ORIGINAL ARTICLE

Is treated hypertension associated with a lower 1-year mortality among older multimorbid residents of long-term care facilities?

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KEY WORDS

arterial hypertension, long-term care facility, multimorbidity, residents, survival

ABSTRACT

INTRODUCTION Residents of long-term care facilities (LTCFs) are typically excluded from clinical trials due to multimorbidity, dementia, and frailty, so there are no clear evidence-based rules for treating arterial hypertension in this population. Moreover, the role of hypertension as a mortality risk factor in LTCFs has not yet been clearly established.

OBJECTIVES The study aimed to investigate whether treated hypertension is associated with lower mortality among older LTCF residents with multimorbidity.

PATIENTS AND METHODS The study was performed in 168 patients aged 65 years or older who were residents of 3 LTCFs. The initial assessment included blood pressure (BP) measurements and selected geriatric scales: the Mini Nutritional Assessment Short-Form, Abbreviated Mental Test Score, and Activities of Daily Living. Data on hypertension, comorbidities, pharmacotherapy, antihypertensive drugs, and mortality during 1-year follow-up were extracted from the medical records and were compared in survivors and the deceased.

RESULTS Survivors and the deceased had similar age, diastolic BP, number of diseases, medications, and antihypertensive drugs. However, the deceased had lower systolic BP (P <0.05) and worse functional, nutritional, and cognitive status than survivors (P <0.001). Hypertension (P <0.001) and antihypertensive therapy (P <0.05) were significantly more frequent among survivors. More hypertensive-treated patients than other multimorbid residents survived follow-up (P <0.001). Multivariable logistic regression analysis showed that treated hypertension had a protective effect on mortality (odds ratio, 0.11; 95% CI, 0.03–0.39; P <0.001).

CONCLUSIONS One-year survival of LTCF residents with treated hypertension was higher compared with others. Appropriate antihypertensive therapy may be a protective factor against death in frail nursing home residents, even short term.

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INTRODUCTION As our aging population is growing, more and more people may be placed in long-term care facilities (LTCFs) due to mental or physical disabilities. Residents of LTCFs are often disabled, frail, with cognitive impairment, malnutrition, and multimorbidity, which is why they are frequently excluded from randomized clinical trials. Hence, there is a considerable gap in the literature with regard to studies, algorithms, or guidelines for treating the most common diseases in this population. We only know that this population should be treated with caution and therapy should be individualized.[1]

Arterial hypertension is a well-known risk factor for many cardiovascular diseases, including coronary heart disease, chronic heart disease, stroke, and many other complications. Long-term antihypertensive therapy has been shown

WHAT'S NEW?

Institutionalized populations are usually excluded from clinical trials because of multimorbidity, polypharmacy, cognitive impairment, and frailty, so there are no precise evidence-based rules for treating hypertension in such populations. That is why it is recommended that pharmacotherapy of nursing home residents should be cautious and individualized. This is the first such large study in the Polish geriatric population with multimorbidity in long-term care facilities, which provides new data on safety and benefits of antihypertensive treatment among institutionalized frail older adults. The study showed that 1-year survival was significantly higher in residents of long-term care facilities with treated hypertension compared with other multimorbid residents. In addition, the study showed that appropriate treatment of hypertension in older residents of nursing homes can be beneficial and should be introduced in the frail, institutionalized population, even for short-term use, as it may be a factor that protects the resident from premature death.

to reduce the incidence of cerebral and cardiovascular events as well as mortality, also in the older population. Recent randomized trials and meta-analyses revealed significant reductions in cardiovascular morbidity and mortality with antihypertensive treatment among community-living individuals.[2-6]

The prevalence of hypertension among nursing home residents' ranges from 16% to 71%, and over 70% of them are treated with antihypertensive drugs,[7] but the role of hypertension as a risk factor for mortality in LTCFs has not been clearly established yet, particularly in short periods. Moreover, there is some controversy regarding the relationship between blood pressure (BP) level and mortality in older hypertensive residents of LTCFs. The PARTAGE (Predictive Values of Blood Pressure and Arterial Stiffness in Institutionalized Very Aged [≥80 years] Population) study revealed that elevated BP was not associated with a higher risk of mortality or major cardiovascular events among nursing home residents during 2-year follow-up.[8] However, they also showed a significant interaction between low systolic BP (SBP) and a higher risk of mortality in patients with low SBP who received multiple BP medications compared with other participants.[9] The mortality risk is particularly high among nursing home residents older than 80 years of age, as shown by Rådholm et al[10] in a Swedish population during a 30-month follow-up.

The study aimed to investigate whether the diagnosis and treatment of hypertension is associated with a lower 1-year all-cause mortality among older LTCF residents with multimorbidity and geriatric problems.

PATIENTS AND METHODS

Study design The presented analysis was a substudy of continuous surveillance of infections in long-term care facilities, carried out among 193 residents.[11] In short, the processes of LTCFs selection and recruitment of patients were as follows. Based on the list of LTCFs in Kraków (Poland), we selected facilities for old and chronically ill patients in which the number of residents over 65 years old was over 50%. The study was performed in 3 LTCFs: 2 residential homes and 1 nursing home. Recruited patients had to be able to give written informed consent before inclusion. The exclusion criterion was age under 65.

An initial assessment of sociodemographic and medical data, estimation of functional capacity, and clinical evaluation results was performed in each facility at the beginning of the study. All-cause mortality was recorded after 1 year of follow-up on the basis of the medical records. During the observation period, there were no cases of transfer, dismissal, or discharge of the study participants from the facilities. The study protocol was approved by the Jagiellonian University's ethics committee and conformed to the guidelines set forth in the Declaration of Helsinki. The study protocol was also approved and implemented voluntarily by the management of chosen institutions.

All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments, or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Terminology A resident was defined as someone who had been at a LTCF for more than 48 hours during the initial assessment. A residential home was defined as a place of residence for people who are incapable of independent living, require assistance and/or supervision in performing daily activities. A nursing home was defined as a place of residence for people requiring 24-hour medical care or a qualified nurse.

Throughout the text, the authors use the following terms: survivors to denote those residents who survived the entire follow-up, and the deceased to denote those residents who died before the end of follow-up.

Tests and measures Prepared questionnaire forms were completed, and study measurements were carried out by trained, qualified nursing staff from each facility. Data from the medical records of residents included information on hypertension, comorbidities, pharmacotherapy, antihypertensive medication use, and follow-up mortality. An initial clinical evaluation included BP, weight and height measurements, and assessment of nutritional, functional and cognitive status on the basis of geriatric scales.

Definition of hypertension Blood pressure was measured twice on the upper arm in a sitting position using oscillometric devices. The average of 2 measurements was taken for further analysis. Hypertension was defined as a history of

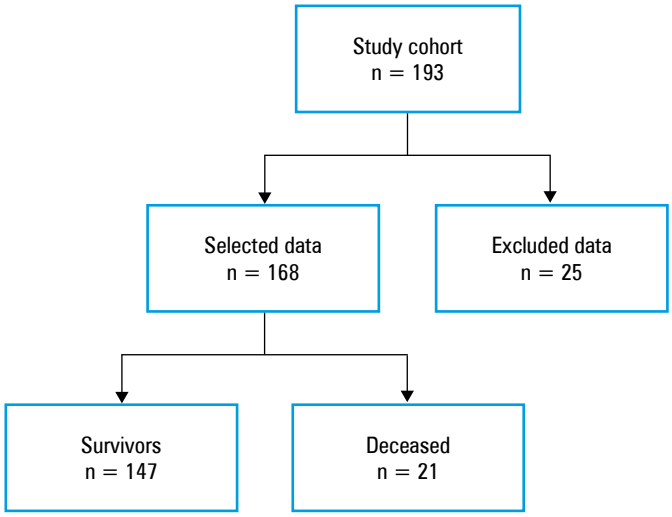

FIGURE 1 Study flow chart

hypertension or antihypertensive treatment (information extracted from the medical records), or it was diagnosed based on baseline measurements using oscillometric devices using the following definition of hypertension: SBP of 140 mm Hg or greater and / or diastolic BP (DBP) of 90 mm Hg or more.[12] Uncontrolled hypertension was defined as SBP of 140 mm Hg or greater and / or DBP of 90 mm Hg or greater in patients receiving antihypertensive medications.[13]

Nutritional status Weight and height were used to calculate body mass index (BMI) according to the following formula: body mass in kilograms was divided by the square of the body height in meters. These measurements were performed by researchers during standard procedures. Body mass index was not calculated among bedridden residents. The risk of malnutrition was estimated using a validated nutrition screening tool, Mini Nutritional Assessment Short-Form (MNA-SF).[14] The scores of MNA-SF range from 0 to 14 points. Scores from 12 to 14 indicated normal nutritional status; 8 to 11, risk of malnutrition; and 0 to 7, malnutrition.

Functional and cognitive status Functional and cognitive capacity was estimated using the following tools: basic Activities of Daily Living (ADL) and Abbreviated Mental Test Score (AMTS). The ADL (scores range from 0 to 6) consisted of self-care tasks that included but were not limited to functional mobility, bathing and showering, dressing, self-feeding, personal hygiene / grooming, and toilet hygiene.[15] The AMTS (scores range from 0 to 10), a rapid screening, was conducted to assess aged patients for the possibility of dementia.[16] A score of 0 to 3 points was interpreted as severe cognitive impairment; 4 to 6, moderate cognitive impairment; and more than 6 points, normal mental status.

Statistical analysis Descriptive and comparative statistics as well as logistic regression were used for statistical analysis. Descriptive statistics were based on the mean (SD), median, and quartile distribution. Study participants' data were compared between 2 groups: survivors and the deceased during 1 year follow-up. Comparisons between 2 groups were performed using the *t* test for normally distributed continuous variables and the Mann–Whitney test for those for which normality was not confirmed. The χ^2 test was used to compare categorical variables between groups.

A multivariable logistic regression model was used to determine independent mortality risk factors among older residents of long-term care facilities with multimorbidity. First, the χ^2 test was used to perform the univariate analysis of categorical variables. A multivariable analysis was then performed using logistic regression for risk factors considered significant in the univariate analysis. All logistic regression results were presented as odds ratio (OR) and 95% CI. A *P* value of less than 0.05 was considered significant. Statistical analysis was performed using Statistica 13 (StatSoft Inc, Tulsa, Oklahoma, United States).

RESULTS **General characteristics** The study group included 193 residents from 3 LTCFs: 107 people were selected from a nursing home and 86 from 2 residential homes. However, we did not obtain BP measurements of 4 residents, and in 21 cases, the residents were under the age of 65, so they were excluded from the analysis, and ultimately, the study sample included 168 people (FIGURE 1).

The general characteristics of the analyzed population were as follows: the mean (SD) age was 78.7 (8.5) years, the participants were mostly women (62%), and most of the participants were at risk of malnutrition based on the median MNA-SF score of 11 (range, 0–14), in a normal mental state based on the median AMTS score of 7 (range, 0–10), and showed moderate impairment based on the median ADL score of 3 (range, 0–6). The majority of study participants were diagnosed with 4 or more diseases and were taking 6 or more medications. The mean (SD) SBP and DBP were 128 (18.6) mm Hg and 72 (11) mm Hg, respectively. Twenty-one residents (12.5%) died during 1-year follow-up, of which only 5 (3%) were residents with hypertension.

Study groups Survivors (n = 147) and the deceased (n = 21) were of similar age and had comparable DBP, number of diseases, number of all medications, and antihypertensive drugs. The deceased presented a significantly worse functional, nutritional, and cognitive status than survivors (TABLE 1). The mean value of SBP was lower among the deceased than survivors ($P < 0.05$). Moreover, the deceased more often lived in a nursing home and had dementia, diabetes, and urinary incontinence. Hypertension ($P < 0.001$) and antihypertensive therapy ($P < 0.05$) were more frequent among survivors than the deceased. All

TABLE 1 General characteristics of survivors and deceased residents

Variable	N valid	Survivors (n = 147)	Deceased (n = 21)	*P* value
Age, y, mean (SD)	168	78 (8.4)	79.5 (9)	0.79
Female sex, n (%)	168	91 (62)	13 (62)	>0.99
Place of residence, n (%)				
Nursing home	168	73 (50)	16 (76)	<0.05
Residential home		74 (50)	5 (24)	
Measurements, mean (SD)				
SBP, mm Hg	168	129 (19.2)	122 (12.4)	<0.05
DBP, mm Hg	168	72 (11.2)	71 (9.5)	0.18
BP level,[a] n (%)				
≤120/60 mm Hg	168	35 (24)	5 (24)	0.13
120–139/60–89 mm Hg		69 (47)	14 (67)	
≥140/90 mm Hg		43 (29)	2 (9)	
Functional and nutritional status, median (IQR)				
ADL,[b] score	165	3 (1–6)	0 (0–3)	<0.001
MNA-SF,[c] score	164	12 (9–13)	8 (6–10)	<0.001
Nutritional status based on the MNA-SF, n (%)				
Normal	165	78 (54)	5 (24)	<0.05
Risk of malnutrition		46 (32)	9 (43)	
Malnutrition		20 (14)	7 (33)	
BMI, kg/m^2, mean (SD)	119	25 (5.3)	22 (5.9)	0.74
Cognitive status by AMTS,[d] score, median (IQR)	165	8 (6–9)	4 (1.5–7.5)	<0.001
Number of diseases, median (IQR)	166	4 (3–5)	4 (2–5)	0.59
Number of medications in general, median (IQR)	162	6 (4–9)	7 (5–10)	0.07
Number of antihypertensive drugs, median (IQR)	168	2 (1–3)	1 (0–2)	0.23
Comorbidities, n (%)				
Congestive heart failure	168	59 (40)	11 (52)	0.29
Coronary heart disease	168	99 (67)	10 (48)	0.08
Hypertension	168	89 (61)	5 (24)	<0.001
Uncontrolled hypertension[a]	168	48 (33)	3 (14)	0.09
Diabetes	168	39 (27)	13 (62)	<0.001
Dementia	168	47 (32)	12 (57)	<0.05
Urinary incontinence	168	51 (35)	15 (71)	<0.001
Pharmacotherapy, n (%)				
Antihypertensive drugs in general	168	121 (82)	13 (62)	<0.05
Angiotensin-converting enzyme inhibitors	168	84 (57)	8 (38)	0.1
β-Blockers	168	57 (39)	7 (33)	0.63
Diuretics in general	168	57 (39)	8 (38)	0.95
Calcium channel blockers	168	26 (18)	3 (14)	0.7
Mineralocorticoid receptor antagonist	168	17 (12)	3 (14)	0.72
Oral antidiabetic agents	168	22 (15)	8 (38)	0.009

a Cutoff values based on the BP distribution (tertiles)

b Score range, 0–6; normal functional status, 5–6 points

c Score range, 0–14; normal nutritional status, 12–14 points

d Score range, 0–10; normal mental status >6 points

Abbreviations: ADL, Activities of Daily Living; AMTS, Abbreviated Mental Test Score; BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; IQR, interquartile range; MNA-SF, Mini Nutritional Assessment Short-Form; SBP, systolic blood pressure

hypertensive residents were treated with antihypertensive drugs throughout the follow-up period. Oral antidiabetic agents were more common among the deceased than survivors (P = 0.009).

Hypertension A total of 95% of the hypertensive-treated population (n = 94) and 78% of the multimorbid population (n = 74) survived 1-year follow-up (P <0.001; FIGURE 2). Survival in the older

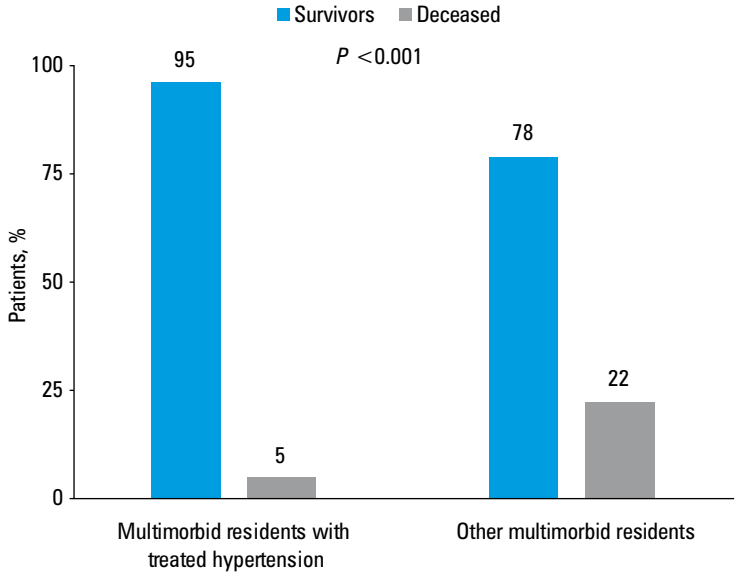

FIGURE 2 Survivors and the deceased due to hypertension in multimorbid residents with treated hypertension (94 [56%]) and other multimorbid residents (74 [44%])

TABLE 2 Risk factors for mortality among older multimorbid residents of long-term care facilities

Risk factor	Multivariable analysis		
	Adjusted odds ratio[a]	95% CI	*P* value
Hypertension	0.11	0.03–0.39	<0.001
Diabetes	8.14	2.52–26.33	<0.001
Dementia	3.82	1.17–12.48	<0.05
Urinary incontinence	2.50	0.79–7.92	0.12

a The odds of death adjusted for hypertension, diabetes, dementia, and urinary incontinence

LTCF population was higher by 17% in residents with treated hypertension compared with other multimorbid residents.

In logistic regression analysis (TABLE 2), hypertension, diabetes, and dementia were associated with mortality, while urinary incontinence was not. The analysis revealed that treated hypertension had a protective effect on mortality of residents of long-term care facilities (OR, 0.11; 95% CI, 0.03–0.39; *P* <0.001).

DISCUSSION Our study showed that treated hypertension had a protective effect on mortality in the LTCF population, and the survival was 17% higher in residents who received treatment for hypertension. In addition, in our study, we characterized the population of the deceased, that is, residents of LTCFs who were more likely to die in short-term follow-up. The deceased can be characterized as follows: they live in a nursing home more often, have much lower SBP, and significantly worse nutritional, functional, and cognitive status than survivors. Moreover, hypertension was less prevalent in the population of the deceased. Our findings suggest that lower SBP could have had an impact on the deterioration of cognitive, functional, and even nutritional status, and next on the earlier death of the deceased. This observation is a novelty as the literature only shows an association between low SBP and cognitive function in the older population. A prospective cohort study with a 1-year follow-up conducted among older adults aged 75 years or older undergoing antihypertensive therapy showed that SBP of less than 130 mm Hg is associated with additional cognitive decline.[17] The impact of low SBP on the nutritional and functional status in the population of nursing home residents has not been clearly defined. Further research will focus on these correlations. However, it is probable that degenerative changes in the central nervous system may affect hunger regulation and physical fitness.

Hypertension is a well-recognized risk factor for cardiovascular morbidity and mortality, even in the geriatric population.[1,18] Optimal control of BP is necessary to reduce the risks of cardiovascular, cerebrovascular, and renal diseases.[12,19] The definition of hypertension in very old patients (≥80 years) is still under discussion, but according to the 2018 European Society of Cardiology / European Society of Hypertension guidelines, pharmacotherapy should be initiated at a BP threshold of 160/90 mm Hg or greater.[20]

However, aggressive lowering of BP is still controversial in very old or frail patients, especially in nursing homes. Recent randomized trials and meta-analyses which revealed the benefits of intensive BP control among the older hypertensive patients did not include very frail patients, those with multiple morbidities, significant cognitive impairment, loss of autonomy, and residents of nursing homes.[2-6]

Frailty status is probably the most important factor modifying the relationship between BP and outcomes of both observational studies among the community and institutionalized geriatric populations.[8-10,21-23] A longitudinal analysis of primary care electronic health record data for a large cohort of community-dwelling octogenarians in the United Kingdom showed that mortality rates increased with frailty category.[24] At each level of frailty, mortality rates were lowest among participants with SBP from 140 to 159 mm Hg, and highest at SBP of less than 110 mm Hg. The results were similar in those treated with antihypertensive medications and those who were not on treatment. Similarly, Dregan et al[25] showed that all-cause mortality was higher in the lower extremes of SBP values (<110 mm Hg) and the lowest risk of cardiovascular disease and all-cause mortality among treated octogenarians was observed in the SBP range of 140 to 149 mm Hg and of 160 to 169 mm Hg in the community-dwelling octogenarians. In the Milan Geriatrics study,[23] higher SBP was related with lower mortality among functionally and cognitively impaired aged subjects.

In a nursing home cohort, Rådholm et al[10] showed that very old participants with SBP of less than 120 mm Hg had higher mortality compared with those with SBP from 120 to 139 mm Hg, and

this association was independent of changes in the use of antihypertensive medications. However, Benetos et al[9] presented that residents with SBP below 130 mm Hg who received a combination antihypertensive therapy had a higher risk of death compared with the rest of the participants. Similarly, Kerry et al[26] found that the use of multiple antihypertensive medications among hypertensive residents in residential care services in Australia was associated with an increased risk of death, particularly in residents with dementia and frailty. In our study, we also observed lower values of SBP among the deceased, although they took antihypertensive medications less frequently than survivors. However, diabetes and geriatric syndromes (dementia, urinary incontinence) also had a negative impact on the probability of survival.

The association of frailty and hypertension has not been precisely determined yet. The latest meta-analysis published by Vetrano et al[27] revealed that the pooled prevalence of hypertension in frail individuals was 72%, and the pooled prevalence of frailty in individuals with hypertension was only 14%. Frailty may induce to increase BP values by chronic inflammation which directly stimulates the renin-angiotensin-aldosterone system.[28] Moreover, frailty has been shown to reduce the ability to use adenosine triphosphate, which may impair vascular smooth muscle relaxation.[29]

In addition, according to the analysis of data from the UK Biobank, the probability of frailty in hypertensive subjects after adjustment for age, gender, socioeconomic status, smoking, and BMI was significantly higher compared with people without hypertension.[30] The influence of arterial hypertension on the occurrence of frailty is probably related to the increased incidence of cardiovascular and cerebrovascular diseases.

On the other hand, the diagnosis of hypertension and its optimal treatment may be a protective factor against death, as demonstrated in our institutional geriatric population. As in our study, data from the Veterans Health Administration showed that the diagnosis of hypertension was one factor protecting the survival of community-dwelling veterans aged 80 to 99 years.[31] Lately, Meng et al[32] documented the association of preexisting hypertension with reduced cardiovascular mortality in patients with systolic heart failure, even after adjustment for all potential risk factors. Probably, appropriate constant care and protection of patients through antihypertensive treatment may have prognostic significance even for older inhabitants of long-term care facilities. This assumption was confirmed by the results of extended follow-up in older populations of randomized, placebo-controlled trials for hypertension treatment.[33-35] The results from the Syst-Eur (Systolic Hypertension in Europe) extension showed that immediate treatment compared with delayed treatment reduced the incidence of stroke and cardiovascular complications in younger elderly with hypertension.[33] In the SHEP (Systolic Hypertension in the Elderly Program) trial, over 4 years of the more extended treatment period for isolated systolic hypertension was associated with longer life expectancy after 22 years of follow-up in the initially active treatment group than in the previous placebo group.[34] The results of the extension of the HYVET (Hypertension in the Very Elderly) trial showed that the benefits of BP control increased within 12 months, even in octogenarians.[35] In the Polish multicenter WOBASZ II study, it was shown that the highest control of arterial hypertension (37.7%) was observed among patients aged 80 years and older.[36]

Although lowering BP is a necessary goal to reduce cardiovascular events in hypertensive patients, reducing inflammation may also be significant. Antihypertensive drugs such as angiotensin-converting enzyme inhibitors / angiotensin receptor blockers (ACEIs / ARBs) present anti-inflammatory activity, and so do β-blockers and calcium channel blockers.[37] Probably, antihypertensive treatment may also reduce inflammation among frailty and prefrailty patients and affect survival. In our study, survivors took antihypertensive drugs more frequently than the deceased ($P < 0.05$). This observation may be supported by the results of a study conducted among 52 727 hospitalized patients with sepsis, which showed that short-term mortality from sepsis was lower among those who were already treated with ACEIs / ARBs when sepsis occurred.[38]

A pooled analysis by Lippi et al[39] suggested that hypertension may be associated with up to 2.5-fold higher risk of severe and fatal COVID-19, especially in older adults. On the other hand, Meng et al[40] showed that ACEIs / ARBs improve clinical outcomes of patients with COVID-19 and hypertension by regulating the immune function and suppressing inflammatory responses. Several recently published studies confirmed that ACEIs / ARBs are not associated with increased mortality in hypertensive patients with COVID-19 and should not be discontinued.[41-44] A systematic review and meta-analysis by Wang et al[45] supported this observation and added that the use of ACEIs / ARBs is associated with a lower risk of ventilator support.

Limitations Our study had some limitations. The study only provided the results of all-cause mortality. What is more, the study population was not very large, and the follow-up period was only a year, but even in such a relatively short time, healthcare providers need more information to consider making the proper care decisions. Another drawback could be the inclusion of study participants from both nursing and residential homes. However, this study's main aim was to investigate the geriatric population of LTCFs in general rather than under specific conditions, which can be considered a strength of the study. In addition, we did not assess the frailty syndrome among the study participants, which may be a weakness

of our study as it may be an important modifying factor in the relationship between BP values and outcomes. Also, we could not obtain information from institutions about complications, cardiovascular events, and exacerbations of chronic diseases that occurred during follow-up in the study population.

Conclusions Our study showed that 1-year survival in the older LTCF population was higher in residents with treated hypertension. Appropriate treatment of hypertension may be a factor that protects from death in the frail nursing home residents, even in a short period of time.

The results of the study may suggest that healthcare professionals in any long-term care facility should periodically screen older LTCF residents to detect and evaluate the effectiveness of treatment for hypertension in this particular population. The follow-up care and antihypertensive treatment of hypertensive residents in LTCFs may be prognostic as it may reduce the incidence of many cardiovascular side effects. Treating hypertension in this population may also provide systematic medical visits, which may be an opportunity to find other health problems. What is more, systematic medication review and screening for malnutrition and dementia of every LTCF resident are also very important to implement not only on admission to the facility, but also periodically during the stay. This minor intervention may reduce the risk of hospitalization, for example due to drug-drug interactions, which is a very common cause in the geriatric population.

ARTICLE INFORMATION

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CONTRIBUTION STATEMENT AK conceived the concept and design of the study, performed analysis and interpretation of data, and wrote the article. AP and BW contributed to interpretation of data. JWM contributed to acquisition of data, coordinated funding for the project. PH contributed to acquisition of data. TG and BG conceived the concept and design of the study, contributed to acquisition of data, and performed interpretation of data. BG contributed to writing the article. AP, BW, JWM, PH, TG, and BG revised the article critically for important intellectual content. All authors gave final approval of the version to be submitted.

CONFLICT OF INTEREST None declared.

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