



Published in final edited form as:

J Nutr Educ Behav. 2016 May ; 48(5): 326–330.e1. doi:10.1016/j.jneb.2016.02.004.

Meal specific dietary changes from Squires Quest! II: a serious video game intervention

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Abstract

Objective—“*Squire's Quest! II: Saving the Kingdom of Fivealot*”, an online video-game, promotes fruit-vegetable (FV) consumption. An evaluation study varied type of implementation intentions used during the goal setting process (none; Action, Coping, or both Action+Coping plans). Participants who created Action plans reported higher FV consumption *6 months post baseline*. This study assessed changes by specific meal in that study.

Methods—400 4th and 5th grade children completed 3 24-hour recalls at baseline and 6 months later. These were averaged to obtain FV intake. Analyses used repeated measures analyses of covariance.

Results—There was a significant group by time effect for V at 6 months ($p=0.011$); Action ($p=0.010$) and Coping ($p=0.036$) group participants reported higher V intake at dinner. There were significant F increases at breakfast ($p=0.009$), lunch ($p=0.014$) and snack ($p<0.001$).

Conclusions and Implications—Setting meal specific goals and action/coping plans may enable children to overcome barriers and consume FV.

Keywords

Videogame; fruit; vegetables; children; implementation intentions; meal specific changes

INTRODUCTION

Few children in the United States consume the daily recommended amounts of fruit and vegetables (FV);¹ at least 1.5 cups of F and 2.0 – 2.5 cups of V.² FV are low in energy density, high in fiber, and may reduce risk for developing chronic diseases, such as cardiovascular disease and certain cancers.^{3, 4} Interventions to establish behaviors in childhood are important so they may track into adulthood.^{5, 6–8} However, interventions to improve FV intake among children have not all been successful.^{9–11}

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Serious video games are designed to both entertain and promote behavior change.^{12–14} One serious videogame intervention, Squire's Quest! (SQ!), successfully improved total FV intake among children,¹⁵ with significant improvements for F and 100% F juice consumption at snacks and for regular V at lunch.¹⁶ The SQ! intervention sessions included setting meal-specific goals for eating FV, suggesting that goal setting was an important component. However, there was only a weak association between goal setting, goal attainment, and FV consumption.¹⁷

Implementation intentions are detailed plans that are connected to achieving a specific goal.^{18, 19} Action plans identify the specifics of how (i.e., what, when, where) the goal will be attained. To create coping plans, children identify common barriers that could interfere with meeting a goal and then ways to overcome them.^{18, 19} In Squire's Quest! II, Saving the Kingdom of Fivealot (SQ!II), an updated and enhanced version of the original SQ! intervention, implementation intentions were added to the goal setting procedure.¹⁸ It was hypothesized that creating either Action or Coping Plans would improve the ability of the children to achieve their goals, and that creating both plans would provide additional assistance to the children to attain their goals and maintain them over a longer time period.

In each game episode the children set goals.^{20, 21} In 5 episodes, children set specific F or V goals for a specific meal: 1 breakfast, 1 lunch, 1 dinner and 2 snacks. Children could select the meal for 1 F and 1 V goal in 2 episodes. In the last 3 episodes, the children were to set a personal FV schema for eating 5 FV servings daily, such as 1 F for breakfast, 1 F and 1 V for lunch, 1 F for snack and 1 V for dinner.

A recent randomized control trial that evaluated SQ!II with 4th and 5th grade children and assessed intake at baseline, ~3 and ~6 months post baseline documented success.²¹ FV intake was significantly higher at 3 months for the Action and Coping groups compared to baseline.²¹ Only the Action group children maintained the increase at 6 months. Regardless of group, there were significantly higher F intakes at both 3 and 6 months compared to baseline.

Because the children completed 24-hour dietary recalls, meal-specific changes could be identified. The objective of this paper is to assess whether there were significant meal-specific changes 6 months after baseline for the children participating in this intervention.

METHODS

Study Design

The primary study methods and outcomes have been described elsewhere, but are briefly summarized here.^{20, 21} The outcome evaluation study was a randomized design with 4 groups; the groups were based on the type of implementation intentions used within the goal setting component in each episode (none, Action, Coping, Action+Coping). All groups played the same 10-episode online videogame and set a goal to eat a FV in each episode. Data were collected at baseline, and at ~3 months and ~6 months post-baseline; only data from baseline and 6 months were analyzed in this study. Children were to attain their FV goal prior to playing the next episode, and record goal attainment in the game.

Parents were emailed a newsletter for each episode and a link to a parent website. The content included information on their child's weekly goals, suggestions for supporting achievement of FV goals, and ways to overcome common barriers to helping their family make healthy food choices.

Sample

Participants were 400 children in the 4th or 5th grade (~9–11 year olds), who spoke English, had a computer and high speed Internet access. Standard recruitment methods were used such as flyers distributed to schools and community groups and postings on volunteer webpages.¹⁸ The study was powered to detect a small effect size (Cohen's $d=0.17$) of at least 0.51 serving^{20, 21} in child FV intake. This study was approved by the Institutional Review Board at Baylor College of Medicine, Houston, TX, USA. Written parental consent and child assent were obtained.

Measurement

At each data collection period, the children completed 3 unannounced 24 hour dietary recalls (2 weekday, 1 weekend day) conducted via phone by trained staff using Nutrient Data System for Research (NDSR-2009, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN).²² As in the primary study, servings of F, but not 100% F juice, and regular V, not high fat V, were calculated using NDSR output. F and V intake from each 3 day period were averaged to improve dietary intake estimates. Breakfast, lunch, snack, and dinner intakes were calculated.

Statistical Analysis

Baseline demographic characteristics and FV intake were examined to identify group differences using chi-square analysis and analysis of variance for categorical and continuous variables, respectively. Numerical (skewness, kurtosis, and Kolmogorov-Smirnov D) and graphical methods were used for data normality testing. Because the dietary data were skewed (some children consumed no food for some food groups), all selected outcomes variables were log-transformed for analyses. The adjusted means presented in the tables were back-transformed to the original scale. Intervention group, time, and group by time interactions were included in the models.

To evaluate meal-specific changes from baseline to 6 months, a repeated measures mixed-effects model²³ with a 4-level between-subject factor (group: control, Action, Coping, and Action+Coping) and a 2-level within-subject factor (time: baseline and 6 months) was used. Subjects were treated as random effects, and group, measurement time (baseline, 6 months) and group by time interactions as fixed effects. Restricted maximum likelihood and weighted least squares estimated variance components and fixed effects, respectively. All mixed-effects models were adjusted for child gender, race/ethnicity, total energy intake, parent age, and household education. Post hoc analyses were conducted for each meal occasion. All statistical analyses were conducted with the Statistical Analysis Software (version 9.3, SAS Institute Inc., Cary, NC, 2012). Significance was set at $p<0.05$.

RESULTS

Baseline Characteristics

The participating children were diverse (White 36.8%, Hispanic 27.4%, AA 26.4%) and 52.7% female. Most parents were female (96.3%), married (77.5%), 40–59 years old (55.3%), with an average household income of >\$61,000 (57.6%). Three hundred and eighty seven children had complete data. There were no group differences in baseline demographic characteristics or FV intake.

FV Intake

At baseline, children consumed a daily average of 0.63 serving of F and 1.13 servings of V regardless of group.²¹ There was a significant intervention group by time interaction effect for V ($p=0.011$); the relationship for V intake between the 2 time points differed based on group. The Action ($p=0.0103$) and Coping ($p=0.036$) group participants reported higher V intake at dinner at 6 months than at baseline. (Table) In the overall models, there were significant increases over time for F intake at breakfast ($p=0.009$), lunch ($p=0.014$) and snack ($p<0.0001$) at 6 months.

DISCUSSION

This study examined longitudinal changes in FV intake by specific meal after children played a 10 episode serious videogame that systematically varied implementation intentions during goal setting. In the primary study, the only significant intervention interaction effect at 6 months was a 0.68 serving increase in total FV intake for the Action group.²¹ However, there were overall significant time effects for F intake alone.²¹ In this current analysis of meal-specific changes, there were significant increases of 32% (1.5 Tablespoons) and 18% (1.2 Tablespoons) in dinner V intake for the Action and Coping groups, respectively. For F, the significant time increases represent approximately 0.66 tablespoons of F at both breakfast and lunch, and approximately 1.5 tablespoons at snack for the Action group and ~0.35 tablespoons at breakfast, ~0.66 tablespoons at lunch and ~1 tablespoon at snack for the Coping group. Although these increases are small, overall meal improvements add up to increases in daily FV that are similar to those in the literature which range from 0.25 to 0.99 serving.^{9, 24, 25} No studies were found that reported meal-specific FV outcomes for adults.

In the original SQ! program, there was a significant improvement in lunch V intake and in F and 100% fruit juice intake at snacks for the intervention group.¹⁶ In the current study, there were significant improvements in F intake alone at breakfast, lunch and snacks over time, and the significant increase for V occurred at dinner. The impact for F intake at 3 meals could reflect the higher preference that children have for F compared to V,^{26, 27} making it easier to improve F selection and consumption. The Action plans the participants created were to identify strategies to help them be successful in meeting their goal, whereas the Coping plans identified potential barriers and ways to overcome those barriers. The number of V goals and either the action or coping plans the children created might have enabled the participants to achieve their V goal for dinner. Whether the children used the plans to attain their goals was not evaluated. A few school-based studies assessed meal-specific FV

changes. Following a 5 A Day program, school lunch observation data revealed a significant increase in total F consumption among 4th and 5th grade students from 0.44 to 0.74 serving.²⁸

A cafeteria-environment intervention resulted in a significant increase in F (no juice) consumption at lunch, based on student meal observations.²⁷ A United Kingdom school-based intervention observed or weighed student lunches in the cafeteria and documented significant improvements in FV intake for school-provided lunches and snacks,^{29–31} and in lunches from home.³⁰ A replication study in the United States, using digital photography to assess consumption, documented significant increases in lunch FV intake.³² None of the previous studies had specific meal and food item goals in the intervention, making it difficult to compare with the present study results.

The significant meal changes in this study also reflect the videogame content which focused on setting goals to eat FV at specific meals and snacks, and the addition of implementation intentions to the goal setting component.²⁰ Participants attained an average of 8.7 out of 9 possible FV goals, and 79% of the children reported meeting all nine FV game goals.³³ There were no differences in number of goals achieved by group. There were 2 weekly goals for eating a V at both lunch and at dinner, 2 weekly goals for eating a F serving at both snack and breakfast; and 1 for eating a F at dinner.²⁰ In the last 3 episodes, children chose a schema during goal setting, and then set a goal to eat the FV in the day's meals guided by that schema. The videogame characters presented their personal schemas as examples.

Another possible explanation for success is the enhanced parent component in the current SQ! II program: a parent website and weekly newsletter emails to parents.²⁰ About 60% of the parents reported visiting the website 6 or more times; ~60% reported reading 4 or more newsletters.²¹ The materials could have helped parents support their children's goal attainment. The appropriate dose of an intervention to enable parents to support child dietary behavior change is unknown. Although parents received 5 newsletters sent home with their child in the previous intervention,¹⁵ no data on whether the parents read the newsletter was reported.¹⁵

The group creating both Action and Coping plans was not successful in improving FV intake. It may be that the cognitive burden needed to create both types of plans for each goal was too great, especially during an interactive videogame. This burden might have resulted in poorly devised plans that did not help children meet their goals, or it may be that the children simply did not make any plans. This study was not designed to capture the failure of combining the 2 plans.

The strengths of this research include a large, multi-ethnic sample; high participation by children (91% played all 10 episodes); low attrition; an intervention developed with children and pilot tested; the ability of the videogame to deliver the intervention as designed; and the long 6 month evaluation period. The goals were specific, proximal and realistic, which are more likely to be achieved.³⁴

Weaknesses include no group that did not set a goal; age of the children, which may have influenced the accuracy of the dietary recalls; the relatively high income and education of

the participating families; and conducting the study in only one geographic region, limiting generalizability.

IMPLICATIONS FOR RESEARCH AND PRACTICE

In this study, a serious video game for children that included creating Action and Coping plans during the goal setting procedure was an effective method for increasing meal-specific V intake at dinner 6 months post intervention, and F intake at breakfast, lunch and snacks for all intervention groups. Qualitative interviews are needed to investigate how children create and use Action and Coping plans in goal setting and to understand why the group that was asked to set both Action and Coping plans was not successful. In addition, further research to replicate the study findings is warranted.

Acknowledgments

This work is a publication of the United States Department of Agriculture/Agricultural Research Center (USDA/ARS), Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, Texas. This project was supported by the National Institutes of Health, National Institute of Child Health & Human Development grant #HD050595 (to Dr. Thompson). This work is also a publication of the USDA/ARS, Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, Texas, and funded in part with federal funds from the USDA/ARS under Cooperative Agreement No. 58-6250-0-008. The contents of this publication do not necessarily reflect the views or policies of the USDA, nor does mention of trade names, commercial products, or organizations imply endorsement from the U.S. government.

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Adjusted means (M) and standard error (SE) for servings of fruit and vegetables across meal, group, and time for 387 4th and 5th grade children participating in the Squire's Quest! II videogame intervention.[§]

Table

	Control (n=97)		Action (n=98)		Coping (n=95)		Action & Coping (n=97)	
	Baseline	6 months	Baseline	6 months	Baseline	6 months	Baseline	6 months
Mean (SE)								
Breakfast								
Fruit ^a ***	0.14 (0.02)	0.16 (0.02)	0.09 (0.02)	0.17 (0.02)	0.09 (0.02)	0.14 (0.03)	0.10 (0.02)	0.10 (0.03)
Lunch								
Fruit ^a *	0.25 (0.02)	0.27 (0.03)	0.21 (0.02)	0.30 (0.03)	0.23 (0.03)	0.31 (0.03)	0.31 (0.03)	0.32 (0.03)
Vegetables	0.41 (0.03)	0.44 (0.03)	0.42 (0.03)	0.50 (0.03)	0.41 (0.03)	0.41 (0.03)	0.47 (0.03)	0.45 (0.03)
Snack								
Fruit ^a ***	0.19 (0.03)	0.25 (0.04)	0.14 (0.03)	0.33 (0.04)	0.20 (0.03)	0.31 (0.04)	0.19 (0.03)	0.32 (0.04)
Vegetables	0.05 (0.01)	0.03 (0.02)	0.04 (0.01)	0.09 (0.02)	0.04 (0.01)	0.08 (0.02)	0.04 (0.01)	0.08 (0.02)
Dinner								
Fruit	0.11 (0.02)	0.08 (0.02)	0.08 (0.02)	0.09 (0.02)	0.07 (0.02)	0.10 (0.02)	0.10 (0.02)	0.09 (0.02)
Vegetables ^b *	0.62 (0.03)	0.73 (0.04)	0.59 (0.03)	0.78 (0.04)	0.67 (0.03)	0.82 (0.04)	0.83 (0.03)	0.71 (0.04)

[§]The intervention included goal setting. The groups varied on whether and/or which implementation intentions were set during the goal setting process (none, Action Plans, Coping Plans, or both Action and Coping Plans.)

* p<.05

** p<.01

*** p<.001

^aSignificant time effect

^bSignificant group x time effect-overall; within groups Action and Coping groups had a significant increase in vegetable intake for dinner at 6 months