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Influence of Positive Life Events on Blood Pressure in Adolescents

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It has been reported that adults suffering from refractory essential hypertension experience significantly fewer positive life events than healthy peers. However, the influence of positive life events on blood pressure (BP) in adolescents has been largely ignored. Therefore, we examined the relationship between self-reported positive life events and BP in 69 sixth graders with a mean age of 11.7 years. Positive life events were assessed with the Adolescent Perceived Events Scale and resting blood pressure was measured with a mercurial sphygmomanometer. Correlational analyses showed an inverse relationship between positive life events and diastolic BP, suggesting that adolescents experiencing more positive life events were more likely to have lower diastolic BP's. Hierarchical regression analyses revealed that physical activity level, dietary sodium-to-potassium ratio, parental history of hypertension, and measures of body composition predicted 24.6% of the variance in systolic BP and 34.6% of the variance in diastolic BP. Moreover, positive life events predicted an additional 4.3% of the variance in diastolic BP when statistically controlling these established risk factors for hypertension. These results suggest that increased perceptions of positive life events may act as a buffer to elevated BP in adolescents.

KEY WORDS: positive life events; blood pressure; adolescents; hypertension.

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INTRODUCTION

The development of cardiovascular disease is a life-long process with origins in the pediatric years (Rowland, 1992). Hypertension, which may also develop in childhood (American Heart Association, 1995), has been identified as the most prevalent antecedent of cardiovascular disease and is the primary cause of 1.25 million coronary events annually (American Heart Association, 1995; Lauer and Clarke, 1989; Scott, 1993). Based on the 1988–1991 National Health and Nutrition Examination Survey III, the Joint National Commission on Detection, Evaluation, and Treatment of High Blood Pressure (1993) reported that as many as 50 million Americans aged 6 and over either have elevated blood pressure or are taking antihypertensive medication.

Many of the mechanisms underlying the etiology of hypertension have not been determined. More than 90% of all hypertensive individuals have essential hypertension or high blood pressure of unknown origin (Livingston, 1993). According to the American Heart Association (1990), factors known to contribute to the development of hypertension include aging, obesity, a sedentary lifestyle, being of African-American descent, a family history of hypertension, and high levels of stress. High dietary intakes of sodium and alcohol and a low intake of potassium may also contribute to elevated blood pressure (Althoff *et al.*, 1988; American Heart Association, 1990). Clearly, the etiology of high blood pressure is multidimensional and the premise that a single factor produces sustained hypertension is unlikely (Brody *et al.*, 1987). Recognition of the multidimensional nature of hypertension has stimulated behavioral research focusing on environmental and psychosocial variables that may influence the development of hypertension (Groer *et al.*, 1994; Johnson *et al.*, 1987).

One environmental mechanism that may cause changes in blood pressure is the accumulation of life events. Although past research has focused primarily on the effect of negative life events on blood pressure (Herd, 1991; Jemerin and Boyce, 1990; Winkleby, *et al.*, 1988), the potential influence of positive life events on blood pressure has received little attention. Preliminary research on the influence of positive life events on adult blood pressure, however, has produced promising findings. Theorell and colleagues (1986) reported an inverse relationship between a 1-year recall of positive life events and blood pressure in a sample of 28-year old males. Employing an interview format that required participants to classify events as either positive or negative, these authors found significant negative correlations between positive life events and resting systolic and diastolic blood pressure. In a later study, Isaksson *et al.* (1992) employed a 10-year retrospective format to assess positive and negative life events in a sample of hypertensive adults and normotensive controls. The interview was based on the Holmes and Rahe Social Readjustment Rating Scale (1967), wherein each participant rated his or her perception of an event on a continuum from "total happiness" to "personal disaster." Despite finding no group differences in the occurrence of negative life events, patients suffering from refractory essential hypertension reported significantly fewer positive events than age- and gender-matched healthy peers. In considering these findings, it should be noted that only major life events, rather than chronic events or what others such as Lazarus (1984) have termed "daily hassles," were analyzed. Perhaps the constant strain (or enjoyment) of daily events, rather than the sole influence of major life events, also plays a role in the relationship between positive life experiences and blood pressure. Hence, research focusing on measures of both major life events and chronic events might further our understanding of the relationship between positive life events and blood pressure.

To our knowledge, only one previous study has examined the relationship between positive life events and blood pressure in adolescents. Svensson and Theorell (1983) reported that 18-year old males with low blood pressure recalled a higher number of positive events during adolescence than males with high blood pressure. However, the influence of positive life events on blood pressure in younger adolescents remains unknown. As it has been established that cardiovascular disease and hypertension begin to develop in childhood (American Heart Association, 1995; Rowland, 1992), the examination of potential antecedents to elevated blood pressure in younger populations is warranted.

Because factors such as obesity, race, physical activity level, family history, and diet have been linked to elevations in blood pressure, it would be important to include these predictors in a study of the relationship between positive life events and blood pressure. Previous studies examining the relationship between positive life events and blood pressure have failed to control statistically many of the factors known to contribute to elevated blood pressure (Isaksson *et al.*, 1992; Svensson and Theorell, 1983; Theorell *et al.*, 1986). Moreover, previous research has contained methodological constraints such as small sample sizes and inclusion of participants who were currently taking medication for hypertension (Theorell *et al.*, 1986). Clearly, the need for more comprehensive and rigorous study of the relationship between positive life events and blood pressure levels is evident.

In view of the preceding discussion, the purpose of this study was to examine the relationship between both major and daily positive life events and diastolic and systolic blood pressure in a sample of sixth-grade adolescents. Based on previous evidence indicating that both adults and older adolescents with low systolic and diastolic blood pressure report experiencing more positive life events compared to their hypertensive counterparts, it was hypothesized that lower blood pressure values would be associated with a higher number of positive life events in this sample of younger adolescents.

METHOD

Participants

Participants were drawn from four sixth-grade physical education classes in an urban public middle school. Data were collected initially on 93 students. Five students were then excluded from the sample because they were on medication known to influence blood pressure levels. Further, only those participants with complete data sets ($N = 69$) were included in the results. The sample of 69 participants was 48% male and 52% female, with a mean age of 11.7 ± 0.7 years. Analysis of racial background revealed that the males were 55% African American, 27% Caucasian, 6% Asian, and 12% Native American and that the female distribution was 53, 42, 5, and 0%, respectively.

Physical Measures

Body Mass and Height. Body weight was measured to the nearest 0.1 lb with an electronic scale (Seca Alpha, Model 770) and converted to body mass (kg). Height was measured to the nearest 0.1 cm using a GPM anthropometer. Body mass and height measurements were used to calculate body mass index, BMI = [weight (kg)/height (m)^2].

Waist-to-Hip Ratio. Waist and hip circumference measurements were taken with a Gulick II Measuring Tape (Model 67020). The tape has a tensioning device that was calibrated to ensure that each measurement was taken with the same amount of tape tension (4 oz). A single circumference value (taken to the nearest 0.1 cm) was obtained at each site. Waist girth was taken at the level of the umbilicus and hip girth was measured at the maximum posterior extension between the buttocks and the iliac crest (Croft *et al.*, 1995). As a practical matter, the waist measurement was taken directly on the skin, whereas the hip measurement was made over the student's gym shorts. The waist measurement was divided by the hip measurement to calculate the waist-to-hip ratio (WHR).

Triceps and Calf Skinfolds. Triceps and calf skinfolds were measured to the nearest millimeter using a Harpendon skinfold caliper. Prior to testing, the technician was validated against an American College of Sports Medicine (ACSM) Exercise Test Technologist and checked for within-tester reliability (intraclass correlations $r = .99$).

Skinfold measurements were taken twice at each site in sequential order and averaged. If the two initial readings did not agree within 1 mm, a third reading was obtained. The triceps skinfold was measured parallel to the longitudinal axis of the upper right arm at the midpoint between the acromium process of the scapula and the olecranon process of the ulna. The calf skinfold was obtained at the medial aspect of the right leg at the level of the maximum calf circumference (Harrison *et al.*, 1988). Prediction equations of percentage fat from triceps and calf skinfolds derived by Slaughter *et al.* (1988) for use with children were used to estimate percent body fat.

Resting Blood Pressure. Seated resting blood pressure was obtained according to the recommendations of the Second Task Force on Blood Pressure Control in Children (Task Force on Blood Pressure Control in Children, 1987). Resting blood pressure was measured with a Labtron mercurial sphygmomanometer (Model 63160). Two resting blood pressure readings were taken by the same technician on each subject and the two values were averaged to produce one resting blood pressure value for each student. All measurements were taken in the late morning, before lunch, and within a 50-min period. Two children at a time were seated, not facing one another, in the measurement room. The same technician took one measurement on each participant before repeating the second reading, approximately 2 min later. Two technicians were validated against an ACSM-certified Program Director and checked for reliability against themselves and the other technician. Intraclass correlation coefficients determined for each pairing revealed high correlations ($r \geq .85$).

Questionnaires

Dietary Analysis. Parents and children jointly completed a food intake questionnaire that was analyzed with the Nutritionist IV: Diet Analysis and Nutritional Evaluation computer program (N-squared Computing, Silverton, OR). This program uses the database from the U.S. Department of Agriculture. The questionnaire, which was used previously in a study of blood pressure and diet in a racially mixed sample (Melby *et al.*, 1989), contains 141 different foods and food categories each with a specified serving size. The families were instructed to record how many servings, if any, the child consumed of each item in a typical week. Further, illustrations of typical serving sizes for the meat products were included in the questionnaire. The telephone number of a registered dietician was included in all packets in the instance that the parents had a question while completing the questionnaire. The questionnaires were analyzed to determine each child's dietary sodium and potassium intake. These data were used to derive the sodium-to-potassium ratio.

Physical Activity. The Weekly Activity Checklist (WAC; Sallis *et al.*, 1993) was employed to measure physical activity. The checklist contains 20 activities (arranged from lowest to highest intensity) performed commonly by children. Students were asked to report which activities they engaged in continuously for at least 15 min during the past week. Based on the instructions provided by the authors of the WAC, participants reported only those activities that were performed outside of school. The checklist was scored by multiplying the frequency of each activity by its metabolic equivalent score and then summing the products. Test–retest reliability for the checklist, with a 3-day interval between administrations, is 0.74. Validity for the checklist, assessed by comparison with a Caltrac monitor on two occasions, was determined to be 0.34 ($p < .01$) and 0.26 ($p < .05$), respectively (Sallis *et al.*, 1993).

Family History. The Coronary Risk Profile (Howard *et al.*, 1991), a checklist that can be used to gather family history data, was developed by Johns Hopkins University Preventive Cardiology Unit. The checklist requests information regarding coronary heart disease, stroke, high blood pressure, diabetes, kidney disease, and cigarette smoking in first degree relatives. An additional column was added to the form so that parents could indicate the age of onset for all items to which they responded in the positive. In coding the information gathered through the checklist, students were given one point for each parent with high blood pressure before the age of 55. Students with no history of parental hypertension received a score of zero, students having one parent with hypertension received a score of 1, and students having two parents with hypertension received a score of 2.

Life Events. The junior high school version of the Adolescent Perceived Events Scale (APES; Compas *et al.*, 1987) was used to measure daily and major life events. This scale contains a list of 164 events representative of those experienced in early adolescence. Students were asked to indicate whether or not each event had occurred in the 3 months preceding the study and to note the perceived desirability of each event by selecting a rating on a Likert scale varying from −4 (extremely undesirable) to +4 (extremely desirable). The APES was scored by calculating the total weighted positive event scores for daily and major life events by summing the desirability scores of each event the participants rated as positive (positive desirability ratings ranged from 1 to 4). Results from the analysis of negative events are reported separately. Ratings were summed separately for daily and major events, according to classifications provided by the authors of the scale, resulting in three scores: a daily event score, a major event score, and a total event score derived by summing the daily and major scores. For illustrative purposes, the following are examples of the type of items Compas *et al.* (1987) classified as daily events, "hobbies or activities (watching TV, reading, playing an instrument, etc.), doing things/spending time with family members, and spending time/talking with boyfriend/girlfriend." Additionally, the following examples were classified as major events, "family members, relatives, step-parents move in or out of house, family member becoming pregnant or having a child."

The 2-week test–retest reliability of the scale for the number of events reported and the weighted positive events is 0.85 and 0.78, respectively (Compas *et al.*, 1987). Although concurrent validity has not yet been determined for the junior high school version of the APES, the developers have determined the validity for the older adolescent version of the APES. Reports of event occurrence and nonoccurrence by subjects and college roommates were examined for rates of agreement. The percentage agreement for event reports by the two sources was 82% (Compas *et al.*, 1987).

Timetable and Logistics of Data Collection

Four weeks prior to data collection, packets containing an information letter and an informed consent form were sent home to parents by the child's physical education teacher. Health history and food intake questionnaires were mailed to those parents who returned signed consent forms. A second copy of each questionnaire was sent to parents who failed to return the forms on the first request. Five questionnaires, which were completed incorrectly, were mailed back to parents with a stamped, self-addressed envelope and a request was made for them to complete the form a second time. Phone calls were made to several parents to address small problems or inconsistencies detected on their completed questionnaires. Data were collected at the school over a 2-week period. Each week, two classes were assessed during regularly scheduled physical education classes by a team of investigators. Data were collected in the following manner.

Day 1. Students were instructed to meet in a designated classroom by the physical education teacher and were seated at individual desks. The testing team was introduced to the class and the agenda for the next two days was explained. The stress questionnaire (APES) was then administered to all students. Each student also completed a general information card with his or her name, sex, age, race, and address.

Day 2. Body mass, height, waist and hip circumferences, and skinfold measurements were taken, as described previously, in one of the gym locker rooms. A station was set up for each measurement and students rotated through the stations in small groups.

Day 3. On the final day of data collection, students completed the physical activity measure and resting blood pressure was assessed as outlined earlier.

Data Analysis

The 69 participants with complete data on every variable were included in all statistical analyses. Bivariate correlations were calculated to examine relationships among all hypertension risk factors and resting systolic and diastolic blood pressure. To determine if any of the three separate life event scores (daily, major, and total) predicted a significant portion of the variance in systolic and diastolic blood pressure, six separate regression analyses were performed. To account for the effect of established hypertension risk factors (e.g., body mass index, percentage body fat, family history of hypertension, physical activity, sodium-to-potassium ratio, and waist-to-hip ratio), these control variables were entered on the first step of the equation. Scores for daily life events, major life events, or total life events were entered on the second step to examine whether the positive life event variable added significantly to the predictive value of the model. Because one-way analyses of variance revealed no significant differences among races on either systolic pressure [$F(3,68) = .225, p = .88$] or diastolic pressure [$F(3,68) = .496, p = .69$], race was not entered into the regression equation. Statistical significance was established at $p < .05$.

RESULTS

Descriptive statistics for each variable are displayed in Table I. A parental history of self-reported hypertension (not included in Table I) was present in a single parent of 11 participants. The distribution of blood pressure values by gender is shown in Table II. Based on criteria established by the Task Force on Blood Pressure Control in Children (1987), 19 to 33% of the females and 48 to 54% of the males exhibited blood pressure levels above the normal range. Similarly, using pediatric standards for obesity of ≥32% for females and ≥25% for males (Lohman, 1992), 33% of the females and 42% of the males were classified as obese.

Bivariate correlations among all hypertension risk factors, positive life events, and mean systolic and diastolic blood pressures are displayed in Table III. There was a significant inverse correlation between diastolic blood pressure and major positive life events ($r = -.27$). No other life event variable was significantly correlated with either systolic or diastolic blood pressure. Of the control variables, diastolic blood was positively correlated with body mass index, percentage body fat, sodium-to-potassium ratio, and waist-to-hip ratio ($p < .01$). Systolic blood pressure was also positively correlated with body mass index, percentage body fat, and waist-to-hip ratio ($p < .01$).

A summary of the regression analyses appears in Table IV. Control variables entered on the first step of the hierarchical regression analyses accounted for 24.6% of the variance in systolic blood pressure and 34.6% of the variance in diastolic blood pressure. When entered on the second step of the regression equation, major life events was a significant individual predictor of an additional 4.3% of the variance in diastolic blood pressure ($p < .05$). Control variables that predicted a significant portion of the variance in diastolic blood pressure included body mass index ($p < .01$) and sodium-to-potassium ratio ($p < .05$). Likewise, body mass index predicted a significant portion of the variance in systolic blood pressure ($p < .05$). Neither daily, major, nor total positive life events significantly accounted for any additional variance in systolic blood pressure. Furthermore, daily and total positive life events failed to account for any additional variance in diastolic blood pressure.

Table I. Subject Characteristics, Control Variables, and Positive Life Event Values

Variable	M	SD
Age	11.7	0.7
Height (cm)	154.9	8.8
Body mass (kg)	54.7	17.3
Body mass index	22.4	5.8
Percentage body fat	25.6	11.1
Waist-to-hip ratio	0.82	0.07
Physical activity	103.9	83.0
Sodium-to-potassium ratio	0.96	0.22
Daily positive events	103.0	45.9
Major positive events	13.6	13.9
Total positive events	116.6	56.9
Mean diastolic BP	75	10
Mean systolic BP	114	14

Table II. Sample Distribution of Male and Female Blood Pressure Values

Blood pressure classification	Males (%)		Females (%)	
	Diastolic	Systolic	Diastolic	Systolic
Normal[a]	46	52	67	81
High normal[b]	30	24	14	8
Significantly hypertensive[c]	18	15	11	8
Severely hypertensive[d]	6	9	8	3

Note. Percentage of total number of males ($N = 33$) or females ($N = 36$).
[a]Systolic and diastolic blood pressure ≤90th percentile for age.
[b]Systolic and diastolic blood pressure between the 90th and the 95th percentile for age.
[c]Systolic and diastolic blood pressure between the 95th and the 99th percentile for age.
[d]Systolic and diastolic blood pressure ≥99th percentile for age.

DISCUSSION

Research and measures of life events in childhood have focused mainly on the influence of major negative or stressful life events on symptoms and disorders (Compas *et al.*, 1987). In an attempt to fill this void in the pediatric literature, the current study examined perceived major and daily positive life events in early adolescents. Concurrently, because hypertension is a multidimensional construct with potential of biological, environmental, and psychosocial triggering mechanisms, numerous factors known to contribute to elevated blood pressure were controlled statistically.

Physically, the participants in this investigation were taller, were heavier, and had higher percentages of body fat than the general age-matched population of children. Comparisons to National Health Center Statistics reference charts for stature and body mass revealed that nearly all of the participant's heights fell between the 70th and the 90th percentiles by age and their body mass fell between the 80th and 97th percentiles by age (Johnston *et al.*, 1982; 1984). Additionally, 42% of the males and 33% of the females in this study would be classified as obese by pediatric standards (Lohman, 1992). For purposes of comparison, the national prevalence of obesity for 12-year-old children is 19% for males and 25% for females (Ross *et al.*, 1985). The majority of the participants exhibited blood pressure values within the normal range (Task Force on Blood Pressure Control in Children, 1987), although there was a noticeable incidence of higher blood pressure values (see Table II). The marked presence of obesity in this adolescent sample may help to explain the elevated blood pressure values. The prevalence of elevated blood pressure may also be related to the fact that the children tended to fall in the upper percentiles for both height and body mass, which, as noted by the Task Force on Blood Pressure Control

Table III. Bivariate Correlations Among Hypertension Risk Factors, Positive Life Events, and Systolic and Diastolic Blood Pressure

	BMI	PBF	WHR	FH	PA	SP	DE	ME	TE	MDBP	MSBP
BMI	1.00										
PBF	0.79**	1.00									
WHR	0.50**	0.49**	1.00								
FH	0.08	0.13	0.05	1.00							
PA	0.00	−0.04	0.08	−0.05	1.00						
SP	0.05	0.14	0.08	0.13	−0.05	1.00					
DE	0.01	0.11	0.11	0.03	0.19	0.00	1.00				
ME	−0.15	−0.07	0.04	0.02	0.19	−0.01	0.73**	1.00			
TE	−0.02	0.07	0.09	0.03	0.20	0.00	0.99**	0.83**	1.00		
MDBP	0.54**	0.44**	0.29**	0.13	0.00	0.24*	−0.06	−0.27*	0.11	1.00	
MSBP	0.46**	0.34**	0.36**	0.05	0.10	0.06	0.13	0.01	0.11	0.69**	1.00

Note. BMI, body mass index; PBF, percentage body fat; WHR, waist-to-hip ratio; FH, family history of hypertension; PA, physical activity; SP, sodium-to-potassium ratio; DE, daily positive events; ME, major positive events; TE, total positive events; MDBP, mean diastolic blood pressure; MSBP, mean systolic blood pressure.

*$p < .05$.

**$p < .01$.

Table IV. Results of Hierarchical Regression Analyses Examining the Influence of Daily, Major, and Total Positive Events on Systolic and Diastolic Blood Pressure

Life event variable	Systolic BP Total R^2 Step 1[a]	Systolic BP Total R^2 Step 2[b]	Systolic BP β	Diastolic BP Total R^2 Step 1[a]	Diastolic BP Total R^2 Step 2[b]	Diastolic BP β
Daily	.246**	.256**	.11	.346***	.352***	−.08
Major	.246**	.247*	.0	.346***	.389***	−.22*
Total	.246**	.254**	.0	.346***	.359***	−.12

[a]Variance in blood pressure accounted for by control variables.
[b]Variance in blood pressure accounted for by control and life event variables combined.
*$p < .05$.
**$p < .01$.
***$p < .001$.

in Children (1987), tends to lead to higher blood pressure values. Therefore, the following findings would appear to be especially generalizable to children who are taller, heavier, and fatter than age-matched peers.

In support of past research in adults (Theorell *et al.*, 1986), a significant inverse relationship between diastolic blood pressure and major positive life events was observed. Hierarchical regression analyses also revealed a significant individual contribution of major positive events to diastolic blood pressure. With the exclusion of BMI and sodium-to-potassium ratio, no other control variables were independently related to systolic or diastolic blood pressure. Additionally, in support of the multifaceted nature of hypertension, only 25 to 30% of the total variance in systolic and diastolic blood pressure was accounted for by the previously established hypertension risk factors employed as control variables. The addition of socioeconomic status, which has been shown to be a predictor of health problems in adults (Adler *et al.*, 1994), as a control variable in future research may prove valuable in accounting for a larger portion of the variance in blood pressure. Further, the use of repeated blood pressure readings, possibly throughout the day or across several days, would be an important addition to future investigations.

Viewed in concert, these findings suggest that positive life events may act as a buffer to elevated blood pressure in early adolescents. Along with such treatments as decreasing percentage body fat (Gortmaker *et al.*, 1987) and increasing physical activity levels (Hansen *et al.*, 1991), increasing the occurrence of or changing an individual's perception of the events in his or her life may provide a potentially effective component of a lifestyle modification treatment program for hypertension. In reviewing our findings, it is of interest to note that major life events predicted diastolic, but not systolic blood pressure. In contrast, Theorell *et al.* (1986) found significant correlations between positive life events and both systolic and diastolic blood pressure. Clearly, more research is needed to ascertain fully the nature of this relationship.

Results from our study also raise an important concern regarding the categorization of life events as being either a major event or a daily event. Relative to this point, Wagner (1990) has noted that the boundary between major and daily events is not sharply defined. The authors of the junior high school version of the APES (Compas *et al.*, 1989), categorized items as major or daily on an *a priori* basis using items from previous measures of major life events in this age group (Johnson and McCutcheon, 1980; Newcomb *et al.*, 1981; Swearingen and Cohen, 1985). Remaining events were independently categorized as major or daily based on agreement of at least two of three raters familiar with research in this area (Compas *et al.*, 1989). To clarify this issue, Wagner *et al.* (1988) have suggested that the distinction between major and daily events be based on both the perceived impact of an event and the frequency of its occurrence. Using this approach, major events would receive high impact ratings (either positive or negative) and would be defined as occurring no more than several times a year. In contrast, daily events would be high frequency events, regardless of their impact rating. Future research into refinement of the way in which major and daily life events are operationalized would be noteworthy. Further, it would be valuable to determine if daily events may play a mediating or intermediary role in the process by which major events are perceived (Wagner *et al.*, 1988).

In conclusion, in this sample of sixth-grade adolescents, major positive life events was a significant independent predictor of diastolic blood pressure after several established risk factors of hypertension were controlled statistically. To assist in understanding more completely the etiology of elevated blood pressure and developing effective prevention and treatment programs for pediatric hypertension, future research should be aimed at further elucidating psychosocial factors that may contribute to the development of elevated blood pressure in childhood.

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