health and cost burdens associated with undetected DM.

Keywords: diabetes mellitus, arterial hypertension, prevalence, association, obesity

INTRODUCTION

The 2007 guidelines of the European Society of Hypertension (ESH), the European Society of Cardiology (ESC) and the European Respiratory Society (ERS) [1], define high blood pressure with the thresholds for systolic and diastolic hypertension of 140 mmHg and 90 mmHg respectively.

Diabetes mellitus is classified by the 2012 American

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RÉSUMÉ • Objectifs : Cette étude évalue la prévalence du diabète chez des patients atteints d'hypertension artérielle. Et indirectement, elle démontre l'importance de rechercher le diabète chez tout patient hypertendu. **Matériel & Méthodes :** C'est une étude réalisée chez des patients hypertendus recrutés dans trois centres hospitaliers universitaires au Liban. La pression sanguine et la glycémie ont été déterminées chez tous les sujets. De même, une histoire clinique complète et un examen physique ont été conduits. Après la collection des données, les fréquences ont été calculées et l'analyse conduite selon le test de χ^2 pour les variables discrètes et le test de T pour les variables continues. **Résultats :** 294 patients étaient inclus dans l'étude. La prévalence du diabète était de 27% et 23% de nouveaux cas de diabète ont été diagnostiqués. Plus de la moitié des patients diabétiques souffraient de troubles de pression, par contre seulement un tiers des patients non diabétiques avaient ce problème. **Conclusion :** La prévalence du diabète chez les patients hypertendus est deux fois plus élevée que celle observée dans la population générale. Compte tenu de ce résultat, la recherche du diabète doit être recommandée chez tout patient hypertendu.

Diabetes Association [2] according to four diagnostic criteria. A random plasma glucose ≥ 11.1 mmol/L, a fasting plasma glucose ≥ 7 mmol/L, an HbA1C value ≥ 6.5 or a two-hour postprandial plasma glucose ≥ 11.1 mmol/L are all indicative thresholds for diabetes mellitus.

In 2008, the World Health Organization (WHO) reported that around 40% of adults aged 25 and over suffered from high blood pressure [3]. The WHO estimated that hypertension causes 7.5 million deaths worldwide, accounting for about 12.8% of the total deaths. For diabetes mellitus (fasting plasma glucose ≥ 7 mmol/L), the global prevalence in 2008 was reported by the WHO as 9%, causing 3.4 million deaths in 2004, which represents 5.8% of total deaths [4].

In Lebanon, cardiovascular diseases (CVD) remain the most prevalent chronic condition. Various sources reported that cardiovascular diseases constitute the major cause of death among the Lebanese population [5-7]. For instance, the most recent data published in 2011 by the WHO, indicated that the leading causes of death are CVD and Diabetes, followed by Cancers and Chronic Respiratory Diseases [7]. In the past decade, the major risk factors associated with CVD, including hypertension and diabetes, became the focus of a number of research studies and national reporting systems. Data re-

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ported by the Lebanese Ministry of Public Health in 2010 illustrate the importance of the problem, as the number of hypertensive cases reached 36,824 ($\approx 0.87\%$) and the number of diabetic cases were around 31,936 ($\approx 0.75\%$) from a general Lebanese population of around 4,227,597 [8]. It is presumed that the reported prevalence data is an underestimation of the problem in Lebanon. However, this is the only epidemiologic reporting that directly assesses diabetes and hypertension on a national level. Other studies, such as those conducted by Taleb *et al.* (2008) in Lebanon, have reported statistics on hypertension in a diabetic population, though that was not their primary purpose. For instance, in one paper, around 53% of diabetic subjects were found to be hypertensive of whom 83% received angiotensin converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARBs) [9-10].

A Lebanese national study conducted in 2004 revealed high prevalence rates of hypertension and diabetes in the population reaching 23.1% and 13.8% respectively [11]. Another national survey in 2009 investigated both reported and measured parameters of the metabolic syndrome, including diabetes and hypertension [12]. Rates of reported cases of hypertension (13.3%) and diabetes (5.6%) were remarkably lower than those revealed in the sample through face-to-face interviews, reaching 42.7% and 52% respectively. The latter study revealed a critical finding, which is the high rate of undiagnosed diabetes and hypertension among the Lebanese population, a problem which would lead to severe complications. Therefore, an urgent need exists to increase the awareness among the Lebanese population and practitioners.

The relationship between high blood pressure and diabetes is well documented in the literature. Several studies have investigated and proven the existence of a relationship between hypertension and diabetes mellitus [13-20]. Two main hypotheses were tested; the effect of high blood pressure and antihypertensive therapy on the initiation of diabetes, and the role of elevated levels of blood glucose and insulin in triggering high blood pressure.

A significant proportion of diabetes cases were reported among patients suffering from high blood pressure. In one study, 68.5% of the patients with essential arterial hypertension reported abnormal glucose levels [13]. Another study on the Lebanese population, analyzed questionnaire reported data from selected respondents and found that around 24% of hypertensive respondents were also suffering from diabetes [11].

The coexistence of hypertension and diabetes implies that optimal management for the two risk factors would greatly reduce their burden as reported by a multinational study from seven different countries (Colombia, England, Iran, Mexico, Scotland, Thailand and the USA) [15]. Moreover, consensus guidelines recommend a blood pressure goal of less than 130/80 mmHg for patients with diabetes according to the National Kidney Foundation [21], the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure

[22] and the American Diabetes Association [23]. The significance of the relationship between diabetes and hypertension requires further research and analysis to understand its various aspects and serious implications.

The primary objective of this study is to evaluate the prevalence of diabetes mellitus among patients with arterial hypertension in Lebanon. To date, there are no clinical prospective studies in Lebanon and the Eastern Mediterranean region investigating the relationship between measured high blood pressure and diabetes. Knowing that the population in this region holds specific distinguishing characteristics would deter the complete applicability of European and international findings to the local context.

METHODS

Study design

This cross-sectional study was performed in hypertensive patients recruited from three different University Hospitals in Lebanon between February and August 2012. Blood pressure and glycemic blood measurements were determined in all subjects. In addition, co-morbidities and associated cardiovascular risk factors were reported from the documented history and physical exam findings of each recruited subject.

The study protocol was reviewed and approved by the appropriate ethics committees at the Lebanese University and corresponding hospitals. The study was conducted in concordance with the fundamental ethical principles, national authorities and the Helsinki declaration.

Study sample

The calculation of the study sample was impeded by the lack of reliable statistics on the prevalence of glycemic abnormalities among hypertensive patients in the Lebanese setting. Therefore, an assumption was made based on similar studies to adopt a prevalence rate of 24% [11, 13, 16]. This resulted in a theoretical sample size of 280 subjects, calculated based on a prevalence rate of glucose abnormalities equal to 24%, with a confidence interval of 0.95 and a precision of 5%. In order to account for unexpected problems and technical difficulties, a 20% increase of the sample size was made, resulting in a total sample of 336 subjects.

The study sample was chosen to be representative of age; the selection process consisted of taking 60 subjects within each age range, irrespective of the genders. The recruited subjects fulfilled the following inclusion criteria: (a) aged 30 or above and (b) suffering from essential arterial hypertension as defined by ESC and ESH [1] (systolic blood pressure ≥ 140 and diastolic blood pressure ≥ 90 ; for diabetic the systolic ≥ 130 , diastolic ≥ 80). Subjects were excluded from the study in one of the following cases: (a) pregnancy, (b) requiring a periodic or continuous use of corticosteroids or any other medications that have an established effect on blood pressure and glycemic profile.

Data collection

Written consent was obtained from hospitals to allow the researchers to collect data collection. Data collection took place from February 2012 and was completed in August 2012. A total of 322 hypertensive patients were recruited, of which 294 were preselected in the study. The 28 subjects were excluded because of several reasons, mainly for presenting a number of missing variables or for having predetermined exclusion criteria.

Procedures

Investigators were located in the three major hospitals during the data collection process. When a hypertensive patient was admitted to the hospital, the investigators were notified to determine whether the patient qualified for the study. After attending to the patient needs, the investigators proceeded to collect relevant information as per the previously developed Case Report Form (CRF).

A complete clinical history and physical exam were performed, the weight and height were measured and the body mass index was calculated (weight in kilograms divided by the square height in meters). In addition, patient demographics and associated cardiovascular risk factors were recorded.

■ Blood pressure measurement

After a minimum of five minutes rest, seated blood pressure was measured three times on the same arm using a mercury sphygmomanometer. The three measurements were separated by at least 5 minutes, and were taken by the same individual. The calculated average of the three readings was used as the blood pressure value in the data analysis.

The blood pressure parameters to identify a person suffering from hypertension were adopted according to the ESH and ESC guidelines¹ as follows:

- a. For non-diabetic patients:
 - i. Systolic blood pressure ≥ 140 mm Hg
 - ii. Diastolic blood pressure ≥ 90 mm Hg
- b. For diabetic patients:
 - i. Systolic blood pressure ≥ 130 mm Hg
 - ii. Diastolic blood pressure ≥ 80 mm Hg

■ Measurements and patient classification criteria

To detect the glycemic dysregulation, blood was drawn from the subjects and laboratory tests for measuring either random plasma glucose levels, fasting plasma glucose levels or HbA1C. Given the fact that glucose is continuously consumed when left at room temperature, the laboratory technicians were strongly recommended to centrifuge the blood within 30 minutes after the draw in order to ensure accuracy. According to the 2012 ADA guidelines, the adopted glu-

cose measurements for diagnosing diabetes mellitus were as follows [2]:

1. Random plasma glucose level ≥ 11.1 mmol/L
2. Fasting plasma glucose level ≥ 7 mmol/L
3. HbA1C of ≥ 6.5 .

Patients were classified based on the criteria outlined below:

- *Diabetes mellitus type 1* (DM1), which is defined as diabetes detected at the age of childhood or adolescence. DM1 is treated by insulin.
- *Diagnosed diabetes mellitus type 2* (DM2), patient reporting a history of diabetes diagnosed on adulthood. DM2 is treated by oral anti-diabetic medication and/or insulin.
- *Silent undiagnosed DM2*, patient with no previous history of diabetes, shows deregulated glucose levels as per the thresholds outlined previously.
- *Normal glucose metabolism*, when none of the previous categories were applicable.

Statistical analysis

Two medical students performed data collection and it was entered using MS Excel 2007. Data was double-checked before starting the analysis. Data analysis was conducted using the Statistical Package for the Social Sciences 19.0 (SPSS Inc., Chicago, IL).

Descriptive statistics were generated and the values are expressed as means \pm standard deviations. Frequencies for the different variables were calculated and in depth data analysis was conducted using the chi-square test for discrete variables and the independent sample t-test for continuous variables.

The calculations were made with a confidence interval of 0.95 and a precision of 5%.

RESULTS

A total of 322 hypertensive patients were recruited, of which 294 were preselected in the study. The 28 subjects were excluded because of several reasons, mainly for presenting a number of missing variables (6 subjects) or due to non-conformity with predetermined exclusion criteria: pregnancy (4 subjects) and use of corticosteroids or any other medications known to affect blood pressure and glycemic profile (18 subjects).

Subjects were recruited from three different centers: Rafic Hariri University Hospital, Rizk University Hospital and Notre-Dame du Liban University Hospital. The distribution of the subjects among the three centers is shown in Table I. In order to identify whether the three groups of patients are homogenous, a chi-square test was conducted.

TABLE I
DISTRIBUTION OF DIABETES MELLITUS (DM) DIAGNOSIS AMONG THE THREE CENTERS - CHI-SQUARE TEST

	Non-diabetic	Known to be DM I	Known to be DM II	Newly diagnosed DM	Total
Rafic Hariri University Hospital	143	6	31	9	189
Rizk University Hospital	54	3	10	5	72
Notre-Dame du Liban University Hospital	18	3	8	4	33
Total	215	12	49	18	294

TABLE II
BASELINE CHARACTERISTICS OF PATIENTS
WITH ARTERIAL HYPERTENSION

	n = 294
Gender male (%)	152 (51.7)
Age (years)	60.23 ± 14.36
Systolic blood pressure (mmHg)	132.77 ± 13.11 (100-172)
Diastolic blood pressure (mmHg)	74.03 ± 7.4 (45.33-90.67)
Heart rate (bpm)	75.88 ± 9.34
Weight (Kg)	81.30 ± 17.28
Height (cm)	167.39 ± 8.5
BMI (Kg/m ²)	28.78 ± 4.44
Risk Factors	
Diabetic (%)	79 (26.9)
Known diabetes mellitus Type 1 (%)	12 (4.1)
Known diabetes mellitus Type 2 (%)	49 (16.7)
Newly diagnosed diabetes mellitus (%)	18 (6.1)
Smoker (%)	151 (51.4)
Dyslipidemia (%)	113 (38.4)
Family history of hypertension (%)	113 (38.4)
Associated Diseases	
Coronary-artery disease (%)	103 (35)
Chronic kidney disease (%)	22 (7.5)
Cerebro-vascular disease (%)	25 (8.5)
Peripheral vessel disease (%)	47 (16)
Medications	
Antihypertensive	
Beta-blockers (%)	161 (54.8)
ARBs (%)	60 (20.4)
ACEIs (%)	56 (19)
CCBs (%)	87 (29.6)
Diuretics (%)	85 (28.9)
Antidiabetic	
Insulin (%)	18 (6.1)
Biguanides (%)	46 (15.6)
Sulfonylureas (%)	13 (4.4)
Alpha-glucosidase inhibitors (%)	5 (1.7)

BMI : body mass index **ARBs** : angiotensin receptor blockers
ACEI s: angiotensin converting enzyme inhibitors
CCBs: calcium channel blockers

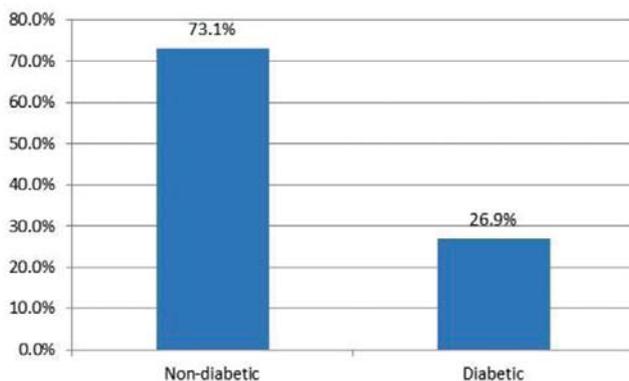


FIGURE 1
Distribution of diabetes mellitus in the sample

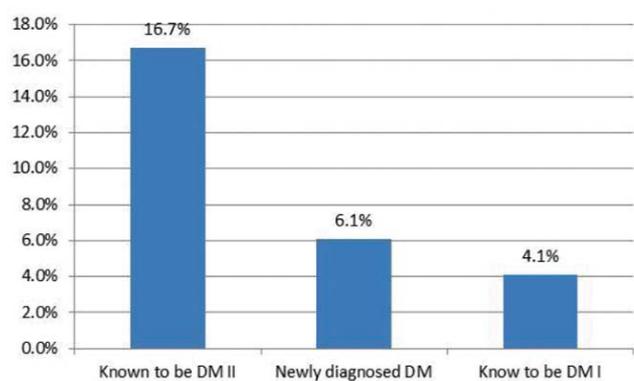


FIGURE 2
Distribution of diabetic subjects in the overall sample

The test revealed no significant difference between subjects from the three centers (p -value = .2). Therefore it would be safe to conclude that there was no center effect on the study sample, as the two variables are not significantly associated. The distribution of patients by diabetes diagnosis and study center is outlined in table I.

As for the overall characteristics of the 294 recruited hypertensive subjects, they are shown in Table II. The sample had slightly more males than females (51.7%) while the mean age was around 60 years.

One striking result was that despite the high cardiovascular risk of the population, 1 out of 2 cases enrolled in this study was a smoker (51.4%). In addition, most patients were suffering from weight disorders with an average BMI of around 28, which reflected in the majority of subjects (82.6%) being overweight with a BMI > 25 kg/m² and a significant number of patients were obese (37.4%) with a BMI > 30 kg/m². In addition, 113 patients suffered from dyslipidemia and a family history of hypertension.

The prevalence of associated diseases was apparent in the study sample with 35% suffering from coronary-artery disease and 16% with peripheral vessel disease. As for the medications, the majority of the sample received β -blockers (55%) while the remaining antihypertensive drugs were almost equally distributed among the study sample.

Diabetes was detected in 79 subjects (\approx 27%), of these 18 were newly diagnosed. This accounts for around 23% of previously undiagnosed diabetes. Figure 1 outlines the distribution of the diabetes mellitus prevalence among hypertensive patients, where 6.1% of the total sample consist of ignored cases.

The distribution of the different glycemc abnormalities is presented in figure 2, highlighting a significant proportion of newly diagnosed DM among diabetic patients (22.8%). Among the 49 patients suffering from previously diagnosed DM II in the study sample, 40.8% have uncontrolled glucose levels. In the hypertensive sample, 12.92% had no reported cardiovascular risk factors; they were nonsmokers, did not suffer from DM, dyslipidemia or CAD and had no family history of hypertension. Only 10 patients from the total study sample were not taking any anti-hypertensive medications.

Comparison between diabetic and non-diabetic subjects: Table III summarizes the frequencies and highlights the differences between the two categories. Chi-square test was used to determine the significant difference for discrete variables and the Independent samples T-test was adopted to detect any significant differences for continuous variables.

More than half of the subjects suffering from DM (54.4%), had uncontrolled blood pressure (SBP \geq 130 and DBP \geq 80), while one third (33.02%) of the non-diabetic subjects had uncontrolled blood pressure (SBP \geq 140 and DBP \geq 90).

DISCUSSION

The study showed a high prevalence of diabetic patients among the hypertensive study sample (26%) taken from three major university hospitals in Lebanon. In the Lebanese population, the estimated prevalence of DM is 11.5%. Thus, patients suffering from hypertension show a DM prevalence of more than double when compared to the general Lebanese population. This significant increase in diabetic prevalence among the Lebanese hypertensive population might suggest the need of aggressive diabetes screening and close glucose control among the hypertensive population.

These results add proof to the suggested pathophysiological correlation of metabolic glycemetic dysregulation with high blood pressure. Therefore, findings imply that arterial hypertension may be considered as a diabetes prone disorder.

The prevalence of DM among Lebanese patients suffering from high arterial blood pressure (26%) revealed an interesting similarity with European prevalence studies [13]. García-Puig *et al.* conducted a cross-sectional study, where 420 essential hypertensive patients were assessed for the prevalence of glucose abnormalities. This study revealed that more than two thirds of the hypertensive patients showed glucose metabolism dysregulations where around one quarter of the patients suffered from DM (25.4%), a percentage comparable to our Lebanese hypertensive sample.

This unexpected concordance of results between two populations known to have ethnic, environmental and cultural differences stimulates the need for further epidemiological studies. It would be interesting to investigate whether the population in Lebanon and the broader Eastern Mediterranean region share the same increased prevalence of DM among hypertensive patients in Europe.

This study helped in determining the prevalence of undiagnosed DM among the hypertensive population. Newly diagnosed cases (6.1%) were reported in this study sample, which is significantly lower than the findings of a previous study conducted on the Lebanese population in 2009 [12]. However, compared to the American normal population (6.5%), the percentage of newly diagnosed cases is very similar. While compared with the European countries (11.5%), the prevalence of newly diagnosed patients with DM in Lebanon was lower.

This indicates an acceptable management of the hypertensive population at the three studied health centers and one could assume that patients are closely monitored for DM in

TABLEAU III
COMPARISON BETWEEN DIABETIC AND NON-DIABETIC PATIENTS

	Non-diabetic	Diabetic	Total	p-value
Age	58.96 \pm 13.96	63.70 \pm 14.96	–	.01
Systolic blood pressure (mmHg)	133.12 \pm 12.82	131.81 \pm 13.91	–	.5
Diastolic blood pressure (mmHg)	74.70 \pm 7.05	72.21 \pm 8.04	–	.01
Heart rate (bpm)	75.6 \pm 9.64	76.62 \pm 8.47	–	.4
Weight (Kg)	81.1 \pm 15.77	81.82 \pm 20.94	–	.7
Height (cm)	167.4 \pm 8.35	167.67 \pm 8.92	–	.9
Body mass index (Kg/m ²)	28.73 \pm 3.86	28.94 \pm 5.77	–	.7
Risk Factors				
Smoker (%)	104 (48.4)	47 (59.5)	151 (51.4)	.1
Dyslipidemic (%)	84 (39.1)	29 (36.7)	113 (38.4)	.7
Family history of hypertension (%)	79 (96.7)	34 (43)	113 (38.4)	.3
Associated Diseases				
Coronary-artery disease (%)	75 (34.9)	28 (35.4)	103 (35)	.9
Chronic kidney disease (%)	12 (5.6)	10 (12.7)	22 (7.5)	.04
Cerebro-vascular disease (%)	15 (7)	10 (12.7)	25 (8.5)	.1
Peripheral vessel disease (%)	23 (10.07)	24 (30.4)	47 (16.0)	.00
Medications – Antihypertensive				
Beta-blockers (%)	123 (57.2)	38 (48.1)	161 (54.8)	.1
Angiotensin receptor blockers (%)	41 (19.1)	19 (24.1)	60 (20.4)	.3
Angiotensin converting enzyme inhibitors (%)	26 (12.1)	30 (38)	56 (19)	.00
Calcium channel blockers (%)	74 (34.4)	13 (16.5)	87 (29.6)	.00
Diuretics (%)	60 (27.9)	25 (31.6)	85 (28.9)	.5

such settings. This finding is in contrast with the general Lebanese population where the screening and detection of DM was very low resulting in extremely elevated percentage of undiagnosed DM patients within the general Lebanese population.

Comparison between diabetic and non-diabetic patients revealed a significant difference concerning age, as diabetic patients were found to be older than non-diabetic patients. Moreover, there was a significant difference in diastolic blood pressure. An important result that might warrant further investigation and epidemiological studies was the elevated number of diabetic patients that had uncontrolled arterial hypertension (54.4%) compared to the non-diabetic hypertensive patients (33.02%). This suggests a need to boost and refocus the regimens adopted by Lebanese physicians towards rigorous application of the required strict arterial hypertension management in all diabetic patients.

In addition, our results revealed that the difference between associated diseases in diabetic and non-diabetic patients was statistically significant for chronic kidney disease and peripheral vessel disease. This significant result may correlate with the alarmingly low percentage of ACE inhibitors prescription among diabetic hypertensive patients (38%). Approximately one third of diabetic hypertensive patients were receiving ACE inhibitors, which possess a proven renal protective effect among that specific population. This may have caused the significantly elevated prevalence of associated chronic kidneys diseases in the study sample.

However, no significant difference was found when comparing coronary artery disease and cerebrovascular disease in these patients. This reflects the fact that chronic kidney disease and peripheral vessel disease are common complications of diabetes especially in the elderly, when patients have uncontrolled glucose levels (discussed above), and with coexistence of hypertension.

Concerning the antihypertensive treatment, the most common antihypertensive medications used among diabetic and non-diabetic patients were β -blockers (57.2% & 48.1% respectively), and diuretics (27.9% & 31.6% respectively). However, there was a significant difference of angiotensin converting enzyme inhibitors (ACEIs) and calcium channel blockers (CCBs) between diabetic and non-diabetic patients, with ACEIs used much more in diabetic patients (38% and 12.1% respectively), and CCBs used much more in non-diabetic patients (16.5% & 34.4% respectively). These results underline the above-mentioned need to increase the prescription rate of ACE inhibitors in diabetic hypertensive patients. These prescription drugs were only received by one third of patients as first line therapy in their arterial hypertension management. Moreover, despite the known benefits of angiotensin receptor blockers (ARBs) in the treatment of hypertension in diabetic patients, there was no significant difference in ARBs prescription rate between diabetic (24.1%) and non-diabetic patients (19.1%).

Finally, the elevated level of uncontrolled arterial hypertension in diabetic patients was an important finding of the study, with more than half of the diabetic patients receiving

lenient hypertensive management. Several speculations may be causing this problem such as lack of education on the necessity of dietary change, prescription of second-line therapy drugs, absence of combination therapy in refractory cases or the negligent follow-up of the diabetic hypertensive patient. Further research is needed to be able to determine the actual causal factors. It is worth noting that until the completion of this study, the most updated guidelines were those published by the ESH/ESC in 2007. However, the newer ESH/ESC Guidelines for the management of arterial hypertension were released in 2013 and should be considered for future research endeavors on the topic.

Limitations

This is an epidemiological study that took place in three university hospitals in Greater Beirut area and thus might have missed important factors from other regions in Lebanon. This would hinder its generalization to the Lebanese population as a whole. Additionally, since the patients were recruited from the emergency departments of tertiary care centers, they may have been at increased risk of having hypertension or diabetes. Thus, the detected cases could have been an overestimation to the general population due to selection bias. Despite this first limitation, the current study can be considered as the first stepping point for further research on the topic. It was conducted for the first time in the Lebanese hospitals. Studies in other countries might not be applicable to the Lebanese population and until the finalization of this manuscript, research in Lebanon strictly analyzed reported data and did not specifically consider the hypertensive population.

A second limitation concerns the measured data in regards to the diversified centers where the study was conducted. For instance, blood analyses were conducted in different labs and blood pressure was measure using different instruments. However, all the lab workers were instructed to treat the samples carefully following international guidelines, the labs were all ISO certified. In addition, a center effect analysis was conducted, showing no significant impact of the center on the collected data. As for the accuracy of the adopted measurements, an oral glucose tolerance test (OGTT) would have been better at detecting the true prevalence of glucose metabolism. Alas, due to unavailable resources the OGTT was not conducted.

A third limitation is the absence of a formal control group, taken from the same Lebanese hypertensive population from which our subjects were recruited. Conducting a multivariate analysis would have circumvented this issue, and it is recommended in future similar studies that would further investigate the relationship between diabetes and hypertension. However, the study did report a doubled prevalence of diabetes in hypertensive patients when compared to the normal Lebanese population, which is in concordance with similar European studies [11]. Additionally a sufficiently large number of patients were recruited and a standardized method was adopted to identify new cases of diabetes in accordance with international guidelines.

Finally, a number of patients were on hypertensive medi-

cations such as diuretics and β -blockers known for their negative effect on glucose metabolism, which could have affected the study results. Results showed that around one third of diabetic patients were taking a diuretic agent and around half were on β -blockers. This raises a serious question about awareness targeting health providers on the personalized care for each hypertensive patient.

CONCLUSION

This study is the first cross-sectional study in Lebanon and in the Eastern Mediterranean region to our knowledge to evaluate the prevalence of diabetes mellitus specifically among patients with arterial hypertension. A significant finding was identified particularly in relation to the increased occurrence of DM among hypertensive patients. Thus, the DM prevalence in patients with high blood pressure was more than double that of DM in the general Lebanese population. Therefore, a major recommendation would be to strictly adopt the diabetes screening requirements and aggressive management among hypertensive patients to minimize both the health and cost burdens associated with undetected DM. In addition, this study establishes an important foundation for future research on this topic both in Lebanon and the Eastern Mediterranean region. As well as it highlights the need for an extensive epidemiological study with the power to generalize the generated significant findings to Lebanon and its surroundings that hold similar cultural and environmental characteristics.

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