

**Patterns of Blood Pressure and Stress: A Descriptive Report among Anesthesiology Residents**

**Institution**

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**Abstract**

**Background** There has been an increase in health problems among physicians due to low primary care maintenance, noncompliance with recommendations for physical activity and balanced eating practices, high levels of caffeine intake, and reduced amount of sleep. We hypothesize that physical health, specifically blood pressure (BP) control, is suboptimal among anesthesiology residents.

**Methods** The purpose of this study is to investigate the prevalence of hypertension and stress among an anesthesiology resident population, and attempt to correlate possible hypertension and increased stress among residents with life and work environment factors. All University of Miami anesthesiology residents in the year 2016 were invited to participate. Blood pressures were taken and anonymous surveys, including demographic and lifestyle questions, were administered.

**Results** Of 85 invited residents, 80 (92%) participated. 18 (22.50%) residents had blood pressures within the normal

range. Twenty (25.00%) residents were hypertensive and 42 (52.50%) were pre-hypertensive. Males exhibited higher systolic blood pressures than females ( $p < 0.0001$ ). The mean Perceived Stress Scale (PSS) for all residents was  $17.16 \pm 7.2$ . Fifty-four (67.50%) residents scored a PSS above 13, indicating stress levels greater than the national average. Thirty-three (41.25%) residents scored above 20, indicating the presence of severe stress. Females were more likely than males to have stress ( $p = 0.0314$ ). Residents sleeping less than 6 hours per night were more likely to have stress ( $p = 0.0158$ ). Residents reporting more than one overnight call per week were also more likely to have stress ( $p = 0.013$ ).

**Conclusions** Our study showed 75% of residents have hypertensive disease and 68% of residents exhibit clinically significant stress. These findings emphasize the need for greater attention to personal health and well-being.

**Introduction**

There has been an increase in health problems among physicians due to low primary care maintenance, noncompliance with recommendations for physical activity and balanced eating practices, high levels of caffeine intake, and reduced amount of sleep. These findings are even more noteworthy in physicians who work greater than 65 hours per week<sup>1,2</sup>. We hypothesize that physical health,

specifically blood pressure (BP) control, is suboptimal among anesthesiology residents. Anesthesiology residents represent a unique population group in their third to fourth decade of life, often involved in high-intensity, fast-paced, critical medical care of severely ill patients on a daily basis. Many factors during residency, such as long work hours, personal life events, and difficulty accessing medical care may impede the ability of physicians to care for themselves physically and emotionally.

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Much of an anesthesiology resident's time is spent learning in the operating room (OR) with a high mental workload during short bursts of critical activity. The practice of anesthesia has often been described as "99% boredom and 1% absolute panic"<sup>3</sup>, with "sustained vigilance" always required<sup>4</sup>. Emotional and physical exhaustion, long working hours, and unpredictable schedules are common stressors that plague residents in all fields of training. However, stressful issues specific to anesthesiology residents include complex OR work conditions, unremitting care of critically ill patients, , and a constantly evolving work environment. Additionally, OR culture can be fraught with interpersonal strain and communication mishaps between supervising anesthesiology faculty, residents, nurses, surgeons, technicians and other ancillary staff members.

Increased BP as a result of occupational stress has been previously studied in physicians. Adams et al. demonstrated an increase in BP in emergency room physicians during night shifts when the workload was increased, and clinical support staff decreased<sup>5</sup>. While the study only had twelve participants, the statistically significant increase in BP helps to illustrate the common stressors that are found throughout multiple medical specialties and the adverse effects they can have on a physician's health. Similarly, in a larger sized study of 375

medical and surgical residents, Leventer-Roberts et al. found that nearly 25% of their study participants exhibited hypertension<sup>2</sup>. Additionally, 34% of the study participants had a BMI that classified them as overweight. These two studies speak volumes to the health concerns facing residents in training.

Cause-specific mortality risks to anesthesiologists have been well studied, with special attention paid to substance abuse and suicide<sup>4,6</sup>. However, there remains a paucity of information on how the Anesthesiology specialty is managing the overall health of their trainees. The purpose of this study is to investigate the prevalence of hypertension and stress among an anesthesiology resident population, and attempt to correlate possible hypertension and increased stress among residents with life and work environment factors. We hypothesize that physical health, specifically blood pressure (BP) control, is suboptimal among anesthesiology residents.

## Methods

### *Setting, Participants, and Data Collection*

Approval was obtained from the University of Miami Miller School of Medicine Institutional Review Board. Study participants included all anesthesiology residents in their post-graduate years (PGY) of training (PGY-2, PGY-3 and PGY-4). Participation was anonymous, all data was de-identified, and no compensation was provided for participation. Of note, this was a convenience sample as anesthesiology residents were readily available for participation.

Of the 85 invited residents, 80 participated. The study team took all BP measurements during a weekly afternoon lecture series over the course of four weeks. Subjects were seated for five minutes prior to the measurement and two readings were taken over a 5-minute time frame and averaged. For consistency, the first reading was taken on the subject's right arm and the second reading on the left arm. A GE Dinamap Carescape V100 monitor (General Electric Company,

Chicago, Illinois) was used for all subjects. Hypertension was defined as a systolic BP  $\geq$  140 mmHg, or as a diastolic BP  $\geq$  90 mmHg. Prehypertension was defined as a systolic pressure between 120-139 mmHg, or a diastolic pressure between 80-89 mmHg. BP parameters were taken from the American Heart Association (AHA) recommendation for BP measurement<sup>7</sup>.

Survey information included demographic questions about a history of hypertension, age, gender, race, and height and weight. Being “overweight” was defined as a body mass index (BMI) between 25 and 30 kg/m<sup>2</sup>, and “obese” when BMI was over 30 kg/m<sup>2</sup>. Brief questionnaires, found in Appendix 1, were developed utilizing questions from the Behavioral Risk Factor Surveillance System Questionnaire created by the Center for Disease Control (CDC) to assess eating habits, physical activity, smoking, inadequate sleep, caffeine intake and weight gain. The survey was completed immediately after blood pressure measurements were taken and submitted in a secure lockbox to maintain anonymity and confidentiality.

#### *Perceived Stress Scale*

Stress levels were evaluated utilizing the Perceived Stress Scale (PSS), which is the most widely accepted tool for measuring the perception of stress<sup>8</sup>. The PSS consists of 10 questions referring to stress experienced over the past month. A 5-point scale was used ranging from never (0) to almost always (4). A score of 13 is the national United States average stress level, with a score of 20 considered high stress<sup>8</sup>. The PSS can be found in Appendix 1.

#### *Alcohol Audit*

The Alcohol Use Disorders Identification Test (AUDIT), developed by the World Health Organization, was used to identify residents with hazardous and harmful patterns of alcohol consumption<sup>9</sup>. The test is scored from 0-40 with scores of 0-7 indicating low risk drinking, 8-15 indicating risky or hazardous drinking, 16-19 indicating high risk or harmful drinking, and 20 or above indicating definite high

risk with high likelihood of alcohol dependency. AUDIT scores have been validated and found to correlate significantly with the Michigan Alcohol Screening Test and MacAndrew Alcoholism Screening Tests<sup>10</sup>. The AUDIT can be found in Appendix 1.

#### *Statistical Analysis*

All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC) with statistical significance set at  $P < 0.05$ . Descriptive statistics were used to summarize the variables of interest. Means and standard deviations were used for continuous variables and frequencies and proportions were used for categorical variables. Associations were examined between certain demographics and two outcomes: BP and PSS. Categorical data were compared by chi-square or Fisher's exact tests and continuous variables by ANOVA. Categorical data are presented as N (%), parametric data as mean  $\pm$  standard deviation.

## **Results**

#### *Demographics*

Of the 85 residents eligible for this study, 80 (92%) participated. Table 1 provides the complete baseline demographics and resident wellness outcomes of responding residents. Table 2 illustrates the association of resident demographics and BP and PSS.

#### *Blood Pressure*

The majority of residents in our study population demonstrated either prehypertension or hypertension. Only 18 (22.50%) residents had blood pressures within the normal range. Twenty (25.00%) of our residents were hypertensive and 42 (52.50%) were pre-hypertensive. Males exhibited higher systolic BPs than females (135.6 vs 122.4 mmHg,  $p < 0.0001$ ). There was no significant BP difference between PGY levels ( $p = 0.8425$ ).

### *Stress*

The mean PSS for all residents was  $17.16 \pm 7.24$ . Fifty-four (67.50%) residents scored a PSS above 13, which indicates their stress levels are greater than the national average. Thirty-three (41.25%) residents scored above 20, implying the presence of severe stress. Females were more likely than males to have higher stress scores (19.59 vs 15.92,  $p=0.0314$ ). Residents sleeping under 6 hours per night also scored higher (19.10 vs 15.23,  $p=0.0158$ ). Scores were also elevated for residents reporting more than one overnight call per week (19.21 vs 15.22,  $p=0.013$ ). There was no significant difference in PSS among the different PGY levels ( $p=0.2602$ ). However, there was a trend toward lower stress levels in PGY4 residents compared to PGY2 and PGY3 residents.

### *Exercise and activity*

Residents, on average, reported performing moderate to vigorous intensity exercise for at least 30 minutes  $2.61 \pm 1.83$  days per week. Thirty-seven residents (46.25%) exercise 2 days or less, and 43 residents (53.75%) reported exercising 3 days or more per week. Residents indicated sedentary activity for an average of  $5.97 \pm 3.70$  hours per day. There was no significant difference in BP ( $p=0.3055$ ) or stress levels ( $p=0.7363$ ) found in residents who exercised 3 days or greater a week compared to those who exercised 2 days or less a week.

### *Sleep*

Resident sleep time ranged between 4-9 hours per night. Forty (50%) residents indicated that they sleep, on average, less than 6 hours per night. Thirty-seven (46.25%) residents reported that their performance suffered 2 or more days per week in the operating room due to inadequate sleep. Fifty-four (67.5%) residents responded that their mood suffered 2 or more days per week due to lack of sleep. There was no significant difference in BP measurements in residents that slept less than 6 hours per night compared to residents that slept greater than 6 hours per night ( $p=0.6952$ ). However, there were significantly higher stress levels in residents that

slept less than 6 hours per night compared to residents that slept greater than 6 hours per night (19.10 vs 15.23,  $p=0.0158$ ).

### *Diet*

Seventy-four (92.50%) residents reported feeling rushed to finish their meals throughout the workday. Fifty-one residents (63.75%) indicated it was “somewhat difficult or difficult” to get their daily 5 cups of fruits and vegetables per the United States Department of Agriculture (USDA) recommendations. On average, breakfast was consumed  $4.47 \pm 2.19$  days per week, with 63.63% of those breakfasts being packaged or not prepared at home. The average number of cups of coffee consumed throughout the day was  $1.88 \pm 2.42$  and the average number of espressos consumed throughout the day was  $0.42 \pm 0.72$ . Fifty (62.50%) residents reported gaining weight throughout residency, with an average weight gain of  $11.06 \pm 5.37$  pounds.

There was no significant correlation between PGY level and weight gain ( $p=0.1800$ ), however, there was a clear trend toward higher weight gain through successive PGY years. PGY4 residents who reported gaining weight averaged  $13.63 \pm 5.04$  pounds as compared to  $10.75 \pm 5.48$  pounds in PGY3 residents, and  $9.89 \pm 5.20$  pounds in PGY2 residents. Sixteen residents (20%) described their overall health as “excellent,” 61 residents (76.25%) described their health as “very good or good,” and only 3 residents reported their overall health to be “fair or poor.” Of the residents who described their overall health as “very good or good,” 31 (50.81%) were overweight with a BMI over 25 and 16 (51.61%) had not had a medical check-up within the past year.

### *Alcohol Audit*

The mean AUDIT score for all residents was  $4.48 \pm 3.36$ , with 14 residents (17.50%) scoring at or above the level for hazardous drinking. There was no significant difference between alcohol consumption and higher BPs ( $p=0.0913$ ) or higher stress levels ( $p=0.3912$ ). However, there was a trend

toward residents with hazardous drinking levels having higher systolic BPs.

## Discussion

There have been several studies looking at BP variance among emergency, medical, and surgical residents and physicians<sup>2,5,11</sup>. To our knowledge, there has yet to be any study investigating BP variance among anesthesiology residents. The major finding of this study is the high prevalence of hypertension and stress among our anesthesiology residents. Twenty-five percent of our trainees were hypertensive and 52.20% were pre-hypertensive. Additionally, 67.5% of residents had stress levels above the national average, with 41.25% of the residents reporting severe stress.

The combination of high stress and elevated BP are worrisome in such a young study population. Excessive job strain, work stress and long working hours have been associated with elevated risks of coronary heart disease, stroke and metabolic syndrome<sup>12</sup>. We were unable to find a direct correlation between stress scores and hypertension, likely due to our small sample size, but the presence of elevated BPs still indicates a need for improved health and wellness during this formative stage of training. Systolic BPs were significantly higher among male residents, and there was a trend toward higher levels among residents reporting high alcohol intake. Our results highlight the overall presence of an unhealthy lifestyle and the importance of emphasizing physical well-being throughout the resident community.

It is well known that residents are at risk of having unhealthy eating and lifestyle habits<sup>2</sup>. Interestingly, many residents perceived their own health status to be “very good or good” despite elevated BMIs, elevated BPs and a lack regular doctor visits. Of all the residents reporting a “very good” or “good” health status, 77% were found to be pre-hypertensive or hypertensive. There seems to be a strong disconnect between reality and the self-perception of our residents’ own

well-being. This could be attributed to denial about one’s own problems, inability or unwillingness to make lifestyle changes, and burnout creating a sense of self-neglect.

Despite the ACGME implemented duty hours in 2003, and update in 2011, sleep deprivation continues to remain an issue, with reports of sleep loss increasing throughout the intern year from 9% to 43%, with associated increases in depression, lack of empathy, and medical mistakes<sup>13</sup>. Fifty percent of our residents reported sleeping less than six hours per night. These residents also demonstrated significantly higher stress scores compared to residents getting more than six hours of sleep a night. More worrisome is the self-reported decrease in OR performance and mood associated with this sleep loss.

Many of the highlighted health issues in this study would necessitate obligatory follow-up with a primary care physician. Unfortunately, only 32.50% of our residents have seen a primary care physician within the last year. This number is significantly lower than presented in the literature. Rosen et al. reported that of 389 internal medicine residents, 63% had a regular primary care physician<sup>14</sup>. It is unclear whether there is no perceived need for primary care among our anesthesiology residents or if there are issues of time, privacy, availability, and/or denial regarding personal health that need to be addressed.

Limitations of our study include the Hawthorne effect, with self-reported behaviors and possible unwillingness to disclose truthful answers to sensitive questions. Additionally, confounders such as family life, relationship status, children, and financial burdens were not considered in this study. Furthermore, additional information such as most recent time of caffeine ingestion, type of most recent case, current rotation, and other stressors that might contribute to acute elevated blood pressure were not accounted for in this study. Although we may not be able to generalize this study to all residents, we hope to add to the growing body of research on the effects that work stress can

have on the health of our physicians, and encourage all residency programs to embrace and promote healthy lifestyles and preventative healthcare with their residents.

## Conclusion

Our study highlights the impact that occupational stress, specifically in the field of anesthesiology, can have on a resident's well-being and health. It is well known that medical training is a time intensive, high-demand work

environment with a multitude of stressors affecting day-to-day work<sup>15</sup>. Our study emphasizes the growing need for residents, and physicians alike, to place an importance on their personal health and well-being.

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Table 1: Baseline Characteristics by PGY level

<b>Demographics</b>	Total	PGY-2	PGY-3	PGY-4
	N=80	N=27	N=30	N=23
Age	30.1 ± 2.28	29.1 ± 2.33	30.4 ± 2.17	30.8 ± 2.10
Gender				
Male	53 (66.25%)	19(70.37%)	18(60.00%)	16(69.56%)
Female	27 (33.75%)	8 (29.62%)	12(40.00%)	7 (30.43%)
Race				
Caucasian	35 (43.75%)	10 (37.03%)	16 (53.33%)	9 (39.13%)
Other	45 (66.25%)	17 (62.96%)	14 (46.66%)	14 (60.86%)
<b>Health Outcomes</b>	<b>Mean ± SD</b>			
	<b>N (%)</b>			
BMI	24.6 ± 2.95	25.5 ± 3.50	23.8 ± 2.83	24.7 ± 2.13
Overweight (25-30)	32 (40.00%)	12(44.44%)	9 (30.00%)	11(47.82%)
Obese (≥ 30)	5 (06.25%)	4 (14.81%)	1 (3.33%)	0 (0%)
Weight Gain				
N (%)	50 (62.50%)	19 (70.37%)	20 (66.66%)	11(47.82%)

Mean $\pm$ SD in lbs	11.06 $\pm$ 5.37	9.89 $\pm$ 5.20	10.75 $\pm$ 5.48	13.63 $\pm$ 5.04
Systolic BP	131.1 $\pm$ 12.72	131.5 $\pm$ 13.85	131.9 $\pm$ 12.48	129.7 $\pm$ 12.09
Diastolic BP	74.7 $\pm$ 9.33	74.2 $\pm$ 8.30	75.8 $\pm$ 10.61	74.0 $\pm$ 8.96
Hypertension	20 (25.00%)	7 (25.92%)	8 (26.66%)	5 (21.73%)
Prehypertension	42 (52.50%)	14(51.85%)	15(50.00%)	13(56.52%)
Normal BP	18 (22.50%)	6 (22.22%)	7 (23.33%)	5(21.73%)
Exercise	2.6 $\pm$ 1.83	2.3 $\pm$ 1.62	2.7 $\pm$ 2.08	2.7 $\pm$ 1.76
Breakfast (days per week)	4.4 $\pm$ 2.19	4.4 $\pm$ 2.00	4.7 $\pm$ 2.37	4.2 $\pm$ 2.23
Medical Checkup within 1 year	26 (32.50%)	9 (33.33%)	9 (30.00%)	8 (34.78%)
Sleep				
4-5 hours	10 (12.50%)	02 (07.40%)	04 (13.33%)	04 (17.39%)
5-6 hours	30 (37.50%)	12 (44.44%)	11 (36.66%)	07 (30.43%)
6-7 hours	25 (31.25%)	11 (40.74%)	09 (30.00%)	05 (21.73%)
7-8 hours	13 (16.25%)	02 (07.40%)	05 (16.67%)	06 (26.08%)
8-9 hours	02 (02.50%)	00 (00.00%)	01 (03.33%)	01 (04.34%)



Table 2: Systolic BP and PSS, by Demographic

Demographics	Systolic BP $\pm$ SD	P-Value	PSS $\pm$ SD	P-Value
Gender		<0.0001		0.03
Male (n=53)	135.6 $\pm$ 9.37		15.9 $\pm$ 6.53	
Female (n=27)	122.4 $\pm$ 14.01		19.5 $\pm$ 8.07	
Race		0.55		0.67
Caucasian (n=35)	132.1 $\pm$ 11.84		16.7 $\pm$ 7.38	
Other (n=45)	130.4 $\pm$ 13.45		17.4 $\pm$ 7.21	
PGY*		0.84		0.26
PGY 2 (n= 27)	131.5 $\pm$ 13.85		17.5 $\pm$ 6.89	
PGY 3 (n= 30)	131.9 $\pm$ 12.49		18.3 $\pm$ 7.79	
PGY 4 (n = 23)	129.7 $\pm$ 12.09		15.1 $\pm$ 6.79	
Sleep		0.69		0.02
< 6 hours (n=40)	131.7 $\pm$ 12.93		19.1 $\pm$ 6.64	
> 6 hours (n=40)	130.6 $\pm$ 12.65		15.2 $\pm$ 1.17	
Overnight call		0.55		0.01
$\leq$ 12 per year (n=41)	130.3 $\pm$ 11.15		15.2 $\pm$ 1.06	
$\geq$ 13 per year (n=39)	132.1 $\pm$ 14.29		19.2 $\pm$ 1.16	
Exercise		0.31		0.74

≤ 2 days per week (n=37)	129.6 ± 11.39		17.4 ± 7.67	
≥ 3 days per week (n=43)	132.5 ± 13.76		16.9 ± 6.95	
Alcohol Audit		0.09		0.39
≤ score of 7 (n=66)	130.4 ± 13.46		17.4 ± 7.4	
≥ score of 8 (n=14)	135.0 ± 7.73		15.6 ± 6.54	

- \*Tested with ANOVA, t-tests used otherwise
- P value <0.05 statistically significant
- Abbreviations: SD, standard deviation, BMI, body mass Index (calculated as weight in kilograms divided by height in meters squared); PGY, postgraduate year, BP, blood pressure.