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BRIEF REPORT

Childhood Socioeconomic Position and Blood Pressure Dipping in Early Adulthood: a Longitudinal Study

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Abstract
Background The experience of low socioeconomic position in childhood may increase risk for adult cardiovascular disease above and beyond the effects of current socioeconomic position. One limitation of most previous research is that childhood socioeconomic position was assessed retrospectively.
Methods Measures of ambulatory blood pressure, heart rate, and heart rate variability were obtained from 110 young men (22 years) who were enrolled in a long-term study of child development at age 6.
Results Men who had lower childhood socioeconomic position had smaller decreases in systolic blood pressure (SBP) during sleep independent of current education, daytime SBP, and body mass index (BMI). They also displayed smaller decreases in low-frequency heart rate variability during sleep. Twenty-four-hour SBP was negatively associated with childhood socioeconomic position independent of current education and BMI.
Conclusions While the mechanisms are unclear, childhood socioeconomic position may influence blood pressure in early adulthood independent of current life circumstances.

Keywords Socioeconomic position · Development · Blood pressure · Nocturnal dipping

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Introduction

The profound impact of socioeconomic position on blood pressure [1] and risk for cardiovascular disease [2] is well appreciated. One of the most interesting aspects, from both a theoretical and clinical perspective, is the possibility that low childhood socioeconomic position may have lingering effects that contribute to risk for cardiovascular disease in adulthood additively and *independently* of current socioeconomic position [3–6]. Results from the CARDIA study suggest that lingering effects of low childhood socioeconomic position on resting blood pressure may be linked with harsh parenting and the development of an enduring negative emotional style [6]. A dramatic and potentially important example of the impact of low childhood socioeconomic position is nocturnal blood pressure dipping. The degree of blood pressure decrease during sleep (dipping) is associated

with risk of cardiovascular disease and adverse cardiovascular outcome [7]. In a recent study involving 24-h ambulatory monitoring of university students, we observed a link between childhood socioeconomic position and the magnitude of blood pressure decrease during sleep that was independent of current socioeconomic position [8].

That said, there were several limitations of this study and, in general, much of the research on childhood socioeconomic position. Most important, it did not employ a longitudinal design. Childhood socioeconomic position is often assessed retrospectively from participant accounts, typically focusing on parental education. While common practice, such reports may be influenced by lack of knowledge, variability in operationally defining educational categories, and retrospective bias in memory associated with current emotional state. Further, parental education does not reflect the multidimensional nature of socioeconomic position. Another problem with much of the research is that "low" childhood socioeconomic position tends to be a relative term. Most samples included few participants with particularly low socioeconomic position.

The present data come from a subset of 1,037 boys living in disadvantaged areas of Montreal, Canada who were enrolled in a longitudinal study of child development at age 6 [9]. Twenty-four-hour ambulatory physiological measures were obtained from 110 of these individuals at age 22 [10]. The associations between childhood socioeconomic position and 22-year-old blood pressure, heart rate, and heart rate variability, focusing on blood pressure dipping, were examined to corroborate and extend our previous findings.

Methods

Participants

Participants were a subsample of a group of 1,037 French-speaking, Caucasian boys enrolled in a longitudinal study of psychosocial adaptation. The group was initially recruited using a community sample of the 53 schools with the lowest socioeconomic index in the largest school board of Montreal [9]. Several follow-up assessments were conducted, including a laboratory visit of 177 at age 14 during which office blood pressure was measured [11]. More important, 110 of those tested at age 14 underwent ambulatory cardiovascular recording at age 22. There were no significant differences in blood pressure or demographic characteristics between those who participated and did not participate in the 22-year-old follow-up [10]. Participants provided informed consent and all procedures for all phases of the study were approved by appropriate institutional review.

Measures

Blood Pressure Assessment

At age 14, blood pressure was assessed in the laboratory. Three measurements of systolic and diastolic blood pressure (SBP, DBP) were obtained after a 15-min rest period with an oscillometric Sunbeam digital monitor (Model 7621, Boca Raton, FL). Although primarily a home monitor, the device received the highest rating for accuracy in a test of 15 commercially available models [12].

At age 22, ambulatory blood pressure was assessed during a typical weekday. An Accutracker DX ambulatory monitor (Suntech Accutracker DX, Raleigh, NC) was worn on the non-dominant arm for 24 h, starting between 8:00 and 11:00 AM continuing until the following morning. This monitor uses the auscultatory method of blood pressure assessment and has been tested according to the British Hypertension Society and the Association for the Advancement of Medical Instruments standards [13]. It was programmed to obtain two measurements of blood pressure per hour at random intervals. Participants were instructed to follow their normal schedule and complete a diary indicating posture, activity, and location at each blood pressure reading when awake, and to note the time when they went to sleep and when they awoke. Blood pressure values were reviewed for artifactual readings using the manufacturer's software and standard criteria. To assess heart rate (HR) and heart rate variability (HRV), participants also wore a Polar R-R monitor (Polar Electro, Kempele, Finland). The monitor samples the electrocardiogram signal and stores successive R wave values. Values were edited using MXedit software and estimates of high-frequency (HF, 0.15–0.40 Hz) and low-frequency (LF, 0.02–0.15 Hz) heart rate variability were calculated offline as discussed previously [10].

Childhood and Young Adult Socioeconomic Position

A measure of socioeconomic position/family adversity was calculated from maternal reports when participants were enrolled in the study at age 6. The measure has a number of advantages including its multidimensional nature and use in considerable research concerning the effects of socioeconomic position on child development [14–16]. It is calculated using (1) years of mother's and father's education, (2) the parents' ages at the birth of their first child, (3) whether or not the family is intact, and (4) ratings of the occupational prestige of the mother and father using Canadian norms [17].

While this measure is a good index of family socioeconomic position, not all of the criteria are as relevant for young adults who might still be in school or recently

graduated and looking for employment, such as the group at age 22. As a result, the young men's current socioeconomic position was assessed using the common measure of years of education.

Data Analysis

For each participant, values of nocturnal dipping, based on diary times, were calculated for each dependent measure (SBP, DBP, HR, HF HRV, LF HRV), as well as 24-h means (Table 1). Nocturnal dipping was defined according to the American Heart Association percent change formula: 100×(1−(Mean Sleep Value/Mean Day Value)). The primary analyses were general linear models (GLM) of the association between childhood socioeconomic position and dipping in each measure using the awake value of the variable, current socioeconomic position, 14-year-old body mass index (BMI), the increase in BMI from age 14 to 22 ($X_{\text{BMI }14}$=21.2±3.6, $X_{\text{BMI }22}$=24.2±4.2), and the presence or absence of parental hypertension as covariates. These variables were included to control for possible confounding effects of socioeconomic position on childhood weight, the increase in weight during adolescence, and family history of hypertension. Statistical control of age and sex was unnecessary due to the fact that all participants were of the same age and sex.

Results

Dipping

There was a significant effect of childhood socioeconomic position on SBP, $F(1, 103)=4.61$, $p=.034$, but not DBP dipping. Participants with lower childhood socioeconomic position had smaller decreases in SBP while asleep regardless of current education (for ease of understanding, Fig. 1 depicts raw SBP change at night; analyses of raw and percent change scores produced identical results).

Low childhood socioeconomic position was also marginally associated with reduced HR dipping, $F(1, 103)=3.03$, $p=.085$. However, childhood socioeconomic position was not related to nighttime change in HF HRV. As would be expected given its association with parasympathetic nervous system activity, high-frequency activity increased significantly when participants were asleep, $F(1, 109)=361.88$, $p<.001$, but this did not vary with childhood socioeconomic position. On the other hand, childhood socioeconomic position was related to LF HRV dipping, $F(1, 103)=7.78$, $p=.006$. Overall, LF HRV decreased when participants were asleep, $F(1, 109)=262.95$, $p<.001$. Participants who grew up in more challenging circumstances had significantly smaller decreases in LF HRV while asleep.

Table 1 Means and standard deviations of physiological variables

Variable	Age 14	Age 22		
		Awake	Asleep	24 h
SBP (mmHg)	107.4±10.6	128.2±11.1	116.9±16.6	124.4±11.5
DBP (mmHg)	60.2±7.1	75.5±8.1	65.5±10.7	72.3±8.2
HR (bpm)		90.1±11.1	59.1±10.3	78.2±8.8
HF HRV (log ms^2)		3.9±1.9	8.2±2.6	5.1±1.9
LF HRV (log ms^2)		4.6±1.4	3.1±1.2	4.1±1.2

At age 14, blood pressure was assessed via the average of three resting seated measurements. Measurements at age 22 were derived from one 24-h period of ambulatory monitoring

SBP systolic blood pressure, *DBP* diastolic blood pressure, *HR* heart rate, *HF HRV* high-frequency heart rate variability, *LF HRV* low-frequency heart rate variability

Although the sample was too small to permit formal model testing and examination of mediators of dipping, two analyses were conducted to provide some insight into possible relationships between the effects of childhood socioeconomic position on SBP and HRV. When the GLM of SBP dipping was recalculated including degree of LF HRV nocturnal dipping as an additional covariate, the effect of childhood socioeconomic position became nonsignificant, $F(1, 102)=2.75$, $p=.100$. To see if this result was an artifact of reduced statistical power, the GLM of SBP dipping was recalculated once again substituting HF HRV dipping for LF HRV dipping as a covariate. In this case, the effect of childhood socioeconomic position on SBP dipping was maintained, $F(1, 102)=4.55$, $p=.035$.

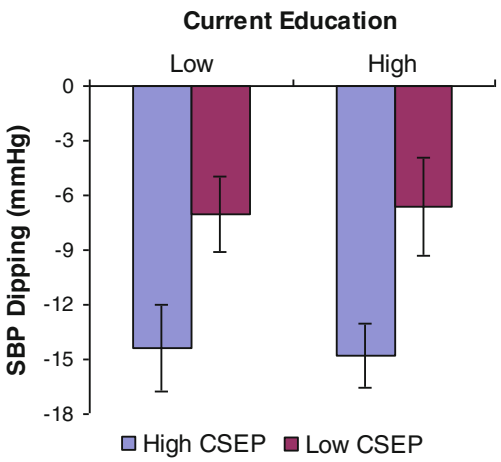

Fig 1 Degree of systolic blood pressure decrease during sleep (SBP dipping) among participants with relatively low and high education at age 22, depending on whether their childhood socioeconomic position (*CSEP*) was relatively low or high (*M*±SE). In general, participants with low CSEP displayed smaller decreases in SBP during sleep regardless of current level of education

24-Hour Blood Pressure

While the study focused on nighttime dipping, relationships between childhood socioeconomic position and 24-h blood pressure levels were also examined. These analyses included 14-year-old blood pressure as an additional covariate. Childhood socioeconomic position was significantly associated with mean 24-h ambulatory SBP even when adjusting for 14-year-old SBP, $F(1, 103)=5.76$, $p=.02$. This finding suggests that the progression of SBP from age 14 to age 22 was associated with adverse economic circumstances in childhood independent of age 14 blood pressure, parental hypertension, body mass, and the degree of weight gain during this period. The effect of childhood socioeconomic position on mean 24-h ambulatory DBP was in the similar direction but not significant.

Discussion

Several previous studies have observed relationships between childhood socioeconomic position and adult blood pressure [3–6] and, in our previous report, blood pressure dipping [8]. However, childhood socioeconomic position was assessed retrospectively, focusing on parental education, using second-hand informants (adult children). As a result, the measures may have been influenced by lack of knowledge or retrospective bias. In the present case, information about family socioeconomic position was obtained prospectively from the parents themselves when their children were young, increasing confidence in the relationships with current blood pressure.

The results indicate that childhood socioeconomic position is related to the progression of SBP between age 14 and age 22 and the degree of nighttime dipping at age 22. The mechanisms remain to be determined but do not seem to involve weight gain and may involve autonomic activity though the meaning of low-frequency HRV is much less clear than high-frequency HRV.

The idea that childhood economic circumstances continue to affect blood pressure in early adulthood has important clinical and theoretical implications. Lehman et al. [6] argue that childhood socioeconomic position may affect adult blood pressure via the development of emotional response styles. It is interesting to speculate that a predisposition for defensive reactions may impair blood pressure dipping at night [18]. Using a stronger model of stress, Mellman et al. [19] found that blood pressure non-dipping was more frequent among individuals suffering from post-traumatic stress disorder. We cannot discount the possibility that the association between childhood socioeconomic position and dipping was due to greater likelihood of trauma among those with low childhood socioeconomic position that influenced, in turn, a variable such as sleep disturbance or sleep quality. On the other hand, the effects could be associated with less intense chronic stress. For example, while associations with ethnic differences in blood pressure and blood pressure dipping remain to be fully elucidated, Spruill et al. [20] suggest that differences between African-Americans and Whites in socioeconomic position are responsible for at least some racial differences in blood pressure and blood pressure dipping. A recent study found that the experience of "everyday discrimination", e.g., feeling that "you are treated with less courtesy than other people," mediated the association between race and blood pressure dipping [21]. It is possible that similar effects occur in lower socioeconomic position people in general [22].

In addition to limited information about possible mechanisms of reduced SBP dipping in low childhood socioeconomic position participants (e.g., autonomic activity, sleep quality, substance use), another limitation concerns the sampling strategy. Focusing on lower socioeconomic position schools reduced socioeconomic variability, though captured a group that is often underrepresented in research. Regardless of the mechanisms, the impact of childhood socioeconomic position on blood pressure dipping is an intriguing and clinically important finding given the association of non-dipping with target organ damage.

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Conflict of Interest The authors have no conflicts of interest to disclose.

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