ORIGINAL ARTICLE

Predictors of 5-year Survival of Elderly with Hypertension. A Prospective Cohort Study

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Background: Given the high prevalence of hypertension in older adults, this study was conducted to identify the factors affecting the 5-year survival of older people with hypertension. **Materials and Methods:** In this cohort study, individuals aged 60 and over living in Amirkola, north of Iran who were diagnosed with hypertension were followed up for 5 years, and the effect of various factors on their survival was analyzed. **Results:** Among 1439 older people, 892 individuals (61.99%) had hypertension. Age (adjusted hazard ratio [aHR] =1.052, 95% confidence interval [CI] =1.019–1.086, P = 0.002), diabetes mellitus (aHR = 2.166, 95% CI = 1.398–3.354, P = 0.001), serum creatinine (aHR = 2.163, 95% CI = 1.391–3.363, P = 0.001), female gender (aHR = 0.460, 95% CI = 0.276–0.766, P = 0.003), body mass index ≥30 kg/m^2 (aHR = 0.386, 95% CI = 0.212–0.701, P = 0.002), physical activity score >150 (aHR = 0.382, 95% CI = 0.162–0.898, P = 0.027), each one unit increase of social support score (aHR = 0.914, 95% CI = 0.861–0.970, P = 0.003), and instrumental functional ability score (aHR = 0.907, 95% CI = 0.843–0.974, P = 0.009) showed a significant effect on 5-year survival of older people. **Conclusion:** Multiple factors (such as age, gender, social support, lifestyle behaviors, and comorbidities including diabetes mellitus and renal function) might predict the 5-year survival of the elderly with hypertension. They should be considered in health-care package of these patients.

Key words: Elderly, hypertension, mortality, survival

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INTRODUCTION

The augmentation of life expectancy leading to a higher proportion of people aged 60 years and over triggered different countries to implement proper policies for the promotion of health and well-being of this age group.[1]

Aging is conclusively correlated with increasing the risk of a large number of risk factors, chronic diseases, and mortality. Hypertension as one of the main noncommunicable diseases and the most prevalent adjustable risk factor globally, leads to several complications including cardiovascular diseases (CVDs), stroke, kidney failure, disability, and ultimately premature death. Despite the fundamental development of antihypertensive medications, hypertension remains a major risk factor for death in the world.[2]

Based on the World Health Organization report, approximately 17 million deaths caused by CVDs were observed globally, and hypertension was related to 9.4 million numbers of these deaths. From 2009 to 2019, the death rate associated with high blood pressure rose 34.2% and the actual number of deaths related to high blood pressure increased by 65.3%.[3] Several studies reported a U-shaped relationship between blood pressure and mortality, showing that patients with very high or very low blood pressure might have higher mortality. This relationship should be noted especially in older people. Due to the comorbidities, frailty, and polypharmacy, the management of senior adults with hypertension is much more challenging than that of younger patients.[4]

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Previous studies regarding the effective factors on the mortality of hypertensive patients demonstrated that the mortality rate of the elderly with hypertension in men might be 1.5 times that of women, in patients with low adherence to treatment protocols 1.66 times that of patients with high medication adherence, people diagnosed with depression 1.8 times more than non-depressed participants, and in patients with dementia almost 1.6 times more than individuals without cognitive impairment;[5] however, the findings differ in various regions.

Given limited research that investigated the concurrent effect of different contributory factors, this study was conducted with the aim of a comprehensive evaluation of various factors affecting the survival of the elderly who were diagnosed with hypertension.

PROCEDURE

Study design and participants

This longitudinal study was part of the Amirkola Health and Ageing Cohort Project (AHAP) (2012–2017). In the first phase of the research, all senior adults aged 60 years and over, living in Amirkola, north of Iran were invited to participate in the research. Out of them, 1616 people accepted to participate. They were visited to complete the study questionnaires. In the second phase (5-year later), all these participants were followed up to explore their death or survival, as the primary research outcomes.[6]

Inclusion criteria were age ≥60 years, living in the region where the cohort study was being conducted, and diagnosis of hypertension in physical examination. The older adults who did not want to participate in the research, or it was not possible to collect research data for them were not included in the study.

Research variables and measurements

General characteristics including age, gender, level of education, living conditions (living alone or with other people), insurance status, smoking, medications, and medically diagnosed comorbidities were collected during face-to-face interviews with the elderly and/or their families.

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using the Omron M3 blood pressure monitor in a sitting position on two occasions in a standard way; hypertension was defined as mean SBP ≥140 mmHg and/or DBP ≥90 mmHg.[7]

The patients with hypertension who reported not to consume the prescribed medications in a regular program were classified as a group with low drug adherence.

Activities of daily living (ADL) were assessed based on Katz ADLs and Rosow-Breslau indices. The Katz index evaluates a person's functional ability to do seven basic tasks (including, personal care, bathing, dressing, toileting, urinary and fecal incontinence, moving around, and eating). A total score as 14 means the person's independence; <14 shows the individual's dependence on others. Lawtons scale consists of 10 items and examines the person's ability to do heavy work at home, shop, climb stairs, and walk almost 1 km without assistance. A score higher than 20 indicates a person's independence from others in carrying out the mentioned activities, and ≤20 means his/her dependence on others.[8]

Physical activity was assessed using Physical Activity Scale for Elderly questionnaire. This questionnaire consists of 12 parts that examine the intensity, duration, and frequency of different physical activities in the elderly during the last week. The final score can range from zero to over 400. A higher score indicates more physical activity.[9]

The cognitive function of the elderly was evaluated using the mini-mental state examination questionnaire. This questionnaire examines the person's awareness of time and place, repetition of requested names, attention and calculation, repetition of sentences, and following complex commands, and scores from 0 to 30. A score of 25 and above is considered normal, 20–24 as mild cognitive impairment, 10–19 as moderate, and a score of 9 and below as severe cognitive impairment.[6]

Depressive symptoms were evaluated with the Geriatric Depression Scale. This questionnaire consists of 15 components. A score of 0–4 is considered as normal mood, 5–8 mild depression, 9–11 moderate depression, and 12–15 is categorized as severe depression.[10]

Social support was assessed using the Duke Social Support Index. This questionnaire includes 11 questions in two subgroups (social interaction including 4 questions and social satisfaction including 7 questions). Items are scored as follows: 1 point for (rarely/very dissatisfied), 2 points for (sometimes/dissatisfied), 3 points for (most of the time/satisfied). The total score is 33, and the higher score shows a higher amount of social support.[10]

Metabolic syndrome was defined according to the 2005 Adult Treatment Panel-III criteria which is defined as the existence of 3 out of the following 5 items: (1) waist circumference of more than 102 cm in men and more than 88 cm in women; (2) blood pressure more than 130/85 mmHg; (3) fasting serum triglyceride more

than 150 mg/dL; (4) HDL <40 in men and <50 in women; and (5) fasting blood glucose more than 100 mg/dL.[11]

Body mass index (BMI) was calculated considering a person's weight in kilograms, divided by height in square meters. Consequently, the subjects were divided into three groups: <25 = normal BMI, 25–29.99 = overweight, and 30 or more = obese.[12]

Serum creatinine was considered as an indicator of kidney function.

Death or survival of the participants was followed with different methods; including data recording system of the related family physicians, information registered in the organization of cemeteries, calling the phone numbers recorded in the elderly data file, and asking for the current status of the research participant.

All laboratory tests were carried out in the central lab of the Health Research Institute, Babol University of Medical Sciences, Iran.

Statistical analysis

Data were analyzed using SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, New York, United States). package. Cox regression model was used to assess the effect of the research variables on the survival of older adults, and the crude and adjusted hazard ratio (aHR) was reported with 95% confidence interval (CI). P <0.05 is considered as statistically significant.

RESULTS

Among 1439 older adults who were evaluated, 892 (61.99%) individuals had hypertension.

The baseline characteristics of the participants are presented in Table 1. This table represents that 52.13% of patients were men; one-third of them (32.06%) were 60–64 years old; and most of them were illiterate (64.91%). The findings showed that only 7.85% of them were living alone. The insurance coverage was 83.18%. Data related to lifestyle behaviors showed that only 19.84% of them had a high physical activity, and 17.04% of them were smokers. In addition, 28.36% of the elderly were obese, 44.51% of them had overweight, and 46.19% had a low drug adherence. One-hundred and twenty patients (13.45%) had high concentration of serum creatinine; moreover, 88.90% of them had SBP of 130 mmHg and above, and even 33.97% of them had SBP of 160 and above.

Findings showed that 721 (80.83%) of hypertensive patients had the criteria of metabolic syndrome, 397 (44.51%) had depressive symptoms, 310 (34.75%) had diabetes mellitus, 295 (33.07%) had cognitive dysfunction, and 264 (29.59%) reported a previous history of CVDs [Figure 1].

Table 1: Baseline characteristics of the participants

Characteristics	Classification	*n* (%)
Sex	Male	465 (52.13)
	Female	427 (47.87)
Age (year)	60–64	286 (32.06)
	65–69	191 (21.41)
	70–74	180 (20.17)
	75–79	145 (16.26)
	80–84	61 (6.83)
	≥85	29 (3.25)
Living condition	Living alone	70 (7.85)
	Living with others	822 (92.15)
Insurance status	With insurance	742 (83.18)
	Without any insurance	150 (16.82)
Level of education	Illiterate	579 (64.91)
	Primary and secondary school	253 (28.36)
	High school and college education	60 (6.73)
Smoking	Yes	152 (17.04)
	No	740 (82.96)
Physical activity	≥150	177 (19.84)
	<150	715 (80.16)
Drug adherence	Yes	480 (53.81)
	No	412 (46.19)
BMI (kg/m^2)	<25	242 (27.13)
	25–29.99	397 (44.51)
	≥30	253 (28.36)
SBP (mmHg)	<130	99 (11.10)
	≥130	793 (88.90)
	<160	589 (66.03)
	≥160	303 (33.97)

BMI=Body mass index; SBP=Systolic blood pressure

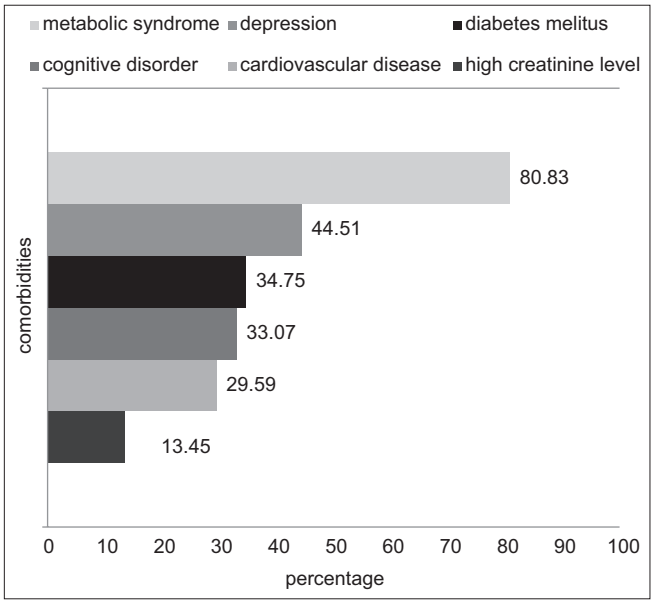

Figure 1: Frequency of comorbidities among the elderly with hypertension

At the end of the study, 108 people (12.11%) died during the 5-year follow-up.

Crude and adjusted HR for the effect of different examined factors on the survival of older adults with hypertension has been presented in Table 2. This table shows that the effect of BMI of 30 and higher (aHR = 0.386, 95% CI = 0.212–0.701, P = 0.002), female gender (aHR = 0.406, 95% CI = 0.276–0.766, P = 0.003), age (aHR = 1.052, 95% CI = 1.019–1.086, P = 0.002), diabetes mellitus (aHR = 2.166, 95% CI = 1.398–3.354, P = 0.001), physical activity score higher than 150 (aHR = 0.382, 95% CI = 0.162–0.898, P = 0.027), one unit increase of social support score (aHR = 0.914, 95% CI = 0.861–0.970, P = 0.003), serum creatinine level (aHR = 2.163, 95% CI = 1.391–3.363, P = 0.001) and one unit increase of instrumental ADL score (aHR = 0.907, 95% CI = 0.843–0.974, P = 0.009) on 5-year survival of elderly people with hypertension was significant, however, other factors such as the level of blood pressure, drug adherence, the level of education, living alone, number of comorbidities, smoking, depression, cognitive impairment, metabolic syndrome, ADL, CVD and insurance status did not show a statistically significant effect (P > 0.05).

DISCUSSION

This research showed no significant difference in the survival rate of the elderly with or without hypertension. Several previous studies demonstrated different findings, for example, Aune *et al*. showed that patients with hypertension had higher mortality rates than those without hypertension.[13] Kuk *et al*. reported that hypertension in isolation was significantly associated with mortality risk of people.[14] This difference in results can be attributed to different characteristics of the study population, and the covariates which have been considered in the design of the study.

In our research, female patients with hypertension had lower mortality rate than that of male individuals. Similar to us, Consolazio *et al*.'s study, found that the mortality rate of women was lower.[15] Furthermore, Menéndez-Villalva *et al*. showed that the mortality rate of men with hypertension was higher than that of women.[16] Literature review reveals gender differences in important cardiovascular risk factors; also, men tend to have more CVDs; although different regions/countries might have differences.[17]

Table 2: Crude and adjusted hazard ratio for the effect of contributing factors on 5-year survival of elderly with hypertension

Characteristics	CHR (95% CI)	*P*	aHR (95% CI)	*P*
Gender (female)	0.549 (0.369–0.817)	0.003	0.460 (0.276–0.766)	0.003
Age (year)	1.091 (1.065–1.118)	<0.001	1.052 (1.019–1.086)	0.002
Level of education				
Illiterate	1 (reference)	0.007	1 (reference)	0.639
Up to diploma	0.464 (0.279–0.772)	0.003	0.935 (0.539–1.621)	0.810
College education	0.540 (0.219–1.332)	0.181	1.539 (0.570–4.156)	0.395
Living alone	1.824 (1.040–3.199)	0.036	1.202 (0.653–2.212)	0.555
One unit increase of social support score	0.884 (0.839–0.931)	<0.001	0.914 (0.861–0.970)	0.003
To have insurance	0.877 (0.540–1.425)	0.597	0.872 (0.522–1.455)	0.599
BMI (kg/m^2)				
<25	1 (reference)	<0.001	1 (reference)	0.006
25–29.99	0.599 (0.397–0.904)	0.015	0.646 (0.412–1.011)	0.056
≥30	0.399 (0.194–0.593)	<0.001	0.386 (0.212–0.701)	0.002
Drug adherence	1.115 (0.762–1.631)	0.576	1.144 (0.746–1.755)	0.538
Number of comorbidities	1.072 (0.978–1.174)	0.138	1.049 (0.928–1.185)	0.447
Serum creatinine level (mg/dL)	3.291 (2.192–4.940)	<0.001	2.163 (1.391–3.363)	0.001
Metabolic syndrome	0.861 (0.543–1.365)	0.526	1.214 (0.679–2.169)	0.514
Diabetes mellitus	1.749 (1.199–2.553)	0.004	2.166 (1.398–3.354)	0.001
Depressive symptoms	1.214 (0.833–1.771)	0.313	1.089 (0.700–1.696)	0.705
Cognitive impairment	1.828 (1.253–2.669)	0.002	1.151 (0.727–1.823)	0.549
One unit increase of ADL score	0.886 (0.707–1.110)	0.291	1.197 (0.873–1.642)	0.264
One unit increase of IADL score	0.838 (0.796–0.882)	<0.001	0.907 (0.843–0.974)	0.009
Physical activity score (>150)	0.222 (0.097–0.506)	<0.001	0.382 (0.162–0.898)	0.027
Smoking	1.177 (1.155–2.732)	0.009	1.167 (0.714–1.907)	0.537
SBP >160 (mmHg)	1.154 (0.781–1.705)	0.473	1.050 (0.702–1.570)	0.814

BMI=Body mass index; SBP=Systolic blood pressure; CI=Confidence interval; ADL=Activities of daily living; IADL=Instrumental ADL; CHR=Crude hazard ratio; aHR=Adjusted hazard ratio

The mortality rate in hypertensive patients increased with age. Jung *et al*. showed that cardiovascular mortality was less at the age of 70–80 years.[18] Menéndez-Villalva *et al*. demonstrated a positive relationship between old age and the mortality of patients with hypertension, which is consistent with the present study.[16] Different mechanisms might justify this association; for example, age-related change in vascular resistance, baroreceptor-medicated responses, muscular contractions, multi-morbidity, and side effects of administered medications.[19]

In this study, instrumental ADL had a significant effect on the mortality of hypertensive patients. Contrary to us, in a study by Windham *et al*., the mortality rate was higher in patients with hypertension and functional impairment at a younger age, but at older ages, functional impairment had a protective impact on mortality.[20] Considering the culture of the study region, and level of education of the participants, since the elderly in this region mostly tend to do the complex indoor and outdoor daily activities by themselves, it might be resulted to less asking for help and consultation with more knowledgeable individuals about their disease condition, medications and so on.

No significant association was found between medication adherence and mortality, while many previous studies have written about drug adherence and its positive effect on the mortality of these patients.[15,21,22] In current research, self-reporting of drug adherence might impact on this result.

In this study, the mortality of the elderly with a BMI of 30 kg/m^2 and above was lower than that of people with a BMI of <25. Furthermore, smoking had no significant association with the mortality of patients, while people with high physical activity had less mortality. In the study of Bai *et al*., the mortality rate of people with a lower BMI was higher than that of people with a higher BMI, which is consistent with our study.[23] However, multiple studies declared that patients who had a healthier lifestyle (including diet, physical activity, BMI, and smoking) had lower mortality than patients with an unhealthy lifestyle.[24,25] A recent systematic review demonstrated the paradox between obesity and mortality in older adults.[26]

No significant association was found between the number of comorbidities and the mortality of people with hypertension; however, a positive relationship was found between the incidence of some of these comorbidities and the mortality rate independently. For example, the elderly with diabetes had a higher mortality rate than non-diabetic patients. Consistent with our finding, the study by Huang *et al*. for investigating the mortality rate in patients with prehypertension and diabetes, with a follow-up of 26,070 individuals over 15 years, it was found that the mortality rate in patients with pre-hypertension and diabetes was significantly higher compared to non-diabetic patients.[27] Furthermore, in the study of Menéndez-Villalva *et al*., diabetes had a positive effect on the mortality of these patients.[16] Yang *et al*. demonstrated that the co-occurrence of diabetes and hypertension made a significant increase in the mortality compared to having each of these diseases separately.[28]

There was no significant correlation between depression and mortality in the elderly with hypertension. While, Guan *et al*. represented that mortality in patients with hypertension and depression was higher than nondepressed and hypertensive patients.[22] In addition, in the study of Aaron, people with depression or anxiety had a higher blood pressure level than individuals who did not have these disorders.[24]

Metabolic syndrome had no significant effect on mortality in the examined subjects. There is a controversy in previous studies about this correlation. Radchenko and Sirenko had also declared that there was no association between metabolic syndrome and mortality in patients with hypertension.[25] In a study by Sung *et al*., metabolic syndrome increased the mortality rate, but this effect disappeared when the patients with hypertension were excluded from the study. Consequently, it was concluded that metabolic syndrome affected the mortality rate when people had a history of hypertension.[29]

No significant relation was found between cognitive impairment and mortality in patients with hypertension. Weidung *et al*. reported that the mortality rate in patients with dementia and hypertension increased significantly compared to the hypertensive patients with no cognitive impairment, which is not consistent with the present study.[5] Similar to our finding, Van De Vorst *et al*. stated that the combined effect of high blood pressure and cognitive impairment on mortality was not statistically significant.[30]

Social support and living alone didn't have a significant association with the mortality of hypertensive patients. While, in the study of Menéndez-Villalva *et al*., social support was effective on the all-cause mortality and specifically cardiovascular mortality of these patients.[16]

The relationship between insurance status and mortality was not statistically significant. However, Li *et al*. predicted that insurance could have a positive effect on the mortality of patients with hypertension.[31] Woolhandler *et al*. concluded although having insurance had a great impact on the treatment and reduction of mortality rate in most of diseases, hypertension was an exception to this statement. In that study, a large number of hypertensive patients did

not have health insurance, and having insurance did not have a significant effect on disease control and mortality of these patients.[32]

The most important strong points of this research are its longitudinal design, a large study population, and comprehensive assessment of multiple covariates which might have an impact on the survival of senior adults with hypertension. This study was carried out in the northern region of Iran; this small geographic area of the study can be presented as a limitation. In addition, this cohort project was designed as a general health assessment research, not a cardiac assessment study. Therefore, continuous tracking of blood pressure and cardiac function tests, such as echocardiography has not been conducted for the study participants. A large-scale multicenter study with a precise cardiac examination in which adults from different socioeconomic characteristics are included is recommended for future researches.

CONCLUSION

Some factors such as the level of blood pressure, the patient's drug adherence, living alone, number of co-morbidities, level of education, smoking, depression, cognitive impairment, metabolic syndrome, and insurance status showed no statistically significant effect on the 5-year survival of the elderly with hypertension. On the other hand, the significant negative effect of age, male gender, diabetes mellitus, and renal function, and protective effect of physical activity, social support, and functional performance on the 5-year survival of the elderly with hypertension should be considered in health-care package of these patients.

Ethics approval and consent to participate

The research protocol was approved by the Ethics Committee of Babol University of Medical Sciences, Iran with approval ID: IR.MUBABOL.HRI.REC.1400.011.

Consent for publication

A written informed consent for publication was obtained from all the participants at the beginning of the study.

Availability of data and materials

Data related to the older adults participating in this cohort project are available in the AHAP databank of Babol University of Medical Sciences. Researchers who want to have joint studies can send an E-mail to hosseinirezaseyed@gmail.com.

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Conflicts of interest

There are no conflicts of interest.

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