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Temporal Changes in Energy-Balance Behaviors and Home Factors in Adolescents with Normal Weight and Those with Overweight or Obesity

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Abstract

This study aimed to examine the temporal changes in energy-balance behaviors and home factors in adolescents with normal weight and those with overweight or obesity (OWOB). Adolescents or parent proxies completed survey assessments two to four years before (T0; n = 82), ≤ six months before (T1; n = 68), and ≤ three months after the COVID-19 pandemic outbreak (T2; n = 82), to capture energy-balance behaviors (i.e., physical activity [PA], screen time, sleep) and home factors (i.e., food environment, food worry, parent support for PA). At T0 and T1 (before pandemic), participants visited our laboratory for anthropometric measurements. At T2, parent proxies also completed a survey to report the COVID-19 pandemic exposure and impact. The participating families experienced moderate levels of pandemic exposure and impact, although exposure was higher in the OWOB group ($F_{1,78}$= 5.50, p < .05). Repeated-measure multivariate analyses of covariance (RM-MACOVAs) did not show significant time by weight status interaction effects (p > 0.05; adjusted for race and sex). However, the models detected significant time (T0 vs. T2) by race (White vs. non-White) interaction effect ($\lambda_{7,66}$=0.81, p < 0.05), with greater increase in food worry ($F_{1,72}$ = 4.36, p < .05) but less increase in screen time ($F_{1,72}$= 4.54, p < .05) among the non-White group. Graphical visualization depicted some favorable change patterns in adolescents with normal weight (vs. those with OWOB) for certain behaviors and home factors (e.g., number of days per week ≥ 60 mins PA, food worry). These findings suggest that the COVID-19 pandemic exerted greater adverse effects on adolescents with OWOB and specifically on screen time and food worry among non-White adolescents.

Temporal Changes in Energy-Balance Behaviors and Home Factors in Adolescents with Normal Weight and Those with Overweight or Obesity

Introduction

Childhood obesity prevention requires concerted efforts to address both individual and environmental contributors (Pereira et al., 2019). The outbreak of the COVID-19 pandemic has brought upon unprecedented disruptions and impacts on nearly all populations and societies worldwide (Ventriglio et al., 2021). Although the rates of COVID-related hospitality and mortality were lower in the young and healthy populations, children and adolescents have experienced reduced opportunities to access programs and resources across environmental settings essential for healthful-living (Chen et al., 2022; World Health Organization, n.d.). Unsurprisingly, recent research from many different countries has shown that health-related outcomes such as childhood obesity (Eneli et al., 2022; Hu et al., 2021; Lange et al., 2021; Maggio et al., 2022; Welling et al., 2022) and mental health (Jones et al., 2021; Welling et al., 2022) have worsened significantly during the pandemic.

Several prior studies have evaluated the impact of the pandemic on energy-balance behaviors (e.g., physical activity [PA], screen time, diet, and sleep) and health-related outcomes in children or adolescents. For example, a Dutch mixed-methods study examined the impact of the pandemic on diet, PA, screen time, and health-related quality of life in children with severe obesity from 83 families (age: $M = 11.2 \pm 4.6$ yrs old), and found that adolescents had larger decline than younger children in weekly PA (-1.9 hours/week) and that minorities engaged in poor dietary intake and experienced a lower level of health-related quality of life (Welling et al., 2022). Similar negative impacts of the pandemic on PA (Welling et al., 2022), diet (Sylvetsky et al., 2022), sleep (Luijten et al., 2021), or screen time (Paterson et al., 2021) are well-documented in other empirical studies conducted in various geographic locations (e.g., countries, regions) and populations (e.g., healthy populations, populations with disabilities or conditions).

Despite the plethora of research on the pandemic's adverse impact on health-related behaviors and outcomes, rarely have these recent research investigations compared the temporal changes in energy-balance behavior and home factors from a longer-term perspective (e.g., from 2-4 years before the pandemic into even early phases of the pandemic), between adolescents with normal weight and those with OWOB. Compared to those with normal weight status, adolescents with OWOB are a vulnerable population at risk of a number of health problems (Garcia-Hermoso et al., 2019; Warnick et al., 2022), whose lived experiences and health-related behaviors might have been affected differently by the COVID-19 pandemic compared to their counterparts. Having a longer timespan to monitor these health-related behaviors and outcomes, before and throughout the pandemic, in adolescents with normal weight or OWOB would provide greater in-depth insights into the temporal changes in these factors, which may inform tailored interventions in the future.

Furthermore, home or family has been a commonly targeted setting for delivering interventions to improve health-related behaviors (Arnason et al., 2021) and outcomes (Feldman et al., 2018; Sung-Chan et al., 2013). For example, in the early phases of the COVID-19 pandemic, nearly all schools worldwide were forced to shut down for in-person instruction and residents were instructed to follow stay-at-home orders. During that difficult time, home was where adolescents and their families spent most of their daily time. Homes were deemed as the

"everything space" during the pandemic (Sheldrick et al., 2022). Prior research found that families, during the early phase of the pandemic, frequently reported increased household chaos, excessive screen time, elevated distress, lacking parental supervision, and poor mental health as challenges, since the traditional school and community supports were not available or compromised (Kracht et al., 2021). Another study reported the negative impact of changes to the physical and social environments at home on children's health-related behaviors such as PA and sedentary behavior (Sheldrick et al., 2022).

Important home factors such as food environment, food worry, and parental social support for PA might have presented influential impacts on adolescents' energy-balance behaviors, weight status, and health-related outcomes. However, these home factors related to energy-balance behaviors and weight status have rarely been studied in a comparative lens (normal weight vs. OWOB), from a longitudinal perspective. Therefore, the overarching aim of this study was to examine the temporal changes in energy-balance behaviors and relevant home factors among adolescents with normal weight or with OWOB across multiple years. While conducting these longitudinal comparative analyses, it is important to control for factors such as race and sex due to their potentially moderating effects (Kracht et al., 2023). Hence, on our retrospective longitudinal investigation, we aimed to address three purposes to fill the identified research gaps: (a) to test the extent to which adolescents changed their weight status by time; (b) to compare the levels of pandemic exposure and impact by weight status (i.e., normal weight vs. OWOB), and (c) to compare the temporal changes in energy-balance behaviors and home factors by weight status (i.e., normal weight vs. OWOB). We hypothesized (a) adolescents' weight status to increase over time, (b) the normal weight group to report greater amount of pandemic exposure and impact, and (c) the normal weight group to report more favorable changes in energy-balance behaviors and home factors. Gender and race may moderate these relationships. This study would generate novel research findings to fill the identified research gaps. The findings would enhance the current understanding of the change patterns of weight status, energy-balance behaviors, and home factors in adolescents with normal weight or OWOB before and during the COVID-19 pandemic.

Methods

Setting and Participants

This study followed the retrospective longitudinal observational research design (Caruana et al., 2015). Funded by the United States Department of Agriculture (Grant #: 3092–51000-056-04A; ClinicalTrials.gov: NCT02784509), our larger research project tracked the growth and development, anthropometric outcomes, energy-balance behaviors, and social and environmental factors of 342 boys and girls (ages 10-16 years). This current study was a part of the larger project, which examined a sub sample who completed three rounds of assessments: 2-4 years before pandemic (T0: 2016-2018), less than six months before pandemic (T1: September 1, 2019 – February 29, 2020), and less than three months after the outbreak (T2; March 1 – May 30, 2020). Table 1 outlines the sample sizes of this study by sex, race, and weight status at the first two time points (T0 and T1). The average age for the sample at T0 and T1 were 13.12±1.94 and 15.06±1.98 years old, respectively. No sociodemographic or anthropometric data were collected during the early phase of the pandemic (T2), to alleviate cognitive burden of the participants and lower the COVID infection risk. The study was approved by the Pennington Biomedical

Research Center Institutional Review Board (IRB) and written parental consent and minors' assent were obtained at the baseline visit before data collection commenced.

Table 1. *Sample Size (N) by Sex, Race, and Weight Status at T0 and T1*

Individual Characteristics	**T0**	**T1**
Sex		
Female	39	39
Male	43	43
Race		
White	49	49
Black	27	27
Other	6	6
Weight Status*		
Normal Weight	43	40
OWOB	36	42

Variables and Measures

To address the three research purposes, we extracted data of the relevant variables for this analysis: weight status, energy-balance behaviors (i.e., PA, screen time, sleep), home factors (food environment, food worry, parental social support for PA), and COVID-19 pandemic exposure and impact. These variables and measures are described in detail below.

Weight status. The adolescent participants' body weight and height were measured using standardized scales, twice and averaged, to the nearest 0.1 cm or 0.1 kg by a trained clinical researcher at our laboratory. A third measurement was taken if the first two measurements differed by more than 0.5 units. Body mass index (BMI) was calculated using the standard formula where weight (in kilograms) was divided by height squared (in meters). BMI was subsequently converted to standardized scores (i.e., BMIz and BMI percentile) considering each participant' age and sex in reference to the national growth curve chart (Kuczmarski et al., 2002). *Normal weight status* was defined as BMI percentile: $\geq 5^{th}$ percentile through $< 85^{th}$ percentile; while *OWOB status* included overweight ($\geq 85^{th}$ percentile but < the 95^{th} percentile) and obesity ($\geq 95^{th}$ percentile; Kuczmarski et al., 2002).

Energy-balance behaviors. Three key energy-balance behaviors including PA, screen time, and sleep were measured using questions adopted from validated measures. For *PA*, the participants were asked to recall over the past seven-day period (1) the number of days that they were physically active for at least 60 minutes per day using one question adopted from the National Health and Nutritional Examination Survey (CDC, 2020); and (2) the number of times on average they engaged in strenuous, moderate, and mild exercises each for more than 15 minutes during free time, using the Godin-Shepherd leisure-time PA questionnaire (Godin, 2011; Godin & Shephard, 1985). Total leisure-time PA was computed using the formula: 9×strenuous exercise + 5×moderate exercise + 3×mild exercise (Godin, 2011; Godin & Shephard, 1985). To measure *screen time*, adolescents were asked to recall the number of hours per day they sat and (1) watched TV or videos, and (2) used a computer or played computer games outside of school. Screen time from watching TV or videos and using a computer or playing computer games were

aggregated to calculate total screen time. For *sleep time*, the parent proxies were asked to recall the time when their child went to sleep and woke up on weekdays and weekend days, which was converted to the amount of sleep time (in hour). The above questionnaires measuring screen time and sleep were previously validated and have been commonly used in research to assess the adolescent population (Joe et al., n.d.).

Home Factors. Parent proxies were surveyed to measure food environment, food worry, and social support for their child's PA behaviors at home. For *food environment*, parents were asked to report the availability and frequency of 17 food choices (i.e., chocolate candy, other candy, raw fruit, regular chips or crackers, baked chips/low-fat crackers/pretzels, raw vegetables, 100% fruit juice, juice drinks, regular sodas with sugar, diet or sugar free sodas, sports drinks, fruit roll-ups or other dried fruit, regular or 2% milk, 1% or fat-free milk, sweetened breakfast cereal, unsweetened breakfast cereal). Choices ranged from "1 = Never" to "5 = Always". In this study, we chose to only examine the unhealthy food items (sum score of the unhealthy food items) in our data analysis. For *food worry*, parents were asked to indicate whether they were worried about food running out and whether they could financially afford to restock food that did not last. These questions measuring food environment and food worry were adopted from the previously validated scale mentioned above (Joe et al., n.d.). In addition, to measure parents' social support for PA, parents were asked to report the number of days in a typical week they provided their child with supervision, encouragement, transportation, and companionship support related to participation in PA. These questions, with choices on the 5-point Likert scale ("1 = never" to "5 = every day"), were adopted from a previously validated scale (Sallis et al., 1987).

COVID-19 Pandemic Exposure and Impact. At T2 (≤ 3mo after the pandemic outbreak), parent proxies were further asked to complete the *COVID-19 Exposure and Family Impact Survey* (*CEFIS*; Enlow et al., 2022). The CEFIS has 25 items, with Yes or No responses, measuring families' *exposure* to COVID-19 and related events including family members who were essential and/or healthcare workers and family members directly affected by exposure or illness/death; and 12 items measuring *impact* of the COVID-19 pandemic including perceived effects on family functioning and distress. Of the 12 items, ten items measured the level of impact on participants' and family's life (4-point Likert scale) and two items measured the level of distress (10-point scale). The instrument was developed and validated by the *Center for Pediatric Traumatic Stress* (Kazak et al., 2021). We subsequently aggregated the scores for exposure and impact, respectively, following the standard scoring protocol (Enlow et al., 2022).

Data Collection and Processing

Three rounds of data were collected for this study at the T0, T1, and T2 time points. At T0 and T1, the participants visited the laboratory to have their weight and height measured by a trained researcher. BMI percentile and BMIz scores were computed for analysis. At T0, T1, and T2, participants and parent proxies completed the surveys (via REDCap; Harris et al., 2019) related to the energy-balance behaviors and home factors on computers with internet connections, either in the laboratory or at home. To gauge the pandemic exposure and impact, at T2, parents completed the CEFIS on REDCap. Incentives were provided to the participants for them to complete the needed assessments. The above data from various sources (e.g., multiple surveys and lab measurements) were merged into one single Microsoft Excel data file (later imported to SPSS for analysis), as matched by participants' assigned ID numbers. De-identified data were cleaned and processed for data analysis.

Data Analysis

To address the first research purpose, we conducted paired-t tests to examine changes in BMI percentile and BMIz scores from T0 to T1. We next conducted cross-tabulation analysis with Pearson's Chi-square test to identify the number of participants who changed weight status groupings (between normal weight and OWOB) and whether these changes were statistically significant. To address the second research question, we conducted one-way analysis of variance (ANOVA) to compare whether the levels of pandemic exposure and impact differed by weight status. Since we had weight status data at T0 and T1, we conducted the ANOVAs separately using the two different weight status groupings. To address the third question, we performed two repeated measure multivariate analyses of covariance (RM-MACOVAs), where energy-balance behaviors (i.e., number of days per week with ≥ 60mins PA, Godin-Shepherd leisure-time PA, sleep time, and screen time) and home factors (i.e., food environment, food worry, and parental social support for PA) were entered as dependent variables, T0 weight status as between-subject independent variable, time as within-subject independent variable, and sex and race as covariates. The first RM-MACOVA used data from T0 and T2 (two time points), and the second RM-MACOVA used data from T0 through T2 (three time points) to present a more in-depth understanding of the temporal changes. For the above inferential statistical analyses, significance level was set as $\alpha < 0.05$ and effect sizes were reported (Cohen's *d* or partial eta square, η_p^2). Line charts were drawn to graphically depict group differences by weight status, time, and covariates.

Results

The adolescent participants significantly increased their BMI percentile scores (T0: M = 69.90±28.32; T1: M = 73.68±27.40; $p < .01$; Cohen's d = 15.19) and BMIz scores (T0: M = 0.87±1.19; T1: M = 1.01±1.20; $p = 0.01$; Cohen's d = 0.49). In addition, while most of the participants did not change weight status grouping from T0 to T1 (n = 70, 85.4%), 12 adolescents did (n = 9 shifted from normal weight to OWOB; n = 3 from OWOB to normal weight). These grouping changes were statistically significant ($\lambda = 42.02, p < 0.01$).

Families of adolescents with OWOB reported greater amounts of pandemic exposure and disruption than those with normal weight, although only exposure (not impact) demonstrated statistically significant group difference (λ = 0.92, $F_{2,79}$ = 3.29, $p < .05$, $\eta_p^2 = 0.08$). Subsequent tests of between-subjects effects found significant group difference only in pandemic exposure ($F_{1,80}$ = 5.13, $p < .05$, $\eta_p^2 = 0.06$). Table 2 shows the marginalized mean and standard error values for the levels of pandemic exposure and impact by the initial weight status (at T0).

Table 2. *Pandemic Exposure and Impact by Y0 Weight Status (Adjusted for Sex and Race)*

Weight Status	**M ± *s.e.***	
	Exposure	**Impact**
Normal Weight	7.74±0.37	27.93±1.34
OWOB	9.06±0.42	31.01±1.52

Note. Normal weight: 5–84.99th BMI percentile; OWOB: ≥85th BMI percentile

RM-MACOVAs did not detect statistically significant time by weight status interaction effects for the energy-balance behaviors and home factors ($p > 0.05$). Table 3 reports the estimated marginalized means and standard errors for the variables by time and weight status. Despite the non-significant results, we plotted line charts, as shown in Figure 1, to capture the change patterns. Across the three time points (T0, T1, and T2), the adolescents with normal weight (vs. those with OWOB) showed more favorable change patterns (across the three time points) for PA (i.e., less decrease in the number of days per week ≥ 60mins PA) and food worry (i.e., less increase and lower level). During the same period, the normal weight group also saw less decline in parental social support for PA than the OWOB group. Furthermore, between T0 and T1, the OWOB group decreased their Godin-Shepherd PA time while the normal weight group showed an increase; however, this trend was reversed from T1 to T2, reflecting the differing, immediate pandemic impact on PA time for the two weight status groups. For screen time, both groups demonstrated an increasing pattern from T0 to T2, with normal weight group showing greater increase from T0 to T1 but less increase from T1 to T2 than the OWOB group.

Table 3. *Descriptive Results for Energy-Balance Behaviors and Home Factors by Time and Weight Status*

Variables	Time	Normal Weight		OWOB	
		M	**s.e.**	**M**	**s.e.**
Number of Days per Week Active ≥ 60mins	T0	4.30	0.32	4.78	0.36
	T1	4.14	0.31	4.00	0.32
	T2	3.72	0.35	2.91	0.39
Godin Leisure-Time PA (mins)	T0	77.64	11.43	88.09	12.74
	T1	88.81	12.36	63.95	12.82
	T2	61.77	14.94	79.46	16.65
Sleep Time (hours)	T0	9.60	0.19	9.09	0.21
	T1	8.97	0.25	9.10	0.26
	T2	9.42	0.17	9.69	0.19
Screen Time (hours)	T0	7.59	0.43	7.39	0.48
	T1	7.72	0.52	7.53	0.53
	T2	8.50	0.38	8.65	0.42
Availability of Unhealthy Food Items at Home	T0	20.31	0.74	20.15	0.82
	T1	20.67	0.84	20.42	0.87
	T2	28.47	0.77	27.89	0.86
Food Worry	T0	0.02	0.06	0.18	0.07

	T1	0.10	0.10	0.30	0.10
	T2	0.08	0.07	0.32	0.07
Parent Social Support for PA	T0	10.60	0.56	11.35	0.62
	T1	10.83	0.66	10.22	0.68
	T2	10.10	0.59	10.11	0.66

Note. The mean values refer to estimated marginalized means from RM-MACOVA with three time points, sex and race as covariates. OWOB: ≥85th BMI percentile

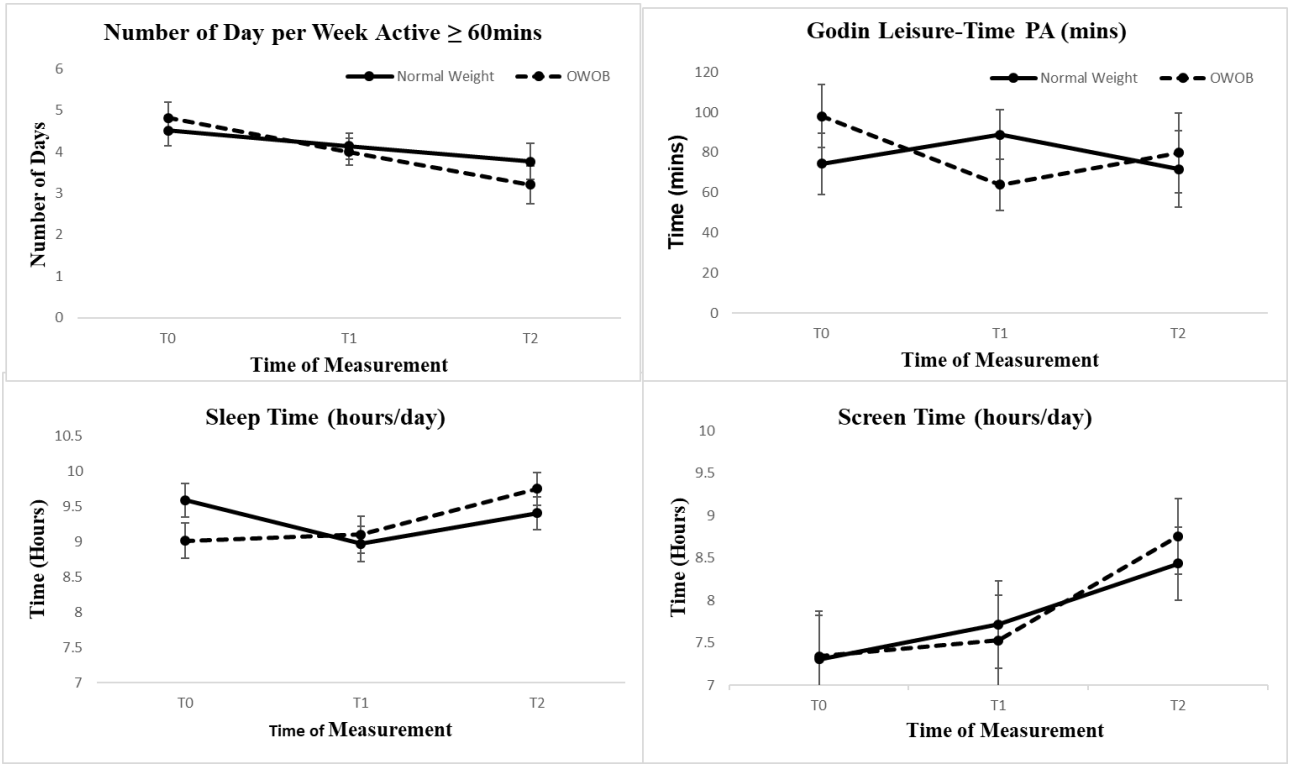


Figure 1. *Energy-Balance Behaviors by Weight Status and Time. OWOB: overweight or obesity.*

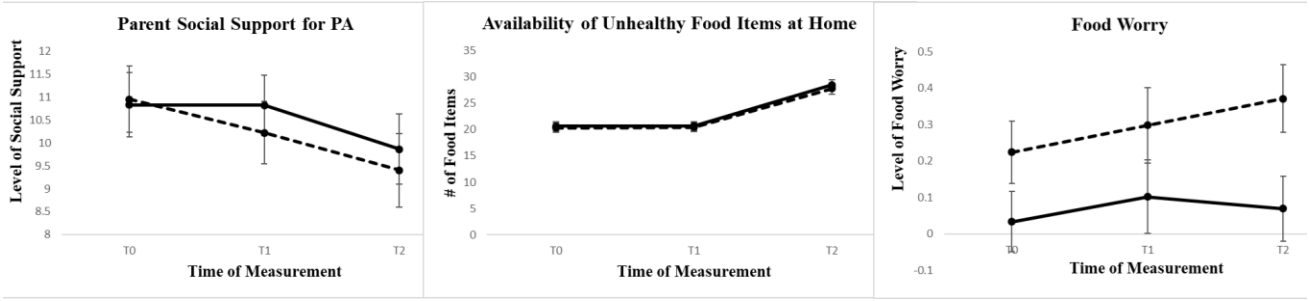
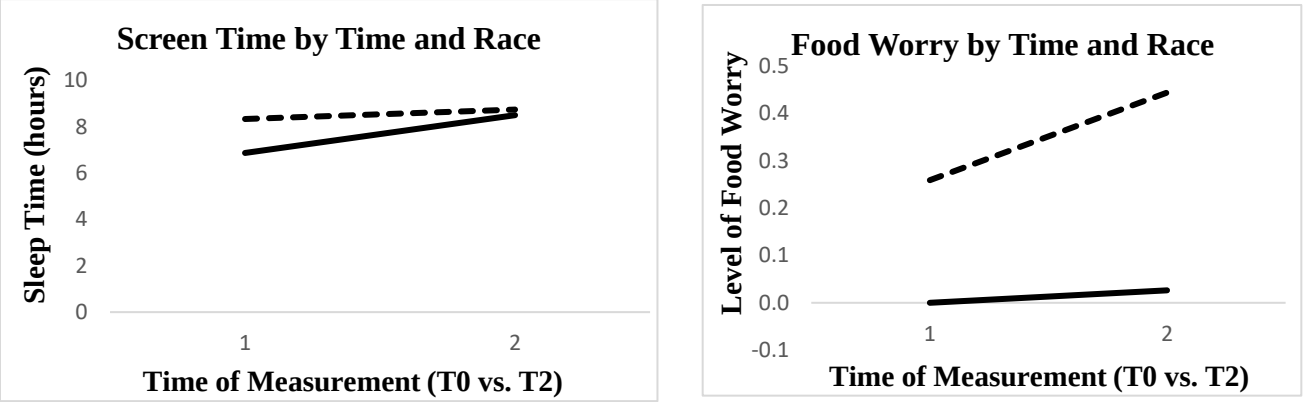


Figure 2. *Home Factors by Weight Status and Time. OWOB: overweight or obesity.*

Our first RM-MACOVA, using T0 and T2 data, detected significant time by race interaction effect (λ =0.81, $F_{7,66}$ = 2.17, $p < 0.05$, $\eta_p^2 = 0.19$)), with non-White (vs. White) adolescents showing greater increase in food worry ($F_{1,72}$ = 4.36, $p < .05$, $\eta_p^2 = 0.06$) but less

increase in screen time ($F_{1,72}$ = 4.54, p < .05, $\eta_p^2 = 0.06$)) from T0 to T2. The second RM-ANCOVA (using T0, T1, and T2 data) further detected a significant main effect for race (λ = 0.77, $F_{7,60}$ = 2.63, p < 0.05, $\eta_p^2 = 0.23$). Subsequent tests of between-subjects effects found these racial differences in sleep (higher in White group), screen time (lower in White group), and food worry (lower in White group) (ps < 0.05).

Figure 3. Screen Time and Food Worry by Time (T0 vs. T2) and Race (White vs. Non-White).



Note. Solid line refers to White group; broken line refers to non-White group.

Discussion

This study aimed to address three purposes: (a) to test the extent to which adolescents changed their weight status by time; (b) to compare the levels of pandemic exposure and impact by weight status (i.e., normal weight vs. OWOB), and (c) to compare the temporal changes in energy-balance behaviors and home factors by weight status (i.e., normal weight vs. OWOB). The findings are discussed below.

Our longitudinal data revealed an increasing trend for weight status with BMI percentile and BMIz scores being higher at T1 than T0, prior to the COVID-19 pandemic. This finding is mostly in line with the national trend that adolescents increase their BMI scores as they grow older (Cooper et al., 2015). These increases are functions of natural human growth (and development), behavioral habits (e.g., less physically active by age), and environmental conditions (e.g., transition to secondary school, lack of sports or PA opportunities, unhealthy food environment) (Cooper et al., 2015; Kenney & Gortmaker, 2017). Due to the risk of viral infection in the immediate months after the pandemic hit, it was impossible to have the participants visit our laboratory for anthropometric measurements at T2. Therefore, BMI data were not collected at T2 to allow for a longer-term analysis. However, the BMI data at T0 and T1 were useful, which allowed us to conduct cross-sectional comparisons by weight status for the other two research purposes.

Specifically, for the second research purpose, we found the OWOB group experienced significantly greater levels of exposure to the COVID-19 pandemic than the normal weight group, whereas no significant group difference was observed for the impact of pandemic. This observation builds upon a recent systematic review of 20 studies indicating youth with obesity had a 4-fold higher risk of being hospitalized with COVID-19 vs. normal weight youth (La Fauci et al., 2022). The present study indicates that youth with OWOB also experienced more familial-level pandemic-related events including family members who faced exposure at their workplace

and family members experiencing illness, hospitalization, and death. The greater exposure to the pandemic likely compromised the energy-balance behaviors, provision of healthy food in the home, and health-related outcomes in these adolescents and their families, similar to the worsening of dietary intake and decline in PA observed in other adolescent cohorts during the COVID-19 lockdown (La Fauci et al., 2022). This set of results have generated novel findings to the field, as little prior evidence has compared the pandemic's exposure and impact between adolescents with normal weight and with OWOB, using the CEFIS instrument. Worse scores on the CEFIS have been linked with mental health concerns and poor family functioning during the pandemic (La Fauci et al., 2022), and the present findings indicate that a high BMI placed adolescents at even greater risk for these adverse psychological and physical health effects.

Related to the third research purpose, our study did not show statistically significant time by weight status interaction effects for the three energy-balance behaviors and home factors, although our graphical visualizations captured more favorable change patterns in the normal weight group for variables such as PA, parental social support for PA, and food worry than the OWOB group. These findings point to key challenges faced by adolescents with OWOB, who others have demonstrated were more likely to experience food insecurity during the pandemic (Tester et al., 2020) while less likely to experience the protective role of PA for physical and mental health (Tandon et al., 2021). The present data indicate a healthier nutrition and PA profile for youth with normal weight when unstructured, homebound days were the norm during the early phase of COVID-19 (Brazendale et al., 2022).

Our RM-MACOVAs further detected some significant differences for the time by race interaction and race main effect. These specific differences were primarily observed for food worry, screen time, and sleep time, all favoring the White group (over the non-White group). These findings suggest underlying contributors to the observed higher prevalence of obesity among non-Whites (Hu & Staiano, 2022) that may be exacerbated during the pandemic as minority youth faced additional food insecurity and worsening health behaviors.

Strengths of the current paper include the longitudinal measurement of health behaviors and home environment prior to and during the early phase of the pandemic. Other strengths include sampling of adolescents of varying weight statuses and unique aspects of the home factors (e.g., availability of unhealthy foods, food insecurity, and parental support for PA), that are crucial for supporting children's healthy behaviors during this unprecedented time. A consideration for the current sample is only 24% (82 of 342) returned survey responses during the pandemic. Those who did not respond may have faced additional barriers to participation and may not be captured in the current results. Still, this sample that did provide data reporting high household chaos and an altered home state (Staiano & Kracht, 2021), suggesting a fundamental change to the household environment, familial stressors, and health behaviors that may continue to impact adolescents. A limitation is the COVID-19 pandemic faced various waves of opening and reopening as public health measures were enacted, thus the current results may only be applicable to the initial lockdown (March 2020-August 2020).

In conclusion, adolescents with OWOB (vs those with normal weight status) experienced more daily impacts of COVID-19 from family exposure, family illness, and worsening of the food and PA environments at home. The findings bear significant practical implications to adolescent obesity prevention and home-based health promotion initiatives. Public health pandemic events such as COVID-19 have caused significant disruptive impacts on people's daily lives across settings and societies (e.g., home, school, community). Our study identified certain differences and similarities concerning the disruptive impact of the pandemic on adolescents

with normal weight or OWOB and their home environments. Given the long-lasting effects of the COVID-19 pandemic on adolescents' energy-balance behaviors and weight status, multi-level supports will be needed to help families and adolescents regain routines, attain healthier energy-balance behaviors, and create healthier households. Future work should continue to monitor the temporal changes in children and adolescents' energy-balance behaviors, weight status, and environmental conditions at home. Tailored interventions should take into account influential environmental and individual factors to reduce adolescents' obesity risk and improve their health-related behaviors and outcomes.

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