Assessing Measures of Allostatic Load among Adolescents with Learning and Behavioral Disabilities

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Importance of the Problem

- Allostatic Load (AL)= "Cumulative biological risk/burden" caused by acute and chronic stress, wear and tear on the body, coupled with the body's attempt to compensate.

- Epigenetic effects over lifespan.

- BS McEwen & TE Seeman (1999). *Ann NY Acad Sci* 896:30-47
- TE Seeman et al. (2001). *PNAS* 98:4770-5.
- PA Jones & D Takai (2001). *Science* 293:1068-70.

Indicators of Allostatic Load I

- Systolic Blood Pressure $\geq$ 148 mmHg
- Diastolic Blood Pressure $\geq$ 83 mmHg
- Waist:Hip Ratio $\geq$ 0.94
- Total Cholesterol: HDL Ratio $\geq$ 5.9
- HDL Cholesterol $\leq$ 37 µg/dl

- TE Seeman et al. (2001). *PNAS* 98:4770-5.
- TE Seeman et al. (2002). *Psychosom Med* 64:395-406.

Indicators of Allostatic Load II

- Glycosylated Hemoglobin $\geq$ 7.1%
- Urinary Cortisol $\geq$ 25.7 µg/g creatinine
- Urine Norepinephrine $\geq$ 48 µg/g creatinine
- Urine Epinephrine $\geq$ 5 µg/g creatinine
- <u>De</u><u>Hydro</u><u>Epi</u>Androsterone sulf. $\leq$350 ng/ml

- TE Seeman et al. (2001). *PNAS* 98:4770-5.
- TE Seeman et al. (2002). *Psychosom Med* 64:395-406.

Previous Studies

- Sum of ten categories (0-10) in which individuals ranked in the highest quartile (eight measures) or lowest quartile (two measures – HDL Cholesterol & DHEA).

- High Allostatic Load Scores significantly associated - increased risk 7-yr mortality.

- Better predictor than metabolic syndrome.

- AL significantly higher if < 3 close friends.

- TE Seeman et al. (2001). *PNAS* 98:4770-5.
- TE Seeman et al. (2002). *Psychosom Med* 64:395-406.

Additional Studies

- For Allostatic Load scores $\geq$ 4 (out of 10 indicators), African Americans were significantly more frequent than Caucasians across age groups.

- Significantly higher C-reactive protein (inflammatory link to CV disease) for African Americans and low SES.

AT Geronimus et al. (2006). *Am J Pub Health* 96:826-33.

DE Alley et al. (2005). *Brain Behav Imm* 20:498-504.

Additional Studies

- Individuals with low C-Reactive Protein levels have better clinical outcomes, regardless of LDL cholesterol.

- High Homocysteine might also increase risk for Heart Disease and Stroke

PM Ridker et al. (2005). *New Engl J Med* 352:20-8.

Homocysteine Studies Collab. (2002). *JAMA* 288:2015-22.

Additional Studies

- Few friends and low social support are linked to Allostatic Load among persons with disabilities.

- Quality of social relationships need to be addressed.

AJ Christensen et al. (1999). *Psychosom Med* 61:141-5.

JT Cacioppo et al. (2002). *Psychosom Med* 64:407-17.

R De Vogli et al. (2007). *Arch Int Med* 167:1951-1957.

Allostatic Impact on Immunity

- Negative affective style weakens immunity.

- Testosterone & Glucocorticoids weaken immunity.

- Stress redistributes leukocytes between blood and other tissues, possibly leading to morbidity.

MA Rosenkranz et al. (2003). *PNAS* 100:11148-52.

ML Roberts et al. (2004). *Animal Behaviour* 68:227-39.

F Dhabhar et al. (1995). *J Immunol* 154:5511-27.

Allostatic Impact on Immunity

- Neuroendocrine and Immune Biomarkers predict future survival and indicate risk contraindicating clinical markers.

- Biomarker cutoff points need to be established (e.g. highest/lowest deciles)

N Goldman et al. (2006). *J Gerontology* 61A:1070-4.

CL Seplaki et al. (2004). *J Gerontology* 59A:201-17.

Allostatic Load and Race/SES

- International study of blood pressure by race showed greater variation within races, and African American BPs are not high across nations.

- Evidence that Allostatic Load may be more strongly linked with SES.

RS Cooper et al. (2005). *BMC Medicine* 3:2.

SL Szanton et al. (2005). *Biol Res Nursing* 7:7-15.

Public Health Ramifications

- IOM Report (2007) – *The Future of Disability in America*

- *Healthy People 2010, Chapter 6 – Disability & Secondary Conditions*

- *Persons with Disabilities significantly un-/underemployed compared to general population*

GE Jones (1997). Hum Res Mgt Rev 7:55-76

Data Needs

- *Need for Distinctive Biomarkers* of Morbidity Risk that can be evaluated longitudinally.

- Specific applications to Persons with Disabilities.

This Study

- NHANES – National Health and Nutrition Examination Survey
- 2001-2002: n = 11,039
- 2003-2004: n = 10,122
- Focus on adolescents, age 12-19.

Independent Variables

- Self-Descriptors (Physician said…)

  Attention Deficit Disorder (ADHD)

  Learning Disability (LD)

  Overweight

  Stuttering/Stammering

  Trouble Seeing even with Lenses

- Covariates

  Gender and Race/Ethnicity

Dependent Variables - AL

- Blood Pressure
  - Systolic
  - Diastolic
- Body Mass Index (BMI)*
- Serum Total Cholesterol:HDL Ratio
- Serum HDL cholesterol
- C-Reactive Protein and Homocysteine
- Immune Cell (Lymphocyte) Counts

Using Age-Adjusted Upper Fels Quartiles per Demerath et al. (2006). Pediatrics 117: e487-e495.

Analyses

- Demographics
- Stage 1: NHANES 2001-2002
- Stage 2: NHANES merged 2001-04
- SPSS, Version 15.0
- ANCOVA and Chi-Square
- Pregnant Women excluded
- Mobile Examination Center weights

Natl. Ctr. Health Statistics (Sept 2006). NHANES Analytical/Reporting Guidelines

Results – Demographics '01-02

Variable	All (n=11,039)		Age 12-19 (n=2,487)	
	k	%	k	%
Doctor said you had ADHD	276	6.7	180	7.3
Doctor said you were Overweight	441	9.4	297	12.0
Doctor said you had LD	312	10.7	170	13.5
Frequent Stuttering/Stammering	142	4.9	62	4.9
Trouble Seeing even with Lenses	1473	14.6	282	11.3
Gender - Female	5708	51.7	1262	50.7
Hispanic	3293	29.8	895	36.0
Caucasian	4606	41.7	739	29.7
African American	2681	24.3	754	30.3
Other/Multiracial	459	4.2	99	4.0
< High School Education	5088	55.8	2179	87.7
High School Diploma or GED	1476	16.2	211	8.5
Postsecondary Education	2553	28.0	95	3.8

Results – Demographics '03-04

Variable	All (n=10,122)		Age 12-19 (n=2,303)	
	k	%	k	%
Doctor said you had ADHD	260	6.9	196	8.5
Doctor said you were Overweight	463	10.9	299	13.0
Doctor said you had LD	279	10.8	143	12.7
Frequent Stuttering/Stammering	110	4.3	42	3.7
Trouble Seeing even with Lenses	1517	16.3	285	12.4
Gender - Female	5152	50.9	1120	48.6
Hispanic	2860	28.3	766	33.2
Caucasian	4133	40.8	627	27.2
African American	2663	26.3	829	36.0
Other/Multiracial	466	4.6	81	3.5
< High School Education	4478	53.6	1957	85.0
High School Diploma or GED	1462	17.5	193	8.4
Postsecondary Education	2422	29.0	151	6.6

Demographics Combined*

Variable	All (n=20,504)		Age 12-19 (n=4,683)	
	k	%	k	%
Doctor said you had ADHD	531	6.8	371	7.9
Doctor said you were Overweight	890	10.0	582	12.4
Doctor said you had LD	590	10.8	312	13.1
Frequent Stuttering/Stammering	251	4.6	103	4.3
Trouble Seeing even with Lenses	2919	15.6	550	11.7
Gender - Female	10203	49.8	2275	48.6
Hispanic	5952	29.1	1619	34.6
Caucasian	8438	41.2	1340	28.6
African American	5228	25.5	1545	33.0
Other/Multiracial	886	4.3	179	3.8
< High School Education	9355	55.6	4060	86.8
High School Diploma or GED	2802	16.7	383	8.2
Postsecondary Education	4666	27.7	236	5.0

*Excluding pregnant females

I. Inferential Statistics '01-02 ‡

Independent Variable	Dependent Variable	Main Effects		Interaction Effects	
		F	p	F	p
ADHD	BMI	7.17	.008**	-	n.s.
LD		1.19	.276		
ADHD	Lymphocytes	5.46	.020*	-	n.s.
LD		.29	.590		
ADHD	Family Income	5.05	.025*	-	n.s.
LD		6.69	.010**		
OW	BMI	128.5	.000**	3.85	.050*
LD		2.44	.119		
OW	BMI	-	n.s.	7.18	.000**
Race		-	n.s.		
OW	Cholesterol	-	n.s.	3.37	.009**
Race		-	n.s.		
OW	Diastolic BP	-	n.s.	3.56	.007**
Race		-	n.s.		

‡Ages 12-19 Excluding Pregnant Females; *Significant at $p \leq .05$; **at $p \leq .01$

II. Inferential Statistics ADHD '01-04 ‡

Independent Variable	Dependent Variable	Main Effects		Interaction Effects	
		F	p	F	p
ADHD	Systolic BP	.072	.788	2.957	.019*
Race		2.816	.024*		
ADHD	Diastolic BP	.460	.498	2.627	.033*
Race		1.793	.127		
ADHD	Cholesterol: HDL Ratio	5.067	.024*	1.049	.380
Race		6.931	.000**		
ADHD	HDL Cholesterol	2.048	.152	4.736	.001**
Race		14.47	.000**		
ADHD	BMI	.630	.427	1.482	.205
Race		2.089	.080		
ADHD	White Blood Cells (Lymphocytes)	.005	.946	2.542	.038*
Race		16.88	.000**		

‡Ages 12-19 Excluding Pregnant Females; *Significant at $p \leq .05$; **at $p \leq .01$

II. Inferential Statistics OW '01-04 ‡

Independent Variable	Dependent Variable	Main Effects		Interaction Effects	
		F	p	F	p
Overweight	Systolic BP	39.597	.000**	.113	.978
Race		3.939	.003**		
Overweight	Diastolic BP	.430	.512	.252	.909
Race		.316	.867		
Overweight	Cholesterol: HDL Ratio	65.458	.000**	.822	.511
Race		6.418	.000**		
Overweight	HDL Cholesterol	31.476	.000**	2.633	.033*
Race		10.558	.000**		
Overweight	BMI	814.13	.000**	8.047	.000**
Race		12.493	.000**		
Overweight	White Blood Cells (Lymphocytes)	16.595	.000**	2.297	.057
Race		32.172	.000**		
‡Ages 12-19 Excluding Pregnant Females; *Significant at $p \leq .05$; **at $p \leq .01$					

II. Inferential Statistics LD '01-04 ‡

Independent Variable	Dependent Variable	Main Effects		Interaction Effects	
		F	p	F	p
LD	Systolic BP	.007	.935	.841	.499
Race		4.871	.001**		
LD	Diastolic BP	5.518	.019*	2.076	.081
Race		1.491	.202		
LD	Cholesterol: HDL Ratio	3.748	.053	1.063	.373
Race		5.240	.000**		
LD	HDL Cholesterol	6.358	.012*	2.207	.066
Race		10.307	.000**		
LD	BMI	.074	.785	.159	.959
Race		1.505	.198		
LD	White Blood Cells (Lymphocytes)	.087	.768	.572	.683
Race		13.206	.000**		

‡Ages 12-19 Excluding Pregnant Females; *Significant at $p \leq .05$; **at $p \leq .01$

II. Inferential Statistics Stuttering '01-04 ‡

Independent Variable	Dependent Variable	Main Effects		Interaction Effects	
		F	p	F	p
Stuttering	Systolic BP	1.024	.312	.276	.893
Race		1.757	.135		
Stuttering	Diastolic BP	4.524	.034	2.299	.057
Race		1.589	.175		
Stuttering	Cholesterol: HDL Ratio	.008	.930	.502	.734
Race		.748	.559		
Stuttering	HDL Cholesterol	.392	.531	.193	.942
Race		2.486	.042*		
Stuttering	BMI	.310	.578	.495	.740
Race		.987	.413		
Stuttering	White Blood Cells (Lymphocytes)	6.388	.012*	1.252	.287
Race		10.598	.000**		

‡Ages 12-19 Excluding Pregnant Females; *Significant at $p \leq .05$; **at $p \leq .01$

II. Inferential Statistics Vision '01-04 ‡

Independent Variable	Dependent Variable	Main Effects		Interaction Effects	
		F	p	F	p
Vision	Systolic BP	4.279	.039*	1.047	.381
Race		4.843	.001**		
Vision	Diastolic BP	.113	.737	.739	.565
Race		1.096	.357		
Vision	Cholesterol: HDL Ratio	.133	.715	1.719	.143
Race		6.504	.000**		
Vision	HDL Cholesterol	1.424	.233	.672	.612
Race		11.196	.000**		
Vision	BMI	5.117	.024*	.317	.867
Race		2.943	.019*		
Vision	White Blood Cells (Lymphocytes)	3.809	.051	.412	.800
Race		30.476	.000**		

‡Ages 12-19 Excluding Pregnant Females; *Significant at $p \leq .05$; **at $p \leq .01$

Conclusions

- Allostatic Load measures are mostly insignificant for persons with LD, Stuttering, and Vision Disabilities.

- There are significant differences between persons with and without ADHD, although there appears to be no consistent patterns of positive and negative stressors.

Conclusions

- The most notable significant differences in allostatic load occur for persons who are:

    Overweight – more negative AL

    African American – more negative AL

- This includes C-reactive protein levels

- Consistent with previous studies

Limitations

- Disability self-report accuracy.

- Arbitrariness of Disability categories.

- Difficulties in age and developmental-stage individual variations in serologies.

- Lack of agreement on allostatic measures.

What this Study Adds

- Demonstration that allostatic load may be relevant to adolescents, particularly with reference to cultural stressors and the "obesity epidemic."

- African Americans and Persons who are overweight are vulnerable.

- Continued lack of adequate measures for disability (e.g. the ICF) in longitudinal studies.

WHO (2001). Intl. Classification Functioning, Disability and Health. Geneva.

Thank You!

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