Original Paper

Aging and Vascular Compliance in Hypertensive Patients Mirrored in Routine Investigations

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ABSTRACT: The global prevalence of arterial hypertension is increasing. Due to its consequences, hypertension is a leading cause of morbidity /mortality. In this regard, awareness of the importance of diagnosis as well as proper treatment of hypertension is mandatory. Objectives: This study aims to analyze vascular compliance and different pressure characteristics depending on age, along with highlighting some clinical-paraclinical correlations in people diagnosed with hypertension. We used usual laboratory analyzes and the blood pressure values obtained using ABPM/24 hr, in addition to highlighting the impact of age on those parameters. Materials and methods: The sample comprises of 99 adults diagnosed with hypertension. We divided them into 2 groups, according to age: cases sample: 52 patients (age> 60 years old) and control sample: 47 patients (age< 60 years old). Results: In the control group, RDW was correlated with the general and diurnal systolic and diastolic hypertonicity indexes and the platelet count was positively correlated only with the morning surge. The dipping profile correlates negatively with RDW. In the elderly, all three systolic blood pressure parameters are influenced by ESR and also correlate negatively with HDL, with an inverse proportional relationship. Statistically significant correlations were found between blood glucose and diurnal systolic and diastolic hypertonicity indexes. Mean Pulse Pressure correlates in the elderly with HDL (negative correlations) and in the young with RDW (positive correlations). Conclusions: Vascular compliance can be estimated with the help of HDL in the elderly and RDW in young people, considering the influence of the two parameters on pulse pressure.

KEYWORDS: *Ambulatory blood pressure monitoring/24 hours; hypertension; age; vascular compliance.*

Introduction

The global prevalence of hypertension is estimated to be around 30-45% of the world's adult population, with a predominance within the elderly population (over 60 years) and the male population [1].

After the age of 60, there is a significant shift towards female population and increased systolic pressure measurements, that is typical in elderly people [2].

From a pathophysiological point of view, the arterial hypertension represents the increase in the pressure exerted by the blood on the vascular walls, which causes the enlargement of the afterload, cardiac and vascular remodeling as well as the installation of a deficit of tissue blood flow with specific repercussions on the target organs.

The main determinants of the regulation of arterial pressure are the cardiac output and the peripheral resistance (especially the diameter and the compliance of the vessels).

Hypertensive patients have structurally altered arteries, with an increased vascular rigidity, as a result of the aging process and the continuous inflammatory mechanisms that occur at the cellular level.

Objectives of the study

This study aims to analyze vascular compliance and different pressure characteristics depending on age, along with highlighting some clinical-paraclinical correlations in people diagnosed with arterial hypertension.

At the moment, the role of inflammation in the pathophysiological mechanisms of hypertension is still unclear, on one hand being considered a consequence of vascular alterations along the aging process and on the other hand-a significant pathological process, in absence of which, high blood pressure would not occur.

In this respect, the study aims to evaluate possible correlations between the usual laboratory analyzes (complete blood count, blood glucose, lipid panel, RDW, ESR, C-reactive protein, fibrinogen, uric acid levels) and the blood pressure values (systolic/diastolic blood pressure, mean arterial pressure, pulse pressure, dipping index, morning surge), in addition to highlighting the impact of age on them.

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Materials and Methods

For this study, the data used was obtained from the 99 medical records of patients who needed specialized consultation, evaluated over a period of approximately 6 months (January-June 2021) in the Internal Medicine Department of the specialized outpatient Clinic in Bucharest (Sanacare Vital Lutheran Clinic).

The selected records belong to patients who were diagnosed with arterial hypertension based on history, physical examination, values of blood pressure at the medical center (sysBP≥140mmHg and / or diaBP≥90mmHg, in accordance with ESC/ESH 2018 Guidelines for the Management of Arterial Hypertension) or following Automated Ambulatory Blood Pressure Monitoring (sysBP≥130mmHg and/or diaBP≥80mmHg, in accordance with ESC/ESH 2018 Guidelines for the Management of Arterial Hypertension).

The study was conducted according to the guidelines of Helsinki Declaration.

After the signed informed consent was verified, the demographic data, details regarding the age, height, weight, occupation, personal pathological and heredo-collateral history, allergic history, alcohol and tobacco consumption were noted.

The records of patients who did not properly keep the blood pressure monitoring device were excluded from the study; at the same time, the records of patients who had a secondary cause of hypertension were excluded.

The diagnostic methods used for these cases were represented by the complete clinical examination, together with the blood tests (complete blood count, blood glucose, total cholesterol, HDL cholesterol, triglycerides, RDW, fibrinogen, ESR, C-reactive protein and uric acid levels) and the data obtained from the Automated Ambulatory Blood Pressure Monitoring (ABPM/24 hours), an ABPM-05 device, Meditech (Hungary) being used.

The data have previously been divided into 2 groups, according to age: cases sample: 52 patients (age>60 years old) and control sample: 47 patients (age<60 years old).

Regarding the analysis of the data, the correlation tables were made using Microsoft Excel 2018, the Pearson correlation coefficient was calculated in order to test the relation between the blood test and blood pressure values from ABPM in both samples.

For each correlation, the level of statistical significance was also calculated.

All numerical data were expressed as an average±standard deviation and all the categorical data were expressed in frequencies and percentages.

The collected variables are confidential and will not be used for any purpose other than teaching.

Results

Distribution of the entire sample by gender and age revealed a slight predominance of females and of those in the 60-70 age categories (Figure 1, Figure 2).

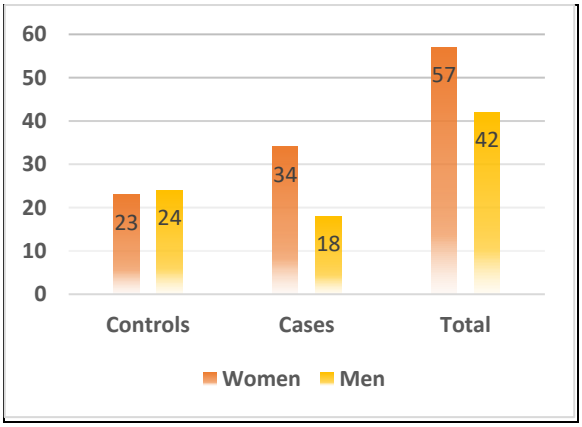

Figure 1. Distribution of the patients by gender.

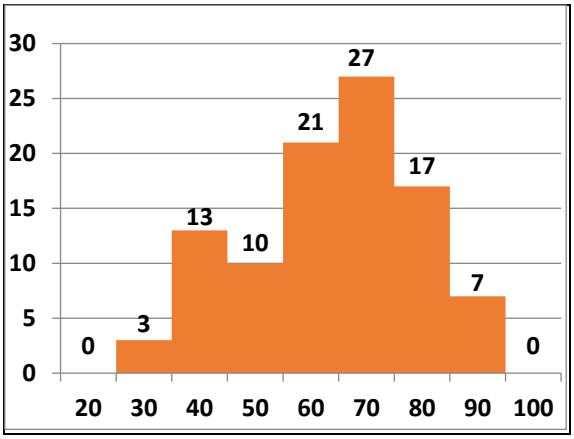

Figure 2. Distribution of the patients by age.

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Table 1. Descriptive statistics of lots.

	CONTROLS (n=47)	CASES (n=52)	P
Age (years)	45.1±10.2	71.7±7.47	*NS*
BMI (kg/m^2)	27±5.06	26.9±4.52	*NS*
sysBP at the clinic (mmHg)	139±14.3	143±16.9	*NS*
diaBP at the clinic (mmHg)	91.7±9.21	84.77±12.17	*0,026*
Total cholesterol (mg/dL)	205±45.8	195±36.7	*NS*
Triglycerides (mg/dL)	182.27±155.3	117.18±60.94	*0,048*
HDL (mg/dL)	50.79±13.20	55.42±14.9	*NS*
Blood glucose (mg/dL)	107.33±27.29	107.06±18.37	*NS*
RDW (%)	13.2±1.29	13.3±1.68	*NS*
Platelet count (10^3/dL)	267996.55±68202.32	236685.71±62777.74	*NS*
Uric acid (mg/dL)	5.71±1.73	19.83±84.42	*NS*
ESR (mm/h)	16.72±16.33	18.47±14.18	*NS*
C-reactive protein (mg/L)	1.28±2.39	1.37±2.51	*NS*
Fibrinogen (mg/dL)	332.6±86.15	345.67±84.46	*NS*
Mean general sysBP (mmHg)	139.2±8.34	128.14±12.62	*NS*
Mean general diaBP (mmHg)	76.69±7.23	69.29±7.70	*0,0001*
Mean diurnal sysBP (mmHg)	144.5±9.43	131.54±12.61	*NS*
Mean diurnal diaBP (mmHg)	81.12±8.27	72.54±8.48	*0,0001*
Mean nocturnal sysBP (mmHg)	128.69±11.67	121.37±14.95	*NS*
Mean nocturnal diaBP (mmHg)	67.81±8.57	63.14±8.40	*0,0141*
General MAP (mmHg)	97.62±5.45	88.77±7.97	*NS*
Diurnal MAP (mmHg)	102.3±6.83	91.18±9.74	*0.0026*
Nocturnal MAP (mmHg)	84.09±10.46	82.91±9.52	*NS*
General PP (mmHg)	50.16±8.23	58.58±11.29	*0,0001*
Diurnal PP (mmHg)	50.86±8.54	58.97±11.18	*0,0001*
Nocturnal PP (mmHg)	49.11±8.81	58.33±12.37	*0,0001*
Dipping index	10.84±8.30	6.91±8.67	*0,0300*
Max general sysBP (mmHg)	168.67±25.03	164.96±20.62	*NS*
Max diurnal sysBP (mmHg)	168.04±25.23	165.21±19.46	*NS*
Max nocturnal sysBP (mmHg)	139.04±26.37	144.82±18.85	*NS*
Max general diaBP (mmHg)	108.21±21.17	95.94±19.95	*0,0041*
Max diurnal diaBP (mmHg)	108.44±19.87	94.84±18.53	*0,0008*
Max nocturnal diaBP (mmHg)	83.86±10.53	80.35±13.84	*NS*
Morning surge	16.58±11.78	16.61±12.4	*NS*

*P<0,05 *NS*=statistically non-significant; MAP=mean arterial pressure PP=pulse pressure, BP=blood pressure; Sys=systolic, dia=diastolic

According to the samples, the average age of the participants in the group of young people was 45.1±10.2 years, with an approximately equal distribution between the two sexes and in the group of elderly, the average age was 71.7±7.47 years, with a predominance in females.

Regarding the blood tests of the patients (complete blood count, lipid panel, RDW, ESR, C reactive protein, fibrinogen, uric acid levels), no significant difference was encountered between the two samples (p<0,05), except for triglycerides (182.27±155.3mg/dl for the control sample and 117.18±60.94mg/dl for the cases sample, with a p-value of 0,048).

In addition, in the case of the blood pressure values obtained in the medical office by the attending physician, a statistically significant difference was found for diastolic blood pressure (91.7±9.21mmHg for the control sample and 84.77±12.17mmHg for the cases sample, with a p-value of 0,026).

For Automated Ambulatory Blood Pressure Monitoring, several parameters can be highlighted, useful both diagnostically and therapeutically or for subsequent patient management.

In this study, statistically significant differences between the two groups are shown for most diastolic parameters (76,69±7,23mmHg vs. 69,29±7,70mmHg for mean general diastolic BP, 81,12±8,27mmHg vs. 72,54±8,48mmHg for mean diurnal diastolic BP, 67,81±8,57mmHg vs. 63,14±8,40mmHg for mean nocturnal diastolic BP, 108,21±21,17mmHg vs. 95,94±19,95mmHg for max general diastolic BP, 108,44±19,87mmHg vs. 94,84±18,53mmHg for max diurnal diastolic BP).

From the point of view of systolic parameters, no statistically significant difference was found.

However, differences can be observed in the case of diurnal mean arterial pressure (MAP) and pulse pressure (PP) (102,3±6,83mmHg vs. 91,18±9,74mmHg for diurnal MAP, 50,16±8,23 mmHg vs. 58,58±11,29mmHg for general PP, 50,86±8,54mmHg vs. 58,97±11,18mmHg for diurnal PP, 49,11±8,81mmHg vs. 58,33±12,37mmHg for nocturnal PP).

However, attempts were made to find correlations between laboratory analyses and the parameters obtained from automated ambulatory blood pressure monitoring, regarding the samples (Tables 2-5).

Table 2. Correlations between uric acid values, lipid panel, blood glucose and ABPM parameters (Elderly - Cases sample).

	Uric acid	Cholesterol	Triglycerides	HDL	Blood glucose
Mean general sysBP	0.16905	-0.04164	0.31089	-0.47208	0.28390
Mean general diaBP	-0.04654	0.09981	0.31274	0.05772	0.15629
Mean diurnal sysBP	0.16753	-0.01401	0.36086	-0.47703	0.32045
Mean diurnal diaBP	-0.04547	0.14906	0.30430	0.07264	0.17249
Mean nocturnal sysBP	0.18444	-0.09472	0.17728	-0.36205	0.21656
Mean nocturnal diaBP	-0.02639	0.00664	0.21143	0.05640	0.10116
General MAP	0.08209	0.05691	0.38154	-0.18846	0.26475
Diurnal MAP	0.07366	0.27360	0.34700	-0.15720	0.02385
Nocturnal MAP	0.06427	0.00110	0.18197	-0.19694	0.09496
Mean general PP	0.21607	-0.06393	0.14951	-0.52391	0.20462
Mean diurnal PP	0.20163	-0.11972	0.14282	-0.57734	0.21708
Mean nocturnal PP	0.23513	-0.10055	0.08481	-0.49919	0.18983
Dipping BP profile	0.03673	-0.28326	-0.11054	0.05680	0.05680
General sys hypertonicity index	0.24527	0.04569	0.34871	-0.26744	0.26697
Diurnal sys hypertonicity index	0.20159	0.09751	0.35765	-0.25093	0.27811
Nocturnal sys hypertonicity index	0.28860	-0.06762	0.24367	-0.26687	0.15016
General dia hypertonicity index	-0.08776	0.07771	0.31325	-0.09673	0.23662
Diurnal dia hypertonicity index	-0.04941	0.12752	0.36595	-0.15837	0.30508
Nocturnal dia hypertonicity index	-0.10293	-0.01947	0.14598	0.12035	-0.06176
Max general sysBP	0.15901	0.02352	0.22452	-0.40540	0.13756
Max diurnal sysBP	0.16698	0.07961	0.31547	-0.41423	0.12578
Max nocturnal sysBP	0.15188	-0.09366	0.24913	-0.27032	0.19843
Max general diaBP	-0.04714	0.31300	0.14086	0.07572	-0.17797
Max diurnal diaBP	-0.03053	0.29890	0.09040	0.01831	-0.14107
Max nocturnal diaBP	-0.06735	-0.04007	0.29580	0.01398	0.16873
Morning surge	-0.04987	0.09610	0.06222	-0.03115	0.16688

Sys=systolic; Dia=diastolic; MAP=mean arterial pressure; PP=pulse pressure; ABPM=Automated ambulatory blood pressure monitoring; BP=blood pressure; *p<0,05

Table 3. Correlations between uric acid values, lipid panel, blood glucose level and ABPM measurements (Control sample).

	Uric acid	Cholesterol	Triglycerides	HDL	Blood glucose
Mean general sysBP	0.15729	0.17253	0.22852	-0.42563	0.26166
Mean general diaBP	0.32781	0.24917	0.16225	-0.31834	0.25347
Mean diurnal sysBP	0.19415	0.11949	0.26410	-0.36044	0.27469
Mean diurnal diaBP	0.34442	0.21679	0.19993	-0.21692	0.26505
Mean nocturnal sysBP	0.05120	0.21919	0.09989	-0.43209	0.19478
Mean nocturnal diaBP	0.23361	0.27433	0.02047	-0.39531	0.17853
General MAP	0.26818	0.26611	0.24003	-0.35749	0.28447
Diurnal MAP	0.28422	0.21296	0.27300	-0.26146	0.27356
Nocturnal MAP	0.13302	0.28934	0.08371	-0.37598	0.27712
Mean general PP	-0.09860	0.03308	0.22919	-0.38966	0.17616
Mean diurnal PP	-0.03763	-0.03152	0.24010	-0.38410	0.19085
Mean nocturnal PP	-0.17262	0.13433	0.16621	-0.38213	0.19753
Dipping profile	-0.10345	0.04447	-0.26055	-0.29447	-0.10855
General sys hypertonicity index	0.08361	0.17017	0.25915	-0.42529	0.22063
Diurnal sys hypertonicity index	0.14836	0.14633	0.37143	-0.42875	0.23292
Nocturnal sys hypertonicity index	0.03428	0.13522	0.09688	-0.42346	0.23383
General dia hypertonicity index	0.35470	0.24708	0.29595	-0.30966	0.22825
Diurnal dia hypertonicity index	0.33490	0.38967	0.17667	-0.23753	0.29746
Nocturnal dia hypertonicity index	0.27838	0.28650	0.14852	-0.35975	0.22132
Max general sysBP	0.06970	0.11691	0.44785	-0.18472	0.23984
Max diurnal sysBP	0.04875	0.11109	0.44938	-0.12700	0.19882
Max nocturnal sysBP	-0.006596	0.18927	0.05907	-0.37326	0.09475
Max general diaBP	-0.206185	0.16677	0.23175	0.20741	0.02542
Max diurnal diaBP	-0.204119	0.17626	0.27946	0.14334	-0.06843
Max nocturnal diaBP	0.21145	0.38783	-0.05895	-0.15464	0.05163
Morning surge	0.20052	-0.38668	0.21027	-0.14921	0.13171

Sys=systolic; Dia=diastolic; MAP=mean arterial pressure; PP=pulse pressure; ABPM=Automated ambulatory blood pressure monitoring; BP=blood pressure; *p <0,05

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From Table 2 and Table 3 it can be seen that in the elderly group, triglycerides show the most statistically significant correlations with general and diurnal blood pressure parameters (mean general and diurnal systolic BP, mean general and diurnal diastolic BP, general and diurnal MAP, general and diurnal systolic hypertonicity index, general and diurnal diastolic hypertonicity index, max diurnal systolic BP), with the exception of max systolic BP, max diastolic BP and PP parameters.

In terms of dipping profile and morning surge, no statistically significant correlations were found.

In the young group, triglycerides significantly correlated only with the max general and diurnal systolic BP values.

All correlations are positive with a directly proportional relationship.

HDL also correlates in the cases group with systolic blood pressure parameters (mean general sysBP, mean diurnal sysBP, mean nocturnal sysBP, max general systolic BP, max diurnal systolic BP) and PP parameters (mean general PP, mean diurnal PP, mean nocturnal PP), but no statistically significant correlation was found in the control sample

Total cholesterol does not correlate with any ABPM parameter, both in young and old.

In the elderly, uric acid does not correlate with any ABPM parameter.

In young people, uric acid correlates positively with mean general diastolic BP, mean diurnal diastolic BP, general diastolic BP hypertonicity index and diurnal diastolic BP hypertonicity index.

Blood glucose, on the other hand, does not correlate with any ABPM parameter in young people, but in the elderly group it shows statistically significant correlations with the diurnal systolic and diastolic BP hypertonicity index.

Table 4. Correlations between ESR, C reactive protein, Fibrinogen, RDW, Platelet count and ABPM values (Cases group).

	ESR	C reactive protein	Fibrinogen	RDW	Platelet count
Mean general sysBP	0.36490	-0.04253	0.01913	0.11241	-0.09113
Mean general diaBP	0.26999	-0.00245	-0.16622	0.24625	-0.09875
Mean diurnal sysBP	0.32905	-0.09386	-0.03908	0.01149	-0.08237
Mean diurnal diaBP	0.21591	-0.06490	-0.24595	0.11717	-0.07085
Mean nocturnal sysBP	0.38913	0.08751	0.15198	0.21224	-0.03144
Mean nocturnal diaBP	0.32472	0.14749	0.02974	0.36879	-0.03357
General MAP	0.38784	-0.02560	-0.09009	0.22789	-0.09445
Diurnal MAP	0.19019	-0.03601	-0.20807	0.06967	-0.05911
Nocturnal MAP	0.23779	0.11622	0.09485	0.35107	-0.13871
Mean general PP	0.21910	-0.04264	0.11047	-0.01189	-0.04424
Mean diurnal PP	0.15934	-0.06193	0.11638	-0.05001	-0.04646
Mean nocturnal PP	0.23409	0.00600	0.16354	0.03289	-0.02135
Dipping profile	0.18663	0.27711	0.25491	0.01855	-0.13268
General sys hypertonicity index	0.44869	0.00141	0.08155	-0.12492	0.04158
Diunral sys hypertonicity index	0.38635	-0.07076	-0.04919	-0.13785	0.03609
Nocturnal sys hypertonicity index	0.44664	0.15941	0.31133	-0.08557	0.10063
General dia hypertonicity index	0.20589	0.05202	-0.13533	0.10815	0.09892
Diurnal dia hypertonicity index	0.24508	0.01995	-0.17298	0.10210	0.15212
Nocturnal dia hypertonicity index	0.21987	0.06859	0.02976	-0.03108	-0.11283
Max general systolic BP	0.16255	-0.07915	-0.02335	-0.15412	0.03391
Max diurnal systolic BP	0.14200	-0.12485	-0.02528	-0.22605	0.09003
Max nocturnal systolic BP	0.33130	0.05419	0.21884	0.01515	-0.02761
Max general diastolic BP	0.09870	-0.07672	-0.15706	-0.15918	-0.01483
Max diurnal diastolic BP	0.12376	-0.05711	-0.24623	-0.13397	-0.11581
Max nocturnal diastolic BP	0.23937	0.02129	-0.04172	-0.05177	0.03723
Morning surge	0.08370	-0.17154	-0.39825	-0.05388	0.05682

Sys=systolic; Dia=diastolic; MAP=mean arterial pressure; PP=pulse pressure; ABPM=Automated ambulatory blood pressure monitoring; BP= blood pressure; *p<0,05

Table 5. Correlations between ESR, C reactive protein, Fibrinogen, RDW, Platelet count and ABPM values (Control group).

	ESR	C reactive protein	Fibrinogen	RDW	Platelet count
Mean general sysBP	-0.10831	-0.15976	0.21808	0.45184	-0.13824
Mean general diaBP	0.01620	0.00145	0.38522	0.30286	-0.27953
Mean diurnal sysBP	-0.13600	-0.15020	0.17671	0.54401	-0.09104
Mean diurnal diaBP	-0.00773	0.02397	0.35075	0.36227	-0.25916
Mean nocturnal sysBP	-0.05833	-0.14919	0.25855	0.18452	-0.21695
Mean nocturnal diaBP	0.08099	-0.04014	0.34850	0.10463	-0.30140
General MAP	0.02071	-0.06799	0.36984	0.38994	-0.16043
Diurnal MAP	-0.01863	-0.06392	0.32813	0.46855	-0.14453
Nocturnal MAP	0.06849	-0.09862	0.35612	0.12329	-0.23712
Mean general PP	-0.19917	-0.24723	-0.04690	0.43059	0.10004
Mean diurnal PP	-0.18165	-0.25893	-0.10174	0.50475	0.15893
Mean nocturnal PP	-0.18474	-0.18896	0.04942	0.22430	-0.05084
Dipping profile	0.02015	-0.11603	0.03244	-0.30671	0.07911
General sys hypertonicity index	-0.14763	-0.18046	0.24276	0.36643	-0.16749
Diurnal sys hypertonicity index	-0.11074	-0.18551	0.26017	0.50356	-0.03999
Nocturnal sys hypertonicity index	-0.14867	-0.13016	0.18416	0.07194	-0.22609
General dia hypertonicity index	0.08257	-0.02300	0.35312	0.33986	-0.31031
Diurnal dia hypertonicity index	0.05771	0.00067	0.25486	0.48652	-0.25905
Nocturnal dia hypertonicity index	0.18154	-0.02324	0.42852	0.07030	-0.23711
Max general systolic BP	0.08836	-0.30827	0.16771	0.47147	-0.01296
Max diurnal systolic BP	0.08824	-0.37817	0.17349	0.43371	0.02587
Max nocturnal systolic BP	0.04616	-0.06694	0.30463	0.19651	-0.21279
Max general diastolic BP	-0.00159	-0.29508	0.45875	0.13526	-0.28298
Max diurnal diastolic BP	-0.01381	-0.26507	0.46971	0.14158	-0.26472
Max nocturnal diastolic BP	0.22148	-0.08889	0.30487	0.25417	-0.20206
Morning surge	0.46676	0.00256	-0.00655	0.30006	0.39734

Sys=systolic; Dia=diastolic; MAP=mean arterial pressure; PP=pulse pressure; ABPM=automated ambulatory blood pressure monitoring; BP= blood pressure; *p <0,05

From Table 4 and Table 5, it can be seen that in the elderly group, the erythrocyte sedimentation rate (ESR) correlates positively with the mean general systolic BP, the mean diurnal systolic BP and the mean nocturnal systolic BP.

At the same time, it correlates positively with the general systolic hypertonicity index, the diurnal systolic hypertonicity index and the nocturnal systolic hypertonicity index. In young people, the only statistically significant correlation is with the morning surge.

C-reactive protein shows no statistically significant correlations.

Fibrinogen correlates negatively in the elderly only with morning surge, while in the young, it shows statistically significant correlations with most diastolic parameters (mean general diastolic BP, mean diurnal diastolic BP, mean nocturnal diastolic BP, max general diastolic BP, max diurnal diastolic BP, max nocturnal diastolic BP) and MAP parameters (mean general MAP, mean diurnal MAP, mean nocturnal MAP)

In the cases group, RDW does not correlate significantly with any ABPM value, while in the control group, RDW correlates with the majority of the most general and the diurnal parameters (except for max general diastolic BP and max diurnal diastolic BP), with the dipping profile (negative correlation) and with the morning surge (positive correlation).

Platelet count does not show any statistically significant correlations in the elderly group, while in the young group, it is only positively correlated with the morning surge.

Discussions

In this study, statistically significant differences were found between the two groups for diastolic blood pressure measured in the doctor's office and for most of the diastolic parameters obtained by ABPM (lower mean values in the elderly group).

At the same time, differences can be observed for mean diurnal blood pressure (lower mean values in the elderly group) and pulse pressure (higher mean values in the elderly group).

As for laboratory tests, only triglycerides show statistically significant difference, with a lower mean value in the elderly.

This could be explained by the fact that after the age of 60, most patients have lipid-lowering medication.

This aspect requires further research, the low value of blood triglycerides being associated in the elderly with cognitive decline [3].

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In addition, there are studies that say that triglycerides are on an upward slope until the age of 50, after which they go through a process of decline [4].

Investigating the relationship between various laboratory tests (blood count, blood glucose, lipid profile, RDW, uric acid, ESR, C-reactive protein, fibrinogen) and the parameters obtained from ABPM (overall / diurnal / nocturnal systolic blood pressure, overall / diurnal / nocturnal diastolic blood pressure, mean general / diurnal l / nocturnal systolic blood pressure, mean general / diurnal / nocturnal pulse pressure, general / diurnal / nocturnal systolic / diastolic hypertonicity index, maximum general / diurnal/nocturnal systolic / diastolic blood pressure, dipping index and morning surge), several correlations were revealed with a significant impact on arterial hypertension management.

Mean blood pressure is a variable that is strongly influenced by the diastolic blood pressure (MAP=1/3 sysBP+2/3 diaBP), so an upward change in diastolic blood pressure will cause a similar increase in mean blood pressure.

Thus, it may be easy to understand why in the cases sample, triglycerides influence not only the general and diurnal diastolic mean, but also the general and diurnal blood pressure mean.

The same directly proportional relationship is also found in control group for fibrinogen, including nocturnal parameters.

However, no statistically significant correlations were found between triglycerides and nocturnal diastolic blood pressure mean and nocturnal blood pressure mean.

In addition, triglycerides also correlate with the general systolic mean and diurnal systolic mean, which in turn influence mean arterial pressure.

Although this study previously showed that blood triglyceride values are lower in the elderly than in the young, they may be a predictor of systolic and diastolic blood pressure values in the elderly.

There are studies confirming their role in the assessment of vascular stiffness, measured by carotid-femoral pulse wave velocity or ankle-brachial index [5,6].

Fibrinogen is considered an important marker of inflammation, with previous studies highlighting its association with arterial stiffness and its role as a predicting factor in cardiovascular diseases [7].

However, our study demonstrates its usefulness in young people in predicting diastolic blood pressure values, before diastolic blood pressure suffers a decreasing process, specific to the elderly.

In young people, general diastolic and diurnal diastolic blood pressure means are also influenced by the uric acid, but these correlations do not apply to mean arterial pressure, such as triglycerides or fibrinogen.

It is possible that these correlations do not occur in the elderly, because of hypouricemic treatment.

However, it has been observed that uric acid is a strong risk factor for hypertension in those with blood pressure values at the diagnostic limit [8].

In the elderly, all three systolic blood pressure parameters (general, diurnal, nocturnal) are influenced by ESR, the latter not influencing diastolic blood pressure parameters or mean arterial pressure.

Systolic blood pressure parameters also correlate negatively with HDL, with an inversely proportional relationship in the elderly.

The only statistically significant correlations found in the elderly for the maximum systolic blood pressure are with the HDL, which has negative correlations with both overall and diurnal maximum systolic blood pressure being negative correlations.

In the young, these parameters positively correlate with RDW.

These correlations comply with our study, considering that the laboratory analyses also have statistically significant correlations with the mean parameters presented above.

Maximum nocturnal systolic blood pressure does not significantly correlate with any parameter assessed.

Maximum general and diurnal diastolic blood pressure do not correlate in the cases group with any parameter, while there is a positive correlation with fibrinogen for the control sample.

Moreover, fibrinogen also correlates positively with the maximum nocturnal diastolic blood pressure.

These correlations in turn support that fibrinogen correlates significantly with mean diastolic parameters, as this study suggests.

Mean pulse pressure is the difference between mean systolic and mean diastolic blood pressure and its normal values are between 40 and 50mmHg.

It is considered a marker of arterial stiffness, with decreased compliance and increased risk of atherosclerosis [9].

At the same time, this indicator may be an independent cardiovascular risk factor [10].

A 10mmHg increase in pulse pressure corresponds to a 20% increase in cardiovascular mortality risk for the same systolic blood pressure value.

Mean PP correlates in the elderly with HDL (negative correlations) and in the young with RDW (positive correlations).

These studies confirm existing studies in the literature, highlighting the role of RDW and HDL in arterial stiffness, along with their prognostic role in hypertensive patients [11,12].

The systolic and diastolic hypertonicity index (PTE sys/dia %) indicates the percentage of time that blood pressure values were above normal values compared to the total time.

If it exceeds 25% it is considered pathological and is assumed to be involved in predicting left ventricular hypertrophy and fatal cardiovascular events [13].

Triglycerides correlate for the cases with systolic and diastolic hypertonicity index, both the overall and diurnal parameter.

No statistically significant correlations of triglycerides with the nocturnal parameter were found in the young group as well.

In the elderly, statistically significant correlations were also found between blood glucose and diurnal systolic hypertonicity index and diurnal diastolic hypertonicity index.

At the same time, correlations were also found between ESR and all three parameters of systolic hypertonicity index.

In the control group, RDW correlated with the general and diurnal systolic and diastolic hypertonicity indices.

In addition, uric acid correlates positively with general and diurnal diastolic hypertonicity index.

Dipping profile correlates negatively in young people with RDW.

There are studies that agree with the current study in demonstrating that RDW is increased in patients with non-dipping profile [14,15].

A patient is characterized as a non-dipper if the blood pressure does not decrease by more than 10% during the night.

Red cell distribution width (RDW) is a widely used parameter, especially in the management of different types of anemia.

However, it can be a significant marker of subclinical inflammation and an important cardiovascular risk factor.

Thus, according to our study, a lower dipping index equals an increased RDW and vice versa, a bidirectional relationship that needs to be studied intensively.

Moreover, a previous study conducted by us showed the same negative correlation between the two parameters.

The current study underlines the important role of RDW, especially in young people, as it can be considered a predictor of blood pressure values in hypertensive patients.

During the morning, there is a sudden rise in blood pressure, a phenomenon known as morning surge.

In some patients, an excessive increase in blood pressure may occur during the morning and this phenomenon could be explained by certain factors such as age, carbohydrate metabolism disorders, alcohol consumption, smoking or physical and emotional stress [16,17].

An important role is played here by the baroreceptors, observing a reduction in their activity in both elderly and young healthy patients but with an exaggerated "morning surge" [18,19].

Many researchers have tried to highlight the role of morning surge in increasing cardiovascular risk, but there are few studies to prove its involvement in the vascular inflammatory response or in the instability of atheroma plaques [20].

In our study, morning surge does not correlate significantly with any parameter within the elderly group.

In young people, morning surge shows positive correlations with RDW, confirming once again the importance of determining RDW in people diagnosed with hypertension.

The lack of statistically significant correlations for protein C could be explained by the non-use of highly sensitive C-reactive Protein (hsCRP) in the study.

This can be measured up to levels of 0.3mg/L (unlike the classical C protein which is detectable in the blood at levels of 3-5mg/L), thus being a more appropriate indicator of the characterization of a low intensity inflammation.

In addition, a clinical study revealed a positive correlation between the highly sensitive C Protein and the intima-media carotid artery thickness, an important marker of atherosclerosis and subsequently hypertension [21].

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Conclusions

In the elderly, triglycerides, HDL and ESR are predictive factors of systolic blood pressure values.

Triglycerides can also be used as a predictive factor of diastolic blood pressure values.

Vascular compliance can be estimated with the help of HDL in the elderly and RDW in young people, considering the influence of the two parameters on pulse pressure.

RDW can be used as an important predictive factor of blood pressure values in hypertensive young patients.

At the same time, RDW is increased in patients with a "non-dipping" profile and in those with morning surge phenomenon.

Authors' contributions statement

Corina Ferdoschi and Răzvan Balan had equal contributions to the manuscript.

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Conflict of interests

None to declare.

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