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Research paper

Relationship between alexithymia and variability of blood pressure measured with ABPM in hypertensive patients

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ABSTRACT

Objective: Studies indicates that dysregulation of emotions plays an important role in the etiology of elevated blood pressure (BP). One of the signatures of emotional dysregulation is alexithymia defined as an impaired ability to experience and express emotions. Previous work indicated that primary hypertension (HT) is marked by higher alexithymia, but little research examined the relationship between alexithymia and variability of evaluated BP with 24 h Ambulatory Blood Pressure Monitoring (ABPM) in HT patients.

Method: Fifty-five participants diagnosed with hypertension and a matched group of thirty-nine healthy participants filled in The Toronto Alexithymia Scale (TAS-20), a clinical-demographic questionnaire, and were assessed with 24 h ABPM.

Results: After removing those with white coat HT, as expected, hypertensive individuals had a higher total score and all three alexithymia subscales. Furthermore, alexithymia was positively correlated with average values of systolic BP.

Conclusion: These findings provided support for the contention that alexithymia is associated with elevated BP, the higher level of alexithymia the higher systolic BP in 24 h BP measurement. Future studies may examine the causal relationship between alexithymia and HT and evaluate the effectiveness of emotional regulation training interventions to reduce BP in people suffering from primary hypertension.

1. Introduction

Hypertension (HT) is an important public health concern, given that it affects 1.13 billion people worldwide [1]. It is marked by an adrenergic dysregulation, manifested by an increased level of noradrenaline in plasma and increased muscle tone due to hyperactivity of the sympathetic nerves [2]. Importantly, psychological factors such as alexithymic personality traits are linked to emotional dysregulation (e.g., [3]), which results in a dysregulation of the autonomic nervous system. In line with this assumption, research shows a high correlation ($r = 0.8$) between alexithymia and the norepinephrine/cortisol ratio in males [4]. Excessive activation of the sympathetic nervous system may cause, among others, exaggerated responses of heart rate and blood pressure to psychological stimuli [5]. Indeed, experimental psychophysiological studies documented an increased resting sympathetic tone in alexithymic individuals or a greater heart rate or blood pressure (BP) reactivity to stressors (for review see [6]). Alexithymia, or emotional blindness, manifests in the form of difficulties in identifying and expressing feelings, difficulties in distinguishing emotions from bodily sensations, and an externally oriented style of thinking [7,8]. These qualities are thought to reflect deficits in the regulation of emotions and cognitive processing and to contribute to the onset or maintenance of numerous medical and psychiatric disorders [9]. For example, elevated levels of alexithymia were found in people with psychiatric problems, including depression [9–11], bipolar disorder, and schizophrenia [12]. Moreover, higher levels of alexithymia were reported in psychosomatic conditions, such as chronic pain [13,14], somatoform disorder [15], inflammatory bowel disease [16], and hypertension [17]. Alexithymia was found to be positively associated with older age, low socioeconomic status, and lower level of education [18], and it is more prevalent among men than among women (9–17% and 5–10% of working-age population, respectively) [9].

As Mann [19] pointed out, psychosomatic research in HT is marked by the inconsistency of results from study to study, which could be attributed, first of all, to the inaccurate diagnosis of HT. The traditional and still common auscultatory technique for the assessment of BP is not only inaccurate, but it also provides merely a 'snapshot' of BP behaviour in circumstances that may adversely affect the level of BP [20]. Ambulatory blood pressure monitoring (ABPM) provides the average of BP readings over a 24-h period. It allows for measurement of BP in real-life settings and at night [21]. ABPM is a method recommended for out-of-office BP measurement and allows for the identification of suspected white-coat or masked HT [21]. ABPM is a better predictor than office BP of HT-mediated organ damage [22] and future cardiovascular outcomes including myocardial infarction or stroke [23,24]. Participants with a reduced night-time dip in BP face an increased cardiovascular risk [25]. Although previous

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Table 1
Demographic characteristics of the sample.

	Hypertensive group (n = 39)	Non-hypertensive group (n = 37)	Group differences
Age	42.86 (SE = 13.53)	36.67 (SE = 11.47)	t = 2.13*
Gender (females)	23	26	Chi^2 = 1.36
Level of education			
Primary education	3	1	Chi^2 = 2.14
Secondary education	16	12	
Higher education	19	24	
Overweight (BMI > 30)	11	2	Chi^2 = 6.99**
Marital status			
Married	23	17	Chi^2 = 3.59
Not married	13	18	
Widowed	1	0	
Divorced	1	0	

Note:
** $p < 0.01$.
* $p < 0.05$.

research has established an association between alexithymia and HT, we are aware of only one study exploring the link between alexithymia and BP as measured with ABPM; furthermore, this study was published in a non-English language journal [26].

Therefore, the aim of the present study was to investigate the relationship between alexithymia and repeated 24-h measurement of blood pressure with ABPM in participants with primary HT and in a control group of healthy individuals. Based on previous research, we hypothesized that: (1) hypertensive participants would have elevated levels of alexithymia compared to those of healthy control individuals; (2) the level of alexithymia would be positively associated with BP; (3) diurnal and nocturnal BP would be associated with alexithymia; and finally, (4) individuals with a low (non-dippers: below 10%) nocturnal drop of BP would have elevated alexithymia compared to the individuals with a high (dippers: at least 10%) nocturnal drop of BP.

2. Method

2.1. Participants

The following two groups of participants were examined: individuals with primary HT (hypertensive group) and healthy controls (non-hypertensive group) recruited from hypertension clinics and community, respectively. Participants with primary hypertension were recruited among people applying for ABPM in a university hypertension clinic. Healthy subjects were recruited through online advertisements and announcements. The exclusion criteria included the co-occurrences of HT comorbidities such as diabetes, myocardial infarction, cerebral stroke history, or renal insufficiency.

2.1.1. Hypertensive group

Fifty-five participants diagnosed with primary HT (29 women and 26 men, age range: 19–67, M_{age} = 42.1; SD = 13.42) were tested.

70.9% of participants with primary HT declared that they were treated for HT (N = 39) and 63.6% declared that they regularly took medications for HT prescribed by physicians (N = 35), with the mean number of medications M = 2.18 (SD = 1.734). The duration of HT ranged from 0 to 35 years (M = 6.819, SD = 6.767), and the length of pharmacological treatment for the disease ranged from 0 to 20 years. Among the hypertensive group, 11 participants (5 women and 6 men) were suspected to have white-coat HT. Their raised BP was found in a doctor's office when using the auscultatory technique, whereas in the ABPM assessment, we found their mean daytime SBP to be <135 and DBP <85. The white-coat effect group was excluded from the analyses. We also excluded 5 HT participants who did not take medications.

A total of 39 HT participants were qualified for the study (23 females, M_{age} = 42.86; SD = 13.53). This group included those individuals who took hypertensive drugs. The body mass index (BMI) of people suffering from HT was higher than that of people in the control group (see Table 1), which is consistent with the high comorbidity of HT and obesity (e.g., [27]).

2.1.2. Non-hypertensive group

This group included 37 healthy participants (26 females, age range 18–62, M_{age} = 36.67, SD = 11.47).

2.2. Measures

2.2.1. Ambulatory blood-pressure monitoring (ABPM)

Pickering et al. [28] encompassed taking BP measurements every 20 min during the day (6:00 a.m. to 10:00 p.m.) and every 30 min at night (10:00 p.m. to 6:00 a.m.). ABPM allows for assessment of systolic and diastolic BP, heart rate and also, night (sleeping time) drop in BP. In the present study, the daytime activity and night-time BP (individual sleeping hours) data were measured for each participant. The use of this procedure increases the reliability of measures and provides a more accurate differentiation between the average and the highest BP values during the sleep period and during daytime activities. Altogether, approximately 60 BP measures were collected during 24 h for each individual. Each participant wore a special cuff on the non-dominant arm and a small digital BP device on the waist belt. The BP device was connected to the cuff around the participant's upper arm. The device is small enough to not interfere with the participants' normal functioning during day and night.

2.2.2. The Toronto alexithymia scale (TAS-20)

Bagby et al. [29] and Taylor et al. [30] were used to measure alexithymia. TAS-20 has three scales: Difficulty Describing Feelings (DDF), Difficulty Identifying Feelings (DIF), and Externally-Oriented Thinking (EOT). The total score internal validity of the Polish TAS-20 version was good (*Cronbach's* α = 0.882), the same for the Difficulty Describing Feelings subscale (*Cronbach's* α = 0.750), Difficulty Identifying Feelings subscale (*Cronbach's* α = 0.815), and Externally-Oriented Thinking subscale (*Cronbach's* α = 0.650). TAS-20 was used, inter alia, in a study on the psychological aspects of HT [17]. Other research confirms that TAS-20 is applicable to intercultural research and that alexithymia can be regarded as a universal trait that extends beyond cultural differences [30].

In the current study, of all participants, based on the cutoffs (TAS > 60) introduced by Bagby, Taylor and Parker [29,31] for alexithymia, there were 7 alexithymic individuals in the hypertensive group (17.9%), compared to two participants in the control group (5.41%).

2.2.3. The clinical and demographic questionnaire

Included information about diseases co-occurring with HT, such as cerebral stroke, heart attack and diabetes, sleeping time at night with ABPM, weight, height, and demographic data: age, gender, education level. Table 1 presents summary statistics for these variables.

2.3. Procedure

After being presented with information about the study, participants signed the informed consent form. Next, they were equipped with the ABPM device for 24 h. At home, participants filled in the TAS-20 scale and provided demographic and clinical information. After 24 h, the ABPM device and questionnaires were collected back at the laboratory. The institutional review board (IRB) of the authors' institution approved the research procedure.

2.4. Statistical analysis plan

The group differences in alexithymia were analysed using Student's

Table 2
Group differences in the average level of alexithymia and correlation coefficients between alexithymia (total score and subscales) and daytime activity and night-time (sleeping time) systolic (SBP) and diastolic blood pressure (DBP).

	Group comparisons			Pearson's correlation				
	Hypertensive mean (SE)	Non-hypertensive mean (SE)	*t*-Test (74)	Cohen's d	SBP daytime	DBP daytime	SBP night-time	DBP night-time
TAS	48.33 (2.21)	37.59 (1.98)	3.61***	0.828	0.265*	0.147	0.181	0.157
DDF	13.05 (0.75)	10.57 (0.74)	2.35*	0.539	0.228*	0.120	0.152	0.163
DIF	17.00 (1.09)	12.95 (0.86)	2.91**	0.695	0.244*	0.152	0.170	0.138
EOT	18.28 (0.86)	14.08 (0.71)	14.08***	0.934	0.216[t]	0.106	0.147	0.110

Note: TAS: total alexithymia score, DDF: difficulty describing feelings, DIF: difficulty identifying feelings, EOT: externally-oriented thinking.
[t] $p = 0.06$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

t-test for independent variables, along with Cohen's *d* indicating the strength of relationship between alexithymia and primary hypertension. The ABPM data (hypertensive and non-hypertensive group) were conceptualized as a two-level model: ABPM measures (daytime activity vs. night-time activity) were nested within persons. The data were analysed using multilevel models with the HLM program [32]. The analyses followed the guidelines and procedures described by Nezlek [33].

3. Results

3.1. Group differences in alexithymia

In line with the first hypothesis, there were statistically significant differences in the average level of alexithymia (TAS total score) between the healthy controls and the primary hypertensive group ($t(74) = 3.61$; $p < 0.001$; Cohen's $d = 0.828$). The mean level of alexithymia in participants with primary HT was higher ($M = 48.33$, $SD = 13.77$) than among healthy controls ($M = 37.59$, $SD = 12.09$). Cohen's *d* coefficient indicated a medium relationship between alexithymia and primary HT. The results for TAS scales are presented in Table 2.

As the 2nd hypothesis predicted, there were statistically significant positive correlations between the level of alexithymia (total score and subscales, except for the Difficulty Identifying Feelings subscale) and daytime and night-time systolic values (Tables 2 and 4). The correlations indicated that higher alexithymia levels were related with higher 24-h SBP values. Diastolic blood pressure was not related to alexithymia and its subscales.

3.2. Descriptive statistics of blood pressure

We started with unconditional models (no predictors at either level of analysis). These models estimated the mean blood pressure and the variance for each level of analysis. The model (1) is shown below.

$$\text{Within-person (level-1) ABPM} = \beta_{0k} + r_{jk}$$
$$\text{Between-person (level-2) } \beta_{0k} = \gamma_{00} + u_{0k}$$

There were *j* ABPM measurements nested within *k* persons. The variance of r_{0jk} is the within-ABPM (level-1) variance and the variance of u_{00k} is the between-person variance. Mean SBP was 119.61 and DBP was 73.86. The results indicated that DBP showed more variability within individual (level-1) ambulatory blood pressure measurements (DBP = 110.43) than between persons (level-2; DBP = 72.43). However, the variance for SBP was similarly distributed among levels of analysis (within-ABPM SBP = 163.37; between-person SBP = 159.09), which suggested higher possibility of between-person differences in systolic rather than diastolic blood pressure.

Table 3
Group differences in blood pressure during daytime activity and night-time.

	Mean (SE)		Comparison
Blood pressure	Control	Hypertensive	χ^2
Systolic			
Daytime activity	114.65 (1.33)	131.58 (1.78)	58.51***
Night-time	99.43 (1.43)	117.16 (1.98)	52.56***
Diastolic			
Daytime activity	72.27 (1.05)	81.88 (1.34)	31.84***
Night-time	58.57 (0.98)	68.93 (1.46)	34.85***

Note:
*** $p < 0.001$.

Table 4
Relationships between alexithymia and blood pressure.

	Systolic blood pressure		Diastolic blood pressure	
Alexithymia	Coeff. (*SE*)	*t*-Test	Coeff. (*SE*)	*t*-Test
Daytime activity				
TAS	3.36 (1.42)	2.36*	1.28 (1.19)	1.07
DDF	2.92 (1.45)	2.01*	1.04 (1.10)	<1
DIF	3.13 (1.48)	2.12*	1.36 (1.24)	1.09
EOT	2.72 (1.39)	1.96*	0.90 (1.08)	<1
Night-time				
TAS	3.54 (1.41)	2.51*	1.54 (1.09)	1.39
DDF	3.37 (1.49)	2.27*	1.66 (1.08)	1.54
DIF	2.61 (1.51)	1.73[a]	1.18 (1.13)	1.05
EOT	3.49 (1.42)	2.45*	1.25 (1.09)	1.15
Final model				
Daytime activity				
Group	8.22 (1.11)	7.43***	4.93 (0.82)	5.99***
TAS	0.38 (1.16)	<1	−0.49 (1.09)	<1
Group × TAS	−1.44 (1.16)	1.24**	−0.97 (1.09)	<1
Night-time				
Group	8.72 (1.29)	6.73***	5.28 (0.91)	5.79***
TAS	0.28 (1.15)	<1	−0.39 (0.97)	<1
Group × TAS	−0.54 (1.15)	<1	−0.74 (0.97)	<1

Note: TAS: total alexithymia score, DDF: difficulty describing feelings, DIF: difficulty identifying feelings, EOT: externally-oriented thinking.
[a] $p < 0.09$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

3.3. Group differences between daytime and night-time blood pressure

Next, we examined differences between primary hypertensive and healthy controls in their mean daytime and night-time blood pressure. To estimate differences in blood pressure between daytime activity and night-time, we added two dummy coded predictors (1, 0) at the level-1 model

(day and night), and we dropped the intercept from the level-1 equation (see [33], p.100). The between-group differences were also estimated by adding two dummy coded variables defining control and hypertensive groups to the person-level model, as shown in the model (2) below.

Within-person (level-1)
$SBP = \beta_1 (day) + \beta_2 (night) + r$
Between-person (level-2)
$\beta_1 = \gamma_{11} (Control) + \gamma_{11} (Hypertensive) + u_1$
$\beta_2 = \gamma_{21} (Control) + \gamma_{22} (Hypertensive) + u_2$

As expected, the analyses showed significant between-group differences both, in daytime and night-time activity blood pressure values (Table 3). The primary hypertensive group had systematically higher blood pressure values compared to those of the healthy controls.

3.4. Relationship between alexithymia and blood pressure

Our third prediction concerned the positive relationship between the level of alexithymia and daytime and nocturnal blood pressure (see also [34]). In order to examine this relationship, we added to the model a standardized alexithymia variable as a person-level predictor (see Table 4).

As predicted, alexithymia turned out to be a significant predictor of systolic blood pressure values. Higher alexithymia scores correlated with higher systolic blood pressure measurements both during the day and during sleeping time. This was true for the total score of alexithymia as well as for its subscales, except for the Difficulty Identifying Feelings subscale, which only at statistical tendency level was related to daytime SBP. Alexithymia was not related to DBP.

At the next step, we tested a model with group and alexithymia included as person-level predictors of blood pressure values, along with their interaction term (see Table 4). The interaction term was added uncentered, and it was calculated by multiplying the contrast coded variable defining the group (code: −1 for controls, +1 for hypertensive individuals) by standardized values of the total alexithymia score. When group and alexithymia were introduced together into the model, only the group significantly predicted blood pressure values.

Within-person (level-1)
$SBP = \beta_1 (day) + \beta_2 (night) + r$
Between-person (level-2).
$\beta_1 = \gamma_{10} + \gamma_{11} (group) + \gamma_{12} (alexithymia) + \gamma_{12}(interaction) + u_1$
$\beta_2 = \gamma_{20} + \gamma_{21} (group) + \gamma_{22} (alexithymia) + \gamma_{23} (interaction) + u_2$

3.5. Relationship between alexithymia and nocturnal drop of BP

Finally, we verified the 4th hypothesis, whether individuals with low nocturnal drop of BP (non-dippers) have elevated level of alexithymia compared to individuals with high nocturnal drop of BP (dippers). In both the HT and control group we counted the numbers of individuals who exhibited at least a 10% drop of BP (dippers) and of those who exhibited a drop of BP below 10% (non-dippers). We found a higher percentage of non-dippers ($n = 17$; 43.6%) and lower percentage of dippers ($n = 22$; 56.4%) in the HT group in comparison to the control group ($n = 10$; 27% and $n = 27$; 73%, respectively). We did not find significant differences in alexithymia between dippers ($M = 43.55$, $SD = 14.70$) and non-dippers ($M = 42.29$, $SD = 12.79$), ($t(74) = 0.372$; $p = 0.711$).

4. Discussion

The relationship between alexithymia and variability of blood pressure was investigated using the 24-h ABPM method for participants with primary HT and for healthy controls. The following hypotheses were addressed: (1) hypertensive participants would have elevated levels of alexithymia and its subscales compared to those of healthy controls; (2) the level of alexithymia would correlate positively with BP; (3) daytime and nocturnal BP would be associated with alexithymia; and finally, (4) individuals with low nocturnal drops of BP would have elevated alexithymia compared to that of others. Only the last hypothesis was not supported by our data.

In line with our prediction, hypertensive individuals exhibited elevated levels of alexithymia compared to those of the control group. Jula et al. [34] similarly reported higher TAS-26 scores in newly diagnosed, untreated hypertensive individuals, compared with normotensive controls (TAS-26 is an earlier version of the TAS-20). Although alexithymia has been conceptualized as a dimensional construct (see [35]), categorization for alexithymic and non-alexithymic individuals may be useful for statistical purposes. Hypertensive participants were also more frequently alexithymic than normal control individuals (17.9% compared to 5.41%, respectively). Our results corroborate the findings of four previous studies on an association between alexithymia and HT [17,34–37]. For example, Todarello et al. [37] reported that 55% of alexithymic individuals belonged to an HT group compared with 16% of alexithymic individuals in a healthy control sample. Such categorization has clinical utility, however it should be used with caution.

Historically, psychosomatic studies in HT focused mainly on consciously experienced negative emotional reactions, particularly anger and anxiety, whereas little work has been done to assess the relationship between blood pressure and emotions that are not consciously experienced [19]. Although it is a point of debate, as some researchers consider alexithymia a neuropsychological state caused by brain dysfunction [38], this construct is often understood as a personality concept related to repression [39]. Our results contribute to the growing evidence that elevation of blood pressure can be related to low emotional awareness, an emotional dysregulation that has an impact on autonomic nervous system dysfunctions.

Our findings expand on previous research by evidencing that alexithymia is positively related to daytime systolic blood pressure values in both hypertensive and normotensive individuals. This was true for the total score of alexithymia as well as for its three subscales: Difficulty Describing Emotions, Difficulty Identifying Feelings, and Externally-Oriented Thinking (at the tendency level). Alexithymia was not significantly related to daytime and night-time DBP. We believe that the lack of significance in this correlation can be explained by the lower variability of DBP values in comparison to SBP. Importantly, when group (HT vs. healthy participants) and alexithymia were introduced into multi-level modelling analysis as predictors of blood pressure values, only group was found to be a significant one.

The current study has certain limitations. Although we have documented that alexithymia is associated with HT, our study is cross-sectional in nature and cannot prove the causality of the reported association. Future studies may benefit from the evaluation of longitudinal effects of alexithymia on the incidence and course of HT. Other limitations involve the relatively small sample size and the fact that the non-hypertensive group was significantly younger than the hypertensive group. Other physiological and psychological phenomena (e.g., anxiety, depression) were not measured and we cannot rule out the possibility that they had an impact on the present findings. Interestingly, alexithymia predicted SBP values in the HT group, even though all of the patients regularly took medication for HT. Data regarding drug adherence were not collected in this study. There are some indications that alexithymia has negative effects on drug adherence in several medical conditions, for example, asthma [40]. It has recently been shown that the majority of studied individuals in treatment-resistant HT were poorly or non-adherent, and that these patients were characterized by elevated alexithymia [41]. Future studies should evaluate the association of alexithymia, drug adherence, and BP control in HT (e.g., [42]).

Finally, future research may benefit from including white-coat hypertension individuals and comparing them with non-hypertensive and hypertensive ones. White-coat hypertension individuals were found to have a priori increased cardiovascular reactivity to mental stimuli. This line of research has great potential since white-coat hypertension is associated with negative outcomes greater than those in non-hypertensive individuals [43].

Despite these limitations, our study provides more insight on important issues regarding the link between emotional dysregulation in the form of alexithymia and primary HT. These results highlight the importance of conducting further longitudinal, observational, and intervention research to better understand the predictive role of alexithymia and poor emotional awareness in relation to the risk of primary HT and its evolution. Future studies should evaluate behavioural interventions intended to target emotional awareness and to increase adaptive emotional regulation in hypertensive individuals. In subsequent studies, it would be important to check whether emotional regulation training would translate into better control of BP in participants suffering from primary HT.

5. Conclusion

In summary, the current results demonstrate statistically significant differences in the levels of alexithymia between hypertensive and control individuals, and a significant positive correlation between alexithymia and SBP values in both groups. To conclude, emotional dysregulation in the form of alexithymia (i.e., poor ability to identify, experience, and express emotions) is associated with increased blood pressure. Future studies should establish if knowledge of patients' level of alexithymia would help to guide our understanding of health status and of responses to treatment of hypertension.

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