Published in final edited form as:

Genet Med. 2011 December ; 8(6): 388–398. doi:10.1016/j.genm.2011.07.002.

Relationship Between Resting Blood Pressure and Laboratory-Induced Pain Among Healthy Children

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Abstract

Background—Adult studies have demonstrated that increased resting blood pressure (BP) levels correlate with decreased pain sensitivity. However, few studies have examined the relationship between BP and experimental pain sensitivity among children.

Objectives—This study investigated the association between resting BP levels and experimental pain tolerance, intensity, and unpleasantness in healthy children. We also explored whether these BP–pain relationships were age and gender dependent.

Methods—Participants underwent separate 4-trial blocks of cutaneous pressure and thermal pain stimuli, and 1 trial of a cold pain stimulus in counterbalanced order.

Results—A total of 235 healthy children (49.6% female; mean age 12.7 [2.9] years; age range 8–18 years) participated. The study revealed specific gender-based BP–pain relationships. Girls with higher resting systolic BP levels were found to have lower thermal intensity ratings than girls with lower resting systolic BP levels; this relationship was stronger among adolescent girls than among younger girls. Among young girls (8–11 years), those with higher resting diastolic BP (DBP) levels were found to have lower cold intensity and unpleasantness as well as lower thermal intensity ratings than did young girls with lower resting DBP levels; these DBP–pain response relationships were not seen among adolescent girls.

Conclusions—Age, rather than resting BP, was predictive of laboratory pain ratings in boys. The findings suggest that the relationship between BP and experimental pain is age and gender dependent. These aspects of cardiovascular relationships to pain in males and females need further attention to understand their clinical importance.

Keywords

blood pressure; children; gender differences; laboratory pain

Introduction

The relationship between blood pressure (BP) and pain has attracted the increasing interest of pain researchers during the past 2 decades. It was proposed that increased resting BP

levels would allow for a more rapid stimulation of baroreceptor pain inhibitory activity with sympathetic stimulation, thus leading to reduced pain.¹ Studies among adults have shown that hypertension is associated with decreased experimental pain responsivity.²⁻⁷ The adult offspring of hypertensives also showed decreased pain responses to a variety of experimental pain stimuli compared with individuals without a family history of hypertension.^{2,8} Among healthy adults with BP in the normal range, there was also an inverse association between resting BP and pain responses, such that a higher resting BP was correlated with lower laboratory pain responsivity. This laboratory pain relationship has been demonstrated with both resting systolic BP (SBP)^{1,2,8-27} and resting diastolic BP (DBP).^{12,16,17} Although several experimental studies involving adults have found an inverse relationship between resting BP and pain responses in both men and women,^{15,16,20,23,26} others have demonstrated this relationship in men only^{11,13,14,17,22} and in women only,^{2,9,10,12,18,21,24} suggesting the necessity of examining gender differences in the BP–pain response.

Despite convincing evidence of the relationship between BP and acute experimental pain responses in adults, few studies have examined this relationship among children and adolescents. Ditto et al²⁸ found that resting SBP was negatively correlated with finger pressure pain intensity ratings in boys. The same research group found resting SBP to be negatively correlated with finger pressure pain intensity and unpleasantness among male adolescents at a 5-year follow up.²⁹ However, this longitudinal study only involved boys, and thus the BP–pain relationship among girls is unknown. There is also a dearth of information on how the BP–pain association may change as a function of development.

The first goal of this study was to examine the relationship between resting BP and laboratory-induced pain among children and adolescents, and to investigate how this association varied as a function of gender and age. We hypothesized that resting BP would be positively correlated with pain tolerance, and negatively correlated with pain unpleasantness and pain intensity in healthy children and adolescents. We explored whether these BP–pain relationships were age and gender dependent.

The second goal of this study was to examine gender differences in BP in children and adolescents and explore whether such differences in BP account for gender differences in pain. Among adults, gender differences have been noted in BP, with women displaying lower average resting SBP levels than do men.^{20,30} Similarly, studies among children and adolescents indicate that girls have lower resting SBP levels than do boys.^{31,32} Based on the previous studies, we hypothesized that healthy females would exhibit lower resting BP levels than males.

Meta-analysis and review articles have suggested that adult women have greater experimental pain responses³³ and higher prevalence of clinical pain compared with men.³⁴ Gender differences in experimental pain responses are also evident among adolescents for pressure and cold experimental pain stimuli, although it remains unclear what mediates these gender differences.³⁵⁻³⁷ As studies have shown that elevated resting BPs are generally higher in males than females, and also that higher BPs are associated with decreased pain measures, it seems that resting BP might be a potential mediator for gender differences in pain responsivity. A better understanding of the factors that mediate gender differences in pain sensitivity among children and adolescents can help to guide future clinical treatment of pain, and might help us to better understand pain regulation and signaling.

Methods

Participants

All recruitment and study procedures were approved by the University of California, Los Angeles, Institutional Review Board (IRB), as well as the IRBs of recruitment sites. Study participants were recruited from a major urban area through mass mailings, posted advertisements, and classroom presentations. Telephone interviews confirmed initial eligibility of 472 (96.5%) of the 489 individuals who were screened; 17 children (3.5% of those screened) were excluded due to use of medications or acute or chronic illnesses that might have affected study outcomes. An additional 228 (48%) individuals declined participation, mainly due to lack of parental interest (54%) or time (21%). All participants completed IRB approved consent and assent forms for parents and children, respectively. Participants received a \$30 video store gift certificate and a t-shirt for their participation.

A total of 244 healthy children (124 female; 50.8%) participated in the study. The participants had a mean (SD) age of 12.7 (3.0) years (range, 8–18 years), with ages of males (mean [SD], 12.4 [3.0] years) and females (mean [SD], 13.0 [3.1] years) closely matched. The ethnic composition of the sample was 40.2% whites, 13.9% African-American, 9.8% Asian-American, 23.8% Hispanic, and 12.3% other. The socioeconomic status of the parents included 3.7% unskilled workers, 4.1% semi-skilled workers, 11.9% clerical/sales, 41.8% technical, and 34.8% professional. A total of 9 participants did not have BP measurement recorded, and were not included in the analysis. Thus, data from 235 healthy children (49.6% female; mean age 12.7 [2.9] years; range 8–18 years) were used for analysis in this study.

Overview of Procedure

Laboratory sessions included the completion of demographic characteristics and psychosocial questionnaires and three laboratory pain tasks. Two experimenters conducted the laboratory sessions between 8 A.M. and 8 P.M. Parents and children were escorted into separate rooms, and did not have contact with one another during the sessions. After completing the questionnaires in a quiet room, participants were seated in a chair in the adjacent laboratory. Participants were instructed on the use of the visual analog scales (VAS) for rating pain intensity and unpleasantness after each task. After a 15-minute laboratory habituation period, resting SBP and DBP were measured using the Dinamap (Wipro GE Healthcare, Milwaukee, Wisconsin) monitor 3 times with a 1-minute interval between each reading.

Participants then completed 3 laboratory pain tasks, including tactile pressure, heat, and cold pressor. The pressure and heat tasks included 4 trials with subject-uninformed identical ceilings in a counterbalanced order across participants. A 2- to 3-minute resting baseline period preceded the first trial of each block and a 1-minute resting period preceded each of the other 3 trials. Two sites were used for the pressure and heat tasks to avoid local sensitization or habituation. Two intensities were also used to allow for greater variation in pain response. The cold pressor task consisted of 1 trial with a 3-minute uninformed ceiling.

Laboratory Pain Tasks

Pressure Task—The Ugo Basile Analgesy-Meter 37215 (Ugo Basile, Collegeville, Pennsylvania) was used to administer focal pressure through a Lucite point approximately 1.5 mm in diameter to the second dorsal phalanx of the middle finger and index finger of each hand. Two of the 4 trials had a pressure of 322.5g and 2 trials had a pressure of 465g. Each trial had an uninformed ceiling of 3 minutes, and there was a 1-minute rest interval

between each trial. A similar device was used in healthy and clinical pediatric samples (aged 5–17 years) without adverse effects.^{38,39}

Thermal Task—The Ugo Basile 7360 Unit was used to administer radiant heat 2 inches proximal to the wrist and 3 inches distal to the elbow on both volar forearms. Four trials with 2 infrared intensities (15, 20) were administered with an uninformed ceiling of 20 seconds. There was a 1-minute rest interval between each trial. Thermal pain tolerance was electronically measured with an accuracy of 0.1 second. A comparable task was used in a sample aged 6 to 17 years without adverse effects.⁴⁰

The presentation order of both tasks (including setting and site of exposure) was counterbalanced across participants. Before each trial, subjects were informed that they would be experiencing sensations of discomfort that might eventually be perceived as pain. Participants were instructed to continue with the task as long as they could, but that they were free to end the task at any time if it became too uncomfortable or painful. All tasks were extensively piloted on volunteers in the targeted age range.

Cold Pressor Task—A commercial ice chest measuring 38 cm wide, 71 cm long, and 35 cm deep filled with 10°C water was used for the cold pressor task. The ice chest contained a plastic mesh screen that separated crushed ice from a plastic large-hole mesh armrest in the water. A pump circulated the cold water to prevent local warming around the hand. Participants were asked to keep their dominant hand in the water for as long as they could with an uninformed ceiling of 3 minutes at a depth of 2 inches above the wrist.

Laboratory Pain Measures

Pain Tolerance—Pain tolerance was defined as the time in seconds elapsed from the onset of the pain stimulus to the participants' withdrawal from the stimulus.

Pain Intensity and Pain Unpleasantness—A vertical sliding VAS was used to assess pain intensity and pain unpleasantness after each trial. The VAS is a brief, easily understood, and sensitive to changes in pain. Previous research has shown it can be used by children 8 to 18 years old,⁴¹ and it has previously been used to rate pain in children during laboratory pain tasks.⁴²

The slider VAS used in this study had numbers from zero at the bottom to 10 at the top. The scale also ranged from white at the bottom to red at the top, as well as faces ranging from neutral at the bottom to a negative facial expression at the top. Participants were told the slider VAS was like a thermometer that would measure their feeling or mood, and they were instructed to slide the bar along the scale until the shade matched how much pain or discomfort they felt. Participants completed 3 practice ratings to ensure their comprehension of how the VAS would be used during the experiment.

Pain Intensity: Immediately after each laboratory pain trial, participants were asked to use the VAS to rate the amount of pain they experienced during the task. Participants were asked, “At its worst, how much pain did you feel?” during the task.

Pain Unpleasantness: Immediately after the participants rated pain intensity, they were asked to use the VAS to rate the amount of distress or bother they experienced during the task. Participants were asked, “At its worst, how much did the task bother you?” Due to alterations in procedure during the study, pain unpleasantness ratings were only obtained for a subset (78%) of participants.

Blood Pressure Recording and Analysis

After a 15-minute laboratory habituation time period, BP was measured 3 times using a Dinamap monitor with a 1-minute interval between each measurement. The mean values of resting SBP and DBP measurements were calculated for statistical analysis.

Statistical Analysis

All variables were normally distributed except for pressure tolerance and cold tolerance. These variables were log transformed to produce normal distributions. Independent *t* tests were used to examine mean differences in resting SBP and DBP levels between boys and girls for 2 age groups: children (8–11 years) and adolescents (12–18 years). Initial bivariate correlation analysis was used to examine the association between BP and all experimental pain response measures among boys and girls separately.

A set of hierarchical regression analyses were used to predict pain responses (ie, pain tolerance, pain intensity, pain unpleasantness) from the BP measurements within girls and boys separately. In block 1, age was entered as a predictor. In block 2, SBP and DBP were entered as predictors. In block 3, the interaction of SBP and age and the interaction of DBP and age were entered as predictors. Each regression analysis was conducted for pain tolerance, intensity, and unpleasantness for each task as dependent variables (predicted variables). Continuous variables were centered for creating the interaction term.⁴³

Results

Table I shows descriptive statistics for BP and laboratory pain response for boys and girls. Independent *t* tests did not reveal gender differences in resting SBP or DBP. However, further examination showed adolescent boys (12–18 years old) exhibited significantly higher resting SBP levels (mean [SD] 110 [12] mm Hg) than adolescent girls (mean 104 [0.5] mm Hg), with a mean difference of 6.1 (two-tailed $P = 0.003$); whereas there was no such gender difference in SBP among children (8–11 years old). No significant gender differences in DBP were found within the older and younger age groups.

Table II shows results of bivariate correlation between BP and pain response measures in boys and girls, respectively. Results supported our initial hypothesis that elevated resting BP would be associated with lower pain response measures. Among boys, higher resting SBP was associated with greater thermal tolerance and decreased thermal intensity ratings. Among girls, higher resting SBP was associated with greater pressure and thermal tolerance, and decreased cold intensity ratings. Higher resting DBP was also associated with decreased cold intensity ratings among girls.

Table III shows results from hierarchical regressions predicting laboratory responses from BP and age among girls. Age was positively associated with pressure and thermal tolerance, and negatively associated with pressure and thermal intensity. The SBP by age interaction was significant on thermal pain intensity, such that the inverse relationship between SBP and thermal pain intensity was stronger in adolescent girls compared with younger girls (Figure 1). The DBP and age interaction were significant for cold and thermal intensity and cold unpleasantness, such that the inverse relationship between DBP and pain was more evident in female children than in female adolescents. Figures 2 through 4 show that female children (age 8–11 years) with low resting DBP had greater cold intensity, cold unpleasantness, and thermal intensity ratings than those with high resting DBP measurements. However, adolescent girls (age 12–18 years) had similar pain ratings for these measurements regardless of their resting DBP level. The interaction of BP and age explained about 6%, 9%, and 9% of variance of thermal intensity, cold intensity, and cold unpleasantness, respectively.

Table IV summarizes the results from hierarchical regressions predicting pain responses from BP and age among boys. Age was positively associated with all 3 tolerance measures, and negatively associated with pressure and thermal intensity, and pressure and thermal unpleasantness. The interactions between BP and age were not significant on any pain response among males.

Discussion

We hypothesized that resting BP would be positively correlated with pain tolerance, and negatively correlated with pain unpleasantness and pain intensity in healthy children and adolescents. The hypotheses were supported among female children for thermal intensity, cold intensity, and cold unpleasantness. More specifically, girls (8–11 years) with low resting DBP levels displayed greater cold pain intensity, cold unpleasantness, and thermal intensity ratings than did those with high resting DBP levels (Figures 2–4). These relationships did not occur among female adolescents (age 12–18 years) or boys of any age. In addition, the inverse relationship between SBP and thermal intensity was more intense among adolescent girls than among younger girls (Figure 1).

Our results are unique, as resting DBP rather than SBP was significantly related to cold pain response measures as well as thermal intensity ratings among young girls. However, among adolescent girls, SBP was found to be related to thermal intensity ratings, which mimics findings among adult studies. Previous studies among children found resting SBP and DBP to be correlated with pain response measures; however, these studies included only boys who were of similar age.²⁹ The majority of adult studies have found correlations between resting SBP and experimental pain measures, but a limited number of studies have found that resting DBP might be related to pain sensitivity. Among adults, resting DBP has been negatively correlated with ischemic pain unpleasantness in both men and women.¹⁶ Other studies involving adults have found positive correlations between DBP and thermal tolerance in women only¹² or men only.¹⁷ However, several other studies have found no correlation between DBP and pain response measures for a variety of experimental pain tasks among adults.^{14,20,22,23} Thus, research among adults regarding the relationship between DBP and pain response measures is inconclusive.

Current research regarding BP and pain sensitivity among children and adolescents is very limited. One longitudinal study found that resting DBP and SBP were positively correlated with pressure pain tolerance and negatively correlated with pressure pain intensity in a group of 19-year-old males after controlling for parental history of hypertension and body mass index (BMI).²⁹ These earlier data contradict our results, which found that pressure tolerance, intensity, and unpleasantness were not significantly associated with resting BP measurements among males. This might be due to the age difference in study participants; the previous study included 119 males of similar age, whereas our study included 120 males ranging from 8 to 18 years.²⁹ Our study indicates that age, not resting BP, is a significant predictor of tolerance for all 3 pain tasks, pressure and thermal intensity, and thermal unpleasantness among boys 8 to 18 years of age.

To our knowledge, there are no studies involving female children or adolescents examining the relationship between resting BP levels and experimental pain sensitivity. Thus, our results indicating that girls (8–11 years) with low resting DBP have greater cold intensity and unpleasantness ratings and thermal intensity ratings than girls with high resting DBP levels are unique. It is unclear what mechanism leads to this relationship among female children, but not among boys or female adolescents. Our results indicating that adolescent girls with elevated resting SBP had lower thermal intensity ratings is also unique. It is unclear why these relationships were found among girls but not boys.

Although age was associated with pressure and heat tolerance among females, resting DBP had a unique predictive value for self-reported variables such as cold unpleasantness and cold and thermal intensity among girls (8–11 years). It is unclear why this relationship among girls only occurred for self-reported variables involving the cold pressor and thermal experimental pain stimuli. Studies among adults have shown that women rely more on external cues rather than internal physiological state alone to determine their response to a stimulus.⁴⁴ Self-reported variables require a participant to integrate their internal physiological response with external cues, such as visualization of the cold pressor water bath, color change of the hand in water, or redness of the skin with the thermal task. Perhaps the young girls in this study also relied on these external cues more than boys to determine their subjective rating of pain intensity or unpleasantness.

In accordance with existing studies regarding BP in children and adolescents,^{31,32} our hypothesis that females would exhibit lower resting BP levels than males was confirmed only among adolescents for SBP. Adolescent males had significantly higher resting SBP levels than adolescent females. There were no gender differences for SBP in younger children; DBP did not differ between boys and girls irrespective of age. This study indicates there are gender and gender by age BP/experimental pain relationships in children. However, further studies are indicated to determine if resting BP is a mediator of gender differences in experimental pain sensitivity among healthy children and adolescents. These studies could help to clarify potential gender differences in pain regulatory pathways, such as baroreceptor modulation or adrenergic systems, and guide future clinical practice in pain management.

Most theories regarding the relationship between resting BP levels and pain response measures have focused on SBP rather than DBP. SBP and DBP are regulated by several complex mechanisms, including sympathetic tone and the renin–angiotensin–aldosterone system. The relationship between resting BP levels and laboratory pain responsivity might be explained by an interaction between pain regulatory pathways and BP levels through sympathetic activation and modulation of descending pain pathways.^{1,13} Pain induces sympathetic arousal, which increases BP levels and stimulates baroreceptors. One function of the baroreceptors is to initiate a signaling cascade that causes pain inhibitory activity. One theory suggests that increased resting BP levels would allow for a more rapid stimulation of baroreceptor pain inhibitory activity with sympathetic stimulation.¹ Another study indicated that it is the degree of phasic baroreceptor stimulation, and not the tonic level of stimulation, that is important, because participants reported less pain during systole than diastole.⁴⁵ Our data does not directly support this theory, as female children with high DBP, not SBP, reported lower cold unpleasantness and intensity levels. It is possible that this pain inhibitory system is regulated somewhat differently among children and adolescents than in adults.

A number of limitations to the study are worth noting. Previous studies with adults have controlled for BMI during analysis, as this provides a measure of obesity and might impact resting BP levels. Initial correlation analysis indicated that BMI was significantly correlated with age and resting BP levels. Although we attempted to collect height and weight information, BMI data were available for only 184 of the 240 participants. However, additional analyses of these 184 participants (data not shown) indicated that inclusion of BMI in regression analysis did not alter the previously mentioned results that were obtained without the inclusion of BMI. Future research in this area needs to be more vigilant about collecting BMI data, perhaps by increasing a sense of privacy during weight measurement, as this may impact an adolescent's willingness to be weighed. Future studies might incorporate continuous BP monitoring throughout pain tasks to assess BP reactivity and its relationship to pain sensitivity among children. Another useful variable to evaluate in future

studies would be a measure of anticipatory anxiety before pain tasks to assess the relationship between anxiety, resting BP levels, and laboratory pain sensitivity. Future studies might also address the role of sex steroid hormones and how the timing of menarche might affect the BP–pain relationship as suggested in adult studies.⁴⁶ Lastly, this study was a cross-sectional study that determined the association between BP and pain responsivity, but no causation could be assessed. Longitudinal studies or experimental studies would help to clarify the temporal or causal relationship between BP and pain.

Conclusion

Female adolescents and adults report greater clinical pain and have greater experimental pain sensitivity than boys of similar age. Among adults, women generally have lower resting BP levels than do men of similar age and health status. These findings indicate that BP might be involved in gender differences in pain responsivity. Our study found that for boys, age, rather than resting BP, was associated with experimental pain sensitivity measures. For girls, however, the relationship between BP and pain responses varied as a function of age. An interaction between age and resting DBP was evident, such that girls (8–11 years) with high resting DBP levels displayed lower cold pain intensity and unpleasantness ratings as well as thermal intensity ratings than did girls with low resting DBP levels. Among adolescent girls, an interaction between age and resting SBP was found, indicating that girls with high resting SBP levels had lower thermal pain intensity than those with low resting SBP levels. Our study points to future research among children and adolescents to examine BP as a potential mediator for gender differences in laboratory and clinical pain responsivity.

Acknowledgments

Dr. Haas was the primary author of this article and performed the statistical analysis under the supervision and guidance of the Pediatric Pain Program team, including Drs. Zeltzer, Tsao, Evans, and Lu. The authors have indicated that they have no conflicts of interest regarding the content of this article.

This study was supported by R01DE012754, awarded by the National Institute of Dental and Craniofacial Research (PI: Dr. Zeltzer), by UCLA General Clinical Research Center Grant M01-RR-00865 (PI: Dr. Zeltzer), and by 1K01AT005093, awarded by the National Center for Complementary and Alternative Medicine (PI: Dr. Evans).

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Figure 1.
Plotted relationship between systolic blood pressure (SBP) and thermal intensity ratings among adolescent and younger girls.

Figure 2.
Plotted relationship between diastolic blood pressure (DBP) and thermal intensity ratings among adolescent and younger girls.

Figure 3. Plotted relationship between diastolic blood pressure (DBP) and cold intensity ratings among adolescent and younger girls.

Figure 4.
Plotted relationship between diastolic blood pressure (DBP) and cold unpleasantness ratings among adolescent and younger girls.

Table 1

Descriptive statistics of study participants and laboratory pain measures.

Pain Measures	n		Minimum		Maximum		Mean		SD	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Resting SBP	119	116	81.50	72.00	138	127.67	105.36	102.52	11.71	11.02
Resting DBP	119	116	43	42.67	83.00	91.50	60.71	61.97	8.06	8.86
BMI	92	92	13.65	12.4	41.19	45.64	21.18	21.25	5.15	5.54
Pressure tolerance	119	120	2.22	3.22	179.9	180	45.91	34.68	47.09	43.79
Pressure intensity	119	120	0	0	9.76	9.76	4.66	5.08	2.47	2.72
Pressure unpleasantness	93	94	0	0	9.46	9.76	3.45	3.53	2.67	2.58
Heat tolerance	120	120	1.15	1.05	20.00	20.00	11.03	10.51	5.25	5.04
Heat intensity	120	120	0	0	9.76	9.76	4.95	5.03	2.76	2.78
Heat unpleasantness	94	94	0	0	9.76	9.76	3.39	3.57	2.73	2.67
Cold tolerance	119	120	4.73	5.31	180	180	52.16	54.66	53.09	55.79
Cold intensity	120	120	0	0	9.76	10	3.33	3.8	2.62	3.06
Cold unpleasantness	94	94	0	0	9.76	9.76	2.84	3.04	2.81	2.82

BMI = body mass index; DBP = diastolic blood pressure; SBP = systolic blood pressure.

Significant correlations between blood pressure and pain response measures among boys and girls.

Table II

Characteristic	Pressure Tolerance	Thermal Tolerance	Cold Tolerance	Pressure Intensity	Thermal Intensity	Cold Intensity	Resting SBP	Resting DBP	Age
Boys									
Resting SBP		0.330 [†]			-0.208 [*]		1	0.649 [†]	0.577 [†]
Resting DBP							0.649 [†]	1	0.250 [†]
Girls									
Resting SBP	0.228 [*]	0.196 [*]				-0.206 [*]	1	0.688 [†]	0.192 [*]
Resting DBP						-0.183 [*]	0.688 [†]	1	0.227 [†]

DBP = diastolic blood pressure; SBP = systolic blood pressure.

^{*} $P < 0.05$.

[†] $P < 0.001$.

Significant results of heirarchical regression among girls: age and blood pressure as predictors of laboratory pain measures.

Table III

Predictors (B) (Independent Variables)	Dependent Variables							
	Pressure Tolerance	Thermal Tolerance	Cold Tolerance	Pressure Intensity	Thermal Intensity	Cold Intensity	Pressure Unpl.	Thermal Unpl.
Age	0.342 [†]	0.480 [†]		-0.296 [*]	-0.272 [*]			
Resting SBP		0.242 [*]						
Resting DBP								
Resting SBP*age					-0.272 [*]			
Resting DBP*age					0.315 [*]	0.369 [*]		0.403 [*]
R ² Change	0.154 [*]	0.254 [†]	0.027	0.116 [*]	0.077 [*]	0.144 [*]	0.049	0.085
								0.148 [*]

DBP = diastolic blood pressure; SBP = systolic blood pressure; Unpl. = unpleasantness.

^{*} *p* < 0.05.

[†] *p* < 0.001.

Table IV

Significant results of hierarchical regression among boys: age and blood pressure as predictors of laboratory pain measures.

Predictors (B) (Independent Variables)	Dependent Variables							
	Pressure Tolerance	Thermal Tolerance	Cold Tolerance	Pressure Intensity	Thermal Intensity	Cold Intensity	Pressure Unpl.	Thermal Unpl.
Age	0.592 [†]	0.695 [†]	0.512 [†]	-0.489 [†]	-0.476 [†]		-0.279 [*]	-0.342 [*]
Resting SBP								
Resting DBP								
Resting SBP*age								
Resting DBP*age								
R ² Change	0.240 [†]	0.434 [†]	0.227 [†]	0.152 [*]	0.210 [†]	0.021	0.103 [*]	0.144 [*]

B = Beta; DBP = diastolic blood pressure; SBP = systolic blood pressure; Unpl. = unpleasantness.

* $P < 0.05$.

[†] $P < 0.001$.