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BIOS 755

Motives for activity participation and changes in physical activity and sedentary behavior levels over time

Executive Summary:

Research topic: I am interested in analyzing the associations between motives for physical activity (PA) on PA and sedentary behavior levels in 5th-11th grade students and determine if these associations vary by sex.

Methods: Data for these analyses came from the Transitions and Activity Changes in Kids I and II (TRACK I and II) studies. This observational study followed children from 5th to 11th grade. Children completed the Motivation for Physical Activity Measure-Revised (MPAM-R) at multiple time points to assess intrinsic and extrinsic factors associated with PA participation. Accelerometers were worn for one week at each measurement time to calculate average minutes per hour of PA and average minutes per hour of sedentary behavior.

Analysis: Linear mixed models were run separately for males and females to determine the association between five different motivation factors, controlling for body fat percentage, SES and race.

Results: Males with high fitness scores were more physically active and were less sedentary at baseline, although they decreased in their PA levels and increased in their sedentary behavior levels more rapidly over time. Females with higher social motive scores were more physically active and less sedentary at baseline, although they decreased in their PA levels and increased in their sedentary behavior levels at a faster rate than females with low social motive scores, holding all other variables constant. Females with higher appearance motive scores had lower total PA scores and higher sedentary behavior levels at baseline, but increased in their PA levels and decreased in their sedentary behavior levels at a faster rate than females with high appearance motive scores, holding all other variables constant.

Conclusion: Interventions should consider targeting these motivation factors as part of a comprehensive strategy aiming to increase PA levels and decrease sedentary behavior in children and adolescents.

Background

Physically activity (PA) in adolescents is associated with many benefits, including improvements in cognitive health and a decreased risk of chronic conditions later in life[1]. Only about 20% of adolescents are currently meeting PA guidelines of 1 hour or more of moderate to vigorous PA per day, with a higher percentage of males meeting these guidelines[1]. Furthermore, PA levels have been shown to decrease steadily during adolescence[2].

Sedentary behavior is defined as waking behavior completed in a seated or reclining position that requires and energy expenditure of ≤ 1.5 METs[1]. Adolescents spend an average of 7.7 hours/day sedentary[1]. While PA is associated with a number of health benefits in adolescents[1], sedentary behavior seems to have the opposite effect, with studies showing an inverse association between time spent sedentary and obesity, self-esteem and academic achievement, independent of PA levels[3].

There are many factors that influence activity levels in adolescents, which are often targeted in interventions aimed at promoting PA and decreasing sedentary behaviors[4]. While some of these interventions target activity levels by intervening in schools, the community or at the family level, many do not target child level factors, such as motives or beliefs about PA[4,5]. This may partially explain why many interventions have such small effect sizes on overall activity levels[5]. These child-level factors have been shown to be associated with activity levels and changes in activity levels over time[5].

Research Question: Which extrinsic and intrinsic motives for PA are associated with changes in adolescent PA and sedentary behavior levels over time? Do these associations differ between males and females? If so, how?

Methods

Study Design: Data for this study were obtained from the Transitions and Activity Changes in Kids I and II (TRACK I and II) study. This observational study was used to identify factors associated with changes in PA levels in children as they transitioned from elementary school to high school. Children were recruited in the 5th grade and followed until the 7th grade. The same children were re-recruited in the 9th grade, and follow up occurred in the 11th grade. Children completed the Motivation for Physical Activity Measure-Revised (MPAM-R)[6] at each time point to assess intrinsic and extrinsic factors associated with PA participation. Accelerometers were worn for one week at each measurement time (except while asleep and performing water based activities) to calculate average minutes per hour of PA and average minutes per hour of sedentary behavior.

Dependent Variables: Mean minutes per hour (min/hr) of PA and mean min/hr of sedentary behavior

Accelerometry data were used to determine activity levels. Mean PA mins/hr was defined as average mins/hr spent above the light PA cutpoint (>100 counts/min). Sedentary behavior was defined as the average mins/hour spent below the light PA cutpoint (<100 counts/min).

Independent variables: Motives for PA - Enjoyment, Competence, Appearance, Fitness/Health, Social

Motives for PA were measured using the MPAR-M[6]. This measure aims to assess reasons for engaging in sport or exercise by looking at 4 different factors, including enjoyment, competence,

appearance, fitness or health and social factors. Overall scores in each category are based on the mean of scores on four, 4-point Likert scale items.

Other covariates of interest included a categorical Race variable (White, Black, Hispanic, Mixed/other), a grade variable that served as a proxy of time (5th, 6th, 7th, 9th and 11th grade), a continuous SES variable (Percentage of students below the Federal poverty level in the census tract where the student lived in the 5th grade) and body fat percentage, which was calculated using the following formula: ((Body Weight – Fat Free Mass)/Body Weight) * 100 (continuous)

Data Analysis

Descriptive statistics were calculated for the entire sample and by grade. Chi-square analyses and analysis of variance (ANOVA) were used to assess differences in descriptive characteristics by grade. The sample size was limited to students who had data for at least three different time points: 5th grade, 6th/7th grade, and 9th/11th grade. Spaghetti plots of mean PA mins/hr and mean sedentary behavior min/hr by grade were used to determine whether the outcome variables needed to be transformed. It was determined that the data would not be transformed before analysis. Figures 1a and 1b display these results.

Multilevel linear mixed models were first developed to assess whether there were differences in the cross-sectional and longitudinal effects of the motivation factors on mean PA mins/hr and mean sedentary behavior mins/hr. Cohort effects did not appear for males when looking at PA and sedentary behavior, but they did appear for females when looking at appearance measures. Therefore, I accounted for this cross-sectional effect in the female linear mixed models.

Two separate linear mixed models were developed to model change in activity over time for each gender. Research shows that there are gender differences in changes in PA levels over time, as well as differences in reasons for being physically active. Therefore, males and females were analyzed separately. The first model used mean PA mins/hr as the outcome variable, while the second model used sedentary behavior as the outcome variable. Scores on measures of extrinsic and intrinsic motives for PA served as predictor variables in both models. Motivation variable*grade interactions were analyzed in order to model changes in mean PA mins/hr over time. Models were first run with random intercepts only, then with random intercepts and random slopes. The final model included all covariates of interest. AIC and BIC were used to determine which models best fit the data. SAS software, Version 9.4 for Windows (SAS institute, Cary, NC) was used for these analyses.

The final models are:

Males, PA

$TotalPA_{ij} = B_0 + B_1(G_{ij}) + B_2(Enjoy_{ij}) + B_3(Comp_{ij}) + B_4(Appear_{ij}) + B_5(Fit_{ij}) + B_6(Social_{ij}) + B_7(Enjoy_{ij}*G_{ij}) + B_8(Comp_{ij}*G_{ij}) + B_9(Comp_{ij}*G_{ij}) + B_{10}(Appear_{ij}*G_{ij}) + B_{11}(Fit_{ij}*G_{ij}) + B_{12}(Social_{ij}*G_{ij}) + B_{13}(Enjoy_{ij}*G_{ij}) + B_{14}(Pov_j) + B_{15}(BF_{ij}) + B_{16}(Bl_j) + B_{17}(Hisp_j) + B_{18}(Oth_j) + b_{0i} + b_{1ij} + e_{ij}$

Females, PA

$TotalPA_{ij} = B_0 + B_1(G_{ij}) + B_2(Enjoy_{ij}) + B_3(Comp_{ij}) + B_4(Appear^{[L]}_{ij}) + B_5(Appear^{[CS]}_{ij}) + B_6(Fit_{ij}) + B_7(Social_{ij}) + B_8(Enjoy_{ij}*G_{ij}) + B_9(Comp_{ij}*G_{ij}) + B_{10}(Comp_{ij}*G_{ij}) + B_{11}(Appear_{ij}*G_{ij}) + B_{12}(Fit_{ij}*G_{ij}) + B_{13}(Social_{ij}*G_{ij}) + B_{14}(Enjoy_{ij}*G_{ij}) + B_{15}(Pov_i) + B_{16}(BF_{ij}) + B_{17}(Bl_i) + B_{18}(Hisp_i) + B_{19}(Oth_i) + b_{0i} + b_{1ij} + e_{ij}$

Males, Sedentary behavior

$MeanSB_{ij} = B_0 + B_1(G_{ij}) + B_2(Enjoy_{ij}) + B_3(Comp_{ij}) + B_4(Appear_{ij}) + B_5(Fit_{ij}) + B_6(Social_{ij}) + B_7(Enjoy_{ij}{*}G_{ij}) + B_8(Comp_{ij}{*}G_{ij}) + B_9(Comp_{ij}{*}G_{ij}) + B_{10}(Appear_{ij}{*}G_{ij}) + B_{11}(Fit_{ij}{*}G_{ij}) + B_{12}(Social_{ij}{*}G_{ij}) + B_{13}(Enjoy_{ij}{*}G_{ij}) + B_{14}(Pov_i) + B_{15}(BF_{ij}) + B_{16}(Bl_i) + B_{17}(Hisp_i) + B_{18}(Oth_i) + b_{0i} + b_{1ij} + e_{ij}$

Females, Sedentary behavior

$MeanSB_{ij} = B_0 + B_1(G_{ij}) + B_2(Enjoy_{ij}) + B_3(Comp_{ij}) + B_4(Appear^{[L]}_{ij}) + B_5(Appear^{[CS]}_{ij}) + B_6(Fit_{ij}) + B_7(Social_{ij}) + B_8(Enjoy_{ij}{*}G_{ij}) + B_9(Comp_{ij}{*}G_{ij}) + B_{10}(Comp_{ij}{*}G_{ij}) + B_{11}(Appear_{ij}{*}G_{ij}) + B_{12}(Fit_{ij}{*}G_{ij}) + B_{13}(Social_{ij}{*}G_{ij}) + B_{14}(Enjoy_{ij}{*}G_{ij}) + B_{15}(Pov_j) + B_{16}(BF_{ij}) + B_{17}(Bl_j) + B_{18}(Hisp_j) + B_{19}(Oth_j) + b_{0i} + b_{1ij} + e_{ij}$

Where G_{ij} = Grade of the ith child at the *j*th measurement; Black, Hispanic and Other = 1 if applicable and 0 otherwise; Pov_i is the Percentage of students below the Federal poverty level in the census tract where the ith student lived in the 5th grade; BF_{ij} is the body fat percentage of the ith child at the jth measurement. Each motive factor has its own beta coefficient for the ith child at the jth measurement; There is an interaction term for time by motive score for each of the motive factors for the ith child at the jth measurement;

Results

There were 274 students, 245 students, 244 students, 217 students and 202 students analyzed in the 5th, 6th, 7th, 9th, and 11th grade respectively. Table 1 shows descriptive characteristics by grade. At baseline, the sample was majority females (58%), and mainly Non-Hispanic Black (44.16%) or Non-Hispanic While (31.75%). Students spent an average of 28 mins/hr physically active and 32 mins/hr sedentary at baseline.

Males

There were no significant changes in average PA levels over time in males. Fitness motive scores had a significant impact on average PA min/hr. In other words, a one-unit increase in fitness motive score was associated with 5.57 additional mins/hr of PA, holding all other variables constant. Males with high fitness motive scores had significantly larger decreases in average PA min/hr over time. Results for this analysis can be seen in Table 2.

There were no significant increase in sedentary behavior levels over time in males. The fitness motive scores had a significant impact on mean sedentary behavior time as well. A one-unit increase in fitness motive score was associated with 4.60 less mins/hr of sedentary behavior, holding all other variables constant. Males with high fitness motive scores had significantly greater increases in total sedentary behavior time over time. Results for this analysis can be seen in Table 3.

Females

There was a significant decrease in PA levels over time in females. Appearance and social motives had a significant impact on total PA min/hr. In other words, a one-unit increase in social motive score was associated with 2.80 additional mins/hr of PA, holding all other variables constant. Additionally, a one-unit increase in appearance score was associated with a decrease of 3.03 mins/hr of PA, holding all other variables constant. Females with high appearance scores had significantly larger increases in average PA min/hr over time, while females with high social scores had greater decreases in average PA min/hr over time. Results for this analysis can be seen in Table 4.

There was a significant increase in mean sedentary behavior levels over time in females. Appearance and social motives had a significant impact on average sedentary min/hr in females. A one-unit increase in social motive score was associated with 2.70 less mins/hr of sedentary behavior, holding all other variables constant, and a one-unit increase in appearance score was associated with 2.92 more mins/hr of sedentary behavior, holding all other variables constant. Females with higher appearance motive scores had significantly larger decreases in mean sedentary behavior min/hr over time, while females with high social motive scores had greater increases in mean sedentary behavior min/hr over time. Results for this analysis can be seen in Table 5.

Discussion

In males, fitness motive scores had a significant impact on average PA and sedentary behavior time. Males with high fitness scores were more physically active and were less sedentary at baseline, although they decreased in their PA levels and increased in their sedentary behavior levels more rapidly over time. In females, appearance and social motives had a significant impact on average PA and sedentary behavior time. Females with higher social motive scores were more physically active and less sedentary at baseline, although they decreased in their PA levels and increased in their sedentary behavior levels at a faster rate than females with low social motive scores, holding all other variables constant. Females with higher appearance motive scores had lower total PA scores and higher sedentary behavior levels at baseline, but increased in their PA levels and decreased in their sedentary behavior levels at a faster rate than females with high appearance motive scores, holding all other variables constant.

These results may seem counter-intuitive at first. Taking fitness motive scores in males as an example, this factor on its own is related to higher levels of PA and lower levels of sedentary behavior. The interaction term argues that males who score higher in this factor decrease in their PA levels at a faster rate than males who score lower in this factor. These results highlight the benefits of using a linear mixed model analysis when looking at the change in activity levels over time – the negative correlation between b_{0i} and b_{1ij} in all four models shows us that students with a larger random intercept regress to the mean faster than students with a smaller random intercept. These results are therefore consistent with previous studies showing a steep decline in PA during adolescence[2].

This study demonstrates the influence of individual cognitive factors on changes in PA levels over time. Interventions should consider targeting these motivation factors as part of a comprehensive strategy aiming to increase PA levels and decrease sedentary behavior in children and adolescents. It is also worth noting the appearance motives in females were shown to increase PA levels and decrease sedentary behavior levels over time. While this is a promising result, interventions that aim to increase PA by targeting motives related to body image in adolescent females must tread cautiously as to avoid the development of unhealthy weight control behaviors[7].

The major strength of this study is the longitudinal assessment of motivation and objective physical activity, although the study was limited by a small sample size.

References

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**Table 1. Characteristics of the study population by grade**

	Grade 5 (N=274)		Grade 6 (N=245)		Grade 7 (N=244)		Grade 9 (N=217)		Grade 11 (N=202)		p
	N	%	n	%	n	%	n	%	n	%	
Sex											0.99
Male	113	41.24	103	42.04	103	42.21	91	41.94	84	41.58	
Female	161	58.76	142	57.96	141	57.79	126	58.06	118	58.42	
Race											0.99
White	87	31.75	83	33.88	72	29.51	70	32.26	59	29.21	
Black	121	44.16	104	42.45	111	45.49	93	42.86	93	46.04	
Hispanic	22	8.03	18	7.35	21	8.61	18	8.29	18	8.91	
Other	44	16.06	40	16.33	40	16.39	36	16.59	32	15.84	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p
Percent below FPL	18.92	6.32									
Total PA min/hr	27.93	4.67	24.28	4.39	22.56	4.21	19.36	5.49	18.92	6.53	<.0001
Mean sedentary min/hr	32.21	4.46	35.83	4.32	37.55	4.13	41.10	4.91	41.82	5.24	<.0001
Body Fat Percentage	25.44	9.16	24.77	10.62	26.00	11.18	25.42	13.18	27.91	13.39	0.06
Motive Scores											
Enjoyment	3.61	0.50	3.56	0.58	3.49	0.67	3.38	0.74	3.38	0.69	<.0001
Competence/Challenge	3.52	0.54	3.42	0.64	3.36	0.66	3.26	0.75	3.30	0.72	<.0001
Appearance	3.11	0.78	3.14	0.82	3.07	0.84	3.11	0.80	3.08	0.73	0.91
Fitness/Health	3.71	0.46	3.66	0.48	3.60	0.46	3.49	0.64	3.48	0.57	<.0001
Social	3.10	0.78	3.10	0.78	3.05	0.75	2.80	0.82	2.82	0.84	<.0001

Abbreviations: HS – high school; SD – standard deviation; FPL – Federal poverty level; PA – Physical activity; min/hour – minutes per hour; BMI – Body mass index
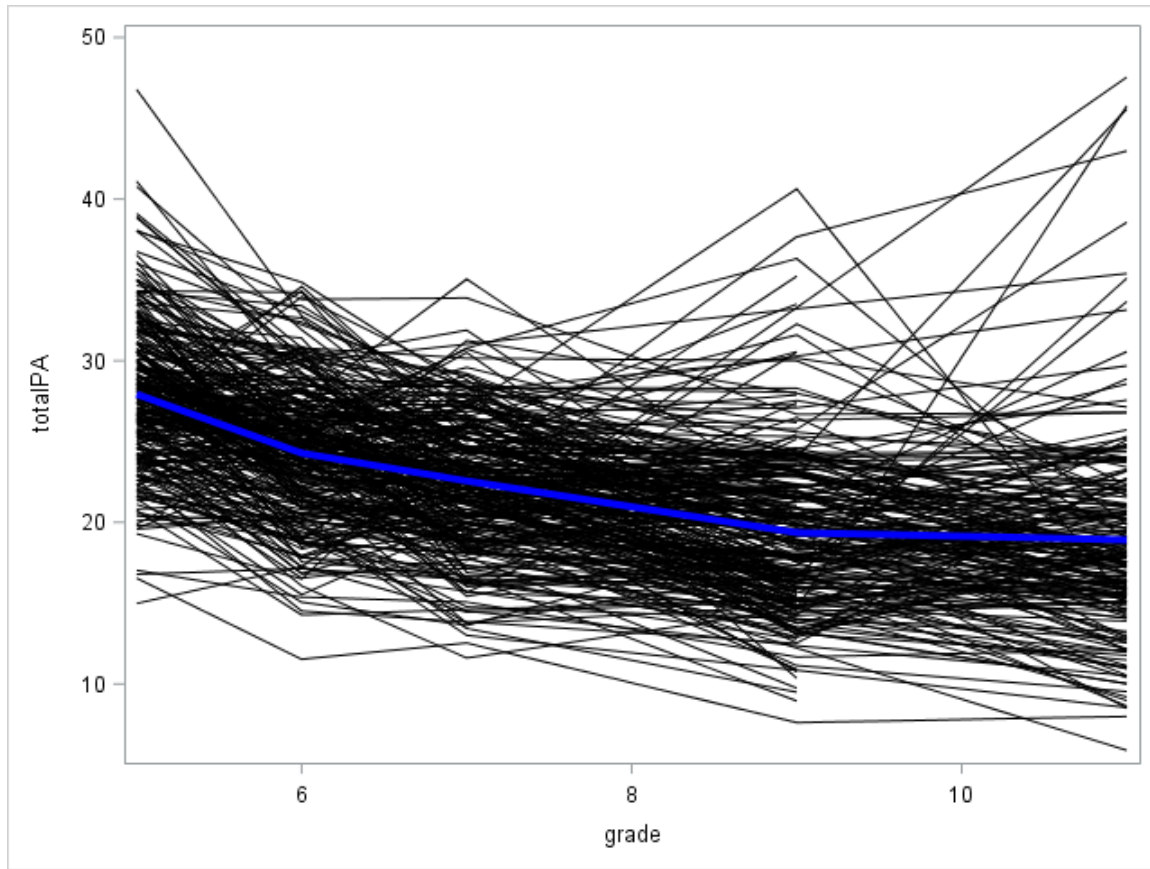
Figure 1a: Distribution of Total Physical Activity mins/hour by grade
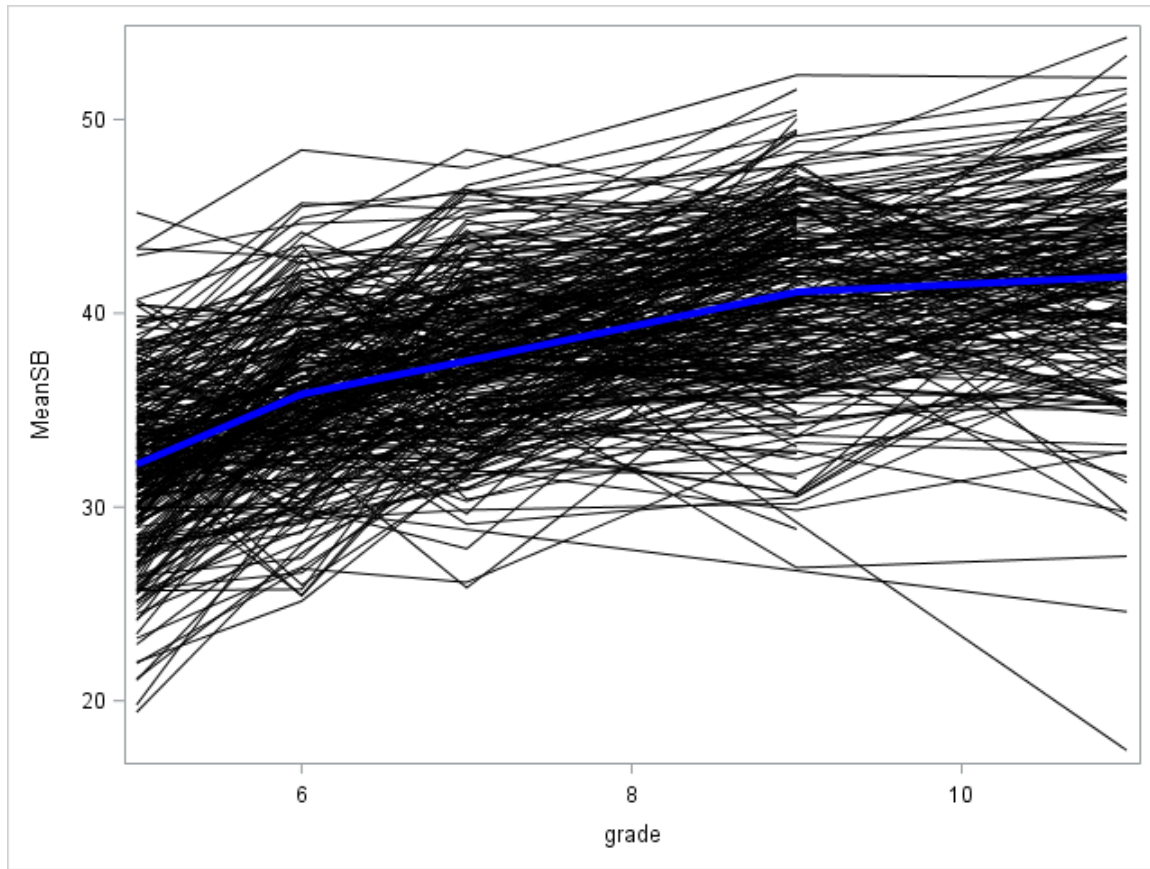
Figure 1b: Distribution of Mean Sedentary Behavior mins/hour by grade

Table 2. Predictors of mean PA mins/hr in males

Effect	Level	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		24.10	7.81	108	3.09	.003
Grade		-0.43	0.99	112	-0.43	.66
Enjoyment		1.43	2.16	250	0.66	.51
Competence		-2.63	2.50	250	-1.05	.29
Appearance		-0.91	1.42	250	-0.64	.52
Fitness		5.57	2.53	250	2.21	.03*
Social		-1.42	1.49	250	-0.95	.34
Enjoyment * Grade		-0.10	0.30	250	-0.32	.75
Competence * Grade		0.25	0.35	250	0.72	.47
Appearance * Grade		0.18	0.20	250	0.90	.37
Fitness * Grade		-0.75	0.34	250	-2.19	.03*
Social * Grade		0.20	0.20	250	1.00	.32
% Below FPL		-0.06	0.05	250	1.16	.25
BF%		-0.01	0.03	250	-0.35	.72
Race	Black	1.42	0.79	250	1.80	.07
r	Hispanic	0.29	1.31	250	0.22	.83
r	Other	-0.31	1.01	250	-0.31	.72
r	White	0	.		.	.

Table 3. Predictors of mean sedentary behavior mins/hr in males

Effect	Level	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		32.21	6.67	108	4.83	<.0001
Grade		1.13	0.82	112	1.38	.17
Enjoyment		-0.03	1.83	250	-0.02	.99
Competence		1.70	2.10	250	0.81	.42
Appearance		1.13	1.19	250	0.96	.34
Fitness		-4.60	2.14	250	-2.15	.03
Social		0.34	1.26	250	0.27	.79
Enjoyment * Grade		-0.09	0.25	250	-0.35	.73
Competence * Grade		-0.18	0.29	250	-0.62	.55
Appearance * Grade		-0.22	0.17	250	-1.31	.19
Fitness * Grade		0.60	0.28	250	2.12	.03
Social * Grade		-0.04	0.16	250	-0.24	.81
% Below FPL		-0.06	0.05	250	-1.15	.25
Body Fat %		0.007	0.02	250	0.30	.77
Race	Black	-1.00	0.75	250	-1.33	.18
r	Hispanic	-0.38	1.26	250	-0.30	.76
r	Other	0.53	0.97	250	0.55	.58
r	White	0	.	.	.	.

Table 4. Predictors of mean PA mins/hr in females

Effect	Level	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		23.07	4.6	155	5.01	<.0001
Grade		-1.19	0.53	159	-2.23	.03*
Enjoyment		-0.34	1.38	342	-0.25	.81
Competence		1.18	1.28	342	0.92	.36
Appearance [L]		-3.03	0.91	342	-3.33	.001*
Appearance [CS]		1.34	0.50	342	2.67	.008*
Fitness		1.29	1.41	342	0.92	.36
Social		2.80	0.87	342	3.21	.001*
Enjoyment * Grade		0.12	0.18	342	0.66	.51
Competence * Grade		-0.12	0.17	342	-0.72	.47
Appearance * Grade		0.33	0.12	342	2.64	.009*
Fitness * Grade		-0.09	0.19	342	-0.46	.64
Social * Grade		-0.40	0.11	342	-3.49	.0005*
% Below FPL		0.03	0.04	342	0.74	.46
Body Fat %		-0.02	0.02	342	-0.75	.46
Race	Black	0.88	0.60	342	1.46	.14
r	Hispanic	0.34	1.01	342	0.34	.74
r	Other	0.25	0.80	342	0.31	.76
r	White	0	.	.	.	.

Table 5. Predictors of mean sedentary behavior mins/hr in females

Effect	Level	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		37.16	4.53	155	8.21	<.0001
Grade		1.15	0.52	159	2.20	.03
Enjoyment		0.37	1.36	342	0.27	.79
Competence		-1.26	1.26	342	-1.00	.32
Appearance [L]		2.92	0.89	342	3.28	.001
Appearance [CS]		-1.34	0.49	342	-2.71	.0071
Fitness		-1.34	1.39	342	-0.96	.34
Social		-2.70	0.86	342	-3.15	.002
Enjoyment * Grade		-0.12	0.17	342	-0.68	.49
Competence * Grade		0.13	0.17	342	0.79	.43
Appearance * Grade		-0.31	0.12	342	-2.59	.0099
Fitness * Grade		0.10	0.18	342	0.56	.58
Social * Grade		0.38	0.11	342	3.42	.0007
% Below FPL		-0.03	0.04	342	-0.78	.44
Body Fat %		0.02	0.02	342	0.73	.47
Race	Black	-0.91	0.59	342	-1.53	.13
r	Hispanic	-0.29	0.99	342	0.96	.77
r	Other	-0.27	0.79	342	0.42	.74
r	White	0	.	.	.	.