



The Learning Connection: Physical Activity, Nutrition, Cognition, and Academic Performance

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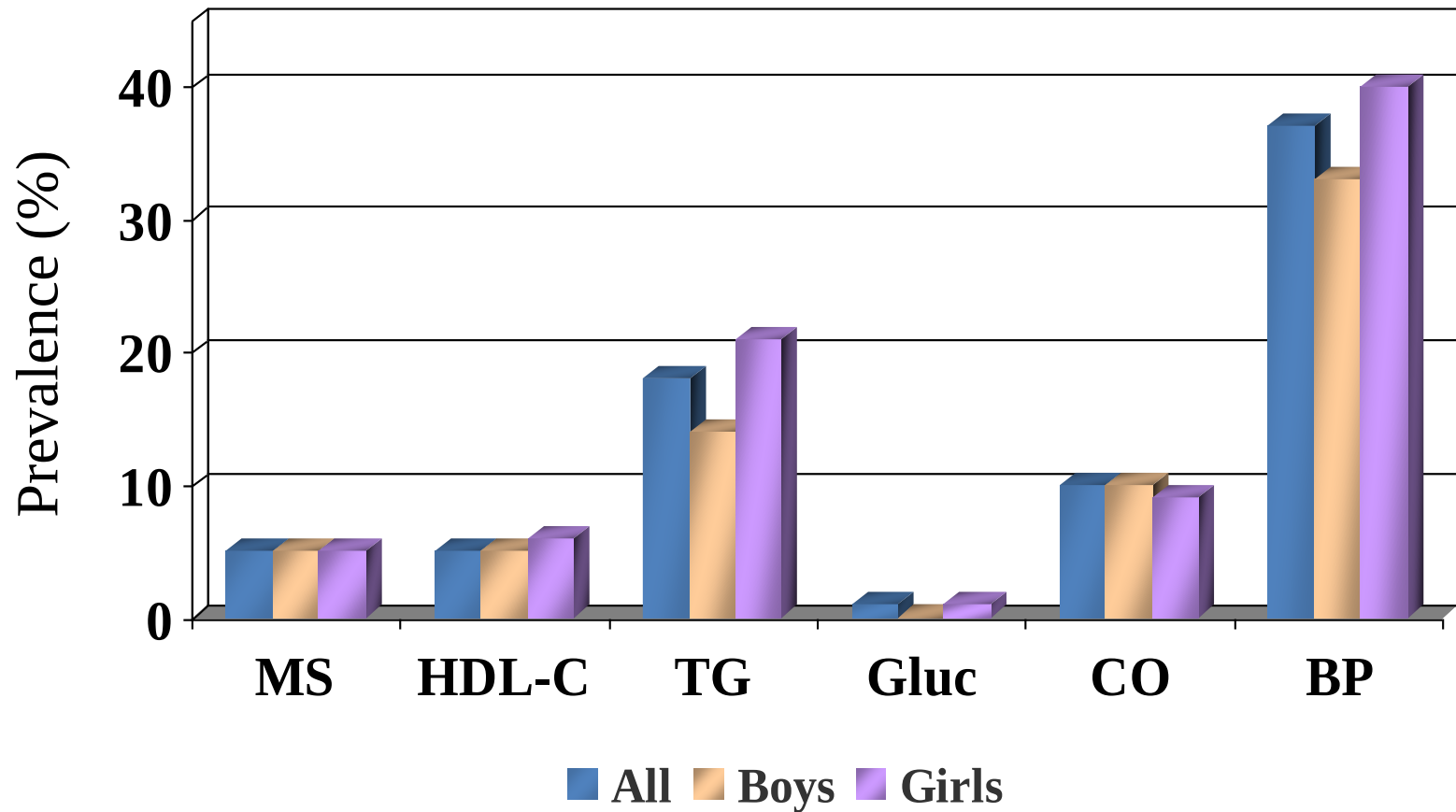
Director, Energy Balance Laboratory

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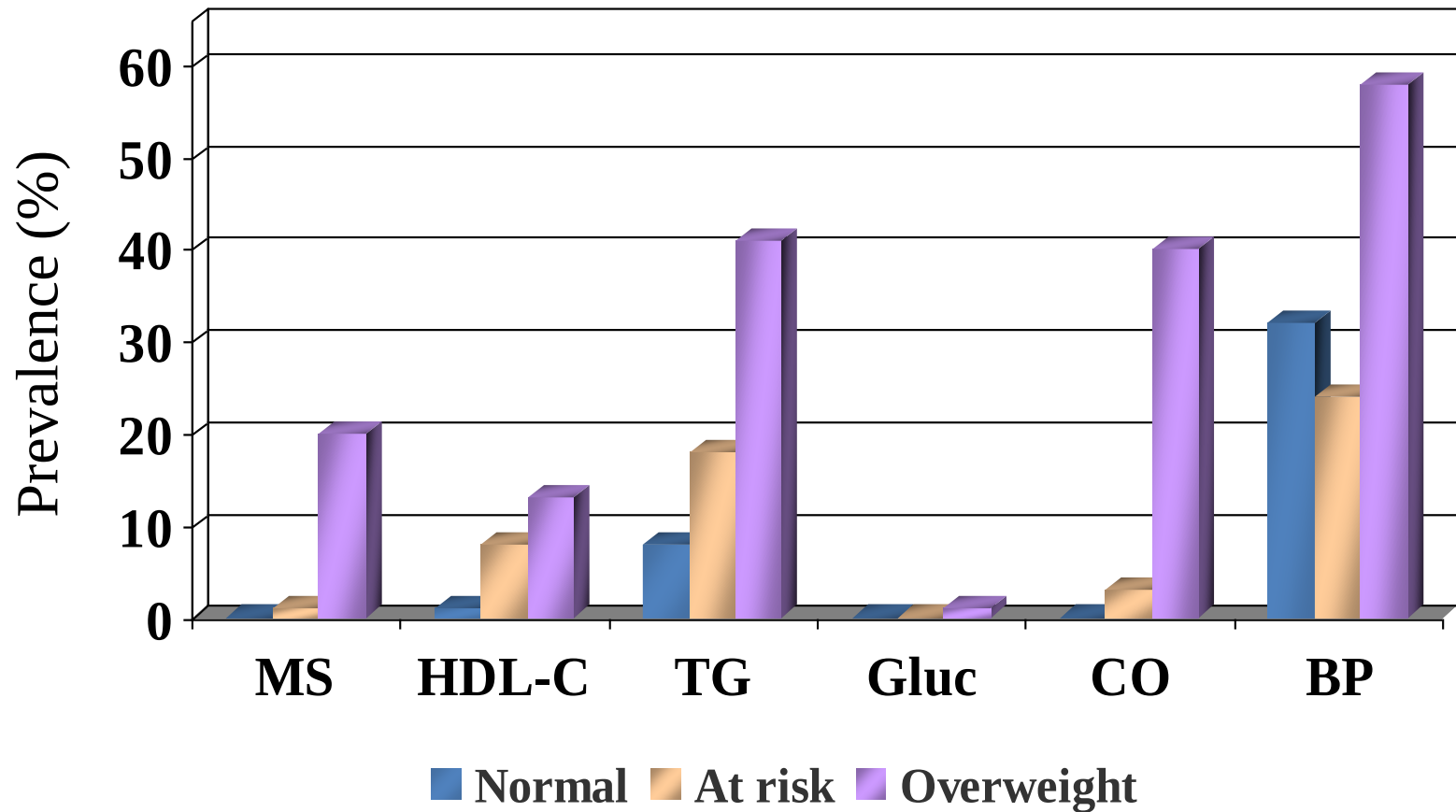
The University of Kansas Medical Center

The University of Kansas-Lawrence

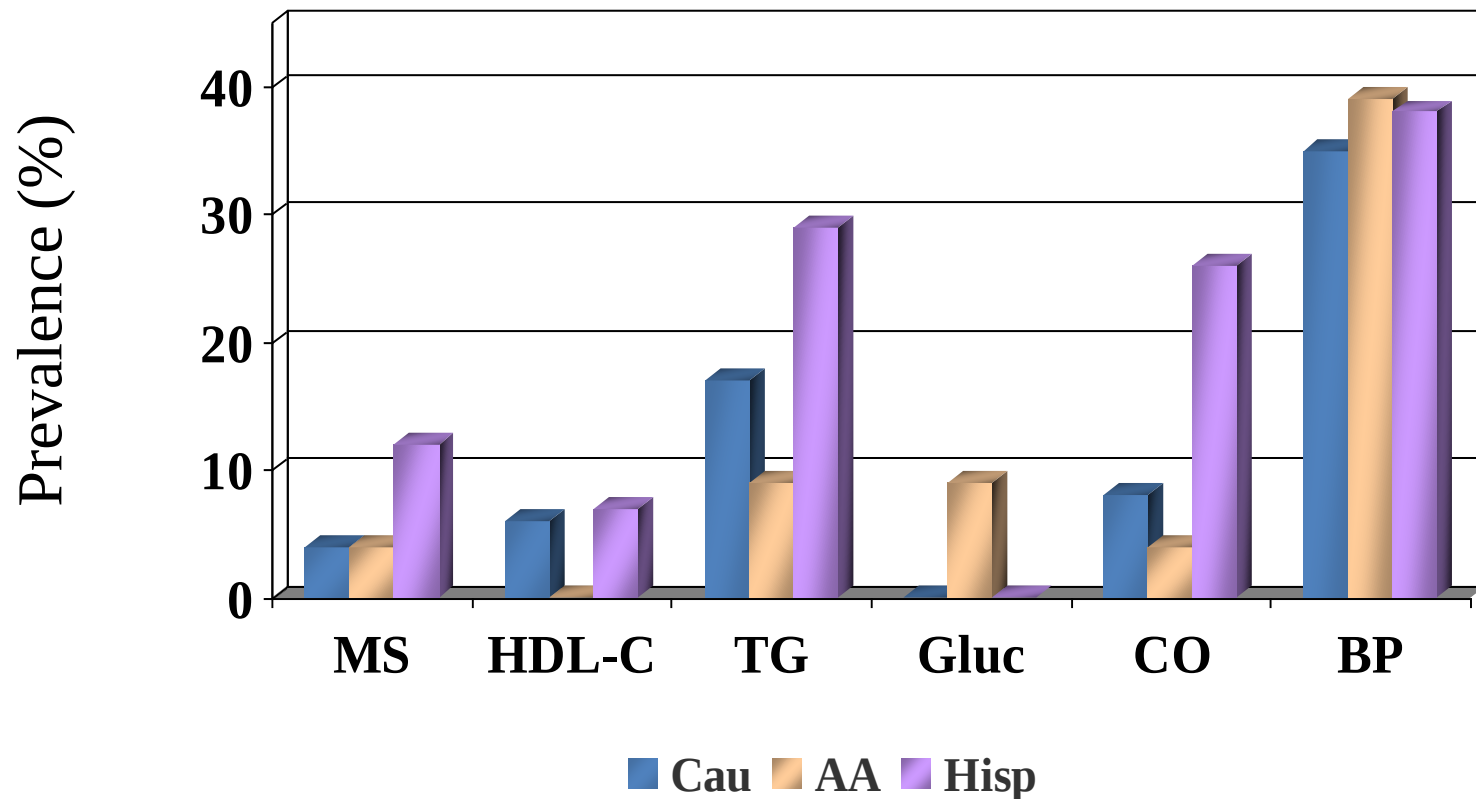
Distribution of the Metabolic Syndrome & Its Related Components



Distribution of the Metabolic Syndrome & Its Related Components By BMI Levels



Distribution of the Metabolic Syndrome & Its Related Components By Race



TOXIC ENVIRONMENT

- An environment that promotes sedentary behavior
- Few opportunities for physical activity during the course of daily living
- Almost no need to be physically active to survive
- Abundance of high density foods
- Little need to expend energy for foods

Food has never been cheaper, more available and accessible



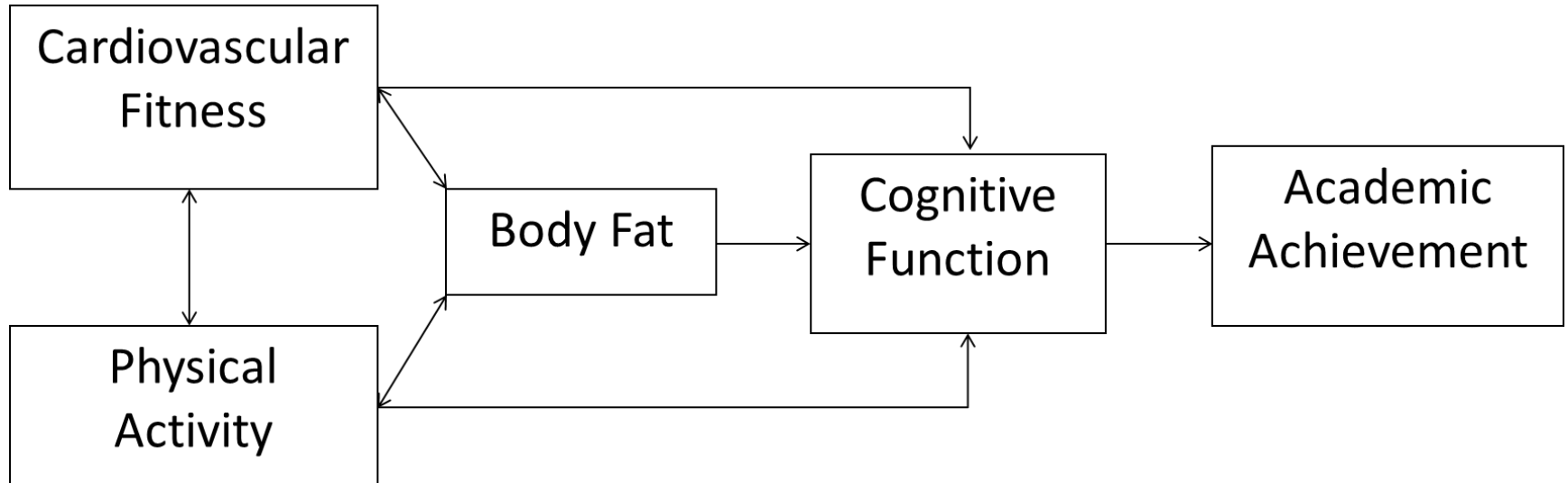
Where has all the physical activity gone?



EVERYTHING

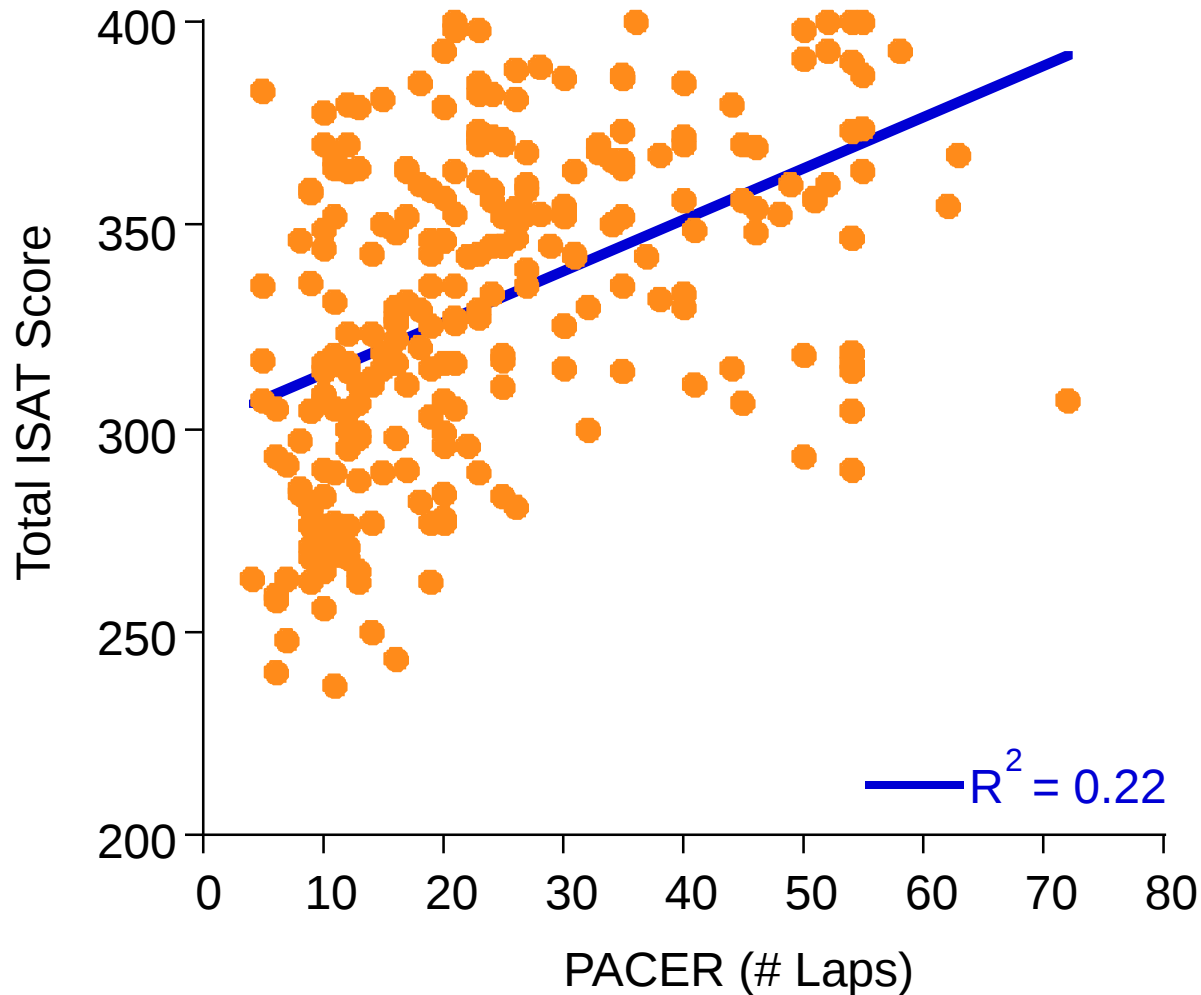


Theoretical Model to Improve Health & Academic Achievement

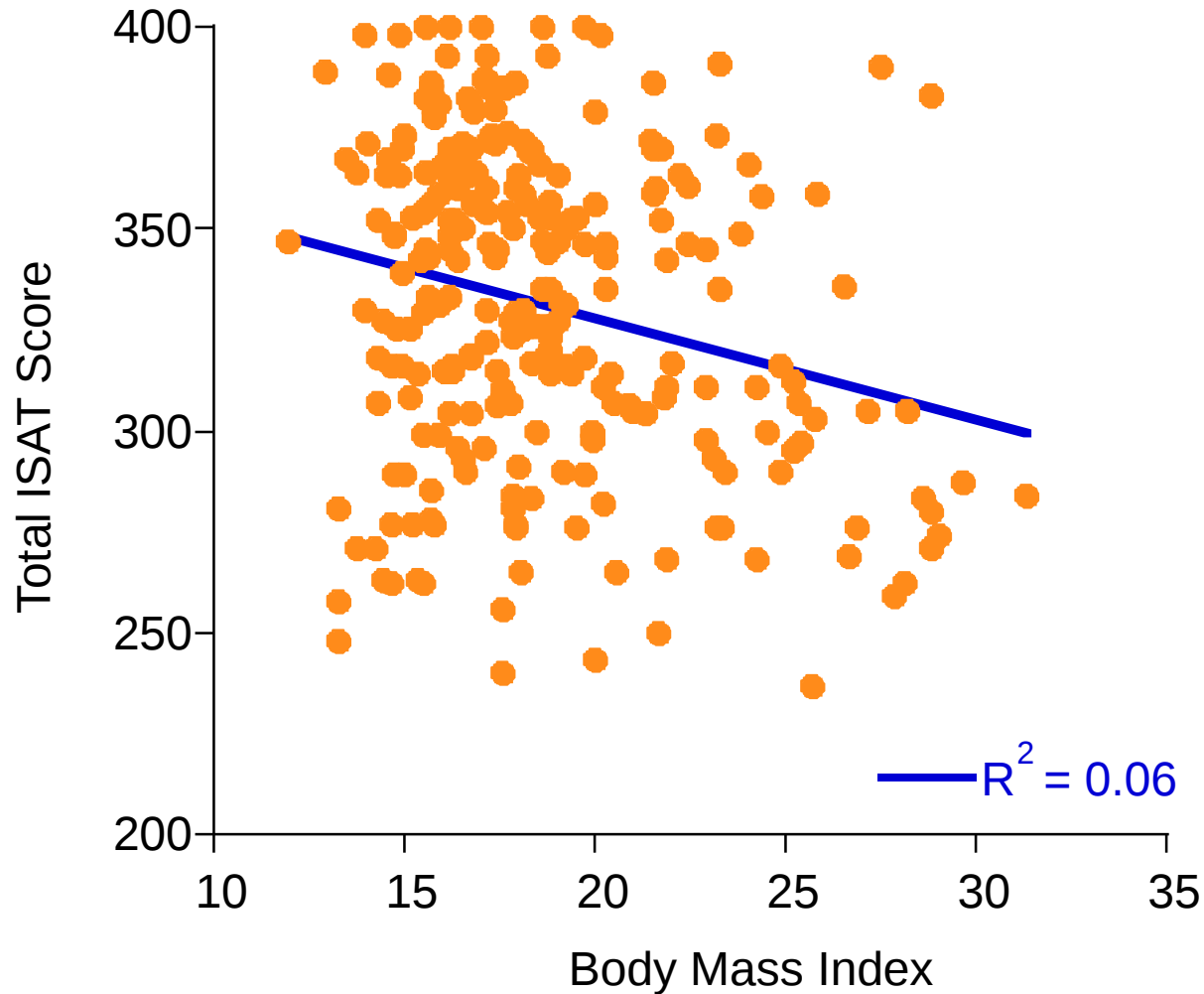


Donnelly JE, Lambourne K, Prev. Med., 2011, 52:S36-42.

Aerobic Fitness & Achievement Test Performance



Body Mass Index & Achievement Test Performance



Schools are Sedentary

- Bus ride can be > 60 min each way
- Recess and physical education has declined to levels that cannot provide adequate stimulus (energy expenditure) for fitness or to protect against fatness
- Motor time off task is discouraged and disciplined
- Traditional teaching paradigm- sit down and be quiet

Car Loading



Schools Present Challenges

- Schools appear to be ideal intervention sites *but*
 - Difficult to penetrate for permission to conduct PA studies
 - Not tolerant of biological samples (i.e. blood)
 - Not tolerant of infringement on classroom time
 - Not tolerant of additional teacher time
 - Frequently have poor facilities

Schools Present Challenges

- PE class in elementary school is generally 30min X 2d/wk, facilities, equipment, teacher to student ratio vary and often are poor, especially in lower SES, ethnic schools
- Recess is frequently eliminated in order to provide more instruction time

More Challenges

- Standardized tests (i.e. No Child Left Behind)
- Special events- field trips, assembly, etc.
 - Note only 40-60% of allocated instructional time is spent in instruction
- Absenteeism
- Child and teacher transfer between schools
- Dose of intended intervention severely compromised by all the above
- Etc.

Schools Provide Opportunities

- Children go to school
- Permanent facility
- Administration can “demand” uniformity
- Educated workforce used to delivering curriculums and evaluating outcomes

Schools Provide Opportunities

- Existing in-service mechanism
- Have physical activity and nutrition (health) mandated at the state level, but have little expertise for design and implementation
- Extended contact with children at most receptive and influential age
 - 8 hours/d
 - 5d/wk
 - 9 months/yr

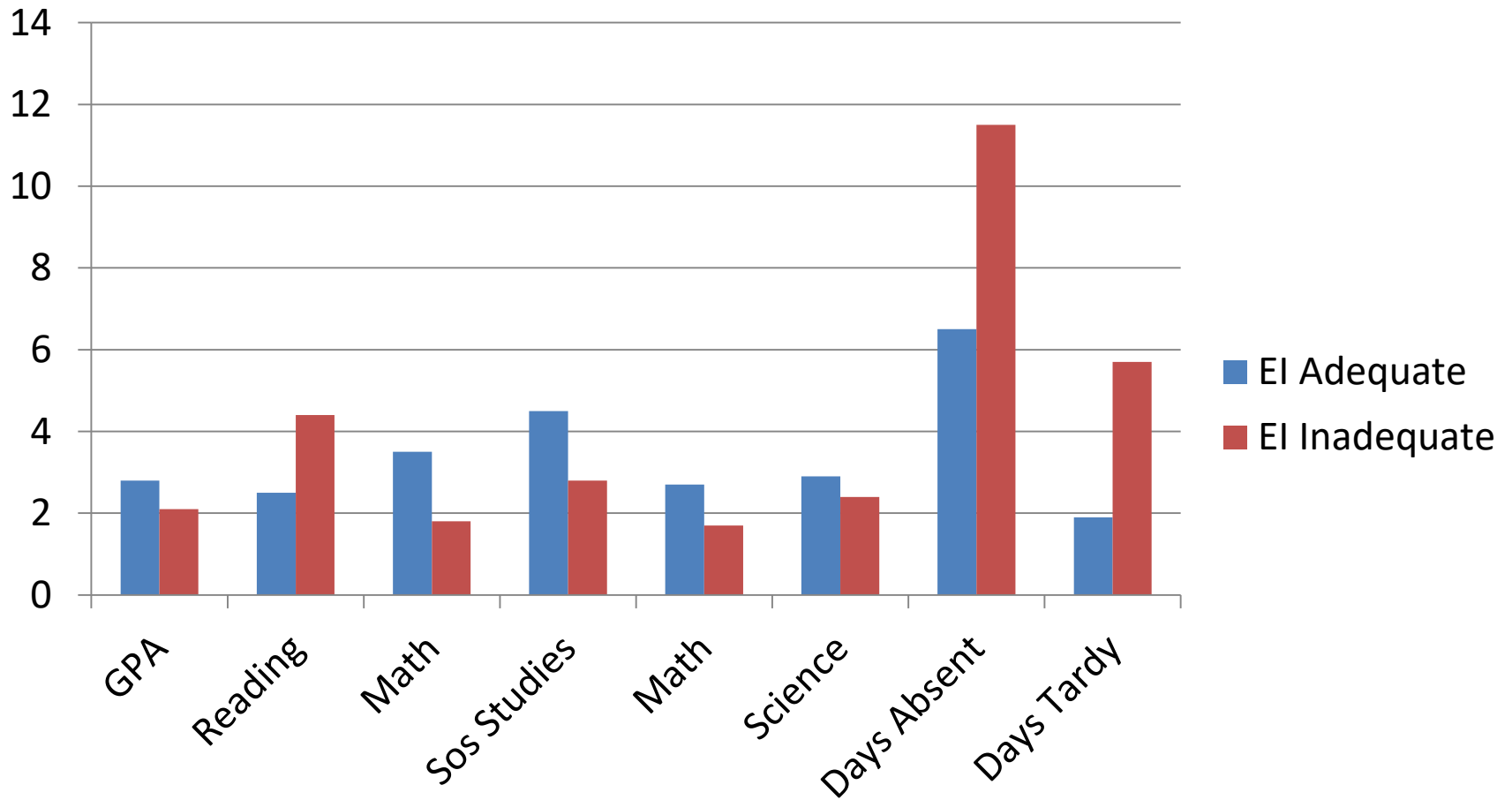
Approach

- Behavioral- individual changes behavior using a variety of strategies such as
 - Improving self efficacy, planning, social support, contingency planning
- Social Marketing- similar to advertising whereby behaviors are marketed as desirable, frequently using “Madison Avenue” techniques
- Environmental- restructure environment to get desired behavior, may employ behavioral economics

Energy Intake



Adequate Nutrition and AA



Kleinman et al., Ann Nutr Metab, 2012

From: **The Relationship of School Breakfast to Psychosocial and Academic Functioning: Cross-sectional and Longitudinal Observations in an Inner-city School Sample**

Arch Pediatr Adolesc Med. 1998;152(9):899-907.

Table 2. Mean Child Adjustment Scores for School Breakfast Program Participation Groups Before Universal Feeding*

Measure	Scores			
	Total No. of Children	School Breakfast Program Participation Groups		
		Rarely	Some	Often
School recorded				
No. (%)	133 (100)	83 (62)	26 (20)	24 (18)
Math grade†	2.3	2.1	2.3	3.0
Days absent	1.5	1.5	1.6	1.4
Days tardy	0.5	0.6	0.4	0.1
Interview				
No. (%)	85 (100)	27 (32)	39 (40)	19 (22)
CDI total score†	6.4	7.9	4.5	3.4
RCMAS total score†	10.1	11.4	8.3	7.2
PSC total score‡	17.2	18.9	14.7	13.9
Teacher reported				
No. (%)	76 (100)	41 (54)	15 (20)	20 (26)
CTRS-39 score	58.4	63.3	57.3	49.1

*Grades are expressed on a 4.0 scale (A = 4.0). CDI indicates Child Depression Inventory³⁰; RCMAS, Revised Children's Manifest Anxiety Scale³²; PSC, Pediatric Symptom Checklist³⁴; and CTRS-39, Connors' Teacher Rating Scale-39.³⁷ Hyperactivity Index (Baltimore, Md, sample only).

† $P < .001$.

‡ $P < .01$.

Figure Legend:

Mean Child Adjustment Scores for School Breakfast Program Participation Groups Before Universal Feeding*

Energy Expenditure





Physical Activity Across the Curriculum (PAAC)

A 3-year, randomized controlled trial of
physical activity and academic
achievement for elementary school
children in grades 2 & 3

Donnelly et al., Physical Activity Across the Curriculum (PAAC): A randomized controlled trial to promote physical activity and diminish obesity in elementary school children. *Prev. Med.* 2009, 49:336-41 (DK61489)

Major Aims of PAAC

- Increase physical activity by using classroom teachers to teach existing lessons with using physical activity
- Primary aim-
 - Diminish increases in BMI
- Secondary aims-
 - Determine association between physically active lessons and academic achievement
 - Characterize metabolic syndrome

The PAAC Program

- **A classroom-based approach to reduce sedentary behavior while maintaining the focus on academics**
- **NO DECREASE in academic instruction time**
- **PAAC is a technique to deliver existing academic instruction through movement**

Traditional VS. PAAC Classroom



Conceptual Framework

- Minimal intervention
- Enhances learning
- No additional teacher preparation time
- No additional cost
- Easily perpetuated and replicated
- Desirable for both teacher and student (i.e., FUN)
- Students “must” participate in classroom lessons

The PAAC Program

Integrate 10 minute periods of physical activity within academic lessons for a total of 90 min/wk (i.e. 1 ten min lesson in morning and afternoon.

- **Language art**
- **Math**
- **Science**
- **History**

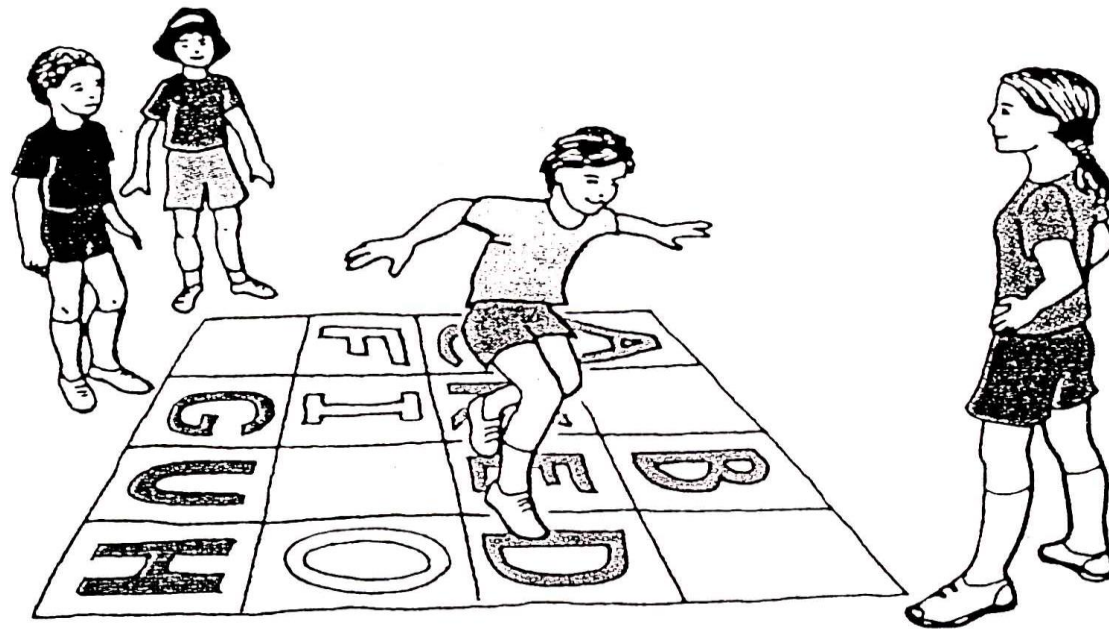
Design

- Cluster randomized, controlled trial N=22
- 3 year intervention
- Grades 2&3
- Target 90 minutes of moderate to vigorous physical activity/wk
- Use classroom teachers to deliver existing academic lessons using physical activity

Active Lesson



Learning to Spell



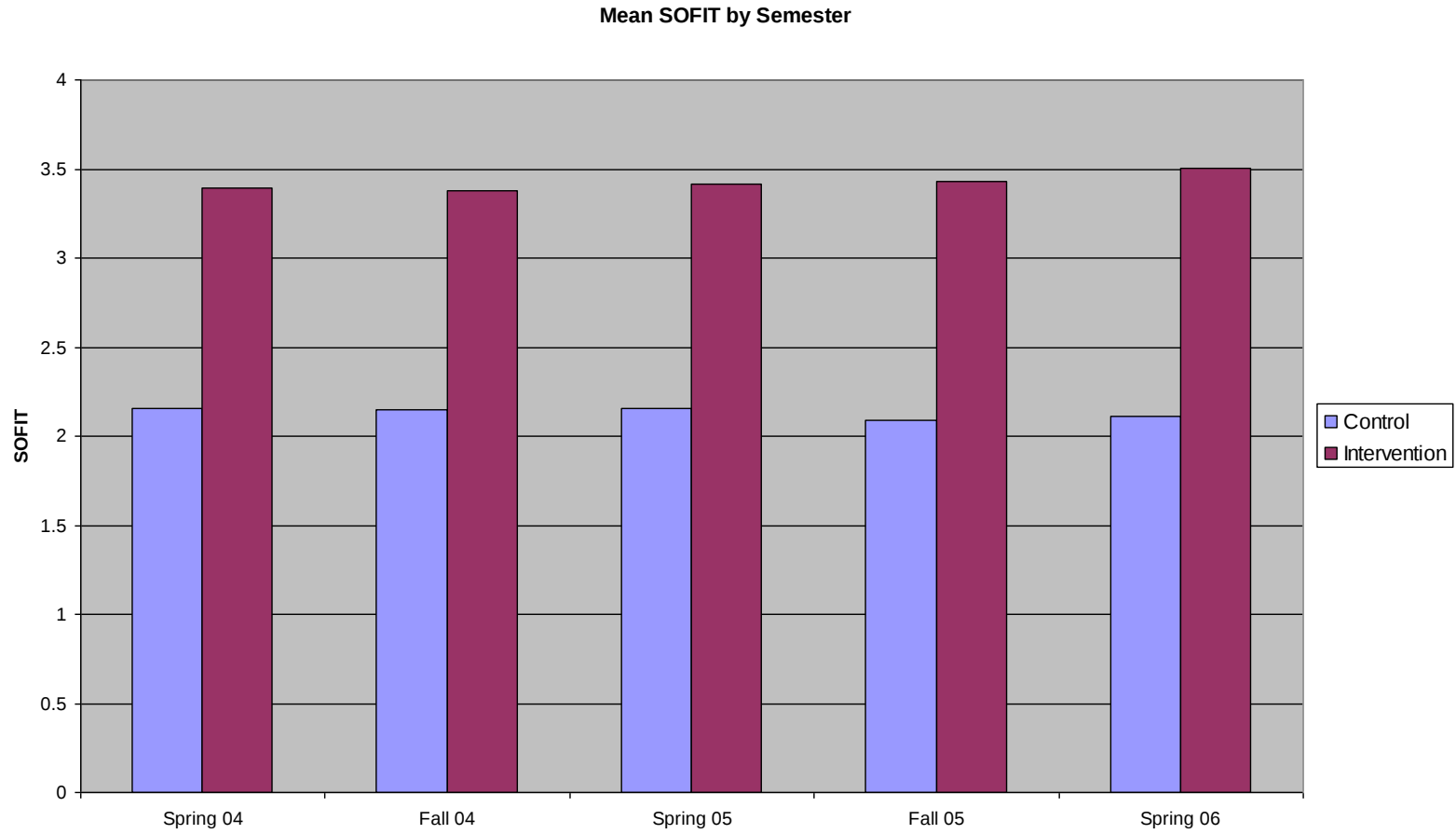
Learning Math



Learning Spanish



Level of Physical Activity



Energy Expenditure of PAAC Lessons with Cosmed



- 38 boys & girls
- Grades 2-5
- PAAC lessons of ≥ 10 min duration
- Average MET = 3.4 (lower end of moderate to vigorous)



Energy Expenditure of Exercise

38 boys & girls

Grades 2-5

PAAC lessons of ≥ 10 min duration

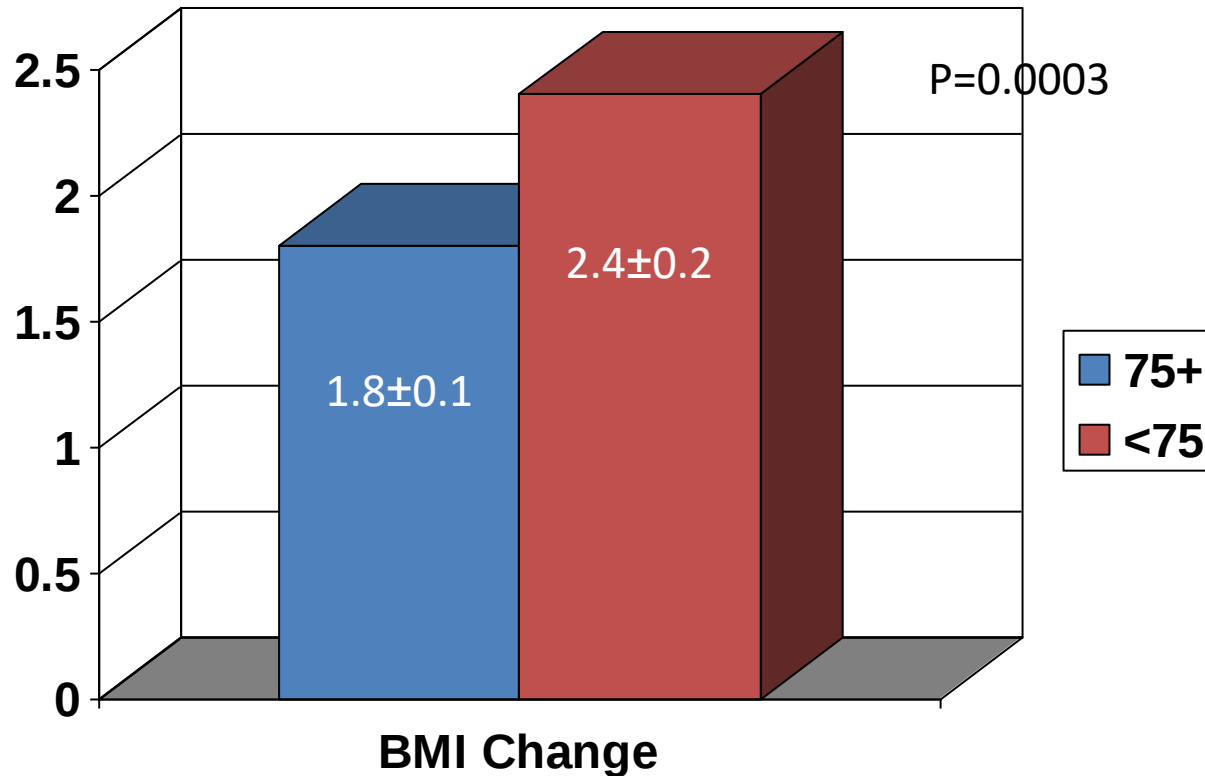
Average MET = 3.4 (lower end of moderate to vigorous)

Honas et al., MSSE, 2008

Will more vigorous exercise provide a greater response for cognitive function (and perhaps academic achievement?) Davis et al., Health Psychol, 2011

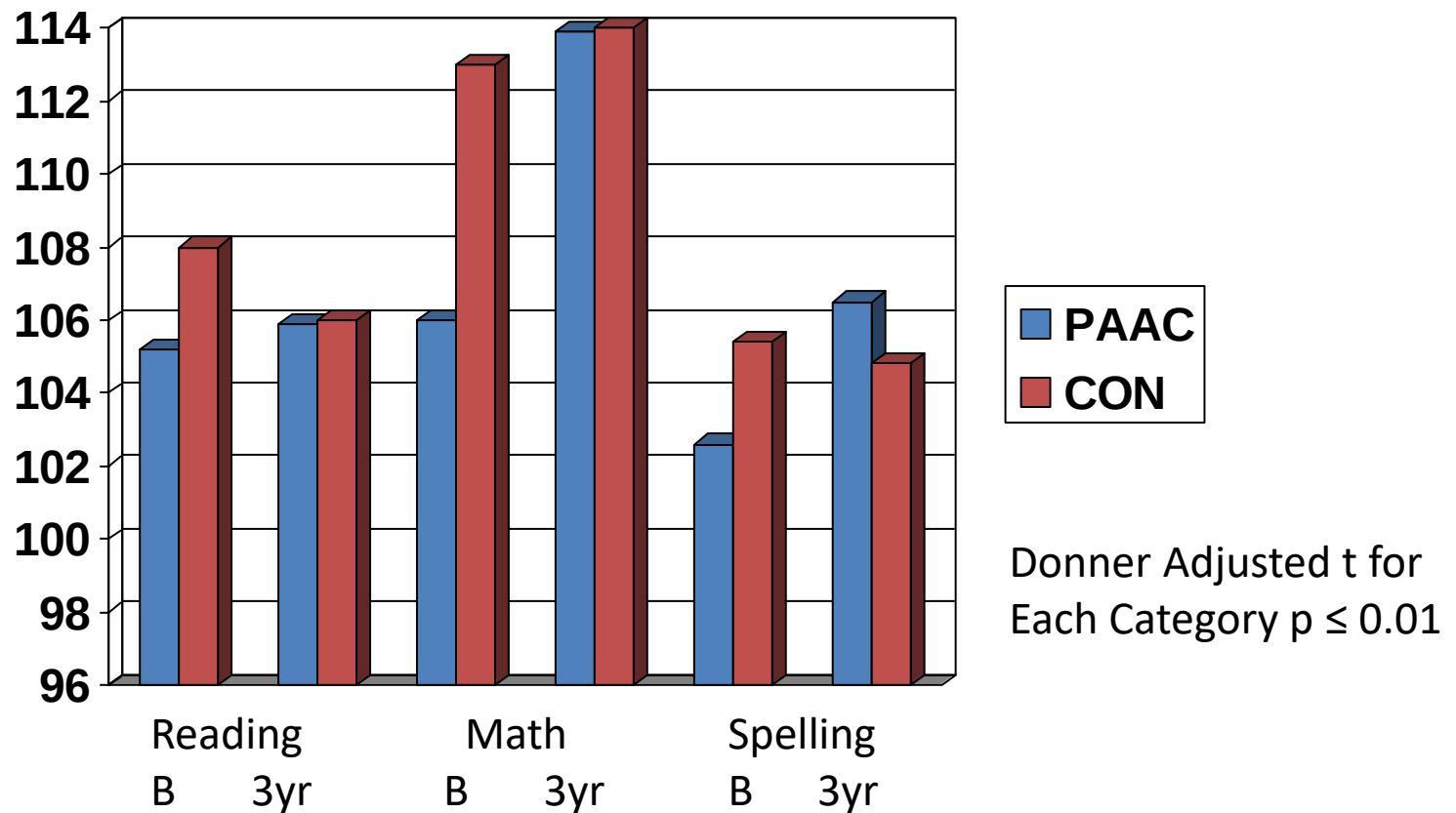


BMI Change Across 3 Years for PAAC Schools Receiving 75⁺ min of PA or < 75 min PA



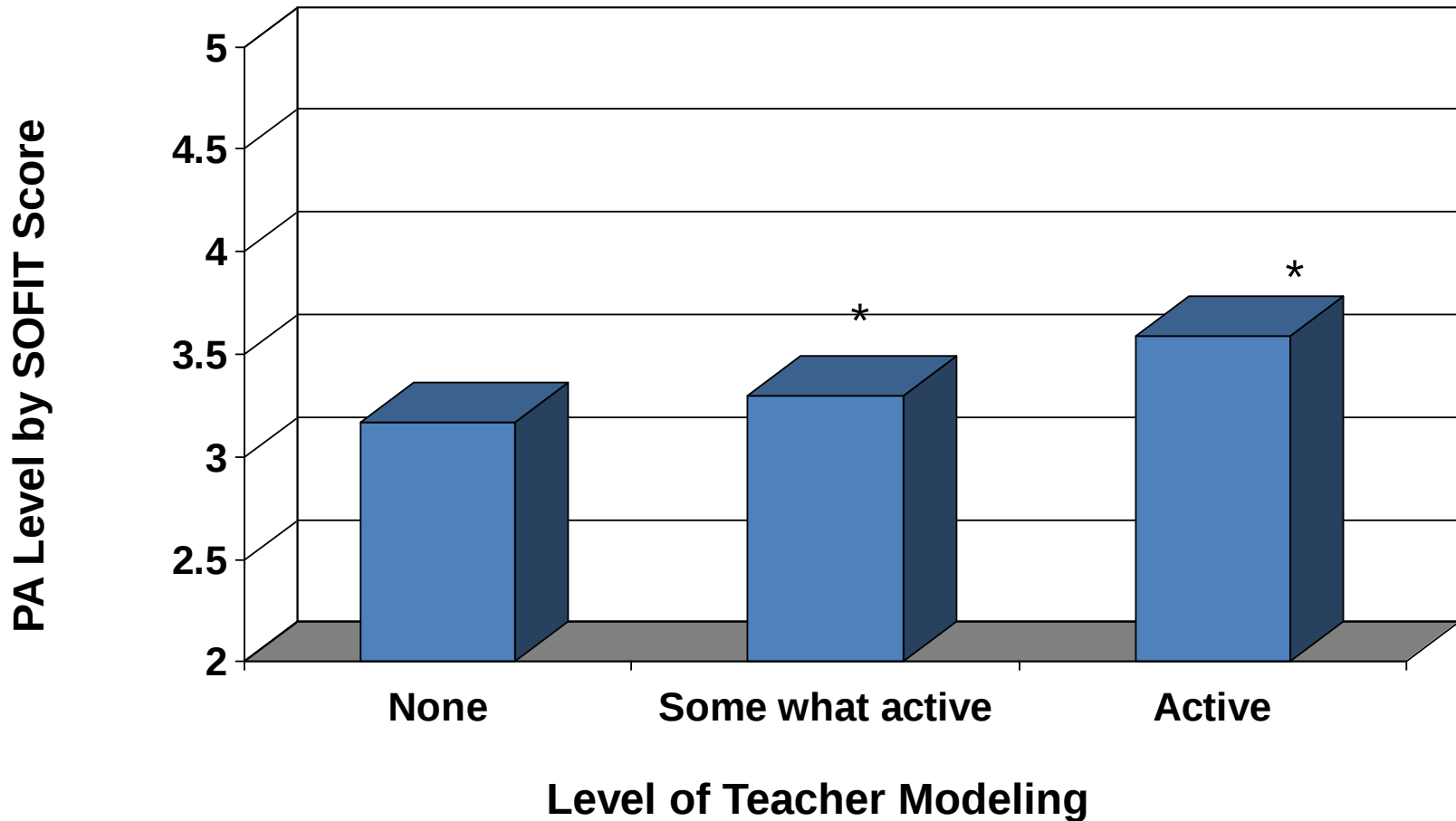
9 schools 75⁺ min
5 school <75 min

Academic Achievement- Individual Categories



Relationship Between Teacher Modeling & Physical Activity Levels in Students

(intervene with teachers to benefit students?)



* $P < 0.0001$; dose-response relationship between teacher modeling and PA level
Gibson et al., IJBNPA, 2008

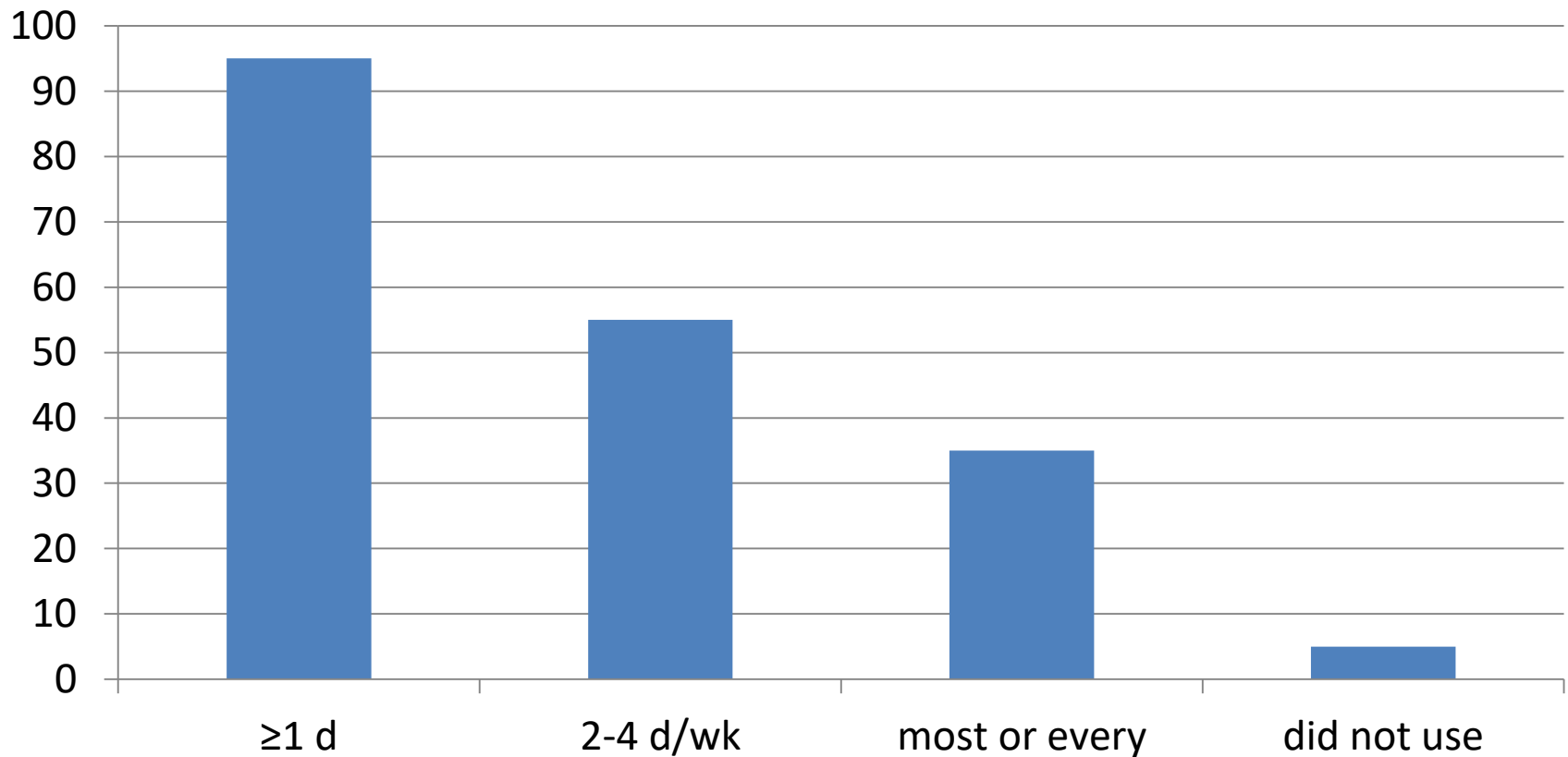
Activity Level Measured by Accelerometry

Accelerometer Period	Control (N=90)	Intervention (N=77)	P value
4-d Ave	744 (183)	851 (233)	0.007
Weekend Day	750 (219)	901 (279)	0.001
During School	606 (205)	688 (199)	0.01
After School	946 (332)	1,017 (365)	NS
Evening	812 (349)	891 (361)	NS

Values are means (SD). * Controlling for gender, race, ethnicity, and cohort.

9-Months Post Intervention Teacher Survey

Percentage Use





A+PAAC Design- Emphasis on Academic Achievement

- Adequately powered, cluster randomized trial
- 17 elementary schools, (9 intervention, 8 control)
- ~ 20 children from 2nd & 3rd grades followed 3 yrs. to 4th and 5th grades (~40/school, 682 children total)
- 20 minutes of A+PAAC lessons/day

A+PAAC Outcomes

- Academic achievement measured by Wechsler Individual Achievement Test III
- State administered achievement tests
- Cognitive function- Flanker, n-back (Hillman)
- Anthropometrics, fitness (Pacer), blood chemistry, blood pressure, attention-to-task (Mahar), energy expenditure of A+PAAC lessons (indirect calorimetry via CosMed)



TAKE 10! To Date

- 4 revisions of the program have been completed -- all with the goal of making the program more effective
- TAKE 10! continues to be used with a “school success” model:
 - 100% of schools are required to be paired in an elementary school
 - no special equipment or training is needed.
 - grade-specific linkages

Reach: over 55,000 elementary classrooms from Oct 2002 to Present



Energy Expenditure

- 3 Classrooms, CSA accelerometers & digital pedometers
- 10-minute sessions

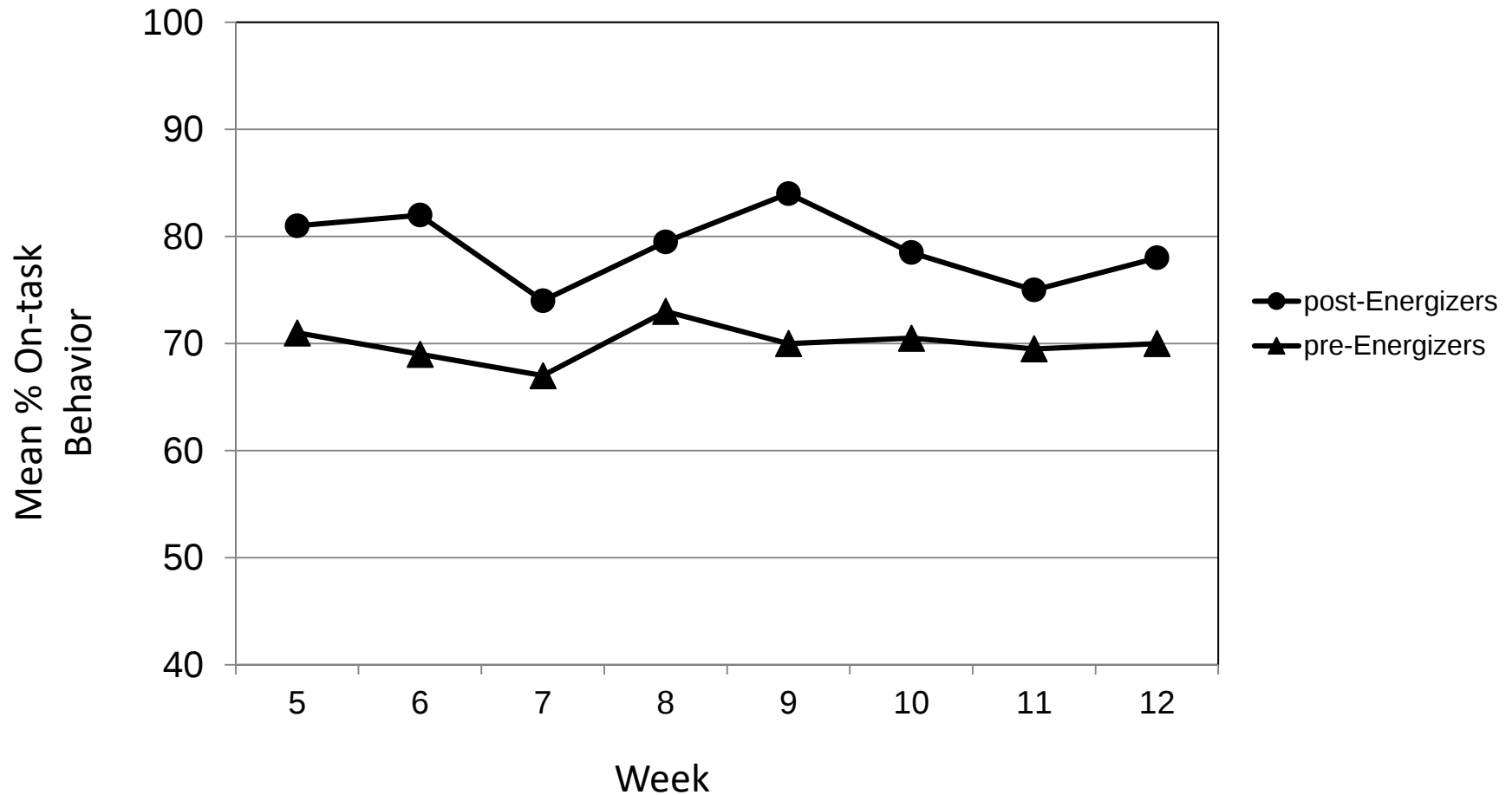
Grade	Avg MET levels	Avg kcal expenditure	Pedometer step counts
1 st Grade	5.72-7.05	25.6-27.8	644-931
3 rd Grade	5.51-6.77	27.6-33.9	659-1376
5 th Grade	4.98-7.19	29.7-42.9	1002-1041

Reference: Stewart JA, Dennison DA, Kohl HW, Doyle JA. J Sch Health. 2004 Dec;74(10):397-400.

How Does Physical Activity Influence Academic Achievement?

- Brain function
- Attention-to-task
- Body fatness
- Physical fitness
- Physical activity
- Parent characteristics, SES

Mean percentage of intervals of on-task behavior pre and post Energizers for one fourth grade class.



Mahar et al., 2006. Effects of a classroom-based program on physical activity and on-task behavior. *Medicine and Science in Sports and Exercise* 38, 2086–2094.



LET'S MOVE in School

www.LetsMoveInSchool.org

Darla M. Castelli, PhD
University of Texas at Austin



JED note- Comprehensive "Saturated Environment"

Comprehensive School-based Physical Activity Program (CSPAP)



Sources: Castelli & Beighle, 2007; NASPE, 2008; USDHHS, 2009



Physical Activity During the School Day

- Embed physical activity in the school curriculum
- No more than 60-mins of sedentary time
- At least 10-mins of physical activity after sedentary time
- Consider activity type, intensity, and the academic task
- Measure physical activity intensity
- Become NASPE certified Director's of Physical Activity
- Provide opportunities for:
 - Formally structured physical activity
 - Informal physical activity – play
 - Content-rich physical activity

DIRECTOR OF PHYSICAL ACTIVITY

Launch!

March 13, 2012

AAHPERD Convention

Boston, MA

NASPE DPA Certification

CDC Review

- 43 articles reporting 50 unique studies
- Coded by physical activity context
- Investigated increasing time spent in physical education or physical activity

Results of CDC Review

- General findings
 - Positive or no relationship between time in physical education/recess/sports and academic achievement and indicators of cognitive function
 - Positive relationships between classroom physical activity and indicators of academic achievement, classroom behavior, and cognitive function

How to Increase Physical Activity in Schools Without Decreasing Academic Instruction

- Increase time children are physically active in physical education and recess
- Provide access to physical activity before and after school
- Promote active transportation
- Provide physically active lessons

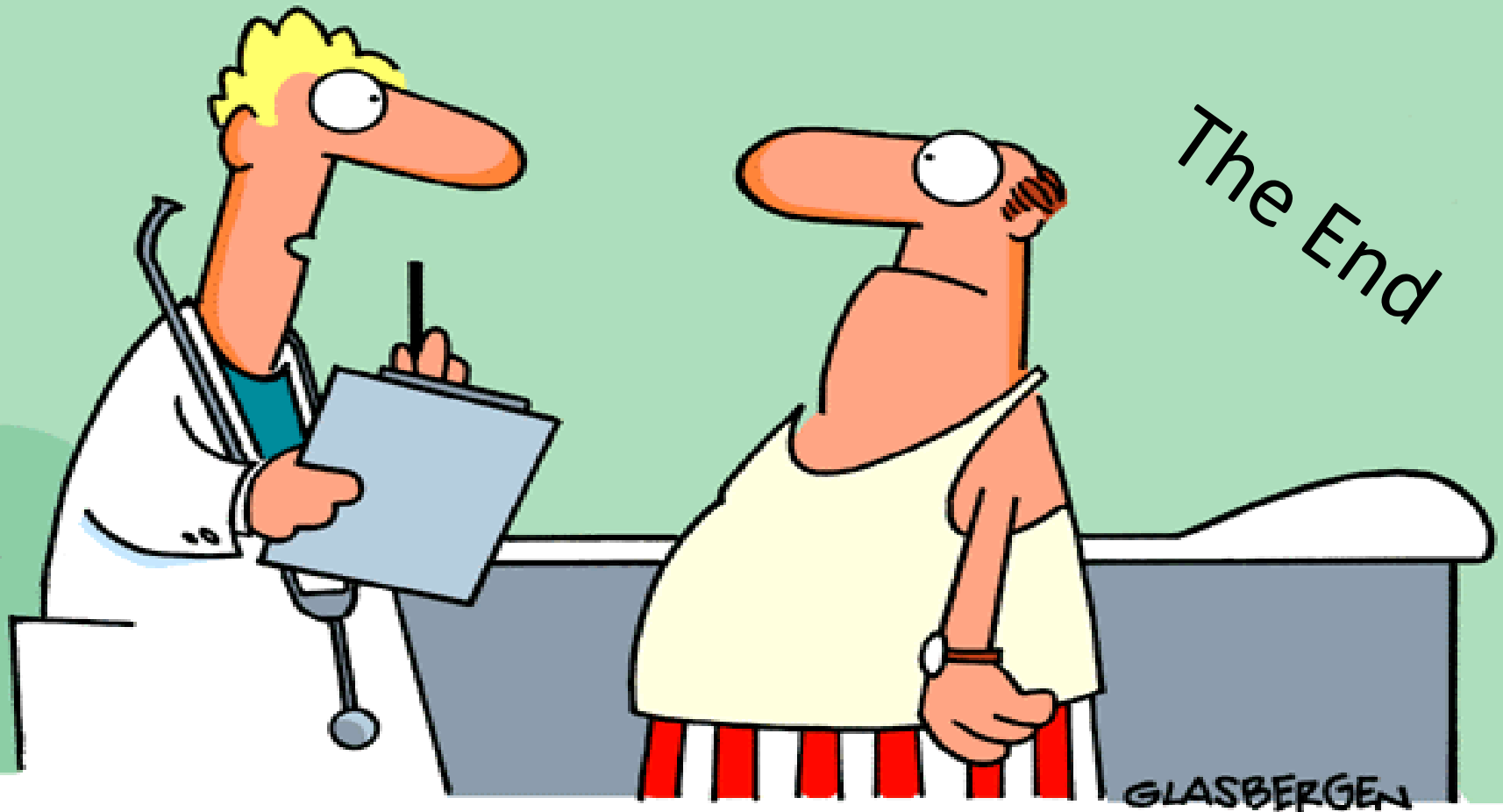
What is Needed to Promote Non-Traditional Physical Activity in Schools

- Low cost/no cost, sustainable programs through university teacher preparation
- Low teacher burden for lesson preparation
- Activity disconnected from motor skills
- Additional evidence to link physical activity/fitness & learning
 - Plausible biological model combined with evidence from well designed interventions linking to state academic achievement tests
- Policy change

Summary: Level of Evidence for Physical Activity, Nutrition & Academic Achievement

- Fitness (aerobic capacity) seems to be associated with academic achievement
- Academic lessons taught with physical activity have been shown to improve academic achievement and attenuate increases in BMI (2 for 1)
- Physically active lessons may improve attention-to-task, a behavior associated with learning, and critical to classroom management

There is no evidence that removal of physical activity programs results in greater academic achievement



“What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?”

Research Questions

- How much PA is needed to improve academic performance and how much can the school be expected to provide
- Are there temporal effects of PA on academic performance and are any observed improvements lasting
- Are any positive effects of PA mediated by cognitive function or are other factors equally important
- Are fitness and fatness independently associated with academic performance
- For which students will active lessons provide the greatest benefits
- Do academic lessons taught by physical activity provide greater benefits compared to fitness breaks
- Etc.