

Improvement in Fruit and Vegetable Consumption Associated with More Favorable Energy Density and Nutrient and Food Group Intake, but not Kilocalories



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ABSTRACT

Background Children generally do not consume adequate amounts of fruits and vegetables (F/V). Eating more F/V can improve energy density and overall diet quality.

Objective Our aim was to investigate whether improvements in F/V consumption were associated with improvements in energy density, total calories, and dietary components related to F/V.

Design We performed secondary analyses of dietary data from a successful four-group randomized controlled trial promoting F/V. Data were collected at baseline, immediately after gameplay, and 3 months post intervention.

Participants/setting Preadolescent child–parent dyads (n=400) were recruited. Eligibility criteria were 4th- or 5th-grade child (approximately 9 to 11 years old) with Internet access and a parent willing to participate in the intervention. Complete dietary data were collected on 387 of the 400 child participants. The videogame was available online on a secure, password-protected website.

Main outcome measures Dietary intake was assessed with three unannounced dietary recalls collected at each data-collection period via telephone by trained staff using Nutrition Data System for Research software. Energy density and F/V, nutrient, and food consumption were calculated.

Statistical analysis performed A 4×3 (group by time) repeated measures analysis of covariance with mixed-effect linear models was used. Covariates included child's sex, race/ethnicity, and total energy intake as well as parent's age and household education. Energy was excluded as a covariate in the energy density and energy models.

Results Significant changes occurred in energy density. A significant interaction (group by time) was observed ($F_{6, 515}=2.40$; $P<0.05$) in energy density from food only, while a significant time effect was observed for energy density from all foods and beverages ($F_{2, 388}=13.75$; $P<0.0001$). Desirable changes were also observed in F/V-related dietary components.

Conclusions Increasing F/V consumption improved energy density and diet quality considerably in preadolescent children.

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CHILDHOOD OVERWEIGHT AND OBESITY COMPRISE A persistent, though preventable, public health epidemic, with 17% of North American children classified as obese during 2011 to 2014.¹ Consumption of excess kilocalories increases risk for overweight and obesity.² Energy-dense foods (eg, desserts, chips, fast food) contain more kilocalories in a given food weight and have been associated with increased risks of overweight and obesity.³ Replacing energy-dense foods with those lower in energy density can decrease total kilocalorie consumption⁴ and improve diet quality.^{5,6} Fruits and vegetables (F/V) prepared without added fat or sugar have low energy density, yet are excellent sources of vitamin C, beta carotene,

potassium, and fiber.³ Thus, increasing F/V consumption can decrease total kilocalorie consumption⁷ and improve diet quality,⁵ particularly when F/V are promoted as replacements for foods higher in fat and added sugar. Research has suggested that higher F/V consumption was also related to decreased sodium intake, a risk factor for hypertension.^{8,9} Because dietary behaviors track into adulthood,^{10,11} increasing F/V consumption in preadolescent children can decrease future risk for overweight and obesity^{12,13} and associated chronic diseases.^{14,15}

Current national guidelines for 9- to 11-year-old children recommend 1.5 to 3.0 cup-equivalents of vegetables and 1.5 to 2 cup-equivalents of fruits per day, depending on age, sex,

Table 1. Mean daily energy, energy density, and nutrient intake for 387 children participating in the *Squire's Quest II* videogame intervention, stratified by group and time obtained using mixed-effect analysis controlling for potential confounders^a

Variable	Baseline	Post 1	Post 2	Change from Baseline ^b	
				Post 1 ^c	Post 2 ^c
	←—————mean (standard error)—————→			←—————P value—————→	
ED^d-all (kcal/g)^{ef***}					
Control	1.02 (0.02)	1.00 (0.02)	0.98 (0.02)	0.630	0.177
Action	1.06 (0.02)	1.00 (0.02)	0.95 (0.02)	0.061	<0.0001
Coping	1.04 (0.02)	1.01 (0.02)	1 (0.02)	0.521	0.231
Action and coping	1.01 (0.02)	0.96 (0.02)	0.94 (0.02)	0.163	0.006
ED-food only (kcal/g)^{ef**g*}					
Control	1.90 (0.04)	1.79 (0.04)	1.91 (0.04)	0.044	0.932
Action	1.95 (0.04)	1.78 (0.04)	1.76 (0.04)	0.0006	<0.0001
Coping	1.95 (0.04)	1.81 (0.04)	1.83 (0.04)	0.002	0.023
Action and coping	1.87 (0.04)	1.80 (0.04)	1.85 (0.04)	0.270	0.845
Energy (kcal)^e					
Control	1,496 (34.71)	1,485 (38.84)	1,523 (39.09)	0.962	0.809
Action	1,477 (34.93)	1,490 (38.85)	1,444 (38.94)	0.945	0.727
Coping	1,487 (35.04)	1,473 (38.88)	1,510 (39.79)	0.930	0.862
Action and coping	1,476 (35.13)	1,467 (39.23)	1,482 (39.31)	0.976	0.987
Vitamin C (mg)^{fxh}					
Control	96.89 (7.97)	88.04 (6.35)	92.66 (11.98)	0.586	0.922
Action	74.25 (8.01)	85.11 (6.36)	87.22 (11.91)	0.446	0.461
Coping	73.37 (8.03)	86.12 (6.38)	96.91 (12.11)	0.328	0.088
Action and coping	84.99 (8.04)	97.17 (6.45)	104.47 (11.98)	0.364	0.179
Beta carotene (µg)^{fxh}					
Control	1,499 (191.00)	1,812 (234.58)	1,855 (300.67)	0.452	0.512
Action	1,557 (192.25)	1,925 (234.41)	2,529 (298.56)	0.330	0.007
Coping	1,208 (192.9)	1,780 (234.33)	1,727 (305.22)	0.070	0.249
Action and coping	2,254 (193.42)	1,905 (236.69)	2,203 (300.72)	0.374	0.986
Sodium (mg)^{fxh}					
Control	2,655 (45.33)	2,511 (50.84)	2,740 (50.96)	0.035	0.328
Action	2,626 (45.58)	2,590 (50.81)	2,562 (50.70)	0.811	0.533
Coping	2,646 (45.71)	2,637 (50.79)	2,667 (51.91)	0.984	0.936
Action and coping	2,623 (45.81)	2,585 (51.30)	2,670 (51.14)	0.780	0.709
Potassium (mg)^{fx***h}					
Control	1,732 (38.1)	1,798 (42.6)	1,789 (45.66)	0.301	0.466
Action	1,668 (38.35)	1,812 (42.61)	1,905 (45.47)	0.003	<0.0001
Coping	1,693 (38.48)	1,828 (42.65)	1,854 (46.42)	0.007	0.003
Action and coping	1,823 (38.59)	1,868 (43.04)	1,858 (45.86)	0.575	0.747

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