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The relationship between the prognostic nutritional index and non-dipping blood pressure pattern in patients with newly diagnosed hypertension

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ABSTRACT

Aims: It has been suggested that immuno-nutritional status may play a role in blood pressure (BP) variations. This study aimed to investigate whether prognostic nutritional index (PNI) values differ between normotensive individuals and patients with newly diagnosed untreated hypertension (NDHT) and to clarify the relationship between the PNI and circadian BP patterns in NDHT patients.

Methods: This retrospective study included 328 adult participants, comprising 164 NDHT patients and 164 normotensive individuals. The non-dipper BP pattern (NDP) was defined as a nighttime decline in BP of less than 10%. The PNI was calculated using the following formula: PNI=([10 × serum albumin (g/dL)] + [0.005 × total lymphocyte count]).

Results: The mean PNI value was lower in the NDHT group than the normotensive group (53.6±6.1 vs. 58.2±5.3, p<0.001). There was a positive correlation between the PNI and the decline in nighttime BP levels (r=0.517; p<0.001). NDP was identified in 45.1% (n=74) of the NDHT patients. The mean PNI value was lower in the NDP group compared to the dipper BP group (49.9±5.6 vs. 56.6±4.8, p<0.001). Decreased PNI was an independent predictor of NDP (OR=0.70, 95% CI=0.61-0.81, p<0.001). The cut-off value of the PNI in predicting NDP was established as ≤51.3 with 72.4% sensitivity and 69.8% specificity.

Conclusion: Patients with hypertension had poorer immuno-nutritional statuses and a low PNI value was an important predictor of NDP. The PNI may be a useful screening tool for circadian BP patterns in patients with NDP.

Keywords: Circadian rhythm, hypertension, nutritional status, prognostic nutritional index

INTRODUCTION

The circadian rhythm of metabolism causes differences in blood pressure (BP) levels throughout the day.[1] The non-dipper BP pattern (NDP) is defined by a reduction of less than 10% in BP levels during sleep relative to daytime BP levels,[2] and it is associated with an increased risk of cardiovascular events.[3] The precise factors contributing to the impairment of circadian BP variations are not yet fully understood. However, several mechanisms have been proposed, including autonomic nervous dysfunctions, systemic inflammation, and insulin resistance.[4,5]

Nutritional status is closely related to potential mechanisms involved in the pathogenesis of hypertension.[6-8] Experimental studies have shown that nutritional factors play a role in modulating peroxisome proliferator-activated receptor-gamma (PPARγ), which is involved in increasing insulin sensitivity, differentiating lipid metabolism, and activating the renin-angiotensin- aldosterone system (RAAS).[9-11] Additionally, it has been shown that inadequate nutrition is associated with the modulation of glycemic, hormonal, and cytokine parameters.[12] This can also lead to an inflammatory response, resulting in leukocyte activation.[13] The activation of T and B lymphocytes leads to the induction of reactive oxygen species and cytokines, which in turn contribute to elevated BP levels.[14,15] Many studies have shown that insulin resistance and inflammation, characterized by increased cytokine release and activation of RAAS, are associated with variations in BP levels.[16-20] Therefore, poor nutrition may be an important mechanism underlying the factors that contribute to variations in BP levels.[21] The prognostic nutritional index (PNI), a surrogate marker of immunological nutritional and systemic inflammation status, is a simple and cost-effective combined score calculated from serum albumin value

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and lymphocyte count.[22] Low PNI levels are indicative of malnutrition.[23] Previous studies have shown that low PNI is associated with resistant hypertension, cardiovascular diseases, and cardiovascular events.[24-27] However, the relationship between the PNI and circadian BP patterns in patients with newly diagnosed untreated primary hypertension (NDHT) has not yet been investigated.

Given the impact of the aforementioned mechanisms of nutritional status on BP variations, we hypothesized that the PNI could be an important indicator of NDP. This study aimed to investigate whether PNI values differ between normotensive individuals and NDHT patients and to investigate the relationship between the PNI and circadian BP patterns in NDHT patients.

METHODS

The study was initiated with the approval of the Bursa City Hospital Clinical Research Ethics Committee (Date: 04.01.2023, Decision No: 2023-1/9). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This research was planned as a single-center retrospective study between December 2020 and December 2022 in the Cardiology Clinic of Bursa City Hospital. Due to the retrospective design, the ethics committee that approved the study deemed it appropriate to waive the need for informed consent.

Study Population

A total of 1060 patients over the age of 18 years who were diagnosed with NDHT were retrospectively evaluated. The inclusion criteria were NDHT with complete ambulatory BP monitoring (ABPM) data and no comorbidities. The exclusion criteria were previously documented hypertension, history of diabetes mellitus, cardiovascular diseases such as coronary artery disease, coronary revascularization, myocardial infarction, angina pectoris, or heart failure, history of peripheral artery disease, history of any systemic inflammatory or autoimmune diseases, coronavirus disease 2019, inflammatory bowel diseases, rheumatic diseases, malignancy, liver or kidney disease, presence of nephrotic proteinuria, cerebrovascular disease, dementia, clinical depression, eating disorders, obesity, use of antioxidants or lipid-lowering agents, metabolic syndrome, thyroid disease, pregnancy or delivery in the last 90 days, lactation and missing clinical data. After the exclusion criteria were applied, 164 NDHT patients and 248 normotensive individuals who met the inclusion criteria were included in the study. The control group was selected from normotensive individuals. Considering the age, gender, and body mass index (BMI) of the patients included in the study, a normotensive control group was formed with propensity score matching using the 1:1 nearest-neighbour matching method. Finally, 164 NDHT patients and 164 normotensive individuals were included in the study.

The hospital's electronic information system and patient files were used to gather demographic and clinical data.

Laboratory Measurements

Blood samples were collected at the time of hospital admission and measured with a Beckman Coulter LH 780 device (Mervue, Galway, Ireland). Levels of hemoglobin (photometrically), platelets (impedance method), C-reactive protein (CRP) (immunoturbidimetric method), albumin (bromocresol green method), triglycerides and total cholesterol (enzymatic colorimetric method), and high-density lipoprotein cholesterol (HDL-C) (homogeneous enzymatic colorimetric method) were determined. The Friedewald formula was used to determine low-density lipoprotein cholesterol (LDL-C) (28). PNI values were calculated according to the following formula: PNI=([10 × serum albumin (g/dL)] + [0.005 × total lymphocyte count]). Triglyceride-to-glucose (TyG) index values were calculated using the following formula: TyG=ln [fasting triglyceride (mg/dL) × fasting glucose (mg/dL)]/2.

In-office BP Measurements

All participants rested for 5 minutes after hospital admission before BP measurements were performed. Their BP levels were subsequently measured 3 times at 5-minute intervals using an Omron M3 sphygmomanometer (Omron Healthcare, Japan). All measurements were averaged.

Ambulatory BP Monitoring

A Tonoport V device (PAR Medizintechnik, Berlin, Germany) was used to perform 24-hour ABPM. Data from the first hour of monitoring were not included in the analysis. BP readings were automatically recorded at 15-minute intervals over 24 hours. Recordings were only included in the analysis if more than 85% of the raw recordings were valid. The pure reduction and percentage reduction in systolic BP for the nighttime-to-daytime period were assessed. Bedtime was determined from the patients' diaries, which documented the time of going to bed and getting up. Nighttime BP levels following bedtime were evaluated from the ABPM records. Average BP levels for the remainder of the 24-hour period were evaluated as daytime BP. Diastolic BP plus 1/3 of the pulse pressure was assessed as the mean BP. The decline in nighttime BP (%) was calculated using the following formula based on average values: (daytime BP-nighttime BP/daytime BP × 100). NDP was defined as a <10% decline in nighttime BP.

The definition of hypertension was based on the 2018 guidelines of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH).[29]

Statistical Analysis

IBM SPSS Statistics for Windows 20.0 (IBM Corp., USA) and Medcalc 11.4.2 (MedCalc Software, Belgium) programs were utilized in the analysis of all data obtained in this study. In light of the results of the Kolmogorov-Smirnov test, numerical data with normal distribution were identified and presented as mean±standard deviation, while data found to have non-normal distribution were presented as median values with interquartile ranges. For comparisons between groups, Student's t-test and Mann-Whitney U test were used based on the normal distribution of numerical data. Categorical variables were provided as numbers and percentages, and comparisons between groups were conducted using the Chi-square test and Fisher's exact test. Relationships between numerical variables were assessed with Pearson or Spearman correlation analysis. Multivariable logistic analysis was conducted to establish any possible independent predictors of NDP. Receiver operating characteristic curve analysis was performed to evaluate diagnostic performance. A two-sided P-value<0.05 were accepted as statistically significant.

RESULTS

The mean age of the NDHT patients was 50.5±13.7 years and the majority of them were male (66.5%). Mean age, gender distribution, mean BMI, and smoking rate did not differ significantly between the normotensive and NDHT groups. NDP was detected in 45.1% (n=74) of the NDHT patients. Baseline characteristics are presented in **Table 1**.

The mean PNI value was lower in the NDHT group than the normotensive group (53.6±6.1 vs. 58.2±5.3, p<0.001), while the mean TyG index value was higher (9.0±0.5 vs. 8.3±0.7, p<0.001) (**Table 1**).

The proportion of male patients was higher in the NDP group compared to patients with the dipper BP pattern, while other demographic characteristics did not differ significantly between the groups. The mean neutrophil count (5.6±1.6 vs. 5.0±1.8 × 103/μL, p=0.035), median triglyceride level (170 vs. 133 mg/dL, p=0.033), and mean LDL-C level (133.7±35.3 vs. 120.3±32.7, p=0.013) were higher in the NDP group compared to patients with the dipper BP pattern, while the mean lymphocyte count (2.1±0.5 vs. 2.6±0.6 × 103/μL, p<0.001) was lower. The mean PNI value was lower in the NDP group compared to patients with the dipper BP pattern (49.9±5.6 vs. 56.6±4.8, p<0.001), while the mean TyG index value was higher (9.2±0.5 vs. 8.9±0.5, p<0.001) (**Table 2**).

Table 1. Demographic characteristics and clinical parameters in study population

Variables	Hypertension group n=164	Normotensive group n=164	p
Demographic findings			
Age, years	50.5±13.7	49.8±16.4	0.675
Gender, n (%)			0.488
Male	109(66.5)	103(62.8)	
Female	55(33.5)	61(37.2)	
BMI, kg/m²	26.2±3.3	25.8±3.5	0.287
Smoking, n (%)	65(39.6)	70(42.6)	0.581
Baseline HR, bpm	80.4±11.4	78.8±10.6	0.189
In-office SBP, mmHg	143.8±12.0	112.2±6.8	<0.001*
In-office DBP, mmHg	84.1±9.2	71.6±3.6	<0.001*
Laboratory findings			
Hemoglobin, g/dL	14.0±1.7	14.2±1.8	0.302
FBG, mg/dL	91.0±8.5	84.0±12.0	<0.001*
WBC, ×10³/μL	7.5±2.2	7.1±2.1	0.093
Neutrophil count, ×10³/μL	5.3±1.9	4.7±1.9	0.013*
Platelet count, ×10³/μL	264.8±59.2	260.5±67.4	0.531
Monocyte count, ×10³/μL	0.7±0.3	0.6±0.3	0.017*
Lymphocyte count, ×10³/μL	2.4±0.6	2.8±0.8	<0.001*
Cholesterol, mg/dL	204.1±53.5	177.1±47.6	<0.001*
Triglyceride, mg/dL	150(115-241)	113(83-185.5)	<0.001*
HDL-C, mg/dL	46.2±13.1	51.1±14.7	0.002*
LDL-C, mg/dL	126.5±35.7	116.1±37.7	0.020*
Creatinine, mg/dL	0.9±0.3	0.8±0.2	0.003*
Albumin, g/dL	4.3±0.5	4.5±0.3	<0.001*
CRP, mg/L	3.5(1.6-5.9)	1.4(1.1-3.2)	<0.001*
PNI	53.6±6.1	58.2±5.3	<0.001*
TyG index	9.0±0.5	8.3±0.7	<0.001*
ABPM findings			
24- hours			
SBP, mmHg	141.6±10.5	123.2±7.0	<0.001*
DBP, mmHg	87.6±17.9	75.7±8.1	<0.001*
Day-time			
SBP, mmHg	144.4±24.1	127±6.6	<0.001*
DBP, mmHg	93.0±9.9	77.6±6.1	<0.001*
Night-time			
SBP, mmHg	127.1±15.3	107.6±6.0	<0.001*
DBP, mmHg	79.4±9.7	66.0±10.2	<0.001*
Decline in night-time BP, %	11.0±4.5	15.2±3.5	<0.001*

Data shown as mean±standard deviation or median (IQR) or number (percentage). * p<0.05 indicates statistical significance. Abbreviations: ABPM, ambulatory blood pressure monitoring; BMI, body mass index; CRP, C- reactive protein; DBP, diastolic blood pressure; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol; HR, heart rate; LDL-C, high-density lipoprotein cholesterol; PNI, prognostic nutrition index; SBP, systolic blood pressure; TyG, triglyceride-glucose index; WBC, white blood cell.

A negative correlation was found between the PNI and 24-hour systolic BP (r=-0.418; p<0.001) and diastolic BP (r=-0.412; p<0.001). A negative correlation was also found between the PNI and TyG index (r=-0.332; p<0.001), while a positive correlation was found between the PNI and the decline in nighttime BP levels (r=0.517; p<0.001) (**Figure 1**). Parameters associated with the decline in nighttime BP (%) and the PNI in patients with hypertension are presented in **Table 3**.

Table 2. Distribution of demographic characteristics and clinical parameters according to dipper and non-dipper blood pressure patterns in hypertensive patients.

Variables	Non-dipper pattern group n=74	Dipper pattern group n=90	p
Demographic findings			
Age, years	50.2±14.4	50.8±13.1	0.792
Gender, n (%)			**0.031***
Male	56(75.7)	53(58.9)	
Female	18(24.3)	37(41.1)	
BMI, kg/m²	26.0±2.9	26.3±3.5	0.556
Smoking, n (%)	30(40.5)	35(38.9)	0.830
Baseline HR, bpm	80.7±10.9	80.2±11.8	0.788
In-office SBP, mmHg	144.3±11.8	143.4±12.2	0.634
In-office DBP, mmHg	85.5±9.0	83.6±9.3	0.189
Laboratory findings			
Hemoglobin, g/dL	13.9±1.8	14.1±1.6	0.438
FBG, mg/dL	92.7±9.4	89.6±7.4	0.023*
WBC, $\times 10^3/\mu L$	7.8±2.3	7.3±2.1	0.148
Neutrophil count, $\times 10^3/\mu L$	5.6±1.6	5.0±1.8	0.035*
Platelet count, $\times 10^3/\mu L$	271.6±57.1	260.5±60.9	0.234
Monocyte count, $\times 10^3/\mu L$	0.7±0.2	0.7±0.3	0.569
Lymphocyte count, $\times 10^3/\mu L$	2.1±0.5	2.6±0.6	<0.001*
Cholesterol, mg/dL	210.5±67.9	198.2±38.1	0.146
Triglyceride, mg/dL	170(123-250)	133(113-210)	0.033*
HDL-C, mg/dL	44.9±13.3	47.4±12.9	0.224
LDL-C, mg/dL	133.7±35.3	120.3±32.7	0.013*
Creatinine, mg/dL	0.9±0.3	0.9±0.2	0.558
Albumin, g/dL	3.9±0.5	4.4±0.3	<0.001*
CRP, mg/L	4.6(2.0-7.8)	2.3(1.8-4.7)	0.012*
PNI	49.9±5.6	56.6±4.8	<0.001*
TyG index	9.2±0.5	8.9±0.5	<0.001*
ABPM findings			
24- hours			
SBP, mmHg	142.9±11.9	140.5±9.2	0.163
DBP, mmHg	88.9±9.2	86.5±22.7	0.362
Day-time			
SBP, mmHg	146.7±12.1	142.5±30.6	0.234
DBP, mmHg	92.5±9.3	93.5±10.4	0.512
Night-time			
SBP, mmHg	134.9±11.4	120.7±15.2	<0.001*
DBP, mmHg	83.4±9.8	76.1±8.4	<0.001*
Decline in night-time BP, %	6.2±2.1	14.0±3.6	<0.001*

Data shown as mean±standard deviation or median (IQR) or number (percentage). * P<0.05 indicates statistical significance. Abbreviations: ABPM, ambulatory blood pressure monitoring; BMI, body mass index; CRP, C- reactive protein; DBP, diastolic blood pressure; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol; HR, heart rate; LDL-C, high-density lipoprotein cholesterol; PNI, prognostic nutrition index; SBP, systolic blood pressure; TyG, triglyceride-glucose index,; WBC, white blood cell.

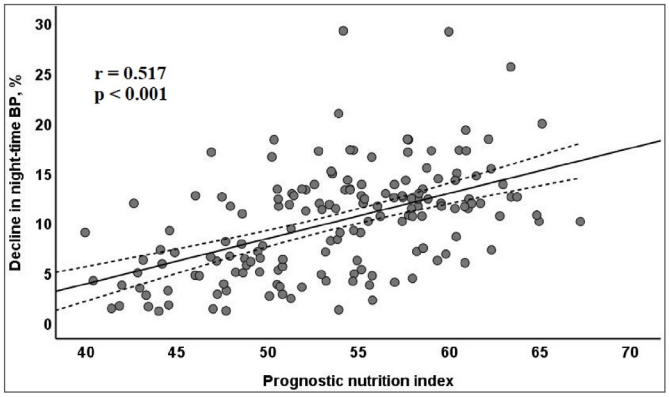

Figure 1. Relationship between prognostic nutritional index and decline in nighttime BP (%) in patients with hypertension.

Table 3. Parameters associated with the decline in nighttime BP (%) and prognostic nutrition index in patients with hypertension

Variables	Decline in nighttime BP (%)		PNI	
	r	p	r	p
Age	-0.115	0.328	-0.105	0.379
BMI	-0.029	0.713	-0.033	0.675
Baseline HR	0.033	0.673	-0.027	0.730
Hemoglobin	-0.105	0.180	-0.106	0.177
FBG	-0.245	0.048*	-0.257	0.040*
WBC	-0.115	0.342	-0.108	0.359
Neutrophil count	-0.297	0.026*	-0.289	0.031*
Platelet count	-0.202	0.383	-0.211	0.334
Monocyte count	-0.149	0.406	-0.123	0.645
Lymphocyte count	0.341	<0.001*	0.679	<0.001*
Cholesterol	-0.124	0.462	-0.178	0.320
Triglyceride	-0.283	0.019*	-0.298	0.011*
HDL-C	0.155	0.483	0.277	0.032*
LDL-C	-0.273	0.046*	-0.267	0.039*
Creatinine	0.018	0.822	-0.043	0.584
Albumin	0.302	0.009*	0.859	<0.001*
CRP	-0.268	0.042*	-0.341	<0.001*
TyG	-0.412	<0.001*	-0.332	<0.001*
PNI	0.517	<0.001*	-	-

* p<0.05 indicates statistical significance. Abbreviations: BMI, body mass index; CRP, C- reactive protein; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol; HR, heart rate; LDL-C, high-density lipoprotein cholesterol; PNI, prognostic nutrition index; TyG, triglyceride-glucose index, WBC, white blood cell.

Variables associated with NDP (**Table 2**) were considered as potential confounding factors. Among these factors, due to their multicollinearity with their respective indices, neither the components of the PNI nor the components of the TyG index were included in the multivariable regression analysis. Multivariable regression analysis showed that decreased PNI (OR=0.70, 95% CI=0.61-0.81, p<0.001) and increased TyG index (OR=7.16, 95% CI=2.30-22.26, p<0.001) values, as well as increased LDL-C levels, were independent predictors of NDP (**Table 4**).

Table 4. Independent predictors of non-dipper pattern in patients with hypertension.

Variables	Univariable Regression			Multivariable Regression		
	OR	95% CI	p	OR	95% CI	p
Gender						
Male	2.17	1.10-4.27	0.031*	-	-	-
Female	ref			ref		
FBG	1.05	1.01-1.09	0.023*		not included	
Neutrophil count	1.20	1.01-1.43	0.035*	-	-	-
Lymphocyte count	0.20	0.10-0.38	< 0.001*		not included	
Triglyceride	1.08	1.05-1.11	0.033*		not included	
Albumin	0.80	0.73-0.87	< 0.001*		not included	
LDL-C	1.09	1.02-1.18	0.013*	1.10	1.03-1.35	0.021*
CRP	1.05	1.01-1.14	0.012*	-	-	-
PNI	0.78	0.73-0.85	< 0.001*	0.70	0.61-0.81	< 0.001*
TyG index	6.62	2.33-13.14	0.004*	7.16	2.30-22.26	< 0.001*
					Adjusted R2=0.592; p<0.001	

Due to their multicollinearity with their respective indices, neither the components of the PNI nor the components of the TyG index were included in the multivariable regression analysis. Abbreviations: CI, confidence interval; CRP, C- reactive protein; FBG, fasting blood glucose; LDL-C, high-density lipoprotein cholesterol; OR, odds ratio; PNI, prognostic nutrition index; SE, standard error; TyG, triglyceride-glucose index.

The diagnostic performance of the independent predictors in predicting NDP is shown in **Figure 2**. The cut-off value of the PNI in predicting NDP was ≤51.3 with 72.4% sensitivity and 69.8% specificity. The diagnostic performance of the PNI in predicting NDP did not differ significantly compared to the TyG index (difference between areas under the curves=0.014, p=0.218) (**Figure 1A**). However, both indices had superior diagnostic performance compared to LDL-C.

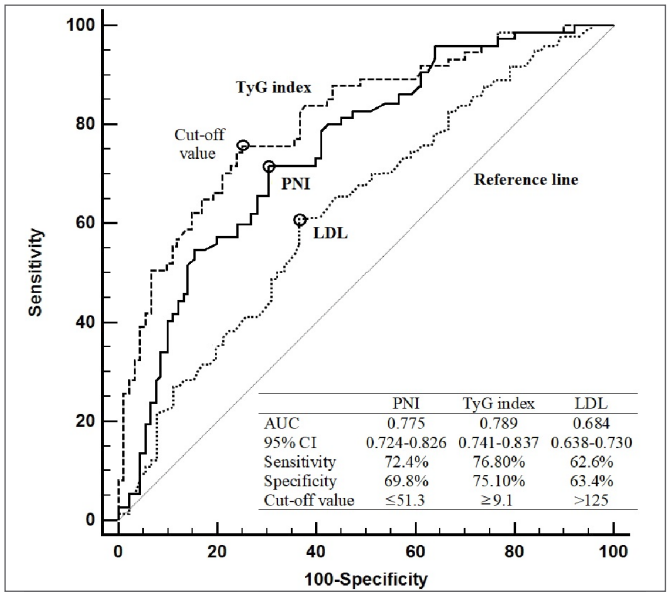

Figure 2. The receiver operating characteristic (ROC) curve analysis of prognostic nutritional index in predicting non-dipper pattern among hypertension patients.

DISCUSSION

This study of NDHT patients has demonstrated that a low PNI value was positively associated with BP level and the decline in nighttime BP (%). The PNI was lower in hypertensive patients compared to normotensive individuals. Low PNI values independently predicted NDP in hypertensive patients. To our knowledge, this is the first study to examine the relationships between the PNI and the decline in nighttime BP (%) and the presence of NDP in NDHT patients.

Epidemiological studies have reported that poor nutrition is common in hypertensive patients.[30-32] Circulating levels of albumin as a negative acute phase reactant and lymphocyte counts as reflectors of immunological status are usually reduced in cases of malnutrition.[33] Therefore, the PNI derived from these parameters is an important indicator of nutritional status beyond the context of inflammation.[34] To the best of our knowledge, there is only one study in the existing literature that compares the PNI between hypertensive patients and normotensive individuals.[27] Consistent with the findings of this study, hypertensive patients exhibited lower PNI levels. Nutritional status is closely associated with insulin resistance and impaired lipid metabolism, both of which contribute to the pathogenesis of hypertension.[12,13,21] This is consistent with the negative correlations between the PNI and atherogenic lipid profile and the TyG index, a surrogate marker of insulin resistance, in patients with hypertension. Experimental studies have shown that PPAR-γ and zinc-alpha-2-glycoprotein (ZAG) may be responsible for this relationship.[9] It has been suggested that PPAR-γ exerts pleiotropic effects on the vascular system, and these effects of PPAR-γ may specifically be due to inhibition of angiotensin-II type 1 receptor expression, which involves suppression of the RAAS and leads to lower BP levels.[10] Besides, ZAG, which plays a role in insulin resistance and lipid modulation, may be suppressed by PPAR-γ.[11] On the other hand, changes in nutritional status can affect the metabolism and function of immune cells,[35] leading to elevated BP levels.[36]

The above-mentioned mechanisms support the previously reported findings that malnutrition can contribute to variations in BP, as well as the development of hypertension and atherosclerosis.[21,37] Although approximately half of all genes expressed in the body have circadian regulatory mechanisms, components of the circadian clock play a role in every cell type and tissue.[38] These mechanisms are likely responsible for diurnal variations in physiological functions such as body temperature, sleeping and waking patterns, metabolism, and BP. The BP levels of healthy individuals repeat throughout the circadian rhythm and there is usually a decrease of more than 10% in nighttime BP levels compared to daytime BP levels.[3] Additional diseases ruled out with the exclusion criteria of this study, such as diabetes mellitus, rheumatic diseases, coronary artery disease, eating disorders, metabolic syndrome, and cancer, may also increase the susceptibility to NDP and affect the variations in BP levels, which play a role in the pathophysiology of hypertension.[39-44] Therefore, we excluded patients with potential additional diseases to more objectively evaluate the relationship between immunological nutritional status and NDP in NDHT patients.

PNI values were lower among NDHT patients with NDP. To the best of our knowledge, this is the first study investigating the relationship between PNI and NPD. In a previous study conducted in hypertensive patients, nutritional status was evaluated using the Control Nutritional Status and the Nutritional Risk Index.[45] It was found that these indices were lower in the NDP group compared to the dipper BP group. Additionally, it was reported that NRI is an independent predictor of NDP.[45] A previous study examining the effects of nutritional parameters on nocturnal BP in Turkish hemodialysis patients revealed an association between malnutrition and a disruption in the circadian BP rhythm.[46] The malnutrition score showed a positive correlation with nighttime and 24-hour BP levels, while it exhibited a negative correlation with serum albumin and anthropometric indices.[46] Therefore, it has been suggested that low serum albumin levels and hypervolemia contribute to the association between impaired nutritional status and elevated nighttime BP.[46] Serum albumin has been identified as a significant predictor of the decline in nocturnal BP, even in patients without albuminuria, proteinuria or diabetes.[47] On the other hand, there is increasing evidence to indicate that nutritional status can play a role in modulating insulin resistance, lipid metabolism, and inflammation, thus contributing to the disruption of the circadian BP rhythm.[35,48,49] This is consistent with the correlations between PNI levels and high triglycerides, low HDL-C, high BP, and high fasting blood glucose, which are important components of metabolic syndrome.

Malnutrition may also exacerbate the effects of sympathetic and parasympathetic nervous system dysfunction in addition to insulin resistance or inflammation.[6] Low serum albumin levels have been shown to be important predictors of autonomic nervous system dysfunction.[8] Some previous studies reported that levels of heart rate recovery at 1 min (HRR1), as an indicator of sympathetic and parasympathetic nervous system activation, were lower in patients with hypertensive NDP.[50,51] Moreover, the negative correlation between the TyG index and HRR1 in NDHT patients was associated with a decline in nighttime BP (%).[51] The negative correlation between the TyG index and PNI detected in the present study may indicate a possible underlying mechanism of malnutrition for both insulin resistance and autonomic function. Furthermore, the PNI was found to be an independent predictor of NDP. The diagnostic performance of the TyG index in predicting NDP was consistent with the results of a previous study with sensitivity and specificity exceeding 70%.[52] However, no significant difference was found in diagnostic performance between the PNI and TyG index in predicting NDP. The cut-off value for the PNI in predicting NDP was ≤51.3, and at this cut-off value, 72.4% of patients were classified as true positive cases. This study shows that the PNI may be an important screening tool for NDP and an important marker for potential mechanisms underlying NDP.

This study has some important limitations. First, it was retrospective in design and the sample size was relatively small. Due to the retrospective nature of the study design, it was not possible to include participants' dietary records. Incorporating dietary records could have provided more insights into the relationship between the PNI and NDP. Finally, the relationship among the PNI index, heart rate recovery, and target organ damage resulting from hypertension could not be evaluated because of the study's retrospective design.

CONCLUSION

Hypertensive patients had worse immuno-nutritional statuses than normotensive individuals. Decreased PNI values correlated positively with declines in nighttime BP and the PNI was found to be an independent predictor of NDP. The negative correlation between the PNI and the TyG index as a surrogate marker of insulin resistance suggests that hypertensive patients may be at risk of insulin resistance. Since these patients may be predisposed to NDP, the PNI may be an important screening tool for circadian BP patterns.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was initiated with the approval of the Bursa City Hospital Clinical Research Ethics Committee (Date: 04.01.2023, Decision No: 2023-1/9).

Informed Consent: Because the study was designed prospectively, informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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