

AN ABSTRACT OF THE DISSERTATION OF

Jennifer A. Jackson for the degree of Doctor of Philosophy in Public Health presented on June 9, 2015.

Title: Associations Between Family Nutrition and Physical Activity, Food Security, and Childhood Obesity in Rural Oregon

Abstract approved: _____

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Childhood obesity and food insecurity are public health issues that often coexist, and both conditions are more prevalent among rural compared to non-rural populations. Social ecological prevention efforts are recommended, yet limited research has examined how rural family-home environments may influence obesity-preventing and -promoting behaviors. The purpose of this dissertation was to examine whether and how family-home environmental and behavioral factors are associated with body mass index (BMI) and food security in rural children. To accomplish the aims of this project, a mixed methods study was conducted.

For the quantitative phase of this study, relationships between family nutrition and physical activity (FNPA), food security, and children's BMI and dietary behaviors were examined. Results indicated no significant associations between FNPA and BMI or between FNPA and food security. More favorable FNPA factors were associated with higher consumption of fruits, vegetables, and dairy, and with lower intake of added sugar.

The qualitative phase of this research involved nine semi-structured focus group

interviews, conducted across six rural communities, to explore parent/caregiver perceptions of factors that influence behaviors related to nutrition and physical activity in the home environment. Four major themes that influence family nutrition- and activity-related behaviors were identified, including *family eating habits*, *food procurement*, *family physical activity*, and *screen time*. Eight themes emerged as environmental supports and/or barriers to family nutrition and physical activity, including *seasonal variation*, *features of home*, *distance from resources*, *foods and beverages encouraged and discouraged*, *screen time limits*, *financial constraints*, *outdoor safety*, and *schedule constraints*.

This study provides evidence that certain factors in the family-home are associated with children's dietary behaviors, and that opportunities for rural children to eat healthfully and be physically active at home are influenced by factors internal and external to the family-home. Understanding how family-home and other environmental factors influence children's eating and activity behaviors and future health outcomes, as well as how public health efforts may support families in navigating challenges specific to rural areas, is an important area of research that warrants further exploration.

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Associations Between Family Nutrition and Physical Activity, Food Security, and
Childhood Obesity in Rural Oregon

by
Jennifer A. Jackson

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Jennifer A. Jackson, Author

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CHAPTER 1. GENERAL INTRODUCTION

Overview of Context

Prevention of childhood obesity is a public health priority in the United States (US).^{1,2} Nearly 18% of US children aged 6-11 years are obese, defined as a body mass index (BMI, kg/m²) at or above the 95th percentile of the sex-specific Centers for Disease Control and Prevention (CDC) BMI-for-age growth charts.³ Approximately 34% of children are either overweight or obese ($\geq 85^{\text{th}}$ percentile). Overweight and obese children are at greater risk for physical, social, and psychological health problems.⁴⁻⁶ Obese children are also more likely to become obese adults.⁵ Related to these health concerns is the substantial economic impact of obesity-related illness, estimated at 20% of annual U.S. health care expenditures.^{7,8} Emerging evidence also suggests that childhood overweight may be negatively associated with academic achievement.⁹⁻¹² Taken together, these consequences present long-term implications for society.

The etiology of obesity is multifaceted, involving a host of biological, behavioral, social, environmental, and economic factors that influence weight status and health.¹³ Consequently, obesity prevention is a complex issue. For children, promoting energy balance is a fundamental component of prevention efforts.^{7,14} Nutrition and physical activity are key lifestyle factors involved in energy balance and, therefore, development and maintenance of healthy body weight. In general, US children eat too many calories and spend too little time being physically active,^{7,14} behaviors that are associated with unhealthy weight gain.^{7,15-18}

Children's eating and activity behaviors are influenced by many factors, including those that occur at the community-level (e.g., access to healthy food and recreational resources), school-level (e.g., availability of healthy school meals and physical activity education), and home-level (e.g., family meal and activity patterns). Socioeconomic status (SES) and food security status are also associated with diet and activity behaviors, and risk for obesity.¹⁹⁻²⁶ Thus, social ecological approaches, targeting multiple levels of influence on health behaviors, have been recommended for obesity prevention.^{7,14}

Population disparities in obesity prevalence present unique challenges for prevention.^{3,24,27,28} Of central importance to this dissertation are the higher rates of obesity among rural compared to non-rural children.²⁹⁻³³ The most current available evidence indicates that compared to urban children, rural children have 26% greater odds of obesity.³³ Evidence to explain this discrepancy is inconclusive.

Research Significance and Implications

Though the behavioral correlates of obesity may be similar, the environmental contexts in which rural and non-rural children eat and play are dissimilar, resulting in different supports for and barriers to achieving and maintaining healthy weight. Challenges associated with rural residency, including structural, socioeconomic, and cultural factors, influence opportunities for children to develop and practice healthy eating and activity behaviors.³⁴⁻³⁸ Whether and how these and other environmental factors contribute to higher obesity prevalence in rural settings is not well defined, however, particularly among elementary-school-age children.²⁹

School and home environments are key settings that shape children's health behaviors and, therefore, these contexts have become targets for obesity prevention efforts that aim to modify diet and/or physical activity.^{7,39,40} Compared with school settings, few studies have focused on the family-home setting, and of those, many have targeted behavioral strategies with less consideration for home environmental factors.^{39,40} A holistic approach to childhood obesity prevention requires a better understanding of how the collective practices, policies, and features of the home environment may promote or prevent obesity. This understanding is especially important in rural settings, where research on the home environment is particularly limited.^{36,41}

An overarching goal of the US Department of Health and Human Services Healthy People (HP) 2020 initiative stipulates the elimination of health disparities, including those related to geographic location and SES.¹ Furthermore, HP 2020 specifies objectives that include reducing obesity among youth populations and reducing household food insecurity. Rural populations experience higher rates of obesity, food insecurity, and poverty compared with non-rural populations.^{29,42-44} Although food insecurity and obesity often coexist, evidence for an association in children is inconsistent,²¹⁻²³ and understudied among rural populations. Given these public health priorities, coupled with the call for more research to support obesity interventions customized for rural settings,²⁹⁻³¹ further examination of obesity and food insecurity in rural environments is warranted.

Data from the Generating Rural Options for Weight (GROW) Healthy Kids & Communities project indicate that the prevalence of overweight and obesity among children in six rural Oregon communities exceeds national averages.^{3,45} For example, in 2013, 39.3% (n=782) of elementary-age (K-5/6) boys were overweight ($\geq 85^{\text{th}}$ percentile) and 20.8% were obese ($\geq 95^{\text{th}}$ percentile). Among girls, 36.8% (n=700) were overweight and 17.8% were obese.⁴⁵ Furthermore, Oregon exceeds national averages for food insecurity with 16.7% of the total population and 27.3% of children food insecure.⁴⁶ These findings demonstrate a need for research to explore factors potentially associated with childhood obesity and food insecurity in rural Oregon.

Research Gap

Considerable evidence exists regarding the multiple factors that influence risk for obesity.¹³ Despite this knowledge, the specific factors associated with the higher prevalence of obesity among rural children are poorly understood.^{29,33,42} Limited research has examined whether and how the family-home environment contributes to childhood obesity, particularly in rural populations. To address disparities in the prevalence of childhood obesity, comprehensive, customized intervention strategies and prevention efforts are recommended.^{24,27} Prior to developing targeted interventions, a better understanding of the factors that contribute to existing disparities is essential. Furthermore, although rural populations experience higher rates of obesity^{29,33,42} and food insecurity,⁴⁴ a dearth of evidence is available on the relationship between obesity and food insecurity in rural settings.

Study Purpose

The goal of this dissertation was to examine whether and how family-home environmental and behavioral factors are associated with BMI and food insecurity in rural children. Specifically, this research assessed family-home factors that are important for the development of healthy eating and physical activity habits and examined their association with child BMI, dietary intakes, and family food security. Additionally, this study explored parent/caregiver insights on supports for and barriers to eating healthfully and being physically active in the rural family-home environment.

Theoretical Perspective

Health behavior theory provides a foundation for understanding, explaining, or predicting health behaviors by demonstrating hypothesized relationships between variables. Two theoretical perspectives informed this research: the Ecological Perspective⁴⁷⁻⁴⁹ and Social Cognitive Theory.^{47,48,50}

Bronfenbrenner⁴⁹ was among the first to postulate that human development is influenced by multiple environmental systems in which an individual interacts. According to Bronfenbrenner, bi-directional interactions and influences between individuals and their interpersonal relationships; the environments and organizations in which they live, learn, play, and work; and social and cultural norms impact human behavior and development. Correspondingly, an ecological perspective of health promotion considers the health status of individuals as it results from complex interactions with multi-level factors of influence.^{47,51}

Building on Bronfenbrenner's work, McLeroy and colleagues⁵¹ proposed an ecological model for health promotion, which assumes that changes in the physical and social environment will result in changes in individuals. According to this model, health behaviors, such as eating and physical activity practices, are determined by five influential factors. These include *intrapersonal factors*, *interpersonal factors*, *institutional factors*, *community factors*, and *public policy factors*. Table 1.1 provides definitions for each level of influence. The ecological perspective is used to explore public health problems, such as disproportionate rates of childhood obesity, through a holistic lens. For example, making healthy food choices may depend on an individual's knowledge about and attitudes toward healthy eating habits (intrapersonal). In addition, the decision to eat healthfully may be influenced by the food choices of family members and friends (interpersonal); availability of healthy foods at home, school, and work (institutional); access to community resources and programs that promote healthy eating (community); and mandatory nutrition standards for foods served and sold in schools (public policy). Similar multi-level factors may influence an individual's physical activity behaviors. The particular nature of the factors of influence varies according to the environment. For instance, rural children and families may face unique challenges that influence their ability to eat healthfully and be physically active, different from the challenges faced by non-rural families. This study examined factors at the intrapersonal (children and parents), interpersonal (family), and institutional (home) levels that may be

associated with eating and physical activity behaviors among elementary-age children, in a rural setting.

Table 1.1 Ecological Perspective: Factors of Influence

Concept	Definition
Intrapersonal	Individual characteristics that influence behavior (e.g., personal beliefs, attitudes, behaviors).
Interpersonal	Primary groups and interpersonal processes, including social networks and social systems (e.g., family, friends, peers), that provide social identity, support, and role definition.
Institutional	Rules, regulations, policies, and informal structures, which may constrain or promote recommended behaviors.
Community	Social networks and norms among individuals, groups, and organizations, which are formal or informal.
Public Policy	Local, state, and federal policies and laws that regulate or support healthy actions and practices for disease prevention, early diagnosis, control, and management.

Note. Adapted from “An Ecological Perspective on Health Promotion Programs,” by K. R. McLeroy, D. Bibeau, A. Steckler, and K. Glanz, 1988, *Health Education Quarterly*, 15(4), p. 351-377. Copyright 1988 by Society for Public Health Education.

Interpersonal theories of health behavior posit that individuals exist within and are influenced by their social environment, such as family members and friends.⁴⁷ Social Cognitive Theory (SCT) contributes to our understanding of how people learn from experiences and regulate behaviors based on the interrelationships and reciprocal interactions between individual factors, environmental factors (social and physical), and behaviors.^{48,50} The present study hypothesized that children's eating and physical activity behaviors (e.g., low-fat milk consumption, leisure-time physical activity) are interrelated with family behavioral factors (e.g., family meal patterns, family physical activity) and rural home environmental factors (e.g., availability of food and physical activity resources). Further, it was hypothesized that the interactions between family-home behavioral and environmental factors influence child BMI. Understanding these relationships is important because the family-home environment is a key behavioral setting for the development of lifelong healthy eating and activity habits.

The central constructs of SCT include *reciprocal determinism* (interactions between person, behavior, and environment), *behavioral capability* (knowledge and skill to perform a behavior), *expectations* (anticipated results of a behavior), *self-efficacy* (confidence in one's ability to perform a behavior), *observational learning* (learning from the actions of others), and *reinforcements* (responses to behavior that influence whether or not it will be repeated).⁴⁷ Ideally, this study would have measured each construct as it relates to children's weight-healthy food and activity behaviors within the context of the family-home environment. Concerns for participant burden as well as time and

budgetary constraints, however, limited the feasibility to measure each construct directly. Nevertheless, a number of SCT constructs were potentially related to the outcomes of interest in this study. Foremost, the central hypothesis, that family-home factors are associated with children's food and physical activity behaviors and, therefore, child BMI, exemplifies reciprocal determinism. Children who live in a family-home environment that provides ample opportunities to eat fresh fruits and vegetables and to be involved in a variety of physical activities, gain experiences and establish preferences that influence the likelihood they will continue to practice such behaviors. Second, this study's measures of family eating and activity practices (e.g., family meals, family physical activity) represent observational learning/role modeling opportunities that influence children's food and activity habits. Additionally, family policies around food and physical activity (e.g., monitoring of junk food, limiting of screen time) may reinforce children's health-related behaviors. Finally, although it is possible that a child's dietary intake could reflect her or his nutrition-related knowledge and skills (i.e., behavioral capability), it is more plausible that dietary intake among elementary-age children is a reflection of family social support and environmental accessibility and availability of food options. In summary, the study hypotheses were informed by social cognitive theoretical constructs that occur within the family-home environment. In addition to the survey measures that were used in this study, we conducted focus groups with rural parents to explore other factors associated with childhood obesity that result from the

dynamic interrelationships between children, parents, and family-home environments in rural communities.

Specific Aims

This research addressed three specific aims using a convergent parallel mixed methods design.⁵² The aims, hypotheses, and research questions were as follows:

- *Specific aim #1:* to determine whether family-home factors related to nutrition and physical activity are associated with BMI (standardized for sex and age), food insecurity, and/or dietary intake in rural children.
 - *The hypotheses were:* After adjusting for covariates, favorable family-home factors will be: 1) inversely associated with BMI, cross-sectionally and prospectively over one year; 2) inversely associated with food insecurity; and 3) positively associated with dietary intake.
- *Specific aim #2:* to determine whether food insecurity is associated with BMI and/or dietary intake in rural children.

The hypotheses were: After adjusting for covariates, risk for food insecurity will be: 1) positively associated with BMI and 2) negatively associated with dietary intake.

- *Specific aim #3:* to explore parent/caregiver perceptions of factors that influence nutrition and physical activity behaviors in rural family-home environments.
 - *The central research questions were:*

- 1) How do rural family-home practices and policies influence eating and physical activity behaviors?
- 2) How do rural family-home environments facilitate and/or hinder healthy eating and physical activity behaviors?

CHAPTER 2. FIRST MANUSCRIPT

The family-home environment, body mass index, and food security
in rural children

Target Journal: Public Health Nutrition

Abstract

Objective: Obesity and food insecurity are public health issues that often coexist. The family home is a key setting for development of lifelong eating and activity habits, yet little is known about how the family-home nutrition and physical activity (FNPA) environment influences food insecurity and childhood obesity, particularly in rural settings. This study examined associations between FNPA, food insecurity, and body mass index (BMI) in rural children.

Design: Participants were recruited through elementary schools. At baseline, parents/caregivers completed FNPA and food insecurity surveys. Child anthropometric data were objectively measured at baseline and 1-year follow-up. Logistic and linear regression analyses examined associations between FNPA factors, food insecurity, and BMI.

Setting: Six rural, low-income communities in the Pacific Northwest.

Subjects: Elementary-age children (n=186) and their parents/caregivers.

Results: Approximately 37% of children were classified as overweight/obese and 43% of families were at-risk for food insecurity. FNPA scores were not associated with BMI or with being at-risk for food insecurity ($p>0.05$). Food insecurity tended to be higher in obese than in normal weight children among families not eligible for the federal free- and reduced-cost school meals program ($p<0.10$).

Conclusions: No statistically significant associations were found between FNPA factors and BMI or food insecurity in rural children. Future work is warranted to clarify the role

of family-home factors in relationship to the disproportionate rates of childhood obesity and food insecurity observed in rural populations.

Keywords:

Nutrition

Physical Activity

Overweight and obesity

Food insecurity

School meals program

Introduction

Prevention of childhood obesity is a public health priority in the United States (US).^{1,2} Nearly 18% of US children aged 6-11 years are obese, defined as a body mass index (BMI, kg/m²) at or above the 95th percentile of the sex-specific Centers for Disease Control and Prevention (CDC) BMI-for-age growth charts, and 34% are overweight ($\geq 85^{\text{th}}$ percentile).³ Obese children are at increased risk for physical, social, and psychological health problems,⁴⁻⁶ and are more likely to become obese adults.⁵ Emerging evidence also suggests that being overweight may be associated with poor academic achievement.⁹⁻¹² Although childhood obesity is a national concern, regional and population disparities present unique challenges for prevention.^{3,24,27,28} Of particular importance is the higher prevalence of obesity among rural children compared to their non-rural counterparts.^{29,30,32,33,53}

The etiology of obesity is complex, involving a multitude of biological, behavioral, social, environmental, and economic factors that influence weight status and health.¹³ From an ecological perspective of health promotion, the health status of individuals is considered a result of complex interactions with multi-level factors of influence.^{47,51} For example, though the behavioral correlates of obesity may be similar, the environmental contexts in which rural and non-rural children eat and play are dissimilar, resulting in different supports for and barriers to achieving and maintaining healthy weight. Challenges associated with rural residency, including structural, socioeconomic, and cultural factors, may influence opportunities for children to develop

and practice healthy eating and activity behaviors.³⁴ Whether and how these and other environmental factors contribute to higher obesity prevalence in rural settings is not well defined, however, particularly among elementary-age children.²⁹

School and home environments are key settings that influence health behaviors and, therefore, these contexts have become targets for obesity prevention efforts that aim to modify diet and/or physical activity.³⁹ Compared with school settings, few studies have focused on the family-home setting, and of those, many have targeted behavioral strategies with less consideration for home environment factors. A holistic approach to childhood obesity prevention requires better understanding of how the collective practices, policies, and features of the home environment may promote or prevent obesity, especially in rural populations.

Food insecurity, or lack of consistent access to enough food to support an active, healthy life, is a related public health concern that is also detrimental to child health and development.⁵⁴⁻⁵⁸ For example, food insecurity has been associated with poorer health status,⁵⁴ iron deficiency anemia,⁵⁹ developmental and mental health problems,^{56,57,60} and poor educational outcomes.^{55,58,61} Food insecurity has also been associated with overweight and obesity.²³

In 2012, approximately 14.5% of US households (17.6 million households) and 15.9% of the US population (33.1 million adults and 15.9 million children) were food insecure.⁴⁴ Food insecurity is most strongly associated with income. Households below the federal poverty threshold experience significantly higher rates compared to those with

incomes above 185% of the poverty line. Prevalence is also higher among non-White and non-Hispanic households, households with children, and in rural areas compared with suburban and exurban areas around large cities.

Rural populations experience higher rates of obesity, poverty, and food insecurity compared with non-rural populations.^{29,42-44} Although food insecurity and obesity often coexist, evidence for an association in children is inconsistent²¹⁻²³ and few studies have examined this in rural settings. An overarching goal of the US Department of Health and Human Services Healthy People (HP) 2020 initiative stipulates the elimination of health disparities, including those related to geographic location and socioeconomic status (SES).¹ Furthermore, HP 2020 specifies objectives that include reducing obesity among youth populations and reducing household food insecurity. Given these public health priorities, coupled with the call for more research to support obesity interventions customized for rural settings,²⁹⁻³¹ further exploration of factors that contribute to obesity and food insecurity in rural environments is warranted.

The primary aim of this study was to determine whether family-home factors related to nutrition and physical activity are associated with BMI and food insecurity in rural children. The secondary aim was to determine whether food insecurity is associated with overweight/obesity in rural children. It was hypothesized that more favorable family environments would be associated with lower standardized (i.e., for sex and age) BMI, cross-sectionally and prospectively over one year, and associated with lower risk of food

insecurity. Further, it was hypothesized that food insecurity would be associated with higher standardized BMI.

Methods

Participants

We utilized data that were collected as part of a larger childhood obesity prevention study, Generating Rural Options for Weight (GROW) Healthy Kids & Communities. GROW uses a community-based participatory research (CBPR) approach to plan, implement, and evaluate a multi-level intervention targeting rural family-home, elementary school, and community settings to promote healthful eating, increase physical activity, and improve BMI among rural children. Sampling for GROW started with selection of three Oregon counties, based on geographic distribution and number of rural, low-income communities. Eligible school districts and schools within each county were determined based on rurality as designated by the US Census⁶² and low-income status ($\geq 50\%$ of families eligible for free- or reduced-cost school meal programs). Two elementary schools were randomly selected from separate communities within each county ($n=6$ schools in 6 communities) and were randomized to control ($n=3$) or intervention ($n=3$) group. Families were assigned to intervention or control according to their school and community-level assignment.

All families with elementary-age children (grades K-5/6; $N=2,200$ children) attending GROW schools were eligible to participate in the study. Participants were recruited via an informational packet sent from the school to the home. Recruitment

materials included a brief description of the study, the steps necessary to enroll, informed consent documents, survey instruments, and a postage-paid envelope. Families could enroll by returning the forms included in the packet or by completing the documents online. Approximately 12% of children (n=270) and their parents/caregivers consented to participate in the GROW family-home study between 2012 and 2014.

Data Collection and Measures

Data for the present study included survey responses about family nutrition and physical activity factors, family food security, and parent and child demographics. Parents/caregivers (henceforth referred to as parents) completed surveys via print or electronic format during fall 2013 (baseline). BMI data were objectively measured during fall of 2013 and 2014 (1-year follow-up). Details on the survey instruments and BMI measures are provided below.

Family nutrition and physical activity factors. Parents completed the Family Nutrition and Physical Activity (FNPA) screening tool, a previously validated instrument designed to assess evidence-based family environmental and behavioral factors that predispose young children to becoming overweight.^{63,64} Ihmels and colleagues⁶³ demonstrated internal consistency of the FNPA instrument (alpha = 0.72) with a sample of urban families and children. Similarly, we found good internal consistency in our study sample (alpha = 0.79). Ihmels et al. found that FNPA score was significantly associated with child overweight status ($\geq 85^{\text{th}}$ BMI-for-age percentile).^{63,64}

The 20-item version of the instrument used in this study includes 10 items for each of two component areas: nutrition and physical activity. These two component areas each contain five domains, which are each comprised of two items. The *domains* (items) in the nutrition component include the following: *family meal patterns* (My child eats breakfast + Our family eats meals together); *family eating habits* (Our family eats while watching TV + Our family eats fast food); *food choices* (Our family uses microwave or ready to eat foods + My child eats fruits and vegetables at meals or snacks); *beverage choices* (My child drinks soda pop or sugar drinks + My child drinks low-fat milk at meals or snacks); and *restriction and reward* (Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior).

The *domains* (items) in the physical activity component include the following: *screen time behavior and monitoring* (My child spends less than 2 hours on TV/games/computer per day + Our family limits the amount of TV our child watches); *healthy environment* (Our family allows our child to watch TV in their bedroom + Our family provides opportunities for physical activity); *family activity involvement* (Our family encourages our child to be active every day + Our family finds ways to be physically active together); *child activity involvement* (My child does physical activity during his/her free time + My child is enrolled in sports or activities with a coach or leader); and *family routine* (Our family has a daily routine for our child's bedtime + My child gets 9 hours of sleep a night).

Item response categories were coded on a four-point scale as “Almost Never” (1), “Sometimes” (2), “Usually” (3), and “Almost Always” (4). All items were coded such that higher scores indicated more favorable behaviors and environments. For example, a high score in the *restriction and reward* domain reflects a family who “almost always” monitors eating of chips, cookies, and candy and “almost never” uses candy as a reward for good behavior. Previous research suggests that a higher total FNPA score reflects more favorable family policies and practices, inferring lower risk for child overweight.⁶⁴ For this study, total FNPA as well as component, domain, and item scores were examined.

At-risk for food insecurity. Family at-risk for food insecurity was assessed via parental report using a previously validated 2-item food insecurity screening instrument.⁶⁵ The screener allows for rapid identification of households at-risk for food insecurity and was previously found to have high sensitivity (97%), good specificity (83%), and convergent validity among a large population (n=30,098) of low-income families with young children. The screener consists of the following questions: 1) “Within the past 12 months, we worried if our food would run out before we got money to buy more,” and 2) “Within the past 12 months, the food we bought just didn’t last and we didn’t have money to get more.” Item response categories were “never true,” “sometimes true,” and “often true.” Responses were dichotomized for analysis (often true or sometimes true versus never true). An affirmative response to question 1 and/or question 2 was used to identify families at-risk for food insecurity.

Child BMI. Height and weight measurements were obtained by trained research staff. Height was measured to the nearest 1 mm using a portable stadiometer. Weight was measured to the nearest 0.1 kg using a digital scale. Measurements were repeated three times on each child and the average height and weight were used to calculate BMI as weight (kg) / height (m²).

Children were classified as underweight (< 5th percentile), normal weight (5th to < 85th percentile), overweight (85th to < 95th percentile), or obese (\geq 95th percentile) according to the sex-specific CDC BMI-for-age growth charts.^{14,66,67} BMI scores were converted to z-scores using the sex- and age-specific parameters from the CDC growth charts to obtain the z-score value. BMI z-score is defined as the child BMI transformed into the number of standard deviations above or below the population mean standardized BMI, and it is used widely in research and clinical studies in youth.⁶⁷⁻⁷⁰

Covariates. Family demographic information provided by respondents included eligibility for free- or reduced-cost school meals and parent education level. Child-level variables were age, sex, race, and ethnicity. Although this study did not evaluate the effect of the GROW intervention, a binary variable for the GROW study intervention or control group was considered as a potential covariate.

Data Analysis

We received surveys from the parents of 69% (n=186) of the 270 children enrolled in the GROW family study. A small number of surveys (n = 10) lacked an answer to one or two FNPA items. Because those ten surveys contained a small amount

of missing data, average FNPA scores were calculated for all individuals based on the number of items completed, which is equivalent to imputing the missing data by the mean of the reported FNPA items. A preliminary analysis indicated no significant differences in child BMI z-score, average FNPA score, or family and child demographics between participants with complete and incomplete surveys. Of the 186 children with FNPA data, baseline BMI data were collected on 177 children, and 1-year follow-up BMI data on 128 children. Height and weight measurements were unavailable for 49 children at the second time point for various reasons, including the child no longer attended the school, was absent on the day of measurement, or opted out of measurement. Compared with the rest of the sample, participants lost to follow-up were older (7.7 vs. 8.5 years), and a higher percentage were eligible for free- or reduced-cost school meals (51% vs. 71%). There were no significant differences for other demographic variables, baseline BMI, or FNPA. Missing data were considered missing at random⁷¹ and as a result, a full information maximum likelihood analysis was conducted.⁷²

Descriptive statistics were examined for all variables. Unadjusted multinomial logistic and linear regressions were used to examine associations between FNPA and BMI percentile category and FNPA and BMI z-score, respectively. Unadjusted logistic regression was used to examine associations between FNPA with at-risk for food insecurity and BMI percentile category with at-risk for food insecurity. Bivariate associations were examined between all potential covariates and dependent variables. Due to small cell sizes, some demographic variable categories were collapsed or

dichotomized for analysis. Covariates significant at the level of $p < 0.1$ were retained for adjusted models.

Associations between FNPA, BMI, and at-risk for food insecurity were then examined using multivariable linear, logistic, and multinomial logistic regression models, adjusted for the retained covariates. Adjusted models also included a cluster variable to account for potentially correlated observations within families. Two-way interactions between independent variables and significant covariates were examined. Likelihood ratio tests and Akaike's information criterion were used for model comparisons. Residual plots, normality tests for residual distributions, and the Hosmer-Lemeshow test were used to assess model assumptions and goodness of fit. For final models, statistical significance was originally set at $\alpha = 0.05$. We also computed False Discovery Rate (FDR) adjusted p-values for multiple comparisons.⁷³ Data analyses were performed using Stata (version 13, 2013, StataCorp) and R (version 3.1, 2015).

Previous research in non-rural settings demonstrated Pearson correlations of -0.17⁶³ and -0.43⁷⁴ between FNPA and child BMI, and a correlation of -0.17⁶⁴ between FNPA and one year change in child BMI. Based on our initial sample size ($n=177$), this study was sufficiently powered (80%) at 95% confidence to detect correlations of fair strength (-0.23) or stronger between FNPA and BMI in cross-sectional analyses.

Human Subjects Protection

The Oregon State University Institutional Review Board approved all protocol and procedures prior to initiation of this study.

Results

Study Participants

Baseline participant characteristics are displayed in Table 2.1. FNPA scores were generally high; the average total score was 3.3 (on a scale from 1 to 4). Approximately 56% of families were eligible for free- or reduced-cost school meals and 43% were at-risk for food insecurity. The majority of children were normal weight (61%); 21% were classified as overweight and 16% as obese. With respect to BMI percentile, this sample was similar to the larger student population across the six GROW schools. The sample included a lower percentage of students eligible for free or reduced school meals (56% vs. 68%) and a higher percentage of white students (89% vs. 75%) compared to GROW schools overall (data not shown).

FNPA Score and BMI Percentile Category

Table 2.2 presents the adjusted cross-sectional associations between FNPA and odds of overweight and obesity compared with normal weight at baseline. FNPA was not significantly associated with being overweight. The adjusted odds ratios indicate that higher scores in FNPA Eating Habits and Restriction and Reward domains were associated with lower odds of being obese. Specifically, children with families that limited watching TV while eating were less likely to be obese (OR= 0.56, $p=0.03$). Children with families that monitored intake of chips, cookies, and candy were also less likely to be obese (OR=0.54, $p=0.01$). After FDR adjustment for multiple comparisons, these associations were no longer statistically significant.

FNPA Score and Change in BMI z-score

We examined FNPA at baseline and BMI z-score at 1-year follow-up (n=128) and found no significant associations for FNPA total, nutrition, or activity scores (Table 2.3). After adjusting for BMI z-score at baseline and the GROW intervention, one FNPA item, breakfast consumption, was a significant predictor of change in BMI z-score. Eating breakfast more often was associated with a lower BMI z-score at year 2 ($B=-0.14$, $p=0.005$) (data not shown). After adjusting for multiple comparisons, however, this association was no longer statistically significant.

BMI and Food Insecurity

For the association between BMI and family food insecurity status, we found an interaction between BMI and eligibility for the federal school meals program ($p<0.05$). Specifically, among children not eligible for free- or reduced-cost school meals, food insecurity and BMI z-score were positively associated ($p=0.001$), whereas for children eligible for free or reduced school meals we found no association between food insecurity and BMI ($p=0.62$). We thus present the results stratified by school meals eligibility; for children who were not eligible for free- or reduced-cost school meals, the odds of being at-risk for food insecurity were greater for children classified as overweight ($OR=6.11$, $p=0.047$) and obese ($OR=11.00$, $p=0.003$) than normal weight (Table 2.4). With adjustment for multiple comparisons, these associations were no longer statistically significant.

FNPA Score and Food Insecurity

As we found with BMI, we found an interaction between FNPA and eligibility for the federal school meals program ($p < 0.05$). Among children eligible for free or reduced school meals, an inverse association was found between food insecurity and some FNPA factors whereas for children not eligible, no associations were found (Table 2.4). The stratified results show that among families eligible for free or reduced school meals, those with higher scores in the Meal Patterns domain had lower odds of being at-risk for food insecurity (OR=0.38, $p=0.03$). More specifically, among eligible families, those who ate meals together more often were 69% less likely to be at-risk for food insecurity (OR=0.31, $p=0.04$). Likewise, higher scores in the Child Activity Involvement domain were associated with lower odds of being at-risk for food insecurity among those eligible for free or reduced school meals (OR=0.69, $p=0.04$). Eligible families with children who were more frequently enrolled in organized sports or activities were 35% less likely to be at-risk for food insecurity (OR=0.65, $p=0.04$). Again, after adjustment for multiple comparisons, these associations were no longer significant.

Discussion

Our results do not support a relationship between FNPA and standardized BMI in a sample of rural elementary-age children. We also found no association between FNPA and family food security. An unexpected finding was the modifying effect of eligibility for free or reduced school meals on the association between family food security and child obesity. Specifically, higher BMI tended to be associated with greater odds of being

at-risk for food insecurity among children whose families were ineligible to receive free or reduced school meals.

In a sample of families from a large urban school district in the Midwest, Ihmels and colleagues found that a lower FNPA total score was associated with increased risk for child overweight, and FNPA predicted change in BMI over a 1-year period.^{63,64} In contrast, we found no association between FNPA total score and child BMI, cross-sectionally or prospectively, in a sample of rural families from three different school districts in the Pacific Northwest. We further examined each of the FNPA domain and individual item scores and found no evidence of significant associations with BMI. Discrepancies in these findings may in part be due to differences in sample demographics. For example, Ihmels and colleagues study was limited to children in first grade whereas our study was more heterogeneous by age, including children in kindergarten through 5th grade. Additionally, our sample included a greater percentage of children with no change or a decrease in BMI percentile over a 1-year period whereas Ihmels et al. observed an overall increase in BMI percentile. Similarly, though unsurprising, both studies found that baseline BMI was the strongest predictor of BMI at 1-year follow-up.

Limited research has examined relationships between family-home nutrition and activity environments with food security status. Although Ihmels and colleagues reported that higher income urban families had higher, more favorable FNPA scores, they did not examine FNPA in relationship to food security.⁶³ Nackers and colleagues found that

food-insecure caregivers of young children reported greater availability of and access to less healthful foods at home compared with food-secure participants, as measured by a comprehensive home food inventory assessment.⁷⁵ Their study involved a small convenience sample, which limited the power and generalizability of the findings, however. In our study, FNPA scores were not significantly associated with family food security, suggesting that food-secure families and families at-risk for food insecurity reported similar home nutrition and activity environments. Differences in study findings may be partially explained by differences in sample populations and study methodology.

We found that food insecurity tended to be more common in obese than normal weight children among families with relatively higher income ($>185\%$ of the federal poverty line). This tendency was not observed among families eligible to receive free or reduced school meals ($\leq 185\%$ of the federal poverty line), however. This finding is in contrast to evidence suggesting that both obesity and food insecurity are more prevalent among the most economically disadvantaged populations.^{21,22,24,44}

A recent review by Franklin and colleagues revealed that whereas some studies demonstrated a linear association between food insecurity and obesity, others identified a U-shaped pattern whereby obesity increased as food security declined to intermediate levels, and those with the most severe level of food insecurity tended to have lower BMI compared to their food secure counterparts.²² Our study used eligibility for the federal school meals program as a proxy for family income, and a two-item screener to assess family food security. Thus, we were unable to differentiate further based on levels of

income and food security. Several reasons could explain a potential association between BMI and food insecurity among families not eligible for the federal school meals program. First, many of the families in our study may have been working-class families experiencing intermediate levels of food insecurity and may have been near, but did not meet, the income eligibility requirement for the federal school meals program. Second, children who are not eligible for free or reduced school meals may consume greater quantities of food purchased by the family, thereby increasing family risk for food insecurity. Additionally, food management practices may differ between families eligible and not eligible to receive free or reduced school meals, which may influence family food security and childhood obesity. Moreover, findings from other studies suggest that the federal school meals program may offer protective effects, such as helping to maintain healthy weight⁷⁶ and reducing food insecurity,⁷⁷ particularly among low-income children.

Our finding that family nutrition and physical activity factors were not associated with standardized child BMI is inconsistent with results from other studies that have used the FNPA instrument.^{63,64,74} This inconsistency may be in part due to different adjustment strategies for multiple comparisons. Additionally, the average FNPA total score in our sample was relatively high 3.3 (on a scale from 1 to 4) and lacked variability, which limited our ability to evaluate higher risk (low FNPA score) environments. Furthermore, one year may not be enough time to observe the potential influence of FNPA factors on children's BMI. Moreover, though the FNPA survey addresses a need for screening tools to evaluate factors that predispose children to becoming overweight or obese,⁷⁸ the

instrument was validated in an urban sample of children and families. The tool may need further evaluation with diverse populations. Other plausible explanations for our findings include the high percentage (62%) of children who had no change or a decrease in BMI percentile at the end of the 1-year follow-up period, resulting in an increase in the number of children in the normal weight category and decreases in the overweight or obese categories. Additionally, our study may have been underpowered to detect associations between FNPA score and child BMI, particularly given the smaller sample size at the 1-year follow-up point.

Other limitations of this study include selection bias and self-reported data on measures of the family environment and food security. To minimize bias in our results, we used validated survey instruments, and anthropometric data were objectively measured. Additionally, family food security and family nutrition and activity data were collected at one point in time. It is conceivable these factors may change over time. Finally, the findings from our study may not be generalizable to families living in other rural areas.

In conclusion, despite our finding that family nutrition and physical activity factors were not directly associated with BMI in children living in rural areas, the family-home is one of the earliest and most influential social and environmental contexts for promoting healthy eating and activity habits.^{40,79-81} The FNPA screening tool may be useful for practitioners and researchers to easily assess home environments and provide simple strategies that families can use to improve nutrition and activity practices and

policies. Messages to families must be considered and communicated in light of the host of environmental factors related to risk for becoming overweight or obese, however. Our study highlights the continued need for obesity prevention efforts that extend beyond the family-home to include schools and communities in addressing this public health issue. Such multi-level interventions may be particularly important in rural areas where families often have limited access to resources that facilitate opportunities to engage in healthy eating and physical activity practices outside of the home. This study also contributes to the inconsistent body of literature on the association between obesity and food insecurity among children, and suggests the need for further examination of the federal school meals program as a potentially influential factor. Future research is needed to better understand the role of family environmental and behavioral factors in relationship to the disproportionate rates of childhood obesity and food insecurity observed in rural populations. Use of comprehensive measures of the family-home nutrition and activity environment and behaviors will assist such endeavors.

Table 2.1. Characteristics of rural elementary-age children at baseline (n=186)

Characteristic	n	Mean (SD) or %
Age (years), mean	181	8.0 (1.9)
Sex, %	186	
Female	79	42.5
Male	107	57.5
Race, %	166	
White	148	89.2
Other	18	10.8
Ethnicity, %	169	
Latino	27	16.0
Non-Latino	142	84.0
Parent education, %	180	
Grade 12 or less	43	23.9
1-3 years of college	91	50.6
4 or more years of college	46	25.6
Eligible for free/reduced school meals, %	176	
Yes	98	55.7
No	78	44.3
At-risk for food insecurity, %	183	
Yes	79	43.2
No	104	56.8
BMI, mean	177	18.4 (3.8)
BMI percentile, mean	177	68.5 (26.8)
Underweight, %	3	1.7
Normal weight, %	108	61.0
Overweight, %	37	20.9
Obese, %	29	16.4
BMI z-score, mean	177	0.7 (1.1)
FNPA score, mean	186	
FNPA: TOTAL ^a	186	3.3 (0.4)
FNPA: NUTRITION ^b	186	3.3 (0.4)
FNPA: ACTIVITY ^c	186	3.3 (0.5)

^aFamily Nutrition and Physical Activity: TOTAL; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

^bFNPA: NUTRITION; Nutrition component; average of 10 FNPA nutrition items

^cFNPA: ACTIVITY; Physical Activity component; average of 10 FNPA physical activity items

Table 2.2 Multinomial logistic regression examining cross-sectional associations between family nutrition and physical activity (FNPA) and odds of being overweight or obese^a among rural elementary-age children (n=177)

Variable	Adjusted Associations ^b					
	Overweight (n=37)			Obese (n=29)		
	OR	p	p-adj [†]	OR	p	p-adj
FNPA: TOTAL	0.92	0.87	0.96	0.47	0.21	0.77
FNPA: NUTRITION	1.00	0.99	1.00	0.34	0.06	0.49
FNPA: Meal Patterns	0.84	0.42	0.87	1.16	0.53	0.88
FNPA 1: My child eats breakfast	0.70	0.34	0.83	1.06	0.87	0.96
FNPA 2: Our family eats meals together	0.91	0.72	0.95	1.22	0.49	0.87
FNPA: Eating Habits	1.03	0.89	0.96	0.63	0.05	0.49
FNPA 3: Our family eats while watching TV	0.94	0.80	0.95	0.56	0.03*	0.49
FNPA 4: Our family eats fast food	1.31	0.49	0.87	0.71	0.43	0.87
FNPA: Food Choices	0.95	0.79	0.95	0.71	0.09	0.54
FNPA 5: Our family uses microwave or ready to eat foods	0.71	0.23	0.77	0.53	0.07	0.49
FNPA 6: My child eats fruits and vegetables at meals or snacks	1.15	0.57	0.89	0.76	0.40	0.87

Table 2.2. (Continued).

FNPA: Beverage Choices	1.06	0.71	0.95	0.94	0.69	0.95
FNPA 7: My child drinks soda pop or sugar drinks	1.30	0.44	0.87	0.63	0.14	0.68
FNPA 8: My child drinks low-fat milk at meals or snacks	1.00	0.99	1.00	1.09	0.63	0.92
FNPA: Restriction/Reward	1.08	0.71	0.95	0.66	0.04*	0.49
FNPA 9: Our family monitors eating of chips, cookies, and candy	1.09	0.75	0.95	0.54	0.01*	0.44
FNPA 10: Our family uses candy as a reward for good behavior	1.05	0.86	0.96	0.99	0.98	1.00
FNPA: ACTIVITY	0.91	0.81	0.95	0.73	0.53	0.88
FNPA: Screen Time Behavior/Monitoring	1.14	0.29	0.78	0.87	0.20	0.77
FNPA 11: My child spends less than 2 hours on TV/games/computer per day	1.23	0.35	0.83	0.95	0.82	0.95
FNPA 12: Our family limits the amount of TV our child watches	1.23	0.38	0.86	0.68	0.05	0.49
FNPA: Healthy Environment	0.78	0.14	0.68	0.80	0.17	0.77
FNPA 13: Our family allows our child to watch TV in their bedroom	0.76	0.22	0.77	0.74	0.14	0.68
FNPA 14: Our family provides opportunities for physical activity	0.78	0.35	0.83	0.91	0.80	0.95
FNPA: Family Activity Involvement	0.91	0.55	0.88	0.88	0.44	0.87
FNPA 15: Our family encourages our child to be active every day	0.71	0.28	0.77	0.86	0.62	0.92
FNPA 16: Our family finds ways to be physically active together	1.01	0.98	1.00	0.83	0.49	0.87

Table 2.2. (Continued).

FNPA: Child Activity Involvement	0.87	0.19	0.77	1.20	0.26	0.77
FNPA 17: My child does physical activity during his/her free time	1.23	0.42	0.87	1.05	0.87	0.96
FNPA 18: My child is enrolled in sports or activities with a coach or leader	0.71	0.05	0.49	1.39	0.10	0.57
FNPA: Family Routine	1.48	0.18	0.77	0.78	0.23	0.77
FNPA 19: Our family has a daily routine for our child's bedtime	1.11	0.76	0.95	0.79	0.46	0.87
FNPA 20: My child gets 9 hours of sleep a night	2.76	0.05	0.49	0.68	0.26	0.77

^aReference category: normal weight and low weight combined

^bAdjusted for parent education and including a cluster variable for correlated data within families

*p<0.05

†FDR-adjusted p-value

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: Meal Patterns; Family Meal Patterns; average of 2 items: My child eats breakfast + Our family eats meals together

FNPA: Eating Habits; Family Eating Habits; average of 2 items: Our family eats while watching TV + Our family eats fast food (both items reverse coded)

FNPA: Food Choices; average of 2 items: Our family uses microwave or ready to eat foods (reverse coded) + My child eats fruits and vegetables at meals or snacks

FNPA: Beverage Choices; average of 2 items: My child drinks soda pop or sugar drinks (reverse coded) + My child drinks low-fat milk at meals or snacks

FNPA: Restriction and Reward; average of 2 items: Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior (reverse coded)

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

FNPA: Screen Time Behavior/Monitoring; average of 2 items: My child spends less than 2 hours on TV/games/computer per day + Our family limits the amount of TV child watches

FNPA: Healthy Environment; average of 2 items: Our family allows our child to watch TV in their bedroom + Our family provides opportunities for physical activity

FNPA: Family Activity Involvement; average of 2 items: Our family encourages our child to be active every day + Our family finds ways to be physically active together

FNPA: Child Activity Involvement; average of 2 items; My child does physical activity during his/her free time + My child is enrolled in sports or activities with a coach or leader

FNPA: Family Routine; average of 2 items; Our family has a daily routine for our child's bedtime + My child gets 9 hours of sleep a night

Table 2.3. Multivariable linear regression examining association of family nutrition and physical activity (FNPA) with BMI z-score at 1 year follow-up among rural elementary-age children (n=128)

Variable	BMI z-score year 2 Adjusted Associations ^a		
	β Coef	p	p-adj [†]
FNPA: TOTAL	-0.08	0.27	0.84
FNPA: NUTRITION	-0.07	0.47	0.89
FNPA: ACTIVITY	-0.06	0.26	0.94

^aClustered for multiple children in families and adjusted for BMI at year 1 and intervention.

[†]FDR-adjusted p-value

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

Table 2.4. Multivariable logistic regression examining associations between BMI and FNPA with odds of reporting family at risk for food insecurity, stratified by eligibility for free- or reduced-cost (f/r) school meals, among rural elementary-age children (n=169)

Variable	Family at risk for Food Insecurity Adjusted Associations ^{a,b}					
	Eligible for f/r school meals (n=95)			Not Eligible for f/r school meals (n=74)		
	OR	p	p-adj [†]	OR	p	p-adj
BMI z-score	0.88	0.62	0.93	3.63	0.001**	0.07
BMI category						
Normal weight	Referent					
Overweight	1.17	0.78	0.93	6.11	0.047*	0.42
Obese	1.07	0.93	0.98	11.00	0.003**	0.09
FNPA: TOTAL	0.29	0.11	0.57	1.30	0.74	0.93
FNPA: NUTRITION	0.36	0.25	0.75	1.55	0.53	0.92
FNPA: Meal Patterns	0.38	.03*	0.38	1.30	0.46	0.92
FNPA 1: My child eats breakfast	0.34	0.11	0.57	0.54	0.42	0.92
FNPA 2: Our family eats meals together	0.31	.04*	0.38	2.29	0.10	0.55
FNPA: Eating Habits	0.84	0.52	0.92	0.93	0.83	0.93
FNPA 3: Our family eats while watching TV	1.07	0.84	0.93	0.72	0.52	0.92
FNPA 4: Our family eats fast food	0.38	0.09	0.55	1.61	0.52	0.92
FNPA: Food Choices	0.92	0.73	0.93	1.06	0.79	0.93
FNPA 5: Our family uses microwave or ready to eat foods	0.79	0.68	0.93	1.18	0.71	0.93
FNPA 6: My child eats fruits and vegetables at meals or snacks	0.00	0.98	0.99	1.01	0.99	0.99

Table 2.4. (Continued).

FNPA: Beverage Choices	0.70	0.17	0.64	1.11	0.73	0.93
FNPA 7: My child drinks soda pop or sugar drinks	0.77	0.61	0.93	2.46	0.21	0.72
FNPA 8: My child drinks low-fat milk at meals or snacks	0.68	0.14	0.63	0.93	0.84	0.93
FNPA: Restriction/Reward	1.28	0.35	0.87	1.18	0.64	0.93
FNPA 9: Our family monitors eating of chips, cookies, and candy	1.11	0.74	0.93	1.43	0.42	0.92
FNPA 10: Our family uses candy as a reward for good behavior	1.62	0.24	0.74	0.87	0.79	0.93
FNPA: ACTIVITY	0.43	0.14	0.63	1.06	0.93	0.98
FNPA: Screen Time Behavior/Monitoring	0.88	0.35	0.87	1.05	0.81	0.93
FNPA 11: My child spends less than 2 hours on TV/games/computer per day	0.89	0.63	0.93	1.69	0.31	0.81
FNPA 12: Our family limits the amount of TV our child watches	0.69	0.19	0.68	0.69	0.27	0.75
FNPA: Healthy Environment	1.00	0.99	0.99	0.90	0.69	0.93
FNPA 13: Our family allows our child to watch TV in their bedroom	1.25	0.49	0.92	0.99	0.96	0.99
FNPA 14: Our family provides opportunities for physical activity	0.72	0.47	0.92	0.71	0.58	0.93
FNPA: Family Activity Involvement	0.90	0.64	0.93	1.22	0.49	0.92
FNPA 15: Our family encourages our child to be active every day	0.58	0.24	0.74	1.60	0.37	0.87
FNPA 16: Our family finds ways to be physically active together	1.02	0.95	0.99	1.10	0.84	0.93
FNPA: Child Activity Involvement	0.69	.04*	0.38	0.94	0.81	0.93
FNPA 17: My child does physical activity during his/her free time	0.65	0.33	0.85	1.34	0.57	0.92
FNPA 18: My child is enrolled in sports or activities with a coach or leader	0.65	.04*	0.38	0.72	0.38	0.87
FNPA: Family Routine	0.82	0.48	0.92	1.83	0.16	0.64
FNPA 19: Our family has a daily routine for our child's bedtime	0.86	0.71	0.93	5.21	0.09	0.55
FNPA 20: My child gets 9 hours of sleep a night	0.77	0.56	0.92	1.55	0.48	0.92

^aAssociation between BMI and at-risk for food insecurity clustered by family

^bAssociation between FNPA and at-risk for food insecurity clustered by family and adjusted for BMI category

* $p < 0.05$, ** $p < 0.01$

†FDR-adjusted p-value

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: Meal Patterns; Family Meal Patterns; average of 2 items: My child eats breakfast + Our family eats meals together

FNPA: Eating Habits; Family Eating Habits; average of 2 items: Our family eats while watching TV + Our family eats fast food (both items reverse coded)

FNPA: Food Choices; average of 2 items: Our family uses microwave or ready to eat foods (reverse coded) + My child eats fruits and vegetables at meals or snacks

FNPA: Beverage Choices; average of 2 items: My child drinks soda pop or sugar drinks (reverse coded) + My child drinks low-fat milk at meals or snacks

FNPA: Restriction and Reward; average of 2 items: Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior (reverse coded)

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

FNPA: Screen Time Behavior/Monitoring; average of 2 items: My child spends less than 2 hours on TV/games/computer per day + Our family limits the amount of TV child watches

FNPA: Healthy Environment; average of 2 items: Our family allows our child to watch TV in their bedroom + Our family provides opportunities for physical activity

FNPA: Family Activity Involvement; average of 2 items: Our family encourages our child to be active every day + Our family finds ways to be physically active together

FNPA: Child Activity Involvement; average of 2 items: My child does physical activity during his/her free time + My child is enrolled in sports or activities with a coach or leader

FNPA: Family Routine; average of 2 items: Our family has a daily routine for our child's bedtime + My child gets 9 hours of sleep a night

CHAPTER 3. SECOND MANUSCRIPT

Rural perspectives on nutrition and physical activity in the family-home: Results from
focus groups with parents of elementary-age children

Target Journal: Journal of Nutrition Education and Behavior

Abstract

Objective: To explore parent perceptions of factors that influence behaviors related to nutrition and physical activity in rural family-home environments.

Design: Qualitative design; nine semi-structured focus group interviews.

Setting: Six rural, low-income communities in the Northwest.

Participants: Sample of 34 parents (n=27 families) of elementary-age children; 79% were female; 92% were white/non-Latino; 25% of families reported eligibility for the federal school meals program; 24% reported being at-risk for food insecurity.

Phenomenon of Interest: Childhood obesity-related behaviors and environments.

Analysis: Focus group interviews were transcribed verbatim and coded independently by two members of the research team using standard content analysis techniques. Frequently emerging patterns were labeled as themes if they were discussed in $\geq 50\%$ of the focus groups.

Results: Four major behavioral themes that influenced family nutrition and physical activity were identified, including family eating habits, food procurement, family physical activity, and screen time. Seven major environmental themes were identified as supports/barriers for healthy eating and physical activity including seasonal variation, features of home, distance from resources, screen time limits, financial constraints, outdoor safety, and schedule constraints.

Conclusions and Implications: This study characterizes factors that influence opportunities for healthy eating and physical activity in rural family-home environments.

Insights from parents provide ideas for future research and interventions to promote weight-healthy environments and behaviors for rural children.

Key Words: Childhood Obesity, Family, Home Environment

Introduction

The prevalence of childhood obesity has increased considerably over the past three decades, from approximately 5% of youth aged 2-19 years in 1976-1980 to 17% in 2011-2012.^{3,82} Obese children are at greater risk for poor health outcomes including cardiovascular disease,⁶ type 2 diabetes,⁴ musculoskeletal problems,⁸³ and social and psychological problems.^{84,85} Obese children are also more likely to become obese adults, with greater risk for morbidity and premature mortality.^{5,86} Related to these health concerns is the substantial economic impact of obesity-related illness, estimated at 20% of annual United States (US) health care expenditures.^{7,8} Taken together, these consequences present long-term implications for society.

Obesity is influenced by a complex interplay of determinants that promote excessive weight gain including biological, behavioral, and environmental factors.¹³ Population disparities present challenges for obesity prevention.^{3,24,27,28} For example, obesity rates are higher among rural compared to non-rural children,²⁹⁻³³ yet evidence to explain this discrepancy is inconclusive. Some research suggests that rural children participate in more physical activity,^{29,30,53} more sedentary activity,³¹ and have poorer dietary intakes²⁹ compared to non-rural children, whereas other research indicates no differences between the two groups.³² Other evidence suggests that rural residency presents socioeconomic, cultural, and structural challenges that influence dietary and physical activity behaviors, though this research has primarily focused on adults.³⁴⁻³⁸

Whether and how these and other factors contribute to obesity among rural children remains unclear.

Previous research in non-rural populations supports associations between children's eating behaviors and family-level factors including parent education and role modeling,⁸⁷⁻⁹¹ family food rules^{87,92} and family meal patterns.⁹³⁻⁹⁶ Likewise, parental modeling of physical activity and limiting of screen time have been associated with physical activity levels and sedentary time among children.^{92,97,98} Other factors in the home environment, such as availability of healthy foods,^{87,91,99} eating while watching TV,¹⁰⁰ and availability of media and physical activity equipment,^{98,101} make it easier or harder for children to eat well or be physically active. Research also suggests that a collection of these family-home behavioral and environmental factors influence children's risk for obesity.^{63,64}

Findings from the above studies were collected using quantitative measures. To capture a more comprehensive understanding of family-home behavioral and environmental factors, it is also important to hear family perspectives, particularly in rural settings where limited research has examined the home environment as it relates to children's risk for obesity.

The idea that eating and activity habits may be challenging to develop and maintain in the absence of a supportive environment is consistent with a social ecological perspective of health.^{48,51} Social Cognitive Theory (SCT) suggests that people learn from experiences and regulate behaviors based on interrelationships and reciprocal interactions

between individual factors, environmental factors, and behaviors.^{48,50} For this study, SCT was used to guide exploration of family-home behavioral and environmental factors that influence children's eating and activity behaviors. Behavioral factors were operationalized as behaviors enacted by family members either individually or with other family members, such as preparing meals or participating in physical activity. Environmental factors were operationalized as characteristics, policies, or features of the family-home environment (social and physical) that make it easier or harder to eat healthfully and/or be physically active, such as availability of healthy foods or limits on screen time.

This qualitative study is part of a mixed methods project that examined whether and how family-home environmental and behavioral factors were associated with childhood obesity in a rural setting. Data were collected in the context of a larger, community-based participatory research project, Generating Rural Options for Weight (GROW) Healthy Kids & Communities. GROW data indicate the prevalence of overweight and obesity among children in six rural Oregon communities exceeds national averages.^{3,45} For example, in 2013, 39.3% (n=782) of elementary-age (K-5/6) boys were overweight ($\geq 85^{\text{th}}$ percentile) and 20.8% were obese ($\geq 95^{\text{th}}$ percentile). Among girls, 36.8% (n=700) were overweight and 17.8% were obese.⁴⁵

The above findings demonstrate the need for research exploring factors that contribute to childhood obesity in rural communities. Because little is known about how rural family-home environments influence obesity-preventing and -promoting behaviors,

we explored parent/caregiver perceptions of factors that influence behaviors related to nutrition and physical activity in the home environment. The primary research questions were as follows: 1) How do rural family-home practices and policies influence eating and physical activity behaviors? and 2) How do rural family-home environments facilitate and/or hinder healthy eating and physical activity behaviors? Understanding the relationships between behavioral and environmental factors is important because the family-home environment is a key behavioral setting for the development of lifelong healthy eating and physical activity habits that influence weight and health later in life.

Methods

Participants

The sample consisted of 34 parents or primary caregivers (henceforth referred to as parents) of elementary-age children from six rural, geographically-diverse, low-income communities in Oregon. Participants were recruited through elementary schools located in each of the communities. Informational flyers were sent home with children and distributed during school activities, such as Back-to-School events. GROW participants were also mailed/emailed flyers or recruited via telephone by GROW staff who adhered to a script that provided information about the project. Enrollment occurred in person at the schools or by telephone/email communication with project staff.

Eligibility criteria included being the adult parent of a child attending one of the GROW elementary schools and for the family to be currently enrolled in the GROW study. The initial intent was to limit participation to only one adult per family. In a few

unplanned instances, however, both parents attended the focus group event and thus both adults were allowed to participate.

The study sample (n=34) included parents from each of the six communities. Participants were 79% female, primarily white and non-Latino (92%), with education levels including college graduate (60%), some college or technical school (28%), and high school graduate or less (12%). Of the 27 families represented, 25% reported eligibility for the federal free- or reduced-cost school meals program and 24% reported being at-risk for food insecurity, as indicated via participant-report on a food insecurity screening instrument.⁶⁵

Data Collection

Focus group interviews were held in private rooms at various locations depending on the community (e.g., elementary school, community library, local restaurant), and lasted 1.5-2 hours depending on the size of the group. A meal was provided for all participants and their children prior to the start of each discussion. Research assistants provided childcare in a separate space during the discussions. No additional participation incentives were provided. All participants provided informed consent prior to participation.

At the beginning of each focus group interview, the moderator (JAJ) provided a brief overview of the study and informed participants that all opinions were valuable, that there were no “right” or “wrong” answers, and that participation by everyone in the group was encouraged but not required. Sessions were audio-recorded, and two research

assistants served as note takers during the discussions. Demographic data used to describe the sample were provided by participants via a survey that was completed as part of the aforementioned GROW project. The Oregon State University Institutional Review Board approved all protocol and procedures prior to initiation of this study.

In total, nine focus group interviews were conducted between June 2014 and November 2014. At least 1 focus group was held in each of the 6 communities and 2 focus groups were held in 3 of the communities. The number of participants in each discussion varied between 1 and 8.

Semi-Structured Interview Guide/Measures

We used a semi-structured interview guide with questions designed to elicit information to provide better understanding of rural family-home environments from a social ecological^{48,51} and social cognitive⁵⁰ theoretical perspective, including practices, policies, and other factors associated with healthy eating and physical activity behaviors. The Family Nutrition and Physical Activity (FNPA) tool, a previously validated instrument designed to screen for evidence-based family environmental and behavioral factors that predispose young children to becoming overweight, informed the topical areas.^{63,64} The interview guide contained open-ended questions about families' typical eating, activity, and screen time (e.g., television viewing, computer use, video games, etc.) habits, how features of the family-home environment influence those habits, and how habits are encouraged or discouraged within the family. Additional questions were designed to elicit discussion of perceived supports and barriers to providing opportunities

for healthy eating and physical activity in rural home environments. The moderator facilitated further discussion by using probing questions following the initial open-ended questions.

Data Analysis

Focus group data were managed and analyzed following content analysis techniques recommended by Berg¹⁰² and Saldana.^{103,104} Sessions were transcribed verbatim from audio tapes and recorded notes were used to add content as necessary. Transcripts were reviewed for accuracy and entered into the software program QSR NVivo 10¹⁰⁵ for organizing, coding, and quantifying thematic content of interest.

A codebook was developed using pre-determined descriptive codes to identify text pertaining to each topic addressed in the focus groups and to capture major themes. As previously mentioned, this study is part of a mixed methods project. The quantitative component of the study used the FNPA instrument⁶³ to assess family nutrition and physical activity factors. Therefore, our coding categories included the two broad categorical topics (i.e., nutrition and physical activity) and the following FNPA domains: family meal patterns; family eating habits; food choices; beverage choices; restriction and reward; screen time behavior and monitoring; healthy environment; family activity involvement; child activity involvement; and family routine. Supports for and barriers to family nutrition and physical activity were also included as pre-determined coding categories. Data that did not fit into one of the pre-determined codes were placed into an “other” category that was used to identify new, recurrent topics. New topics were

discussed by the researchers and agreed upon as new codes, which were then added to the codebook. The final codebook included 26 codes with definitions and examples of inclusion and exclusion criteria for each code.

Each transcript was coded independently by two of the researchers (JAJ and KF), with discrepancies resolved through discussion and consensus. Following coding of all data, frequently emerging patterns were identified. Patterns were labeled as themes if they were discussed in at least 50% of the focus groups. Themes were interpreted and discussed by the research team, and quotations were selected to illustrate themes. All identifiable information was removed.

Results

Multiple themes emerged from the focus groups and were grouped into two broad theoretical categories around family-home: a) behavioral factors and b) environmental factors. Results were further organized according to the two topical categories addressed by this study, namely; nutrition and physical activity. Many of the themes were interrelated and overlapping within and between categories.

Family Nutrition Behavioral Factors

Table 3.1 presents the behavioral themes, sub-themes, and examples of commonly discussed topics. Two themes that emerged as important influences on family nutrition-related behaviors were the following: *family eating habits* and *food procurement*. These themes and related sub-themes were predominant across 100% of the focus groups, and are described in more detail below.

Family Eating Habits. The family eating habits theme emerged from many conversations focused on **mealtime** practices and policies, with emphasis on family meals, breakfast, special orders, mealtime responsibilities, and eating while watching TV. Most families ate dinner together regularly, at the table. Many parents indicated that they did not typically prepare special orders (i.e., no “short order cooking”). Rather, all family members were expected to eat the same meal. In most families, one parent was primarily responsible for the dinner meal preparation. In some families, two parents contributed equally to preparing the meal and/or children helped with preparation or clean up.

The breakfast meal was described as a different situation compared to the dinner meal. Many parents expressed that weekday mornings were rushed and unorganized, leaving family members to fend for themselves at breakfast. In general, parents said that children ate breakfast every morning and that families rarely ate breakfast together, except on the weekends.

Participants were divided between those whose families did and did not frequently eat meals while watching TV. A common reason for watching TV while eating was that mealtime is the only time of day to unwind and relax. As stated by one participant: “And the TV is on quite a bit but... by the time we get to dinner time that’s the only downtime. So it [mealtime and TV] does get mixed together. Because usually something else has gone on and that’s our first time to even sit down.”

Food Procurement. Food procurement was a theme that emerged from parents talking about foods that were purchased, grown at home, and otherwise acquired.

Families **purchased foods** primarily at grocery stores and from local vendors. Most participants discussed regular grocery shopping routines involving purchases at multiple stores, such as “Safeway, Winco, Fred Meyer,” often located in nearby, larger towns. Additionally, venues such as local produce stands, farmer's markets, and butcher shops were frequently mentioned food sources. For example: “He’ll [husband] stop at that fruit stand... They have milk there even, so I might just get milk from there. But we get our produce from them. And then we buy our ground beef from a butcher.” Many participants remarked that only a small grocery or convenience store was located in their town, and they did not frequently shop at such stores. Food eaten away from home (e.g., restaurant food) was discussed in fewer than half of the focus groups and was identified as a regular source of food for very few families.

A majority of participants stated that, in addition to purchased foods, they **acquired foods in other ways**, most frequently by growing it themselves. Nearly all families had a home garden that was used for growing food that was eaten fresh and, in many cases, preserved for consumption during the winter months. As described by one participant, “And then we have a gigantic garden. So every year we make and can and freeze as much as we can. So that’s fun. And nice. A lot of work but worth it.”

In addition to gardening, several participants shared that they raised their own meat and/or eggs. Others said that hunting and fishing provided food for their family. A few families received foods, such as meat, eggs, or garden produce, from family and

friends. Two participants said their families received food benefits from the federal Supplemental Nutrition Assistance Program (SNAP).

Family Physical Activity Behavioral Factors

Two themes that emerged as important influences on family physical activity were the following: *family physical activity* and *screen time*. These themes and related sub-themes, prevalent across all nine focus groups, are described in more detail below.

Family Physical Activity. The family physical activity theme stemmed from conversations about how families are physically active, together and individually. Most parents indicated that their families were physically active together on a somewhat regular basis. Only a few said that their families were rarely active together. Common **family activities** included walking, biking, running, swimming, basketball, gardening, and doing chores. As shared by one parent, "...in the summertime we spend most of the time on the playground, or somewhere where we can play, or in our garden... In the summer we like to ride bikes together...We play basketball together." In contrast, many parents also engaged in some type of individual physical activity, such as walking, running, workout videos, or performing a physically demanding job. A few parents mentioned exercising at a gym.

Conversations about **children's activities** centered on home-based activities and organized activity programs. Almost all parents said that their children regularly engaged in physical activities at home. Common activities included playing outside, riding bikes, playing games such as basketball and soccer, and doing chores. For example, as one

parent described her children's physical activity habits at home: "My kids go outside in rain boots a lot. I mean, we go outside a lot." Another added:

The kids, like during the summer a lot of times they're just out running around. I mean like with the [summer] weather, water guns, bikes, they've got bicycles they ride around. They're in the barn climbing in the hay. So they're, I mean they're six and ten so there's, my six year old is just busy all the time with something. So they just, yeah, go outside and play most of the day...And then weekends are chores.

Most parents also said that their children were involved in at least one sport or other organized activity (e.g., dance classes). Few parents stated that their children were not involved in any organized physical activity programs.

Screen Time. The screen time theme emerged from conversations about family use of electronic devices. Participants discussed **using a wide variety of technology** at home, including TV, computers, tablets, cell phones, and video games. All families reportedly had at least two types of technology available in their households. In general, parents reported greater use of technology among themselves compared to their children, with the exception of video games. Some families also used active technology (e.g., Wii fit, workout videos). The following quotation illustrates family access to and use of various types of technology:

We have more then we use. We have 2 TVs in our house, oh no we have 3... We have a Wii and the Wii Fit with the Balance Board... I actually have 2 iPads. One usually stays at school. My husband has a tablet. He hardly uses his... We bought my daughter a Kindle Fire... She goes through phases where she uses it and doesn't...My husband and I both have smart phones...And then I have a work laptop and a personal laptop...

Generally speaking, parents conveyed **awareness of and concern for screen time practices** at home. Most expressed that children, in particular, spent too much time using technology, although some parents also voiced concern for their own screen time habits. Whereas some parents reported strict screen time limits for children, others did not. The following quotations illustrate varying perspectives and limitations on screen time: “The children have a TV that they have very limited access to, maybe an hour a day in the summer. They have no iPads, no cell phones... My children feel underprivileged in that area. Like, ‘all the other kids do it!’ ‘Well, you’re not all the other kids’.”

I’d say the boys, during the summertime, probably spend a good few hours a day [on video games]... I’d say at least two. Minimum. Two to four... There’s a lot of times where they’ll play and we’ll just say no more, it’s done for the rest of the night. Or you can’t play tomorrow... Usually Sunday we turn off, no electronics... But they’re way worse, which they just recently got them, is the iPhones.

...they [children] have to earn their time playing the Xbox or playing on the tablets or whatever. They do their chores, then they can touch it. They get five minutes per chore they do. That way they actually do their chores... Him [husband] and I on the other hand use our phones way too much... But the kids... they’ll get however much time they earn.

Family Nutrition and Physical Activity Environmental Factors: Supports and Barriers

Several themes emerged from an exploration of factors perceived as supports for and/or barriers to family nutrition and physical activity practices (Table 3.2). The predominant themes, discussed in more detail below, included seasonal variation, features of home, distance from resources, foods and beverages encouraged and discouraged, screen time limits, financial constraints, outdoor safety, and schedule constraints.

Seasonal Variation. Seasonality emerged as a theme that was both a support and a barrier to family nutrition, depending on the time of year. For example, in the summer season, families reportedly ate more fruits and vegetables due to greater availability and accessibility of seasonal produce. Alternatively, they ate less produce in the winter because it is more difficult to get fresh fruits and vegetables at that time of year. Despite the fact that some parents reported better eating habits (i.e., more fruits and vegetables) during the summer months, participants generally agreed that eating habits were more stable during the school year due to more structured family schedules compared to the flexibility of summer. As stated by one parent:

I think school year maybe, I'm a little more prepared because you're kind of forced to be because you have to make the kids lunches to go to school and they have to eat on a schedule and I think actually we do better with that than we do in summer. Because you know, the kids wake up later and then that puts them off for lunch and I don't prepare things the night before because I don't really have to.

Seasonal variation was also described as a support and a barrier for family physical activity. Many parents commented that physical activity levels were higher during the summer months. Some expressed that physical activity was more challenging during the winter months because they did not go outside as often due to cold and/or wet weather. Others explained that children were more active during the school year due to sports and physical education at school. Three parents stated that physical activity levels were consistent throughout the year, though the type of physical activity may change seasonally. Comments from two participants illustrate the general consensus that seasonal weather patterns influenced family physical activity habits, but the degree of

influence varied for different families: “Definitely summer time is much easier than winter time...but I mean, winter time it’s, when it just constantly rains, we are stuck in the house...but [physical activity] definitely gets hard in the winter unless you spend money.”

The activity changes and where we do it changes. Like instead we’ll go sledding on the mountain. But it [physical activity] does taper down just because of the cold. We’re not out as much. And it’s not like after dinner we want to go walk in the rain, you know, bike in the rain. So it does slow down. We just do different things I think.

Features of Home. Parents discussed how features of the home influenced family food and activity-related practices. For example, many parents shared that healthy foods (e.g., vegetables and fruits) were readily available and accessible within their homes. A few parents expressed that specific physical aspects of the indoor environment, including plenty of kitchen and storage space, made meal planning and preparation easier. For other families, however, lack of space at home was a barrier. For two families, limited storage space made it difficult to stock up on food items. One parent commented that having a small kitchen made it hard to prepare meals. Others shared that lack of furniture or space made eating together a challenge. As stated by one parent, for example: “My family didn’t eat dinner a lot together but he’s [husband] getting us to where we do. Except for right now, we’ve got enough chairs for the kids to sit at the table and we kinda sit off wherever we got a place right now.” Another participant added: “See and that’s us too. The table is small and usually covered with a craft project of some sort. It’s not a lot of [space], we eat at the same time if we’re all home, but not necessarily around the table.”

Some families reported eating meals in front of the TV because their tables were too cluttered to be used for meals.

In contrast, other attributes of the home environment, both indoor and outdoor, were perceived to promote opportunities to be physically active. As summarized by one parent: "...it's pretty much set up to be easier. Because we do have a fairly big house and a yard and space that we can do pretty much whatever we want to do if we choose to." Another parent explained that outdoor space, in particular, was an advantage of living in a rural area: "But I mean, you can look at it both ways too. I mean probably kids in Portland, they've got all those programs and stuff but they're living right next to their neighbor, where here..." "They don't have a horse in their yard," his wife concluded.

Availability of physical activity equipment in the home environment was also identified as a support for family physical activity. Parents reported a variety of equipment utilized by family members. For example, indoor physical activity equipment included treadmills, weights, and workout videos. Outdoor physical activity gear included bicycles, trampolines, play structures, and swimming pools.

Distance from resources. Most participants stated that they lived a significant distance from large towns, which limited access to food and physical activity resources. Although some remarked that they lived relatively far away (i.e., 30 minute drive or more) from grocery stores, distance from food resources was not identified as a barrier for most families. Rather, distance from resources was perceived as a rural reality and was related to the benefit of having ample outdoor space. As explained by one

participant: “And I do believe, there’s pros and cons about living rural. Because our markets are a little farther away. But we also do have the space to create a garden. We have the space.” Likewise, other participants commented that gardens and other local food resources available in their rural communities supported family eating habits, such as opportunities for hunting, fishing, and purchasing locally raised meat products.

Alternatively, some parents expressed that living at a distance from food resources was a challenge, resulting in less frequent grocery shopping and decreased availability of perishable foods in the household, for example: “Or you know, I’ll say I could make this but I’m missing this ingredient and I’m a half hour from the grocery store. So I think that is hard. I try to stock up on canned beans and vegetables, things like that. But the fresh stuff is hard to keep.”

Furthermore, local grocery or convenience stores were described as expensive and/or limited in food options. As stated by one parent: “Well, there’s like little stores. There’s two stores... Yeah, it sucks though because it’s really expensive.” A parent in a different community said: “Well there’s a general store but it’s... if you need milk, eggs, toilet paper, something random, but otherwise... Because you can’t get a head of iceberg lettuce at the general store... everything leaving there is beer, chips, soda.”

Distance from resources also emerged as a theme in the family physical activity environment. Many families lived far away from physical activity resources, presenting a challenge for participation in physical activity programs. For example, one parent shared how moving to a rural community changed her physical activity habits: “Because it was

really hard moving here, there's no gyms close by, it's hard to work out. So we have to do something different.” Another parent described how living far away from physical activity resources influenced her exercise habits:

...it's not like an option to want to go to the gym and drive a half an hour in a snow storm. It's not worth risking your life to exercise in the gym. If it was near me I would go. But I'm not going to do it. Nor do I even want to drive a half an hour in the summer time just for that purpose. Really kills your day.

Another parent expressed that having more indoor physical activity resources nearby would be beneficial for her family: “Somewhere close that isn't taking a whole day or a whole weekend to go and be active. Just somewhere close and indoors because it's only sunny here for like two or three months and then it goes to crud.” In contrast, one participant voiced that driving long distances to provide physical activity opportunities for her children is something she expected to do as a rural resident: “...it's just something [driving into town] that we accepted when we chose to live out here, that we knew we were gonna have to do if we wanted to live out here, to keep our kids active in things in town.”

Foods and Beverages Encouraged and Discouraged. All parents expressed efforts to promote “healthy” eating habits for their families, though “healthy” was not universally defined. When parents described the types of foods and beverages they encourage and discourage at home, and approaches for doing so, they shared a variety of policies and practices used to promote or prevent particular eating habits within their households. For example, some parents referenced “good food/bad food” policies such as restricting the availability of certain foods (e.g., chips, soda) and increasing the

availability of others (e.g., vegetables, fruits). According to one parent: “We actually lock up sugar. We put it in a drawer and lock it.” Another parent shared how she promotes moderation and small portion sizes in her family:

We always try to, no matter what they [our children] eat, try to get them to have a fruit or vegetable with it... you know, try to limit the bad stuff, but they do eat it... chips and sweets and sodas... But we try, like I’ve been getting them just the smaller portion bag, trying to do stuff like that so that they realize... they don’t just eat a whole bag of chips. When we do get the sodas, we get the small cans so they just have a small can of it. So we’re trying to work on portion control... not this ‘you can’t have it, it’s bad,’ but ‘here’s a little bit’ type thing.

Some parents discussed how they encouraged children to try new foods by offering unfamiliar items and preparing new recipes without forcing kids to eat against their will. Others families had rules for trying new foods and/or provided familiar, kid-friendly menu options for children described as “picky eaters.” For example:

Well our rule is they at least have to try it, and then I mean there are foods we love and we cook, and we know our kids don’t like, so we usually try to time that with when we have leftovers or you know, just that night they get a hot dog and something with it. But in general, they just eat what we eat... if you just don’t like it then just swallow it with some drink... But the rule is they have to try it.

Additionally, many parents discussed how they promoted vegetable and fruit consumption by ensuring such foods are available and accessible within their households. As stated by one participant: “You [children] have to ask for these things [bread and cheese] but you never have to ask for fruits and vegetables. There will always be fruits and vegetables here, you never have to ask.”

Several participants specified that limited or no soda consumption was allowed in their family. In some families, parents consumed soda and kids were only allowed to

drink juice and/or milk. In other families, parents provided flavored water to encourage children to drink more water. Although there was a lack of consensus about what and how specific eating habits were promoted, participants generally expressed that food practices and policies were important in their families.

Screen Time Limits. The screen time limits theme emerged from many conversations focused on concerns about children spending too much time using electronic devices. Some parents suggested that screen time reduced physical activity because children preferred to use electronics instead of being active. In other cases, screen time activities, such as workout videos, were perceived to facilitate physical activity. Parents primarily conveyed, however, that it was difficult to regulate children's use of technology when they were not around to monitor it, and it was challenging to keep track of the time that family members spent using electronic devices. As one parent explained: "I have not set boundaries on the electronics, I had not really thought that I needed to, because I was always out doing stuff and so I never really set boundaries and so that's one of the things I think that actually is a hindrance within my home... we are out of control in this area." Another parent stated: "That's a huge challenge for us [regulating screen time]. And it does sort of seep into a half hour seeps into an hour... It is tough."

Conversely, some parents commented that screen time was not a challenge because they have rules in place and/or their children are not interested in screen time activities. As one parent shared:

I try to limit the time. Our daughter likes to read so she is not as guilty of it as her brother. If he had his choice he would sit in front of the plasma with the Xbox all day... So we limit the screen time. And that goes for the computer it's not just, ok you get an hour of TV. It's an hour of TV, computer, everything. So you know, one or two hours or whatever it is a day... after that he can read or go outside and play.

Financial Constraints. For some families, finances were perceived as a barrier to healthy eating habits. Families were sometimes unable to purchase the foods they preferred to eat because less desirable, “processed” foods were less expensive. In contrast, one parent explained that, in an effort to cut down on costs, she prepared meals from scratch as much as possible: “Mine [eating habits] is dictated by finances because I’m a single mom. So I try everything homemade. I do not do box mixes, I cut out all of that kind of stuff.”

Across the majority of focus groups, the general perception was that healthy eating is more expensive, especially during the winter season when fresh produce costs more, and that meals tended to be less healthy when families had less money to spend. Some parents indicated that their food purchases were based primarily on what is affordable, and that they stocked up on foods when they were on sale, including seasonal fruits and vegetables. Alternatively, in one focus group, two parents expressed that they would make other sacrifices before purchasing food of a lower quality than perceived to be healthy for their families. In the words of one parent: “I’ll take a bus and sell my car before I ever buy junk.”

Financial constraint was not a major theme related to the family physical activity environment. Although a few parents indicated that community physical activity

programs (e.g., sports) and facilities (e.g., local pool) were too expensive for their families to access, most parents did not express financial concerns in relationship to opportunities for physical activity.

Outdoor Safety. Safety emerged as a theme related to the family physical activity environment. Specifically, parents expressed safety concerns regarding outdoor physical activity opportunities for their children. A few parents stated that roads were too hazardous for walking or biking. Other parents voiced concern for children playing outside without supervision due to fear of strangers whereas others were concerned about wild animals. Some parents, however, perceived that rural areas offered a safer environment for children to play outside compared to non-rural areas.

Schedule Constraints. Schedule constraints emerged as a theme related to the family nutrition environment. Although most parents reported that their families regularly ate meals together, when asked to describe what made mealtime challenging, busy schedules were the primary obstacle. The consensus was that eating healthfully takes more time; less healthy food is more convenient. According to parents, busy schedules made it difficult for families to cook healthy meals and to eat meals together. As one parent shared:

Our meals are very chaotic. We always eat dinner together, or try to. It kind of varies on what happens. I wish I had a baby gate to keep everybody. We just kind of switch it around... it kind of depends on what's going on. My 9-year old plays a lot of sports so we kind of have to go with, and our dinner time fluctuates with what he's doing or what somebody else, like swim lessons or somebody else has plans. Or who cleans up or what happens. It is a rotating thing. It's very chaotic.

For a few families, busy schedules prevented family meals except on rare occasions. For two families, limited time was the reason they ate fast food on a weekly basis. Another family reportedly ate breakfast in the car six days per week due to schedule and distance from school/work. For another family, lack of time was cited as the reason they did not have a garden, even though they would like to have one. Although schedule constraints were generally viewed as barriers to family eating habits, two parents shared that working from home allowed for a schedule that made it easier to plan and prepare meals for their families.

Schedule constraints did not emerge as a major theme related to family physical activity. A few parents reported that their families were rarely active together due to parent work schedules. Alternatively, one parent shared that being a stay-at-home parent made it easier for him to provide transportation to and from his children's physical activity programs.

Discussion

This study was part of a mixed methods project examining whether and how family-home behavioral and environmental factors are associated with childhood obesity in rural Oregon. In a concurrent phase of this project, we quantitatively examined associations between family-home nutrition and physical activity factors with body mass index (BMI, kg/m^2) for sex and age among rural elementary-aged children. Findings from the quantitative study indicated no association between the family-home factors with BMI. This qualitative study provides evidence that, among some rural parents, perceived family-

home behavioral and environmental factors may influence eating and physical activity habits; habits that influence children's risk for being overweight or obese later in life.

Inconsistent practices and policies across family-home environments were salient among the themes that emerged from this study. For example, though parents unanimously expressed strong values for family eating habits, the methods by which foods and beverages were encouraged or discouraged within households were variable. Many parents described opportunities for children to develop healthy eating behaviors through observational learning, such as parental modeling of healthy eating habits. In some cases, however, family practices were contrary to recommendations for development of weight-healthy eating behaviors.¹⁰⁶ For example, some parents discussed restrictive feeding practices that are associated with unhealthy eating behaviors and weight gain in children.¹⁰⁷⁻¹⁰⁹ Thus, families may benefit from additional knowledge and skills regarding factors associated with development of healthy eating habits, such as principles of responsive feeding,¹¹⁰ family meal patterns,^{93-96,111} and eating while watching TV.^{100,112,113}

Notably, study participants cited more family practices and policies regarding eating behaviors relative to physical activity behaviors, suggesting that eating habits may be more highly prioritized compared to physical activity habits. Parents may perceive feeding children as a responsibility whereas being physically active with children may be perceived as a choice. Given that fewer than half of children in the U.S. meet the current guidelines for physical activity,¹¹⁴ efforts that support children to achieve the recommended ≥ 60 minutes per day are warranted. Parents in our study indicated that children were

primarily physically active via participation in organized athletic activities outside the home or unorganized activities at home, both of which assist children with meeting their recommended physical activity needs. A related need, however, is to decrease the amount of time children spend engaging in sedentary activities. Use of electronic media, for example, has been associated with higher odds of obesity among rural children.³² Our study participants identified regulation of screen time as a particularly challenging factor within the family-home environment, suggesting a need for strategies that help parents to overcome this barrier.

Consistent with previous research in rural areas,^{36,37} we found that financial constraints, outdoor safety, schedule constraints, and access to food and physical activity resources were commonly perceived environmental factors that influence opportunities for families to eat healthfully and/or be physically active. A unique contribution of our study was the identification of overlapping factors perceived to influence both nutrition and physical activity (e.g., seasonal variation, features of home). In addition, many factors were perceived as both a support and a barrier to healthy eating and/or physical activity (e.g., seasonal variation, distance from resources), highlighting some of the interrelated benefits and challenges of living in a rural community. It is valuable to understand, from a parent perspective, how such factors influence the family-home nutrition and physical activity environment and, subsequently, children's eating and physical activity behaviors.

For example, features of home, seasonal food availability, and distance from resources are factors that influence food access and, therefore, family eating habits. These

factors may be perceived as advantages or disadvantages connected to the place where people live. Based on the perspectives of parents in our study, a benefit to living in a rural area was having adequate outdoor space to grow a garden. Gardens provide increased availability of fresh produce during the summer, thereby making it easier for families to eat more vegetables and fruits. In contrast, families live far away from grocery stores, resulting in less frequent food purchases and decreased availability of perishable foods in the home. This barrier is particularly problematic during the winter season when garden produce is unavailable, leading to decreased consumption of vegetables and fruits during that time of year.

From a social ecological perspective, factors external to the family-home environment, such as access to food and recreation resources and seasonal variation, influence family food and physical activity practices. Consistent with the SCT concept of reciprocal determinism,⁴⁸ children's ability to develop and maintain healthy habits depends on opportunities to practice behaviors at home, which depends on the environment (social and physical) within the family-home. When asked about family eating and physical activity habits, parents in our study described typical practices and policies as well as how other factors within the family-home environment (e.g., features of the home), and external to the family-home environment (e.g., distance from resources), made it easier or harder for children and families to eat healthfully and be physically active.

Overall, parents expressed value for and intent to promote weight-healthy eating and activity behaviors in the family-home. They also communicated challenges that

influence opportunities to practice healthy behaviors at home. Although some families were more challenged than others, and certain barriers within the family-home were predominant (e.g., screen time), the broader challenges perceived to influence family eating and physical activity habits were described as factors that existed outside of the rural family-home environment.

A strength of this study is that we investigated the determinants of both healthy eating behaviors and physical activity behaviors related to the family-home environment. Our study population included parents from low-income rural communities with high prevalence of child overweight and obesity. Further, the qualitative nature of this study allowed for in-depth exploration of parent perceptions of factors that influence nutrition and physical activity behaviors, providing a more comprehensive understanding of the family-home environment than would likely be achievable using quantitative methods alone. Our study offers insight into findings from previous research that indicate higher prevalence of overweight and obesity among rural children,²⁹⁻³³ yet limited explanation of why this disparity exists and the potential role of the home environment.

This qualitative study is not without limitations. We recruited 34 participants from six rural communities located in three geographically-diverse Oregon counties in order to increase the likelihood of capturing a broad spectrum of viewpoints. Participants may have been uniquely interested in the study topic, however, and their family-home behaviors and environments may differ from those of non-participants. Additionally, self-reported data are subject to recall and social desirability bias. Although the moderator created a

welcoming atmosphere and used interviewing techniques to maximize participation during the focus groups, it is possible that participants provided or withheld information due to the nature of the topic and/or the group setting. Despite these limitations, this study is among the first to examine the family-home nutrition and physical activity environment in a rural setting, and our findings provide important insights and direction for future research and practice.

Implications for Research and Practice

The insights from parents can be used to inform future practice and research in rural communities. Our findings demonstrate that while parents expressed values for eating healthfully and being physically active, they identified barriers that limit opportunities for children to practice healthy habits at home. Thus, it is important for practitioners to consider the unique qualities of a family's home environment and available family resources when providing guidance for behavior change. Further, our study suggests that parents may prioritize the provision of opportunities for healthy eating over physical activity. It would be advantageous for practitioners to promote physical activity, as well as healthy eating, as an essential component of children's health and development.

Future research is needed to identify effective strategies to assist families in navigating challenges related to the family nutrition and physical activity practices and policies. Potential interventions may involve integration of educational guidance on healthy eating and physical activity behaviors for children¹⁰⁶ with environmental

strategies to modify the family-home environment such that it favors healthy behaviors. For example, the health benefits of family mealtime could be promoted along with recommendations to either remove the TV from the eating area or implement a TV turn-off policy during mealtime. Likewise, efforts to educate families on screen time recommendations¹¹⁵ could be reinforced with suggestions for modifying the home environment to promote physical activity over screen time, such as decreasing access to electronic devices, implementing screen time policies, encouraging active play, and modeling of appropriate physical activity and screen time behaviors by parents.

Future research may also identify intervention strategies that optimize the family-home environment with special consideration for the realities of rural living. Based on insights from this study, potential strategies to minimize barriers in the family nutrition environment during the winter season include promoting shopping habits that include purchases of a variety of fresh, frozen, and canned vegetables and fruits, or the use of storage techniques that keep produce fresh for longer periods of time. At the community-level, strategies may involve improving access to food resources closer to home, such as developing farmer's markets that are open year-round or increasing the availability of healthy food selections at small grocery and convenience stores in rural towns.

Likewise, interventions designed to increase opportunities for indoor and outdoor activities, particularly during the winter season, may help rural children and families to maintain physical activity levels year-round. Potential strategies for the family-home environment include helping families to designate indoor physical activity space at home

and to implement home-based, family-friendly physical activity programs. At the community-level, increasing the number of recreational programs offered year-round, including programs that stimulate enthusiasm for outdoor activities during inclement weather, or decreasing the cost of using existing physical activity resources (e.g., community swimming pool) may facilitate family physical activity.

This study sets the table for future investigations that will generate the knowledge needed to develop comprehensive, customized interventions to promote weight-healthy behaviors, particularly among rural populations. Many overlapping and interrelated factors that influence eating and physical activity habits were identified, suggesting that family-home nutrition and physical activity environments and behaviors be studied together versus as separate components (i.e., nutrition or physical activity). Our findings also suggest that rural children's eating and physical activity behaviors vary seasonally. Future studies should consider assessment methods and intervention strategies that account for seasonal variations. Finally, future research on family-home environments should connect with school-based efforts to promote healthy eating and physical activity behaviors. As schools implement federal wellness policy requirements,¹¹⁶ they provide model environments that can influence children and parents to improve nutrition and physical activity at home thereby making the healthy choice the easy choice across the key settings where children eat, play, and grow.

Table 3.1 Behavioral factors that influence family nutrition and physical activity as discussed in focus groups

Nutrition			
Theme	Sub-theme	Examples	Summary
<i>Family Eating Habits</i>	Mealtime	Family meals	Many families regularly ate dinner meals together, generally at the table
		Breakfast	Mornings were generally rushed and unorganized; family members typically fend for themselves at breakfast time
		Special orders	In most families, all family members generally ate the same meal
		Responsibilities	Generally, one parent was primarily responsible for meal preparation; children were sometimes invited or required to help with meal prep and/or clean-up
		Eating while watching TV	Some families watched TV while eating whereas others always turned off the TV during mealtime
<i>Food Procurement</i>	Purchased Foods	Grocery stores	Families shopped regularly at multiple grocery stores located in nearby towns
		Local foods	Some families also shopped at local farmer's markets, produce stands, and butcher shops

Table 3.1. (Continued).

Foods Grown or Acquired Otherwise			
		Garden/other food produced at home	Most families had home gardens that were used to grow food that was eaten fresh as well as preserved for consumption throughout the winter; some families raised their own meat and/or eggs
		Hunting/fishing	Hunting and/or fishing provided food for some families
Physical Activity			
Theme	Sub-theme	Examples	Summary
<i>Family Physical Activity</i>	Family activities		Families were physically active together as a group fairly often; Many parents did some type of individual physical activity, such as walking, running, workout videos, or a physically demanding job
	Child activities		
		Home-based activities	Children regularly engaged in physical activities at home
		Organized sports/activities	Most children were involved in at least one sport or organized physical activity
<i>Screen Time</i>	Technology usage		Families used a wide variety of technology in their home environments, including TV, computers, tablets, cell phones, and video games; some families use active technology at home
	Technology practices		Some families had strict screen time limits whereas others had no set limits

Table 3.2 Environmental factors that influence family nutrition and physical activity as discussed in focus groups

Nutrition			Physical Activity	
Theme	Support	Barrier	Support	Barrier
Seasonal Variation	Structure of the school year provides stability for eating habits; greater availability of fresh produce during the summer season provides opportunities for families to eat more vegetables and fruits	Flexible summer schedule results in less stable eating habits; decreased availability of fresh produce during the winter season makes it challenging for families to consume vegetables and fruits	Summer weather allows for more outdoor activities; families are more active during the summer months	Winter weather forces families to stay inside; families are less active during the winter months
Features of Home	Adequate outdoor space offers gardening opportunities; healthy foods are available and accessible; large kitchens and storage spaces make meal planning and preparation easier	Lack of indoor space makes it harder to eat meals together as a family and to store or stock up on food items	Adequate outdoor space is a benefit of rural life; availability of indoor and outdoor activity equipment in the home environment supports family physical activity	
Distance From Resources	Local food resources, such as home gardens, farmer's markets, local meat producers, and hunting, support family eating habits	Grocery stores are located relatively far away; small grocery or convenience stores located in rural towns are expensive and do not offer a variety of foods		Physical activity facilities and organized physical activity programs are located relatively far away

Table 3.2. (Continued).

Foods & Beverages Encouraged/Discouraged	A variety of family practices and policies are used to promote or prevent certain eating habits			
Screen Time Limits			Strict limits on screen time help to reduce sedentary time; active technology promotes physical activity	Regulation of screen time is a challenge; screen time reduces physical activity
Financial Constraints		Less desirable, more "processed" foods are more affordable; families are sometimes unable to purchase the foods that they prefer due to cost		
Outdoor Safety			Rural areas offer a safe environment for children to play outdoors	Rural areas are not safe for children to play outdoors due to dangerous roads, people, and wildlife
Schedule Constraints		Busy schedules make it harder for families to cook healthy meals and to eat together		

CHAPTER 4. THIRD MANUSCRIPT

Associations of family nutrition and physical activity and food insecurity with dietary intakes in rural children

Introduction

Obesity prevalence is higher among rural children compared to non-rural children,²⁹⁻³³ yet evidence to explain this disparity is inconclusive. Behavioral and environmental factors in the family-home, such as those related to healthy eating, may influence children's risk for obesity.^{63,64} Some research suggests that rural children have poorer dietary intakes²⁹ compared to non-rural children whereas other research indicates no differences.³² Research in non-rural populations suggests associations between child eating behaviors and family-level factors including parent education and role modeling,⁸⁷⁻⁹¹ family food rules^{87,92} and family meal patterns.⁹³⁻⁹⁶ Other factors in the home environment, such as availability of healthy foods^{87,91,99} eating while watching TV¹⁰⁰ and fast food consumption,^{88,100} may make it easier or harder for children to eat healthfully. Research on these and other obesity-promoting or -preventing factors in rural family-home settings is limited, however.

Rural populations also experience higher rates of food insecurity compared with non-rural populations.^{43,44} Some research suggests that dietary behaviors differ between food-insecure and food-secure children²⁰ whereas other research suggests no differences.¹¹⁷ Although food insecurity and obesity often coexist, evidence for an association in children is inconsistent²¹⁻²³ and research in rural settings is scarce. Given that obesity and food insecurity rates are higher among rural populations, it is important to understand factors that potentially mediate this association.

The first aim of this cross-sectional study was to determine if family nutrition and physical activity (FNPA) factors are associated with dietary intakes (i.e., food groups and added sugars) in rural children. The second aim was to determine if food insecurity is associated with dietary intakes in rural children. It was hypothesized that more favorable FNPA factors would be associated with healthier dietary intakes and that being at-risk for food insecurity would be associated with less healthy dietary intakes.

Methods

Participants

Data for the present study were collected as part of a larger childhood obesity prevention study, Generating Rural Options for Weight (GROW) Healthy Kids & Communities. Sampling for GROW started with selection of three Oregon counties, based on geographic distribution and number of rural, low-income communities. Eligible school districts and schools within each county were determined based on rurality as designated by the United States (US) Census⁶² and low-income status ($\geq 50\%$ of families eligible for federal school meal programs). Two elementary schools were randomly selected from separate communities within each county (n=6 schools in 6 communities).

All families with elementary-age children (grades K-5/6; N=2,200 children) attending GROW schools were eligible to participate in the GROW study. Participants were recruited via an informational packet sent from the school to the home. Recruitment materials included a brief description of the study, the steps necessary to enroll, informed consent documents, survey instruments, and a postage-paid envelope.

Families could enroll by returning the forms included in the packet or by completing the documents online. Approximately 12% of children (n=270) and their parents/caregivers consented to participate in the GROW family study between 2012 to 2014.

Data Collection and Measures

Data for the present study included survey responses about children's dietary intake, FNPA factors, family food security, and parent and child demographics.

Parents/caregivers completed surveys via print or electronic format between summer and fall of 2014. BMI data were objectively measured during fall of 2014. Details on the survey instruments and BMI measures are provided below.

Dietary intake. Children's dietary intake was assessed using the Block Kids Food Screener (BKFS) developed by NutritionQuest.¹¹⁸ The BKFS was designed to evaluate dietary intake of nutrients and food groups in youth aged 2-17 years and has been used in other dietary intake studies.¹¹⁹⁻¹²¹ The relative validity of the BKFS was examined in a sample of youth aged 10-17 years (n=99), using three 24-hour dietary recalls as the reference measure.¹²¹ De-attenuated correlations between estimates produced by the two dietary assessment instruments ranged from 0.478 to 0.878.

The two-page BKFS survey consists of 41 items. Parents report the frequency and quantity of foods and beverages consumed by their child during the previous week. For example, the first item on the BKFS is "Cereal, like corn flakes, Frosted Flakes." Each item is followed by two questions. The first question is "How many days last week did your child eat or drink it?" Response categories for frequency of consumption range

from “none” to “every day.” The second question is “How much in one day?”

Quantities consumed include three to four categories depending on the food type. For the first item, cold cereal, quantity is the number of bowls consumed per day (i.e., 1 to 3 bowls). The BKFS food list was developed from National Health and Nutrition Examination Survey (NHANES) data for youth aged 2-17 years. Portion sizes are assigned according to the age and sex of the child based on amounts consumed in the most recent NHANES survey 24-hour recall data.

The completed BKFS surveys were submitted to NutritionQuest¹¹⁸ who returned dietary intake data to the investigators. For this study, we examined the following BKFS estimates: ounce/cup equivalents of fruits, vegetables (total, including potatoes and legumes), whole grains, dairy, protein foods (meat, fish, and poultry); added sugar (tsp); and total calories. The food group servings were defined by the US Department of Agriculture MyPyramid Equivalents Database (MPED) 2.0.¹²² For each MyPyramid food group and subgroup, the MPED provides the number of MyPyramid equivalents that are present in 100g of each of the foods consumed by participants in NHANES. Recommended intakes based on the US Department of Agriculture (USDA) Dietary Guidelines for Americans were used for comparison.¹²³

Although the BKFS was not designed to specifically assess energy intake, estimated energy intake per day can be calculated for each participant and is provided as part of the dietary intake data by NutritionQuest. For the purpose of this study, estimated energy intake was used to identify over-reporters and to standardize food group intakes.

No standard exclusion criteria exist for under- or over-reporting of food intake estimated by food screeners. Therefore, we defined under-reporting of food intake as two or fewer food items reported per day and over-reporting as estimated total energy intake >5000 kcal/day, as previously described by Choumenkovitch and colleagues.¹¹⁹

Family nutrition and physical activity factors. Parents completed the Family Nutrition and Physical Activity (FNPA) screening tool, a previously validated instrument designed to assess evidence-based family environmental and behavioral factors that predispose young children to becoming overweight.^{63,64} Ihmels and colleagues⁶³ demonstrated internal consistency of the FNPA instrument ($\alpha = 0.72$) with a sample of urban families and children. Similarly, we found good internal consistency in our study sample ($\alpha = 0.79$). Ihmels et al. found that FNPA score was significantly associated with child overweight status ($\geq 85^{\text{th}}$ BMI-for-age percentile).^{63,64}

The 20-item version of the instrument used in this study includes 10 items for each of two component areas: nutrition and physical activity. These two component areas each contain five domains, which are each comprised of two items. The *domains* (items) in the nutrition component include the following: *family meal patterns* (My child eats breakfast + Our family eats meals together); *family eating habits* (Our family eats while watching TV + Our family eats fast food); *food choices* (Our family uses microwave or ready to eat foods + My child eats fruits and vegetables at meals or snacks); *beverage choices* (My child drinks soda pop or sugar drinks + My child drinks

low-fat milk at meals or snacks); and *restriction and reward* (Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior).

The *domains* (items) in the physical activity component include the following: *screen time behavior and monitoring* (My child spends less than 2 hours on TV/games/computer per day + Our family limits the amount of TV our child watches); *healthy environment* (Our family allows our child to watch TV in their bedroom + Our family provides opportunities for physical activity); *family activity involvement* (Our family encourages our child to be active every day + Our family finds ways to be physically active together); *child activity involvement* (My child does physical activity during his/her free time + My child is enrolled in sports or activities with a coach or leader); and *family routine* (Our family has a daily routine for our child's bedtime + My child gets 9 hours of sleep a night).

Item response categories were coded on a four-point scale as “Almost Never” (1), “Sometimes” (2), “Usually” (3), and “Almost Always” (4). All items were coded such that higher scores indicated more favorable behaviors and environments. For example, a high score in the *restriction and reward* domain reflects a family who “almost always” monitors eating of chips, cookies, and candy and “almost never” uses candy as a reward for good behavior. Previous research suggests that a higher total FNPA score reflects more favorable family policies and practices, inferring lower risk for child overweight.⁶⁴ For this study, total FNPA and the overall nutrition and physical activity component

scores were examined. We further examined each of the nutrition domains and individual items to evaluate associations with dietary intake.

At-risk for food insecurity. Family at-risk for food insecurity was assessed via parent-report using a previously validated 2-item food insecurity screening instrument.⁶⁵ The food insecurity screener allows for rapid identification of households at-risk for food insecurity and was previously found to have high sensitivity (97%), good specificity (83%), and convergent validity among a large population (n=30,098) of low-income families with young children. The screener consists of the following questions: 1) “Within the past 12 months, we worried if our food would run out before we got money to buy more,” and 2) “Within the past 12 months, the food we bought just didn’t last and we didn’t have money to get more.” Item response categories were “never true,” “sometimes true,” and “often true.” Responses were dichotomized for analysis (often true or sometimes true versus never true). An affirmative response to question 1 and/or question 2 was used to identify families at-risk for food insecurity.

BMI. Height and weight measurements were obtained by trained research staff. Height was measured to the nearest 1 mm using a portable stadiometer. Weight was measured to the nearest 0.1 kg using a digital scale. Measurements were repeated three times on each child and the average height and weight were used to calculate BMI as weight (kg) / height (m²).

Children were classified as underweight (< 5th percentile), normal weight (5th to < 85th percentile), overweight (85th to < 95th percentile), or obese (≥ 95th percentile)

according to the sex-specific CDC BMI-for-age growth charts.^{14,66,67} BMI scores were converted to z-scores using the sex- and age-specific parameters from the CDC growth charts to obtain the z-score value. BMI z-score is defined as the child BMI transformed into the number of standard deviations above or below the population mean standardized (i.e., for age and sex) BMI, and it is used widely in research and clinical studies in youth.⁶⁷⁻⁷⁰

Covariates. Family demographic information provided by respondents included eligibility for free- or reduced-cost school meals and parent education level. Child-level variables were age, sex, race, and ethnicity. School and standardized BMI were also considered as potential covariates.

Data Analysis

We received BKFS surveys from the parents of 38% (n=102) of the 270 children enrolled in the GROW family study. No participants were excluded based on the under- or over-reporting criteria previously described. Two participants were excluded because they had missing data on one or more of the three primary variables (i.e., BKFS, FNPA, or food insecurity). Five participants were excluded because they had missing data on one or more of the covariates used for analyses. The final sample size was 95.

Food categories were energy adjusted by dividing by total energy intake and expressed per 1,000 kcal. Descriptive statistics were examined for all variables. Unadjusted linear regression models were used to examine associations between dietary intakes with FNPA and food insecurity. Bivariate associations were examined between

all covariates and dependent variables. Due to small cell sizes, some demographic variable categories were collapsed or dichotomized for analysis. Covariates significant at the level of $p < 0.1$ were retained for adjusted models.

Associations were then examined using multivariable linear regression models, adjusted for the retained covariates. Adjusted models also included a cluster variable to account for potentially correlated observations within families. Two-way interactions between independent variables and significant covariates were examined. Likelihood ratio tests and Akaike's information criterion were used for model comparisons. Residual plots and normality tests for residual distributions were used to assess model assumptions and goodness of fit. For final models, statistical significance was originally set at $\alpha = 0.05$. False Discovery Rate (FDR) adjusted p-values for multiple comparisons were also computed.⁷³ Data analyses were performed using Stata (version 13, 2013, StataCorp) and R (version 3.1, 2015).

Human Subjects Protection

The Oregon State University Institutional Review Board approved all protocol and procedures prior to initiation of this study.

Results

Study Participants

Baseline participant characteristics are displayed in Table 4.1. FNPA scores were generally high; the average total score was 3.3 (on a scale from 1 to 4). Approximately 47% of families were eligible to receive free- or reduced-cost school meals and 28% were

at-risk for food insecurity. The majority of children were normal weight (65%); 16% were classified as overweight and 17% as obese. Based on BMI percentile, this sample had a slightly lower percentage of students classified as overweight (85th to < 95th percentile), but was otherwise similar to the larger student population across the six GROW schools. The sample included a lower percentage of students eligible for free or reduced school meals (47% vs. 68%) and a higher percentage of white students (93% vs. 75%) compared to GROW schools overall (data not shown).

Dietary Intakes

Table 4.2 presents the mean dietary intakes from the Block Kids Last Week Food Screener compared with recommended intake levels based on the Dietary Guidelines for Americans.¹²³ Children in our sample consumed less than the recommended amounts of vegetables, whole grains, dairy, and protein foods, and exceeded the recommendations for fruit and added sugars. On average, children ate approximately 1.3 cups of fruit, 0.8 cup of total vegetables, 0.6 oz of whole grains, 1.5 cups of dairy, and 1.9 oz of protein foods per day per 1,000 kcal. Children also consumed 4.6 teaspoons of added sugar per 1,000 kcals.

FNPA and Dietary Intake

Multivariable linear regression analyses showed that multiple elements of the FNPA score were independently associated with dietary intakes after adjusting for covariates and with FDR adjustment for multiple comparisons (Table 4.3). A higher, more favorable FNPA total score was associated with lower intake of added sugar ($\beta=-$

2.81, $p=0.01$). The FNPA Nutrition and Activity components were both significantly associated with lower added sugar intake ($\beta=-2.50, -1.68$; $p=0.04, 0.04$, respectively). For nutrition, the inverse association between FNPA and added sugar intake was driven in part by the Food Choices domain ($\beta=-0.79, p=0.01$). More specifically, children with families that used microwave or ready to eat foods less often had lower intakes of added sugar ($\beta=-1.39, p=0.04$). Children whose parents reported more frequent consumption of fruits and vegetables at meals or snacks tended to consume less added sugar ($\beta=-0.78, p=0.06$). Additionally, children whose parents reported less frequent consumption of sugar-sweetened beverages had lower added sugar intake ($\beta=-1.37, p=0.04$).

A higher FNPA total score was also associated with higher vegetable intake ($\beta=0.29, p=0.04$). Specifically, children whose parents reported more frequent consumption of fruits and vegetables at meals or snacks had higher intakes of vegetables ($\beta=0.17, p=0.01$). Vegetable consumption tended to be higher for children with families that use microwave or ready to eat foods less often and for those with families that monitor consumption of chips, cookies, and candy ($\beta=0.20, 0.11$; $p=0.06, 0.06$).

A higher, more favorable FNPA nutrition score was positively associated with fruit intake ($\beta=0.71, p=0.01$), driven by the Meal Patterns and Food Choices domains ($\beta=0.20, 0.24$ $p=0.01, 0.04$, respectively). Specifically, children whose parents reported that children ate breakfast more often, and those whose parents reported more frequent consumption of fruits and vegetables at meals or snacks, had higher intakes of fruit ($\beta=0.24, 0.33$; $p=0.04, 0.00$, respectively). Children with families who ate meals together

more often also had higher fruit intakes ($\beta=0.25$; $p=0.04$). Finally, children whose parents reported more frequent consumption of low-fat milk at meals or snacks had higher dairy intakes ($\beta=0.29$, $p=0.00$). No significant associations were observed between FNPA scores with dietary intakes of whole grains or protein foods.

Food Insecurity and Dietary Intake

We found no significant associations between family food security and dietary intake.

Discussion

This study examined associations between components of FNPA, as measured by the FNPA screening tool,⁶³ and dietary intakes, as measured by the BKFS,¹²¹ in a sample of rural elementary-aged children. The FNPA instrument is a validated, evidence-based screening tool designed to assess risk for childhood obesity;^{63,64} however, it has not been validated against dietary intake or physical activity levels. Our findings indicate that more favorable FNPA factors were associated with higher consumption of fruits, vegetables, and dairy, and with lower consumption of added sugar.

Certain associations between FNPA factors and children's dietary intake were unsurprising. For example, children whose parents reported more frequent consumption of fruits and vegetables at meals or snacks had higher intakes of fruits and vegetables. Likewise, children who more frequently drank low-fat milk at meals or snacks consumed more dairy. Children whose parents reported less frequent consumption of sugar-sweetened beverages had lower added sugar intakes.

Our results show that other components of the FNPA were also associated with children's intakes of fruits, vegetables, and added sugars. For example, less frequent use of microwave or ready to eat foods was associated with lower intake of added sugar. Less frequent use of microwave or ready to eat foods also tended to be associated with higher vegetable intake, as was more frequent monitoring of chips, cookies, and candy consumption. Additionally, eating breakfast and eating family meals more often were both positively associated with fruit intake. Finally, a more favorable score on the FNPA Activity component was associated with lower added sugar intake. Together, these findings suggest that the FNPA screening tool captures several elements of the family-home nutrition and activity environment that promote behaviors consistent with current dietary guidance for children,^{106,123} including increased consumption of vegetables and fruits and decreased consumption of added sugars. Conversely, other FNPA items that have been associated with dietary intake and/or weight status in previous research, such as watching TV while eating^{94,100,113,124} and fast food consumption,^{88,100} were not associated with dietary intake in our study.

We found no associations between FNPA scores with intake of whole grains or protein foods. While protein intake in the US is adequate, and thus perhaps of less importance to FNPA factors, most children do not meet the current dietary recommendations for whole grains.^{106,123,125} Whole grain consumption has been associated with multiple health outcomes, including healthier BMI.^{119,126} Thus, the FNPA

instrument may be strengthened by including availability and accessibility of whole grain foods in assessment of the family-home environment.

We also examined the association between family food security and children's dietary intakes and found no significant associations. Previous evidence on this association among non-rural children is conflicted. For example, Fram and colleagues found that greater levels of food insecurity were associated with poorer dietary intakes and lower levels of physical activity.²⁰ Conversely, Trapp and colleagues found no difference in dietary intake among children from food-insecure households compared to those from food-secure households.¹¹⁷ Despite these mixed findings, other research indicates that food insecurity is associated with fewer opportunities for physical activity^{26,127} and lack of access to healthy and affordable foods,^{19,128-132} factors that influence dietary and activity habits. Limited research has examined these associations in rural children, however. Our study may have been underpowered to detect an association between food insecurity and dietary intake. Larger studies with more comprehensive measurement of diet and food insecurity may be important for determining whether a relationship exists. Future research may also benefit from examining the impact of federal food assistance programs in this association, including the Supplemental Nutrition Assistance Program (SNAP), the School Breakfast Program (SBP), and the National School Lunch Program (NSLP).¹³³

A limitation of this study was the cross-sectional design that does not allow for causal inference. Other limitations include selection bias and self-reported data. To

minimize bias in our results, we used validated survey instruments. Another potential limitation was the use of a brief (i.e., screener) food frequency questionnaire (FFQ) to assess dietary intake. The 24-hour multiple pass recall method, conducted over a 3-day period with parents as proxy reporters, has been suggested as the most accurate method to estimate total energy intake in children.¹³⁴ The BKFS screener used in this study underestimates total energy intake, however, it has been shown to have good relative validity for assessing dietary food group and added sugar intake when compared against three 24-hour recalls.¹²¹ We further examined intake as both absolute amounts of food groups and food group intake standardized per 1,000 calories. Although our results indicate that children in our sample did not meet recommended intake levels for vegetables, whole grains, or added sugars,¹²³ these findings are consistent with data from the 2003-2004 National Health and Nutrition Examination Survey (NHANES)¹²⁵ as well as other studies that have used the BKFS.^{120,121}

This is the first study to examine the FNPA screening tool in association with dietary intake. We found that some, but not all, FNPA factors were associated with dietary intake in a sample of rural children. Specifically, more favorable FNPA factors were associated with higher intakes of fruits, vegetables, and dairy, and lower intake of added sugar. Future studies on the relationship between FNPA factors and risk for obesity would benefit from the inclusion of objective measures of children's diet and activity habits, as well as BMI, to clarify which FNPA components are most central to the relationship with child weight status and related health outcomes. Research including

larger, demographically diverse samples is also recommended. Finally, although we found no association between food insecurity and children's dietary intake, more research is warranted. Rural populations experience higher rates of food insecurity compared to other populations;⁴⁴ thus, examining this association in rural settings is particularly important.

Table 4.1. Characteristics of rural elementary-age children

Characteristic	n	Mean (SD) or %
Age (years), mean	102	8.5 (2.0)
Sex, %	102	
Female	47	46.1
Male	55	53.9
Race, %	98	
White	91	92.9
Other	7	7.1
Ethnicity, %	99	
Latino	7	7.1
Non-Latino	92	92.9
Parent education, %	102	
Grade 12 or less	11	10.8
1-3 years of college	45	44.1
4 or more years of college	46	45.1
Eligible for free/reduced school meals, %	101	
Yes	47	46.5
No	54	53.5
At-risk for food insecurity, %	100	
Yes	28	28
No	72	72
BMI, mean	82	18.4 (4.0)
BMI percentile, mean	82	65.1 (27.7)
Underweight, %	2	2.4
Normal weight, %	53	64.6
Overweight, %	13	15.9
Obese, %	14	17.1
BMI z-score, mean	82	0.6 (1.1)
FNPA score, mean	100	
FNPA: Total ^a	100	3.3 (0.3)
FNPA: Nutrition ^b	100	3.3 (0.3)
FNPA: Activity ^c	100	3.2 (0.4)

^aFamily Nutrition and Physical Activity: Total; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

^bFNPA: Nutrition; Nutrition component; average of 10 FNPA nutrition items

^cFNPA: Activity; Physical Activity component; average of 10 FNPA physical activity items

Table 4.2. Dietary intakes from the Block Kids Last Week Food Screener in a sample of rural elementary-age children (n=95)

Dietary Intakes	Study Sample		Recommended^a
	Mean (SD)	Mean (SD) per 1,000 kcal	per 1,000 kcal
Fruits (cups/day)	1.63 (0.99)	1.33 (0.68)	1.07
Vegetables (total)^b (cups/day)	0.98 (0.50)	0.84 (0.37)	1.07
Whole Grains (oz/day)	0.70 (0.60)	0.61 (0.49)	1.79
Dairy (cups/day)	1.84 (0.91)	1.55 (0.65)	1.79
Protein Foods (oz/day)	2.26 (1.38)	1.88 (0.80)	2.86
Added Sugar (tsp/day)	5.42 (3.02)	4.55 (2.13)	2.59
Energy (kcal/day)	1193 (410)	---	---

^aRecommended Intakes based on Dietary Guidelines for Americans 2010 (p. 78) and Estimated Energy Requirements for sedentary male/female aged 8 yrs (1400 kcal)

^bIncludes potatoes and legumes

Table 4.3. Multivariable linear regression examining associations between FNPA factors and at-risk for food insecurity with dietary intakes in a sample of rural elementary-age children (n=95)

Variable	Fruits (cups/day) per 1,000 kcals ^a		Vegetables (cups/day) per 1,000 kcals ^b		Whole grains (oz/day) per 1,000 kcals ^c	
	β Coef	p-adj [†]	β Coef	p-adj	β Coef	p-adj
FNPA: Total	0.58	0.07	0.29	0.04*	0.01	0.95
FNPA: Nutrition	0.71	.01*	0.31	0.07	-0.08	0.80
FNPA: Meal Patterns	0.20	.01*	0.08	0.12	0.01	0.93
FNPA 1: My child eats breakfast	0.24	0.04*	0.10	0.18	0.13	0.14
FNPA 2: Our family eats meals together	0.25	0.04*	0.10	0.16	-0.06	0.73
FNPA: Eating Habits	0.16	0.16	0.04	0.68	-0.05	0.68
FNPA 3: Our family eats while watching TV	0.18	0.16	0.01	0.95	0.00	0.97
FNPA 4: Our family eats fast food	0.26	0.44	0.12	0.55	-0.17	0.24
FNPA: Food Choices	0.24	0.04*	0.15	0.000***	-0.02	0.86
FNPA 5: Our family uses microwave or ready to eat foods	0.12	0.68	0.20	0.06	-0.09	0.70
FNPA 6: My child eats fruits and vegetables at meals or snacks	0.33	0.000***	0.17	.01*	0.01	0.95
FNPA: Beverage Choices	0.03	0.84	-0.03	0.68	-0.01	0.95
FNPA 7: My child drinks soda pop or sugar drinks	0.30	0.16	0.11	0.37	0.20	0.16
FNPA 8: My child drinks low fat milk at meals or snacks	-0.03	0.86	-0.06	0.35	-0.06	0.61
FNPA: Restriction/Reward	0.09	0.56	0.08	0.16	-0.03	0.80
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.10	0.56	0.11	0.06	0.01	0.95
FNPA 10: Our family uses candy as a reward for good behavior	0.06	0.72	.03	0.84	-0.09	0.61
FNPA: Activity	0.23	0.45	0.14	0.16	0.07	0.80
At-risk for Food Insecurity	0.20	0.49	0.04	0.87	-0.10	0.68

Table 4.3 (Continued).

Variable	Dairy (cups/day) per 1,000 kcals ^d		Protein Foods (oz/day) per 1,000 kcals ^e		Added Sugar (tsp/day) per 1,000 kcals ^e	
	β Coef	p-adj	β Coef	p-adj	β Coef	p-adj
FNPA: Total	0.21	0.68	-0.03	0.95	-2.81	0.01*
FNPA: Nutrition	0.31	0.56	0.15	0.84	-2.50	0.04*
FNPA: Meal Patterns	0.04	0.86	0.09	0.62	-0.63	0.16
FNPA 1: My child eats breakfast	-0.07	0.87	0.18	0.16	-0.69	0.45
FNPA 2: Our family eats meals together	0.12	0.57	0.06	0.86	-0.87	0.24
FNPA: Eating Habits	0.01	0.95	0.08	0.72	-0.57	0.16
FNPA 3: Our family eats while watching TV	-0.04	0.90	0.12	0.68	-0.66	0.24
FNPA 4: Our family eats fast food	0.07	0.86	0.08	0.88	-0.82	0.24
FNPA: Food Choices	-0.06	0.68	0.13	0.38	-0.79	0.01*
FNPA 5: Our family uses microwave or ready to eat foods	-0.04	0.93	0.16	0.72	-1.39	0.04*
FNPA 6: My child eats fruits and vegetables at meals or snacks	-0.09	0.68	0.14	0.49	-0.78	0.06
FNPA: Beverage Choices	0.25	0.000***	-0.14	0.24	-0.06	0.91
FNPA 7: My child drinks soda pop or sugar drinks	0.04	0.93	0.12	0.80	-1.37	0.04*
FNPA 8: My child drinks low fat milk at meals or snacks	0.29	0.000***	-0.20	0.16	0.23	0.68
FNPA: Restriction/Reward	0.04	0.84	0.02	0.93	-0.40	0.38
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.15	0.32	-0.01	0.95	-0.74	0.16
FNPA 10: Our family uses candy as a reward for good behavior	-0.15	0.34	0.07	0.84	0.05	0.95
FNPA: Activity	0.06	0.86	-0.12	0.82	-1.68	0.04*
At-risk for Food Insecurity	-0.08	0.86	0.20	0.68	-0.15	0.88

^aClustered for multiple children in families and adjusted for child sex

^bClustered for multiple children in families and adjusted for child race/ethnicity, age, and school

^cClustered for multiple children in families

^dClustered for multiple children in families

^eClustered for multiple children in families

^gClustered for multiple children in families and adjusted for parent education and school

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

†FDR-adjusted p-value

FNPA: Total; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: Nutrition; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: Meal Patterns; Family Meal Patterns; average of 2 items: My child eats breakfast + Our family eats meals together

FNPA: Eating Habits; Family Eating Habits; average of 2 items: Our family eats while watching TV + Our family eats fast food (both items reverse coded)

FNPA: Food Choices; average of 2 items: Our family uses microwave or ready to eat foods (reverse coded) + My child eats fruits and vegetables at meals or snacks

FNPA: Beverage Choices; average of 2 items: My child drinks soda pop or sugar drinks (reverse coded) + My child drinks low fat milk at meals or snacks

FNPA: Restriction and Reward; average of 2 items: Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior (reverse coded)

FNPA: Activity; FNPA Physical Activity component; average of 10 FNPA physical activity items

CHAPTER 5. GENERAL CONCLUSION

Childhood obesity remains a public health priority.^{1,2,13} Prevention recommendations advocate for social ecological approaches,^{7,14} yet limited research has examined the role of the family-home environment.⁴⁰ Disparities in obesity prevalence suggest a one-size-fits-all approach to prevention may not suffice.^{3,24,27,28} Central to this dissertation is the disparity among rural children, who experience higher rates of obesity compared to non-rural children.²⁹⁻³³

Little is known about how rural family-home environments may influence obesity-preventing and -promoting behaviors. Therefore, the purpose of this dissertation was to examine whether and how family-home environmental and behavioral factors are associated with body mass index (BMI, standardized for sex and age) and food insecurity in rural children. Specifically, this research assessed family-home factors that are important for the development of healthy eating and physical activity habits and examined associations with child BMI, dietary intakes, and family food security. Additionally, this study explored parent/caregiver insights on supports for and barriers to healthy eating and activity habits in rural family-home environments. Investigating these relationships allowed for exploration of how family-home factors are associated with children's nutrition- and activity-related behaviors, and for identification of potentially modifiable factors that may influence opportunities for children to eat healthfully and be physically active at home.

This dissertation was a mixed methods project. Data were collected from families and elementary-age children in the context of a larger, community-based participatory research project in rural Oregon communities. For the quantitative phase of this study, associations between family nutrition and physical activity (FNPA) factors, child BMI and family food security were examined. We hypothesized that favorable FNPA factors would be inversely associated with BMI, cross-sectionally and prospectively over one year, and inversely associated with food insecurity. We further hypothesized that risk for food insecurity would be positively associated with BMI. Our results indicated no significant associations between FNPA and BMI or between FNPA and food insecurity. An unexpected finding was the modifying effect of eligibility for the free- or reduced-cost school meals program on the association between family food security and child obesity. Specifically, higher BMI tended to be associated with greater odds of being at-risk for food insecurity among children who were ineligible to receive free or reduced school meals ($p=0.07$). This tendency between BMI and food insecurity was not observed among children eligible to receive free or reduced school meals. These findings suggest that the impact of the federal school meals program warrants further exploration.

The quantitative study also examined children's dietary intakes in association with FNPA and food insecurity, respectively. The hypotheses were that more favorable family environments would be associated with healthier dietary intakes and that being at-risk for food insecurity would be associated with less healthy dietary intakes. Findings indicated that more favorable FNPA factors were associated with higher consumption of

fruits, vegetables, and dairy, and with lower intake of added sugar. We found no associations between FNPA factors and intakes of whole grains or protein foods. We also found no associations between family food security and children's dietary intakes.

The qualitative phase of this study involved nine semi-structured focus group interviews, conducted across six rural communities, to explore parent/caregiver perceptions of factors that influence behaviors related to nutrition and physical activity in the family-home environment. The primary research questions were a) how do rural family-home practices and policies influence eating and activity behaviors and b) how do rural family-home environments facilitate and/or hinder healthy eating and activity behaviors?

We developed a codebook with pre-determined descriptive codes, including constructs from the FNPA instrument used in the quantitative phase of this study as well as perceived supports and barriers in the family-home environment, to identify text and capture major themes from the focus groups. Multiple themes emerged and were grouped into two broad theoretical categories around family-home: a) behavioral factors and b) environmental factors. Results were further organized according to the two topical categories addressed by this study, namely; nutrition and physical activity. Within the behavioral category, four themes emerged as important influences on family nutrition and physical activity including *family eating habits*, *food procurement*, *family physical activity*, and *screen time*. Within the environmental category, eight themes emerged from an exploration of factors perceived as supports and/or barriers to family nutrition and

physical activity, including *seasonal variation, features of home, distance from resources, foods and beverages encouraged and discouraged, screen time limits, financial constraints, outdoor safety, and schedule constraints.*

Our qualitative findings offered insights that can be used to design intervention strategies for rural families and to inform future research, including considerations for quantitative measurement of children's eating and activity behaviors that may be important when studying associations with BMI. Many overlapping and interrelated factors that influence eating and activity habits were identified, suggesting that future research and public health programs address nutrition and activity environments and behaviors together versus separately (e.g., nutrition or physical activity). Supports and barriers were also interrelated and overlapping, suggesting that consideration for the unique strengths and challenges of rural living is essential for effective intervention design.

The qualitative results also provide insight on possible explanations for our quantitative findings. For example, consistent with the quantitative finding that FNPA scores were high (i.e., favorable) overall and positively associated with children's dietary intakes, focus group participants expressed values for eating healthfully and being physically active. Further, they reported family-home practices and policies that are positively associated with children's development of weight-healthy behaviors. Together, these findings suggest that rural family-home environments support weight-health; however, the lack of association between FNPA and BMI suggests that the factors

measured in our study may not represent the most critical family-home factors related to children's BMI or that our study was either underpowered and/or lacking in duration necessary to observe a significant effect. Alternatively, as suggested by focus group participants, barriers to healthy eating and activity behaviors for rural families and children may exist outside the family-home environment (e.g., school and community factors). Conversely, our study may not have captured a potential association between family-home factors and BMI for other reasons. For example, data were collected during summer and fall, yet focus group participants reported barriers to healthy eating and physical activity behaviors specific to the winter season. Thus, our data may have captured seasonal patterns in family-home factors and related dietary behaviors, which may or may not reflect the most typical patterns.

Theoretical Connections

Two theoretical perspectives informed this study of whether and how family-home environmental and behavioral factors are associated with BMI in rural children. The first, an ecological perspective, suggests that health behaviors, such as healthy eating and physical activity, are determined by interactions with multi-level factors of influence.^{47,48,51} Our quantitative findings support associations between family-home factors, such as family meal patterns and food choices, and children's eating habits. Furthermore, though we did not explicitly inquire about influences outside of the family-home environment, our qualitative findings revealed rural community-level factors that influence family-home environments, including access to food and physical activity

resources. From a social ecological perspective, families may struggle to promote healthy eating and activity behaviors in the family-home due to external factors, despite parental value for and intent to provide a healthy home environment. Ultimately, this may influence rural children's opportunities to develop healthy eating and physical activity habits.

The second theoretical perspective that informed this dissertation, Social Cognitive Theory, suggests that people learn from experiences and regulate behaviors based on interrelationships between individual factors, environmental factors, and behaviors.^{47,48,50} In the context of this theory, children's eating and activity behaviors (e.g., low-fat milk consumption, leisure-time physical activity) are interrelated with family behavioral factors (e.g., family meal patterns, family physical activity) and home environmental factors (e.g., availability of food and physical activity resources). To a certain extent, the insights from our qualitative study support the quantitative results that demonstrated more favorable family-home environments were positively associated with children's dietary behaviors. Despite the challenges identified, parents generally expressed strong values for healthy eating. For the most part, they described family-home environments that promoted children to develop healthy eating habits primarily due to availability of healthy foods and family meal patterns. Some insights, however, suggest that other family-home factors, such as parental feeding practices and policies, may negatively influence children's eating behaviors. Our qualitative findings also suggest that families may differently prioritize eating and activity policies and practices.

Recommendations for Future Research

Recommendations for future research are discussed throughout the manuscripts in this dissertation. Findings from this study have implications for observational and intervention studies. Our quantitative findings support associations between certain factors in the family-home environment and children's dietary intake. Future investigations may benefit from the use of more comprehensive measures of home- and community-level nutrition and activity environments as well as objective measures of children's diet and activity habits, accounting for seasonal variations, in addition to BMI. Our qualitative findings support relationships between children's diet and activity behaviors and family-home environmental factors, consistent with social cognitive theoretical constructs of reciprocal determinism and observational learning. Future studies may examine additional constructs, including behavioral capability, expectations, and self-efficacy, to clarify the role of the family-home environment in children's development of weight-healthy behaviors.

The association between food insecurity and obesity also warrants further investigation, particularly in rural populations, as rates of obesity,³³ food insecurity⁴⁴ and poverty⁴³ are higher compared to other populations. Studies may benefit from detailed assessment of food security status and should consider the potential effect modification of federal food assistance programs. Related to this, future research examining obesity prevalence in rural populations and/or the influence of family-home factors on risk for obesity may also benefit from exploring perceptions among families with diverse SES

characteristics. Although our quantitative study sample was relatively economically diverse, the focus group participants represented primarily higher SES families. Thus, our sample may have masked greater challenges faced by families with fewer resources. Future studies may consider examining differences in supports and barriers for healthy eating and physical activity across demographic groups.

This dissertation provides direction for future interventions that may positively impact family-home nutrition and activity environments, particularly in rural Oregon communities. Potential interventions include parent-targeted strategies that integrate educational guidance for promoting healthy eating and activity behaviors along with environmental strategies to modify the family-home environment such that it favors weight-healthy behaviors. For example, families in rural Oregon may benefit from strategies designed to address perceived challenges related to screen time reduction and seasonal changes in eating and activity habits. Finally, our findings highlight the continued need for obesity prevention efforts that include and extend beyond the family-home to involve schools and communities. Multi-level interventions may be particularly important for rural families, as they often have limited access to resources that facilitate opportunities to engage in healthy eating and physical activity practices outside of the home.

Final Conclusions

Obesity and food insecurity are public health issues that impact the current and future health of many children in the US. Rural populations experience disproportionate

rates of childhood obesity and food insecurity. Causality, much less a solution, has yet to be determined. This mixed methods dissertation explored the relationship of family-home environmental and behavioral factors on childhood obesity and food insecurity among families in rural Oregon. Although our quantitative findings do not support associations between family-home factors and BMI or food insecurity, our results provide evidence that certain factors in the family-home are associated with children's dietary behaviors. Furthermore, our qualitative findings suggest that rural parents perceive opportunities for children to eat healthfully and be physically active are influenced by factors internal and external to the family-home. Understanding how family-home and other environmental factors influence children's healthy eating and activity behaviors and future health outcomes, as well as how public health efforts may support families in navigating challenges specific to rural areas, is an important area of research that warrants further exploration.

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APPENDICES

APPENDIX A. LITERATURE REVIEW

Prevalence and Consequences of Childhood Obesity

Over the past three decades, the prevalence of childhood obesity in the United States has increased considerably. Data from the 1976-1980 National Health and Nutrition Examination Survey (NHANES) indicate that approximately 5% of U.S. youth aged 2-19 years were obese, defined as a body mass index (BMI) at or above the 95th percentile of the sex-specific CDC BMI-for-age growth charts.⁸² In contrast, approximately 17% of U.S. youth were obese in 2011-2012.³ Rates were highest among non-Hispanic black and Hispanic youth compared to those who were non-Hispanic white or non-Hispanic Asian, and higher among youth aged 6-11 years and 12-19 years compared to those aged 2-5 years.³ These data demonstrate that childhood obesity has become highly prevalent in the U.S., with varying rates by age and race/ethnicity.

National data also indicate that obesity prevalence is higher among rural children compared to their non-rural counterparts.²⁹⁻³¹ An analysis of the 2003 National Survey of Children's Health (NSCH) by Lutfiyya and colleagues³¹ found that rural children five years of age and older were 25% more likely to be overweight or obese than children living in urban areas. A more recent study by Liu and colleagues,²⁹ utilizing the 1999-2006 National Nutrition and Health Examination Survey (NHANES), found that prevalence of both overweight and obesity were higher among rural compared to urban children. Rural children had 30% higher odds of being overweight and/or obese, even after adjustment for sociodemographics and obesity-related health behaviors.

Childhood obesity is associated with a number of negative health and developmental outcomes. Obese children are at greater risk for cardiovascular disease,⁶ type 2 diabetes,⁴ breathing problems,¹³⁵ musculoskeletal problems,⁸³ as well as fatty liver disease, gallstones, and gastro-esophageal reflux.^{4,13} Children who are obese are also more likely to become obese adults,^{5,136,137} with increased morbidity and mortality risks.^{138,139} In addition to health consequences, childhood obesity has been associated with greater risk of social and psychological problems.^{4,84,85,140} Furthermore, evidence suggests a negative association between academic achievement and overweight status during childhood.^{9-12,141}

The economic impact of childhood obesity is also a concern. The estimated annual cost of obesity-related illness, based on data from the Medical Expenditure Panel Survey, was \$190 billion (2005 dollars), or approximately 20% of annual health care expenditures in the U.S.⁷ Another recent study estimated the incremental lifetime direct medical cost for an obese child to be \$19,000 (2012 dollars) compared to a normal weight child who maintains normal weight throughout adulthood (or \$12,660 compared to a normal weight child who gains weight throughout adulthood).⁸ Assuming the lifetime medical cost estimate of \$19,000 multiplied times the current number of obese 10-year-old children, the authors estimated the total direct medical cost of obesity to be roughly \$14 billion for this age cohort alone. Notably, these cost estimates do not account for obesity's effect on health-related quality of life or on nonmedical costs, such as decreased productivity and increased absenteeism.

Reducing the prevalence of childhood obesity is a public health priority. The U.S. Department of Health and Human Services Healthy People (HP) 2020 specifies objectives for reducing the proportion of children and adolescents who are obese (Objective NWS-10).¹ Furthermore, an overarching goal of HP 2020 stipulates the elimination of health disparities, such as obesity rates that disproportionately affect sub-populations of children. Attainment of these goals may help to improve the health of the U.S. population and to decrease the social and economic burden associated with obesity. The prevalence of childhood obesity among rural populations suggests rural children may be at risk for the negative physical, developmental, and economic consequences associated with being overweight. The explanation as to why obesity rates are higher among rural compared to urban children is unclear, however. In order to reduce obesity prevalence in this population, a better understanding of obesity-promoting factors specific to rural settings is essential.

Origins of Childhood Obesity

By simple definition, obesity results from an energy imbalance. That is, a surplus of energy intake coupled with insufficient energy expenditure leads to weight gain over time. Indeed, individual health behaviors such as diet and physical activity practices have been associated with risk of obesity.^{7,15-18} In general, U.S. children and adults consume excess calories and spend too little time being physically active.¹⁴ A host of other factors that affect individual susceptibility to weight gain, including, but not limited to, genetic variation, epigenetic gene regulation, birth weight, endocrine disruption,

infections, and sleep duration may also influence obesity risk.^{5,67,123,138,142} Therefore, the simplistic calorie imbalance explanation is likely insufficient to explain the high prevalence of childhood obesity in the U.S.

An alternative explanation is that risk for obesity is influenced by a complex interplay between biological, behavioral, social, environmental, and economic factors that together promote weight gain.¹³ This is consistent with a social ecological perspective, which considers interactions and influences between individuals and their interpersonal relationships, the organizations and environments in which they work and play, as well as social and cultural norms.⁴⁹ According to this perspective, behaviors related to weight maintenance (i.e., diet and physical activity) may be challenging to practice or change at the individual level, particularly in the absence of a supportive environment. As articulated by the Institute of Medicine,⁷ “Taking a population approach to obesity prevention is not to deny the importance of genetic or biological factors, but to recognize the difficulty of maintaining energy balance when sedentary lives are the norm and high-calorie foods are ubiquitous.” Hence, social ecological approaches that target multiple levels of influence have been recommended to prevent childhood obesity.¹⁴

Numerous social, environmental, political, and economic factors have been associated with risk of childhood obesity, primarily due to influences on food and physical activity behaviors. One of the earliest and most influential social and environmental contexts affecting health behavior is the family home. Parents and caregivers can strongly influence children by teaching and encouraging healthy

behaviors, values, and attitudes, providing opportunities to practice behaviors, and by serving as role models. With regard to child eating behaviors, social influences include parental education and role modeling,^{87-91,143-145} family food rules,^{87,92} and family meal patterns.^{93-96,111} Likewise, parental modeling of physical activity and limiting of screen time have been associated with physical activity levels and sedentary time among children.^{92,97,98} Additional factors in home environment, such as availability of unhealthy foods (e.g., sweet and savory snacks and soft drinks),^{97,144-148} availability of healthy foods (e.g., fruits and vegetables),^{87,91,99,145,146} eating while watching TV,¹⁰⁰ fast food consumption,^{88,100} availability of media equipment,⁹⁸ and availability of physical activity equipment^{98,101} may make it easier or harder for children to eat well or be physically active.

Beyond the home environment, access to and availability of opportunities to eat healthfully and be physically active within school and community settings also influence obesity-related behaviors among children.¹⁴ School practices, policies, and physical environmental features may hinder or support healthy eating and physical activity habits. Contributing factors include availability of competitive foods (e.g., calorie-dense snacks and beverages sold outside of the school meals program), provision of healthy school meals, participation in farm-to-school programs and school garden programs, curriculum standards for nutrition and physical activity education, and frequency, intensity, and duration of physical activity at school.¹⁴²

At the community level, environmental attributes associated with opportunities to be physically active include access to safe recreation, accessibility of recreation facilities, and active transportation options.⁸⁹ Community features associated with eating behaviors include proximity of supermarkets and grocery stores, availability of healthy options at food outlets, and access to restaurants and fast food establishments.^{89,149} At the broader social, political, and economic levels, food choices may be influenced by food marketing and portion sizes,^{148,149} food prices,^{89,130,149} and food assistance programs.¹⁴⁹ Aspects that make it more or less difficult to be physically active include population density and land use policies.⁸⁹

Furthermore, risk for obesity has been associated with multiple socioeconomic factors including race-ethnicity, gender, and income and education levels, with the highest rates of obesity generally occurring among the most disadvantaged groups.^{19,130} Findings from a study of the National Survey of Children's Health indicated that children from low-income and low-education households had 3.4-4.3 times greater odds of obesity than children from higher SES households.²⁴ Yet another important socioeconomic factor that has been associated with both income and obesity is food insecurity.²¹⁻²³

Food insecurity is a lack of consistent access to enough food to support an active, healthy life. In 2012, approximately 14.5% of U.S. households (17.6 million households) and 15.9% of the U.S. population (33.1 million adults and 15.9 million children) were food insecure.⁴⁴ Prevalence of food insecurity differed according to individual and household demographic variables including gender, race-ethnicity, and family status.

However, food insecurity was most strongly associated with income; households below the federal poverty threshold experienced significantly higher rates compared to those with incomes above 185% of the poverty line. Rates of food insecurity were also above the national average for all households with children (20.0%). Geographically, food insecurity was highest among households located in large cities (16.9%) and rural areas (15.5%) compared with suburban and exurban areas around large cities (12.7%). Regionally, prevalence was highest in the South (16.0%) compared to the West (14.4%), Midwest (14.2%) and Northeast (11.9%). Oregon exceeded national averages with 16.7% (653,000 people) of the total population and 27.3% (235,410) of children food insecure in 2012.⁴⁶

Food insecurity has been associated with multiple adverse health effects among adults and children in the U.S. For example, in adults, food insecurity has been associated with negative health outcomes such as diabetes,¹⁵⁰ heart disease,¹⁵¹ and depression.¹⁵² Child food insecurity has been associated with poorer health status,⁵⁴ iron deficiency anemia,⁵⁹ developmental and mental health problems,^{56,57,60} and poor educational outcomes.^{55,58,61} Food insecurity has also been associated with overweight and obesity among both adults and children, with the strongest evidence for this association among adult women.²³

Multiple review studies have concluded that the relationship between food insecurity with child overweight and obesity remains unclear.²¹⁻²³ Findings from more recently published research are also inconsistent. For example, among low-income

children aged 2-5 years, one study found that persistent household food insecurity was associated with greater odds of child obesity whereas another study with children of similar age and income status found no association between household food insecurity and child BMI.^{117,153} Yet another study found no association between food insecurity and obesity among children aged 2-5 years, yet there was an association among children 6-11 years of age.¹⁵⁴ Kirk and colleagues also found a positive association between food insecurity and BMI among elementary-aged children in Canada.¹⁵⁵ Reasons for contradictory findings among these and other studies include differences in study design, participant demographics, and measures of food insecurity and weight status.

Recent evidence suggests that diet and activity behaviors may differ between food-insecure and food-secure children. For example, Fram and colleagues found that greater levels of child food insecurity were associated with poorer dietary intake and lower levels of physical activity.²⁰ Another study found that food-insecure children did less moderate to vigorous physical activity compared to their food-secure counterparts.²⁵ Conversely, Trapp and colleagues found no difference in dietary intake patterns among children from food-insecure households compared to those from food-secure households.¹¹⁷

Food insecure populations may have greater risk of obesity due to additional risk factors associated with poverty,¹⁵⁶ including, but not limited to, fewer opportunities for physical activity^{26,127} and lack of access to healthy and affordable foods.^{19,128-132} Findings from further investigation into the relationship between food insecurity and childhood

obesity, including how food insecurity may be associated with family and child nutrition and physical activity practices, may support efforts to improve home environments and behaviors that, in turn, may enhance the health status of children living in food insecure households. Examining the associations between food insecurity and obesity in rural settings is particularly important as rural populations experience higher rates of poverty,⁴³ food insecurity,⁴⁴ and obesity^{29,42} compared to other populations.

Obesity in the Rural Context

Rural and urban are multidimensional concepts and, therefore, many definitions of “rural” exist.¹⁵⁷ In some cases, the definition concerns population density, in other cases geographic isolation. Depending on the definition, population thresholds used to differentiate rural and urban communities range from 2,500 to 50,000 people.¹⁵⁷

According to the U.S. Census Bureau, “‘rural’ encompasses all population, housing, and territory not included within an urban area.”¹⁵⁸ Rather than considering communities in terms of a rural-urban dichotomy, however, it is more helpful to think of them on a rural-urban continuum and small geographic scale, with communities falling along the continuum based on various contextual characteristics that are associated with most rural or urban definitions.¹⁵⁷

There is evidence that rural residency presents unique challenges for maintenance of healthy body weight, including cultural and structural barriers that influence diet and physical activity³⁴ as well as prevalence rates that indicate rural children may be disproportionately at risk for obesity.^{29,31} A limited amount of childhood obesity research

has focused specifically on rural populations, however. Furthermore, of the existing data on rural obesity, much of it has been gathered across different rural regions, states, and counties in the U.S. and therefore, findings may not be generalizable to all rural communities.

Similar to non-rural settings, evidence suggests that the behavioral correlates of obesity among adults in rural communities include being sedentary, ordering large portion sizes, eating while doing other activities, watching TV, and consuming sugar-sweetened beverages (SSB).^{16,35} Some obesity-related behaviors may be more prevalent among rural populations, however. For instance, Sharkey and colleagues¹⁵⁹ found that prevalence of SSB consumption may be higher in some rural compared to urban areas. Furthermore, high levels of SSB consumption in rural areas has been associated with low SES, having children in the home, frequent consumption of fast-food meals, infrequent breakfast meals, low fruit and vegetable intake, and household food insecurity.^{159,160} Whereas obesity-promoting behaviors may be similar between rural and non-rural populations, other influential factors may differ such that these behaviors may be promoted to a greater extent in rural settings.

For example, rural populations experience unique environmental correlates of obesity. Perceptions of rural residents specify several factors that hinder physical activity, including lack of or distance to recreational facilities; lack of adequate sidewalks and bike lanes; safety concerns related to crime, strangers, and traffic; schedule conflicts and lack of time; and inadequate physical education;³⁵⁻³⁸ whereas factors that facilitate

physical activity include popularity of youth sports and proximity to natural areas.^{37,38} Barriers to healthy eating include limited availability and high cost of food,^{36,37,161,162} travel distance to acquire food or access a supermarket,^{36,162} and busy lifestyles;^{37,161} as well as school-level factors including convenience stores near schools and limited healthy food choices at school.³⁷ Factors that may facilitate healthy eating in rural places include the agricultural setting and popularity of gardening.³⁷

Empirical evidence suggests that correlates of obesity may differ among rural children compared to children living in urban areas. For example, Lutfiyya and colleagues³¹ found that rural overweight children were more likely to be white, live in low-income households ($\leq 200\%$ of the federal poverty level), have no health insurance, have not received preventive health care in the past 12 months, be female, use a computer for non-school work more than 3 hours per day, and watch TV for more than 3 hours per day. Findings from another study revealed that rural children consumed 90 more kcal/day than urban children did, and they were more likely to consume the recommended amount of dairy per day.²⁹ Among 12-19 year olds, rural youth were less likely to consume any fruit or meet daily recommendations for fruit consumption. Additionally, more rural children reported participating in exercise 5 or more times per week than urban children of the same age. After adjustment for sociodemographics and health behaviors however, rural children had 30% higher odds of being overweight and/or obese compared to their urban counterparts.

Taken together, existing evidence suggests that rural community-level factors present unique challenges for being active and eating healthfully, and that rural children may differ individually and behaviorally from their urban peers. The recent findings by Liu and colleagues²⁹ indicate that obesity-related risks associated with rural residency are not yet well defined, however, and suggest that factors beyond the individual-level may contribute to childhood obesity risk in rural environments. Further exploration of rural social and environmental characteristics associated with children's obesity-related behaviors may reveal additional factors associated with rural residency.

Childhood Obesity Prevention

Childhood obesity prevention efforts aim to prevent children from gaining excessive body weight and reduce risk of developing obesity. School and home environments are key behavioral settings that influence risk for childhood obesity,¹⁴ and have become primary targets for prevention efforts that aim to modify diet, physical activity, sedentary activity, or a combination thereof.³⁹ To date, however, relatively few studies have examined childhood obesity prevention in the home setting compared to the school setting.^{39,40}

Results from a recent systematic review of childhood obesity interventions demonstrated that the strength of the evidence was high that school-based diet and physical activity interventions that include a home and community component prevent obesity.³⁹ The strength of the evidence to support that school-based interventions alone contribute to obesity prevention was moderate, and the strength of the evidence to

support the effectiveness of home-based programs on childhood obesity prevention was low.^{39,40} Although this finding was partly due to the small number of published studies on home-based programs, Showell and colleagues⁴⁰ reported that several of the home-based studies targeted individual behavior change without modifications to the child's food or physical activity environment. Accordingly, the authors recommend addressing home environmental influences on obesity-risk behaviors as an important area for future research to guide effective prevention efforts. Although childhood obesity prevention appears to be most effective when approached from a multi-level perspective, a better understanding of the family home environment, specifically, may inform future efforts to facilitate collaborative prevention efforts between communities, schools, and homes thereby enhancing the promotion of healthy weight behaviors with consistent supports across multiple levels of influence.

Emphasis on the Family Home Environment

The literature supports associations between childhood obesity and family-level practices (e.g., meal patterns) as well as certain aspects of the home environment (e.g., availability of healthy foods); however, a limited number of instruments exist to capture a comprehensive picture of the home environment as it relates to nutrition and physical activity behaviors and, therefore, childhood obesity. In a recent systematic review, Pinard and colleagues examined measures of the home environment related to childhood obesity and the degree to which they can validly and reliably assess the home environment.⁷⁸ Findings revealed that many current measures of the home food and

physical activity environment focus on only one or two constructs (e.g., emphasis on fruit and vegetable consumption). The authors recommended that more comprehensive measures as well as short screeners are needed to capture home environmental influences on food and activity behaviors of children. Notably, they also concluded that existing measures of the home environment do not necessarily translate to specific sub-populations that experience obesity at disproportionate rates.

The Family Nutrition and Physical Activity (FNPA) survey is a simple screening tool with evidence of validity for identifying at-risk-for-overweight in children.^{63,64,74} The instrument assesses a composite of items related to practices and policies in the home environment, such as family eating habits (i.e., eating while watching TV, fast food consumption), meal patterns (i.e., breakfast consumption, family meal frequency), screen time behavior and monitoring (i.e., screen time per day, limits on TV time), and family activity involvement (i.e., family encourages child to be active, family finds ways to be physically active together). Ihmels and colleagues⁶⁴ demonstrated that total FNPA score explained unique variance in child BMI at one year, after adjustment for baseline BMI, parental BMI, and demographic variables. Although the FNPA was developed based on evidence-based factors in the family home nutrition and physical activity environment, the tool was validated with a sample of urban elementary-aged children. Before the instrument can be effectively and broadly utilized as a screening tool, additional research is necessary, including the need to evaluate utility in different populations and settings, such as families and children living in rural communities. Subsequently, the FNPA

screening tool may be useful for both researchers and practitioners to assess and promote health behaviors that reduce risk for child obesity in the context of the family home.

APPENDIX B. SURVEY INSTRUMENTS

GROW Healthy Kids & Communities Child Information Form (CIF)

1. What is <u>your child's</u> name? Last: _____ First: _____ Middle: _____	
2. What is <u>your child's</u> gender? <input type="checkbox"/> Female <input type="checkbox"/> Male	
3. What is your child's date of birth? ____ / ____ / ____ (month/day/year)	
4. What is your child's grade in school? <input type="checkbox"/> Kindergarten <input type="checkbox"/> 1 st grade <input type="checkbox"/> 2 nd grade <input type="checkbox"/> 3 rd grade <input type="checkbox"/> 4 th grade <input type="checkbox"/> 5 th	
5. What is the name of your child's classroom teacher? Last: _____ First: _____	
6a. Which of the following describes your child's following describes your ethnicity? <input type="checkbox"/> Hispanic or Latino <input type="checkbox"/> Not Hispanic or Latino Native	6b. Which one or more of the child's race? <u>(Check all that apply.)</u> <input type="checkbox"/> American Indian or Alaska <input type="checkbox"/> Asian <input type="checkbox"/> Black or African American <input type="checkbox"/> Native Hawaiian or Other
7. Does your child spend time living in more than one household? <input type="checkbox"/> Yes <input type="checkbox"/> No	
8. About how much time does your child live in <u>your</u> home? <input type="checkbox"/> 100% <input type="checkbox"/> 75% <input type="checkbox"/> 50% <input type="checkbox"/> 25% <input type="checkbox"/> Less than 25%	

Instructions: For each question, check the box ☒ for the answer that best fits your child. Choose the most common or usual pattern and not what you would like to happen.

	Almost Never	Some- times	Usually	Almost Always
9. My child eats breakfast...				

10. My child eats vegetables and fruits at meals or				
11. My child drinks soda pop or sugar sweetened				
12. My child drinks low fat milk at meals or				
13. My child spends less than 2 hours on				
14. My child does physical activity during his/her				
15. My child is enrolled in physical activity or sports programs with a				
16. My child gets at least 9 hours of sleep a night...				

GROW Healthy Kids & Communities Family Information Form (FIF)

1a. What is <u>your</u> name? Last: _____ First: _____ Middle: _____	
1b. What is your relationship to the child / children enrolled in the study? <input type="checkbox"/> Mother <input type="checkbox"/> Grandmother <input type="checkbox"/> Aunt <input type="checkbox"/> Other (describe) <input type="checkbox"/> Father <input type="checkbox"/> _____ <input type="checkbox"/> Uncle _____ <div style="text-align: center;">Grandfat</div>	
2a. Which of the following describes your ethnicity? <input type="checkbox"/> Hispanic or Latino <input type="checkbox"/> Not Hispanic or Latino	2b. Which one or more of the following describes your <u>(Check all that apply)</u> <input type="checkbox"/> American Indian or Alaska Native <input type="checkbox"/> Asian <input type="checkbox"/> Black or African American <input type="checkbox"/> Native Hawaiian or Other Pacific Islander <input type="checkbox"/> White
3. List the number of other adults that live in your home and care for your elementary age child. _____ Do not include yourself in this number.	
4. Of all adult caregivers living in your family home, what is the <u>highest</u> year of school completed? <input type="checkbox"/> Never attended school <input type="checkbox"/> Grades 9 through 11 <input type="checkbox"/> College 1 to 3 yrs (Some college or technical school) <input type="checkbox"/> Grades 1 through 8 <input type="checkbox"/> Grade 12 or GED (High school graduate) <input type="checkbox"/> College 4 yrs or more (College graduate)	

5. What best describes your family home?		
<input type="checkbox"/> Apartment	<input type="checkbox"/> Single family house	<input type="checkbox"/> Family farm
<input type="checkbox"/> Condominium	<input type="checkbox"/> Multi-family	<input type="checkbox"/> Other (describe)
6. What best describes the setting of your family home?		
<input type="checkbox"/> Wooded Setting	<input type="checkbox"/> Farmland	<input type="checkbox"/> Variable terrain (e.g. wooded and mountainous)
<input type="checkbox"/> Mountainous	<input type="checkbox"/> Neighborhood	<input type="checkbox"/> Other (describe)
7. If you are employed, how far must you travel to get to work?		
<input type="checkbox"/> 0 miles (work from home)	<input type="checkbox"/> 6-20 miles	<input type="checkbox"/> more than 30 miles
<input type="checkbox"/> 0-5 miles	<input type="checkbox"/> 21-30 miles	<input type="checkbox"/> Stay at home care provider to kids/other family
8. If you are employed outside the home, by what means do you travel to get to work?		
<input type="checkbox"/> walk	<input type="checkbox"/> alone in my own vehicle	<input type="checkbox"/> bus
<input type="checkbox"/> bike	<input type="checkbox"/> carpool	<input type="checkbox"/> Other (describe) _____

Please tell us about your family home food environment.

Instructions: For questions 5-10, check the box ☒ for the answer that best fits your family. Choose the most common or usual pattern and not what you would like to happen.

	Almost Never	Some- times	Usually	Almost Always
9. Our family eats meals together...				
10. Our family eats while watching				
11. Our family eats fast food...				
12. Our family eats fruits or vegetables ...				
13. Our family eats fruits or vegetables that we grow at home				
14. Our family eats foods that contain whole grains such as 100% whole wheat bread, pasta, tortillas, crackers				
15. Our family uses microwave or 'ready to eat' foods				

16. Our family monitors eating of chips, cookies,				
17. Our family uses candy or sweets as a reward for good behavior				

Please tell us about your family's ability to access food resources.

18. Are the children in your household eligible to receive free or reduced meals at school?		
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> I Don't Know
19. Within the past 12 months we worried if our food would run out before we got money to buy more.		
<input type="checkbox"/> Never True	<input type="checkbox"/> Sometimes True	<input type="checkbox"/> Often True
20. Within the past 12 months the food we bought just didn't last and we didn't have money to get more.		
<input type="checkbox"/> Never True	<input type="checkbox"/> Sometimes True	<input type="checkbox"/> Often True

Please tell us about your family activity environment.

Instructions: For each question, check the box ☒ for the answer that best fits your family. Choose the most common or usual pattern and not what you would like to happen.

	Almost Never	Some- times	Usually	Almost Always
21. Our family limits the amount of				
22. Our family allows our child to watch TV/games/computer in his/her				
23. Our family provides opportunities for physical				
24. Our family encourages our child to be active				
25. Our family finds ways to be physically active				
26. Our family actively participates in gardening activities such as weeding, digging, hoeing, planting, harvesting				
27. Our family has a daily routine for our child's bedtime				

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	HOW MANY DAYS LAST WEEK DID YOUR CHILD EAT OR DRINK IT?						HOW MUCH IN ONE DAY?										
	None last week	1 day last week	2 days last week	3-4 days last week	5-6 days last week	Every day last week											
Refried beans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Hamburgers, cheeseburgers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Hot dogs, corn dogs, or sausage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Lunch meat like boloney, ham, Lunchables	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Pizza or pizza pockets	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Spaghetti or ravioli with tomato sauce	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Macaroni and cheese	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Chicken, including nuggets, wings, tenders, also in sandwiches or stew	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Fish, fish sticks or sandwiches, tuna, shrimp	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Burritos or tacos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Beef like roast, steak or in sandwiches	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Meat balls, meat loaf, beef stew, Hamburger Helper	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Pork, like chops, roast, ribs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Popcorn	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Snack chips like potato chips, Doritos, Fritos, tortilla chips	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Ice cream	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Candy, candy bars	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Cookies, donuts, cakes like Ho-Hos	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Cheese. Remember cheese in sandwiches or nachos with cheese or quesadillas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
Whole wheat bread or rolls (NOT white bread)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>								
What kind of cereal did your child eat? (MARK ONLY ONE) <ul style="list-style-type: none"> <input type="radio"/> Plain Cheerios, Grape Nuts, Shredded Wheat, Wheaties, Wheat Chex, Kix <input type="radio"/> Honey Nut Cheerios, Cap'n Crunch, Lucky Charms, Life, Golden Grahams, Frosted Mini Wheats, Raisin Bran <input type="radio"/> Other sweet cereals, like Frosted Flakes, Froot Loops <input type="radio"/> Any other cereal, like Corn Flakes, Rice Krispies 																	
What kind of milk did your child drink? (MARK ONLY ONE) <table border="0"> <tr> <td><input type="radio"/> Whole milk</td> <td><input type="radio"/> Low fat 1% milk</td> <td><input type="radio"/> Chocolate milk</td> <td><input type="radio"/> Lactaid milk</td> </tr> <tr> <td><input type="radio"/> Reduced fat 2% milk</td> <td><input type="radio"/> Nonfat milk</td> <td><input type="radio"/> Soy milk</td> <td><input type="radio"/> Don't know</td> </tr> </table>										<input type="radio"/> Whole milk	<input type="radio"/> Low fat 1% milk	<input type="radio"/> Chocolate milk	<input type="radio"/> Lactaid milk	<input type="radio"/> Reduced fat 2% milk	<input type="radio"/> Nonfat milk	<input type="radio"/> Soy milk	<input type="radio"/> Don't know
<input type="radio"/> Whole milk	<input type="radio"/> Low fat 1% milk	<input type="radio"/> Chocolate milk	<input type="radio"/> Lactaid milk														
<input type="radio"/> Reduced fat 2% milk	<input type="radio"/> Nonfat milk	<input type="radio"/> Soy milk	<input type="radio"/> Don't know														

Please tell us about your child

Are they	<input type="radio"/> Male	<input type="radio"/> Female	How old are they?	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> 7	<input type="radio"/> 8	<input type="radio"/> 9	<input type="radio"/> 10	<input type="radio"/> 11	<input type="radio"/> 12	<input type="radio"/> 13	<input type="radio"/> 14	<input type="radio"/> 15	<input type="radio"/> 16	<input type="radio"/> 17
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APPENDIX C. FOCUS GROUP INTERVIEW GUIDE

GROW HKC Parent Focus Group Guide

This script is not intended to be delivered word-for-word. We understand conversations will vary across focus groups. This script should serve as a guide to ensure facilitators get sufficient and similar information across focus groups.

Introduction:

Facilitator: Hello and welcome. Thank you for volunteering to participate in our discussion today! My name is ____ and I will be our discussion moderator. I am a graduate student and research assistant for the GROW Healthy Kids and Communities study. The study aims to learn more about how kids eat, play, and grow in rural communities. I'd like to introduce my teammates, ____ and _____. We will be spending about 2 hours together today. During this time, we will be talking about how your family eats and plays together.

During today's discussion, we are interested in learning about your family's perspective on food, physical activity, and screen time practices, such as time spent watching TV or using computers. We also want to learn about how your family's food and physical activity practices might be affected by the community that you live in. For the purposes of this discussion, think of "family" as all the individuals that live in your household. We are interested in learning about food and physical activity practices as they happen in your family's home setting, and we are also interested in learning about your family's eating and activity practices outside of your home. As you consider the questions asked today, please think about all of the ways your family eats together and is active together.

There are no right or wrong answers. We are interested in hearing and learning about what you have to say. We all come from different backgrounds and may have very different experiences. We want to hear everyone's thoughts and be respectful of different opinions. Let us make sure we give each other a comfortable sharing space, and let us be mindful of how we use our time together. Please turn your cell phones or any other electronic devices to silent mode. We want this to be a conversational experience, but to facilitate our conversation without talking over each other, we ask that you select a die from the center of the table when you have something to say. I will then call on you when it is your turn to speak. How does that sound? We highly encourage that everyone

participates in answering every question but please know that you are not obligated to do that. If you have any questions at any point please don't hesitate to stop and ask me.

We want to remind everyone that you have already signed a consent document that indicates we can use the information collected today for research. In that same document we (the GROW project) committed to doing everything possible to ensure that your anonymity will be protected and that your identity will not be revealed in any of the data that we report. It is also very important that every person in this room respects the confidentiality of the discussion that takes place today. The conversation should not be shared outside this room.

My teammates, ____ and ____ will be taking notes during our conversation today. We will also be audio recording today's conversation so that we can be sure we accurately capture everyone's contributions to the discussion. We would like each person to choose a name, first name only, that you will use today. It may be your real name or a different name. Please write the name you choose on both sides of the place card and put it on the table in front of you so that everyone can see. We will use this name – your “stage name” for today – in our conversations. This way, individual participants will not be identifiable to us or any member of the research team when we listen to the recordings to confirm that we accurately captured the focus group discussion. Please remember to speak loudly and clearly so that the recording as well as our note takers can capture what you have to say.

Please remember to use the name on the place card when referring to yourself or anyone here by name. Does anyone have any questions before we get started?

Warm-up:

Because we will be discussing food and physical activity today, we thought it would be nice to introduce ourselves to one another by sharing briefly about what each of our families like to eat and like to do for activity. First, please use the colored pens/crayons provided to draw a picture of your family's favorite food or meal. It doesn't matter if it's healthy or not, just indicate your family's favorite food or meal. Next, draw a picture of your family's favorite “healthy” food or meal. Next, draw your family's favorite way to spend time together when you have free time. Last but not least, draw your family's favorite way to be physically active together. If you prefer, write out your answers instead of drawing pictures. Be as creative as you wish. Let's take 5 minutes to complete this activity and then we'll each share with the group.

OK, let's share. First, please tell us your name/pseudonym and then your family's favorite food or meal and favorite "healthy" food or meal.

Next, tell us your family's favorite way to spend time together when you have free time. Last but not least, what is your family's favorite way to be physically active together?

That was fun! Thanks, everyone, for sharing. Now, we'll move on to more in-depth discussion about how families eat and are physically active together. Please feel free to use the paper and pens provided to write down any questions, notes, or feedback. For example, we would like to know if you have ideas of other questions we should be asking, or if there is a different way we could ask the questions, as well as your overall experience as a participant in this discussion. I will collect any feedback at the end of our discussion.

Focus Group Discussion Questions:

1. First, we want to learn about your family's food patterns/habits and eating practices.
 - A. Think about your family in terms of the family group's food choices and eating habits. When we say "food" or "eating," we mean what family members eat and drink. We also mean where, when, and how the family eats, including meals and snacks, at home or away from home, together and each person individually. Again, keep in mind that we all eat differently and we may all define healthy eating differently. Please be respectful of other people's food choices during our conversation.

Prompts:

- For example, describe the types of foods and beverages your family typically eats. How are these typical eating and drinking habits encouraged in your family? How are they discouraged? How are eating habits the same or different for adults and children?
- Are food choices and eating habits always the same or do they change from day to day or month to month?
- What does mealtime look like in your family – what happens, when do meals happen, who is there, what are adults and children doing?

- B. How do aspects or features of your family home affect your family's eating habits? For example, think about you're the size or layout of your house, your kitchen, the place in your house where you eat...

Prompts:

- For example, let's talk about your kitchen – how do the features of your kitchen make it easier or harder to prepare meals and/or snacks? Why? What other aspects or features of your family home help or hinder your family's eating habits or food choices?

- C. How does your family get the food you eat?

Prompts:

- How often do you shop for food, and where? Can you always find the foods and beverages you want to find? What other items do you want to find? Does your family grow any food? What types of food does your family grow? Are there other ways your family gets the food you eat?

- D. When you think about healthy eating for your family, what does that mean?

Prompts:

- What are some of the foods and beverages that your family chooses when you eat healthfully? How is healthy eating the same or different for children and adults in your family?
- What are some of the ways healthy eating is made easier in your family? What are some of the things that get in the way of eating healthfully most every day for your family? What about family schedules, food preferences, shopping, and preparing meals? What about school meals?
- What are some things that would make eating healthfully most every day easier for your family?

2. Next, we want to learn about your family's physical activity habits.

- A. Please tell us about your family's physical activity time. When we say "physical activity," we mean any activity that involves moving your body. It can be to get to a destination, like walking to school or bicycling to work or to the store. It also can be for recreation, like playing sports or hiking in the woods; for health, like

walking, jogging, or exercise classes; or for labor, like yard work, house work, or even working on a farm.

Prompts:

- For example, describe all the different ways your family is physically active, individually and together as a group. Do activity levels change throughout the year? Why does or would your family participate in physical activities together? When your family isn't being active together as a family, how do you spend time together in other ways?
- What are some of the ways that physical activity is made easier in your family? What are some of the things that get in the way of being physically active most every day for your family? What about family schedules and favorite activities? What are some things that would make being physically active most every day easier for your family?

B. How are your kids physically active?

Prompts:

- How does your family encourage physical activity for your children? What type of before or after school programs in which your kids participate involve physical activity? How regular is their participation? If your kids don't participate regularly in programs that involve physical activity, what stops them from joining and participating in programs?

C. How do features of your family's home – the actual place you live - affect your family's participation in physical activities at home?

Prompts:

- Are there features of your home that help your family to be more active at home? How are your kids active in your house, in your yard, near your house, or in your neighborhood? Is this the same for every person in your family? What are some aspects of your family home that make it hard for your family to be active when at home?

3. Now, we want to learn about family screen time. By screen time, we mean use of technologies and electronic devices that have a screen, such as TVs, computers, iPads, gaming devices, and cell phones.

A. Please tell us about the electronic devices with a screen that your family has and uses.

Prompts:

- For example, what are the electronic devices your family uses together? What types of devices do your children use? When, where, how and for what purpose does your family and family members use electronic devices? In a typical day, how much time does your family spend using electronic devices? What about each family member? Is there anything you'd like to share regarding the amount of time your family spends using these devices?
 - How does the use of electronic devices affect physical activity in your family? What are some ways your family encourages less inactive or "sitting" time related to the use of electronic screen devices? What are some ways that your family uses these devices to be active? What makes it hard to be active while using electronic devices?
4. In summary, are there any other ways that healthy eating or physical activity is made easier or harder for your family? If you had a wish list to make healthy eating and physical activity easier for your family, what would be on the list?

APPENDIX D. GROW INTERVENTION DESCRIPTION

Utilizing a community-based participatory research (CBPR) approach, the GROW intervention was informed by local community members, and therefore, intervention activities and timeline differed for each community and school. At the community level, baseline data collection began in fall 2012, including assessment of rural community features viewed as obesity preventing or promoting and community resources and readiness to implement and support environmentally-based obesity prevention efforts. Assessment results were used to map access to healthy foods and active play spaces, to determine appropriate sites for changes to the built environment, and to generate community support for healthful eating and physical activity behaviors. At the school-level, child height and weight data were collected biannually and features of the school physical activity and nutrition environment were assessed annually, beginning in the 2012-13 academic year. Starting in 2013-14, school environmental assessment results were used to guide changes in the school environment to support healthful eating and physical activity behaviors, such as increasing the availability of healthy food options, growing school gardens, and improving active play spaces.

Parents completed annual assessments of the family nutrition and physical activity environment, beginning in fall 2013. The family-level intervention began in winter 2014, consisting of monthly nutrition- and physical activity-focused newsletters with behavioral and environmental strategies directed toward changing aspects of the home environment to support family and child energy balance. Control families received more general

newsletters about healthy eating and physical activity. Additionally, all enrolled families received a reusable lunch bag filled with small items to promote healthy activity and eating behaviors (e.g., Frisbee, water bottle, healthy snacks).

APPENDIX E. APPENDIX TABLES

Appendix Table 1. Unadjusted and adjusted multinomial logistic regression examining cross-sectional associations between family nutrition and physical activity (FNPA) and odds of being overweight or obese^a among rural elementary-age students (n=177)

Variable	Overweight (n=37)					
	Unadjusted			Adjusted ^b		
	OR	95% CI	p-adj	OR	95% CI	p-adj
FNPA: TOTAL	0.88	.32, 2.43	0.95	0.92	.34, 2.50	0.96
FNPA: NUTRITION	1.03	.36, 2.98	1.00	1.00	.34, 2.92	1.00
FNPA: Meal Patterns	0.90	.62, 1.30	0.88	0.84	.55, 1.28	0.87
FNPA 1: My child eats breakfast	0.82	.43, 1.56	0.88	0.70	.34, 1.44	0.83
FNPA 2: Our family eats meals together	0.93	.59, 1.48	0.95	0.91	.54, 1.52	0.95
FNPA: Eating Habits	1.02	.71, 1.47	0.98	1.03	.71, 1.50	0.96
FNPA 3: Our family eats while watching TV	0.96	.61, 1.51	0.96	0.94	.57, 1.54	0.95
FNPA 4: Our family eats fast food	1.22	.60, 2.48	0.89	1.31	.61, 2.80	0.87
FNPA: Food Choices	0.97	.69, 1.35	0.96	0.95	.67, 1.36	0.95
FNPA 5: Our family uses microwave or ready to eat foods	0.74	.41, 1.32	0.78	0.71	.41, 1.24	0.77
FNPA 6: My child eats fruits and vegetables at meals or snacks	1.14	.71, 1.83	0.89	1.15	.71, 1.86	0.89
FNPA: Beverage Choices	1.06	.79, 1.42	0.95	1.06	.78, 1.44	0.95
FNPA 7: My child drinks soda pop or sugar drinks	1.35	.69, 2.64	0.87	1.30	.67, 2.49	0.87
FNPA 8: My child drinks low fat milk at meals or snacks	1.00	.72, 1.39	1.00	1.00	.68, 1.48	1.00
FNPA: Restriction/Reward	1.05	.74, 1.50	0.95	1.08	.73, 1.60	0.95
FNPA 9: Our family monitors eating of chips, cookies, and candy	1.05	.68, 1.63	0.95	1.09	.66, 1.78	0.95
FNPA 10: Our family uses candy as a reward for good behavior	1.04	.60, 1.82	0.96	1.05	.59, 1.87	0.96

Appendix Table 1. (Continued).

FNPA: ACTIVITY	0.85	.40, 1.83	0.95	0.91	.42, 1.95	0.95
FNPA: Screen Time Behavior/Monitoring	1.09	.88, 1.35	0.87	1.14	.90, 1.44	0.78
FNPA 11: My child spends less than 2 hours on TV/games/computer per day	1.17	.81, 1.67	0.87	1.23	.80, 1.89	0.83
FNPA 12: Our family limits the amount of TV our child watches	1.14	.76, 1.69	0.88	1.23	.77, 1.96	0.86
FNPA: Healthy Environment	0.76	.58, 1.02	0.49	0.78	.56, 1.09	0.68
FNPA 13: Our family allows our child to watch TV in their bedroom	0.74	.51, 1.08	0.66	0.76	.49, 1.18	0.77
FNPA 14: Our family provides opportunities for physical activity	0.77	.48, 1.24	0.77	0.78	.47, 1.31	0.83
FNPA: Family Activity Involvement	0.92	.70, 1.20	0.88	0.91	.66, 1.25	0.88
FNPA 15: Our family encourages our child to be active every day	0.75	.44, 1.28	0.78	0.71	.38, 1.32	0.77
FNPA 16: Our family finds ways to be physically active together	1.00	.65, 1.53	1.00	1.01	.63, 1.60	1.00
FNPA: Child Activity Involvement	0.88	.70, 1.10	0.77	0.87	.71, 1.07	0.77
FNPA 17: My child does physical activity during his/her free time	1.18	.74, 1.88	0.87	1.23	.74, 2.06	0.87
FNPA 18: My child is enrolled in sports or activities with a coach or leader	0.75	.55, 1.02	0.49	0.71	.51, 1.00	0.49
FNPA: Family Routine	1.45	.84, 2.49	0.77	1.48	.84, 2.62	0.77
FNPA 19: Our family has a daily routine for our child's bedtime	1.14	.55, 2.37	0.95	1.11	.58, 2.11	0.95
FNPA 20: My child gets 9 hours of sleep a night	2.30	.87, 6.11	0.54	2.76	.99, 7.67	0.49

Appendix Table 1. (Continued).

Variable	Obese (n=29)					
	Unadjusted			Adjusted ^b		
	OR	95% CI	p-adj	OR	95% CI	p-adj
FNPA: TOTAL	0.47	.16, 1.33	0.71	0.47	.14, 1.53	0.77
FNPA: NUTRITION	0.31	.10, .93	0.49	0.34	.11, 1.05	0.49
FNPA: Meal Patterns	1.18	.76, 1.85	0.87	1.16	.74, 1.80	0.88
FNPA 1: My child eats breakfast	1.00	.46, 2.17	1.00	1.06	.52, 2.14	0.96
FNPA 2: Our family eats meals together	1.30	.74, 2.29	0.86	1.22	.69, 2.15	0.87
FNPA: Eating Habits	0.63	.43, .92	0.49	0.63	.40, .995	0.49
FNPA 3: Our family eats while watching TV	0.59	.37, .94	0.49	0.56	.34, .94	0.49
FNPA 4: Our family eats fast food	0.61	.28, 1.31	0.77	0.71	.29, 1.69	0.87
FNPA: Food Choices	0.73	.52, 1.03	0.49	0.71	.48, 1.05	0.54
FNPA 5: Our family uses microwave or ready to eat foods	0.50	.27, .90	0.49	0.53	.27, 1.05	0.49
FNPA 6: My child eats fruits and vegetables at meals or snacks	0.84	.51, 1.37	0.87	0.76	.41, 1.43	0.87
FNPA: Beverage Choices	0.91	.67, 1.25	0.88	0.94	.72, 1.24	0.95
FNPA 7: My child drinks soda pop or sugar drinks	0.58	.32, 1.06	0.53	0.63	.34, 1.17	0.68
FNPA 8: My child drinks low fat milk at meals or snacks	1.07	.74, 1.53	0.95	1.09	.76, 1.57	0.92
FNPA: Restriction/Reward	0.60	.41, .87	0.44	0.66	.44, .98	0.49
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.50	.32, .79	0.00†	0.54	.33, .87	0.44
FNPA 10: Our family uses candy as a reward for good behavior	0.91	.51, 1.62	0.95	0.99	.51, 1.94	1.00

Appendix Table 1. (Continued).

FNPA: ACTIVITY	0.77	.34, 1.76	0.88	0.73	.27, 1.97	0.88
FNPA: Screen Time Behavior/Monitoring	0.88	.70, 1.09	0.77	0.87	.70, 1.08	0.77
FNPA 11: My child spends less than 2 hours on TV/games/computer per day	0.95	.65, 1.39	0.95	0.95	.64, 1.42	0.95
FNPA 12: Our family limits the amount of TV our child watches	0.70	.48, 1.03	0.49	0.68	.46, .99	0.49
FNPA: Healthy Environment	0.84	.61, 1.15	0.77	0.80	.57, 1.11	0.77
FNPA 13: Our family allows our child to watch TV in their bedroom	0.77	.51, 1.17	0.77	0.74	.49, 1.11	0.68
FNPA 14: Our family provides opportunities for physical activity	0.96	.55, 1.68	0.96	0.91	.46, 1.83	0.95
FNPA: Family Activity Involvement	0.93	.69, 1.25	0.93	0.88	.63, 1.22	0.87
FNPA 15: Our family encourages our child to be active every day	0.93	.49, 1.74	0.95	0.86	.47, 1.57	0.92
FNPA 16: Our family finds ways to be physically active together	0.91	.57, 1.44	0.95	0.83	.48, 1.42	0.87
FNPA: Child Activity Involvement	1.15	.89, 1.49	0.77	1.20	.87, 1.67	0.77
FNPA 17: My child does physical activity during his/her free time	1.15	.69, 1.93	0.86	1.05	.57, 1.94	0.96
FNPA 18: My child is enrolled in sports or activities with a coach or leader	1.20	.86, 1.69	0.77	1.39	.94, 2.05	0.57
FNPA: Family Routine	0.82	.55, 1.22	0.80	0.78	.53, 1.17	0.77
FNPA 19: Our family has a daily routine for our child's bedtime	0.82	.43, 1.55	0.88	0.79	.42, 1.48	0.87
FNPA 20: My child gets 9 hours of sleep a night	0.73	.39, 1.36	0.80	0.68	.35, 1.33	0.77

^aReference category: normal weight and low weight combined

^bAdjusted for parent education and including a cluster variable for correlated data within families

*p<0.05

**p<0.01

†FDR-adjusted p<0.10

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: Meal Patterns; Family Meal Patterns; average of 2 items: My child eats breakfast + Our family eats meals together

FNPA: Eating Habits; Family Eating Habits; average of 2 items: Our family eats while watching TV + Our family eats fast food (both items reverse coded)

FNPA: Food Choices; average of 2 items: Our family uses microwave or ready to eat foods (reverse coded) + My child eats fruits and vegetables at meals or snacks

FNPA: Beverage Choices; average of 2 items: My child drinks soda pop or sugar drinks (reverse coded) + My child drinks low fat milk at meals or snacks

FNPA: Restriction and Reward; average of 2 items: Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior (reverse coded)

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

FNPA: Screen Time Behavior/Monitoring; average of 2 items: My child spends less than 2 hours on TV/games/computer per day + Our family limits the amount of TV child watches

FNPA: Healthy Environment; average of 2 items: Our family allows our child to watch TV in their bedroom + Our family provides opportunities for physical activity

FNPA: Family Activity Involvement; average of 2 items: Our family encourages our child to be active every day + Our family finds ways to be physically active together

FNPA: Child Activity Involvement; average of 2 items; My child does physical activity during his/her free time + My child is enrolled in sports or activities with a coach or leader

FNPA: Family Routine; average of 2 items; Our family has a daily routine for our child's bedtime + My child gets 9 hours of sleep a night

Appendix Table 2. Unadjusted and adjusted linear regression examining association of family nutrition and physical activity (FNPA) with BMI z-score at 1 year follow-up among a sample of rural elementary-age students (n=128)

Variable	BMI z-score year 2							
	Unadjusted				Adjusted ^a			
	β Coef	95% CI	p	p-adj	β Coef	95% CI	p	p-adj
FNPA: TOTAL	-0.19	-.68, .30	0.45	0.89	-0.08	-.22, .06	0.27	0.84
FNPA: NUTRITION	-0.42	-.92, .08	0.10	0.84	-0.07	-.25, .12	0.47	0.89
FNPA: ACTIVITY	0.02	-.35, .39	0.93	0.98	-0.06	-.15, .04	0.26	0.94

^aClustered for multiple children in families and adjusted for BMI at year 1 and intervention.

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

Appendix Table 3. Unadjusted and adjusted logistic regression examining associations between BMI and FNPA with odds of reporting family at-risk for food insecurity, stratified by eligibility for free- or reduced-cost (f/r) school meals, among a sample of rural elementary-age students (n=169)

Variable	Family at-risk for Food Insecurity							
	Eligible for f/r school meals (n=95)							
	Unadjusted				Adjusted ^{a,b}			
	OR	95% CI	p	p-adj	OR	95% CI	p	p-adj
BMI z-score	0.88	.58, 1.35	0.57	0.92	0.88	.55, 1.43	0.62	0.93
BMI category								
Normal weight	Referent				Referent			
Overweight	1.17	.41, 3.35	0.78	0.93	1.17	.39, 3.50	0.78	0.93
Obese	1.07	.35, 3.31	0.91	0.97	1.07	.26, 4.33	0.93	0.98
FNPA: TOTAL	0.31	.08, 1.12	0.07	0.53	0.29	.06, 1.33	0.11	0.57
FNPA: NUTRITION	0.38	.10, 1.40	0.15	0.64	0.36	.06, 2.06	0.25	0.75
FNPA: Meal Patterns	0.38	.21, .71	.002**	0.07†	0.38	.16, .90	.03*	0.38
FNPA 1: My child eats breakfast	0.34	.10, 1.11	0.08	0.55	0.34	.09, 1.29	0.11	0.57
FNPA 2: Our family eats meals together	0.32	.14, .73	.01**	0.21	0.31	.11, .94	.04*	0.38
FNPA: Eating Habits	0.85	.57, 1.27	0.43	0.92	0.84	.50, 1.42	0.52	0.92
FNPA 3: Our family eats while watching TV	1.07	.66, 1.74	0.79	0.93	1.07	.56, 2.03	0.84	0.93
FNPA 4: Our family eats fast food	0.40	.17, .94	0.04*	0.38	0.38	.12, 1.15	0.09	0.55
FNPA: Food Choices	0.92	.59, 1.44	0.72	0.93	0.92	.56, 1.51	0.73	0.93
FNPA 5: Our family uses microwave or ready to eat foods	0.79	.37, 1.70	0.55	0.92	0.79	.26, 2.42	0.68	0.93
FNPA 6: My child eats fruits and vegetables at meals or snacks	1.01	.59, 1.71	0.98	0.99	0.00	.51, 1.94	0.98	0.99

Appendix Table 3. (Continued).

FNPA: Beverage Choices	0.71	.49, 1.02	0.07	0.53	0.70	.43, 1.16	0.17	0.64
FNPA 7: My child drinks soda pop or sugar drinks	0.78	.40, 1.53	0.47	0.92	0.77	.28, 2.12	0.61	0.93
FNPA 8: My child drinks low fat milk at meals or snacks	0.68	.44, 1.04	0.08	0.55	0.68	.40, 1.14	0.14	0.63
FNPA: Restriction/Reward	1.26	.87, 1.83	0.22	0.72	1.28	.77, 2.14	0.35	0.87
FNPA 9: Our family monitors eating of chips, cookies, and candy	1.11	.70, 1.76	0.65	0.93	1.11	.60, 2.08	0.74	0.93
FNPA 10: Our family uses candy as a reward for good behavior	1.63	.86, 3.08	0.14	0.63	1.62	.73, 3.63	0.24	0.74
FNPA: ACTIVITY	0.44	.17, 1.17	0.10	0.55	0.43	.14, 1.33	0.14	0.63
FNPA: Screen Time Behavior/Monitoring	0.88	.70, 1.12	0.30	0.8	0.88	.67, 1.15	0.35	0.87
FNPA 11: My child spends less than 2 hours on TV/games/computer per day	0.90	.61, 1.33	0.59	0.93	0.89	.56, 1.42	0.63	0.93
FNPA 12: Our family limits the amount of TV our child watches	0.71	.44, 1.13	0.15	0.64	0.69	.40, 1.21	0.19	0.68
FNPA: Healthy Environment	0.996	.70, 1.41	0.98	0.99	1.00	.63, 1.58	0.99	0.99
FNPA 13: Our family allows our child to watch TV in their bedroom	1.24	.77, 2.00	0.38	0.87	1.25	.66, 2.36	0.49	0.92
FNPA 14: Our family provides opportunities for physical activity	0.72	.40, 1.29	0.27	0.75	0.72	.29, 1.76	0.47	0.92
FNPA: Family Activity Involvement	0.91	.66, 1.26	0.57	0.92	0.90	.59, 1.38	0.64	0.93
FNPA 15: Our family encourages our child to be active every day	0.59	.27, 1.25	0.17	0.64	0.58	.23, 1.44	0.24	0.74
FNPA 16: Our family finds ways to be physically active together	1.03	.64, 1.65	0.90	0.97	1.02	.53, 1.97	0.95	0.99
FNPA: Child Activity Involvement	0.71	.54, .93	.01*	0.21	0.69	.49, .98	.04*	0.38
FNPA 17: My child does physical activity during his/her free time	0.67	.38, 1.18	0.16	0.64	0.65	.27, 1.54	0.33	0.85
FNPA 18: My child is enrolled in sports or activities with a coach or leader	0.65	.46, .93	.02*	0.32	0.65	.43, .97	.04*	0.38
FNPA: Family Routine	0.84	.52, 1.35	0.47	0.92	0.82	.47, 1.42	0.48	0.92
FNPA 19: Our family has a daily routine for our child's bedtime	0.87	.45, 1.68	0.67	0.93	0.86	.39, 1.91	0.71	0.93
FNPA 20: My child gets 9 hours of sleep a night	0.79	.38, 1.65	0.54	0.92	0.77	.31, 1.88	0.56	0.92

Appendix Table 3. (Continued).

Variable	Family at-risk for Food Insecurity							
	Not Eligible for f/r school meals (n=74)							
	Unadjusted				Adjusted ^{a,b}			
	OR	95% CI	p	p-adj	OR	95% CI	p	p-adj
BMI z-score	3.63	1.64, 8.03	0.001**	0.07†	3.63	1.75, 7.53	0.001**	0.07†
BMI category								
Normal weight	Referent				Referent			
Overweight	6.11	1.37, 27.32	0.02*	0.32	6.11	1.02, 36.58	0.047*	0.42
Obese	11.00	2.39, 50.59	0.002**	0.07†	11.00	2.30, 52.69	0.003**	0.09†
FNPA: TOTAL	0.8	.20, 3.14	0.75	0.93	1.30	.27, 6.22	0.74	0.93
FNPA: NUTRITION	0.88	.20, 3.93	0.87	0.95	1.55	.40, 5.99	0.53	0.92
FNPA: Meal Patterns	1.48	.80, 2.73	0.22	0.72	1.30	.65, 2.61	0.46	0.92
FNPA 1: My child eats breakfast	0.61	.27, 1.38	0.24	0.74	0.54	.12, 2.46	0.42	0.92
FNPA 2: Our family eats meals together	2.71	1.10, 6.70	.03*	0.38	2.29	.85, 6.11	0.10	0.55
FNPA: Eating Habits	0.84	.50, 1.43	0.53	0.92	0.93	.46, 1.87	0.83	0.93
FNPA 3: Our family eats while watching TV	0.61	.31, 1.19	0.14	0.63	0.72	.27, 1.93	0.52	0.92
FNPA 4: Our family eats fast food	1.81	.59, 5.56	0.30	0.8	1.61	.37, 6.98	0.52	0.92
FNPA: Food Choices	0.87	.58, 1.30	0.5	0.92	1.06	.71, 1.57	0.79	0.93
FNPA 5: Our family uses microwave or ready to eat foods	0.86	.42, 1.77	0.68	0.93	1.18	.51, 2.74	0.71	0.93
FNPA 6: My child eats fruits and vegetables at meals or snacks	0.78	.40, 1.53	0.48	0.92	1.01	.53, 1.90	0.99	0.99

Appendix Table 3. (Continued).

FNPA: Beverage Choices	1.03	.66, 1.62	0.89	0.96	1.11	.62, 2.00	0.73	0.93
FNPA 7: My child drinks soda pop or sugar drinks	1.87	.61, 5.75	0.27	0.75	2.46	.61, 9.95	0.21	0.72
FNPA 8: My child drinks low fat milk at meals or snacks	0.9	.55, 1.47	0.68	0.93	0.93	.44, 1.96	0.84	0.93
FNPA: Restriction/Reward	0.87	.52, 1.46	0.6	0.93	1.18	.59, 2.34	0.64	0.93
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.93	.49, 1.77	0.83	0.93	1.43	.59, 3.44	0.42	0.92
FNPA 10: Our family uses candy as a reward for good behavior	0.82	.39, 1.71	0.6	0.93	0.87	.32, 2.35	0.79	0.93
FNPA: ACTIVITY	0.80	.28, 2.30	0.68	0.93	1.06	.24, 4.70	0.93	0.98
FNPA: Screen Time Behavior/Monitoring	1.06	.76, 1.48	0.74	0.93	1.05	.68, 1.62	0.81	0.93
FNPA 11: My child spends less than 2 hours on TV/games/computer per day	1.94	.99, 3.81	0.05	0.42	1.69	.61, 4.70	0.31	0.81
FNPA 12: Our family limits the amount of TV our child watches	0.63	.36, 1.09	0.10	0.55	0.69	.36, 1.33	0.27	0.75
FNPA: Healthy Environment	0.76	.50, 1.14	0.18	0.66	0.90	.53, 1.52	0.69	0.93
FNPA 13: Our family allows our child to watch TV in their bedroom	0.8	.48, 1.33	0.38	0.87	0.99	.52, 1.86	0.96	0.99
FNPA 14: Our family provides opportunities for physical activity	0.62	.29, 1.31	0.21	0.72	0.71	.22, 2.34	0.58	0.93
FNPA: Family Activity Involvement	1.04	.68, 1.58	0.85	0.93	1.22	.69, 2.19	0.49	0.92
FNPA 15: Our family encourages our child to be active every day	1.19	.50, 2.85	0.7	0.93	1.60	.58, 4.46	0.37	0.87
FNPA 16: Our family finds ways to be physically active together	0.93	.49, 1.78	0.83	0.93	1.10	.43, 2.78	0.84	0.93
FNPA: Child Activity Involvement	0.91	.65, 1.27	0.57	0.92	0.94	.56, 1.57	0.81	0.93
FNPA 17: My child does physical activity during his/her free time	1.15	.57, 2.32	0.69	0.93	1.34	.48, 3.70	0.57	0.92
FNPA 18: My child is enrolled in sports or activities with a coach or leader	0.76	.47, 1.23	0.26	0.75	0.72	.36, 1.48	0.38	0.87
FNPA: Family Routine	1.27	.58, 2.80	0.54	0.92	1.83	.79, 4.25	0.16	0.64
FNPA 19: Our family has a daily routine for our child's bedtime	2.46	.35, 17.36	0.37	0.87	5.21	.80, 34.13	0.09	0.55
FNPA 20: My child gets 9 hours of sleep a night	1.15	.37, 3.52	0.81	0.93	1.55	.46, 5.18	0.48	0.92

^aAssociation between BMI and at-risk for food insecurity clustered by family

^bAssociation between FNPA and at-risk for food insecurity clustered by family and adjusted for BMI category

* $p < 0.05$

** $p < 0.01$

†FDR-adjusted $p < 0.10$

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: Meal Patterns; Family Meal Patterns; average of 2 items: My child eats breakfast + Our family eats meals together

FNPA: Eating Habits; Family Eating Habits; average of 2 items: Our family eats while watching TV + Our family eats fast food (both items reverse coded)

FNPA: Food Choices; average of 2 items: Our family uses microwave or ready to eat foods (reverse coded) + My child eats fruits and vegetables at meals or snacks

FNPA: Beverage Choices; average of 2 items: My child drinks soda pop or sugar drinks (reverse coded) + My child drinks low fat milk at meals or snacks

FNPA: Restriction and Reward; average of 2 items: Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior (reverse coded)

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

FNPA: Screen Time Behavior/Monitoring; average of 2 items: My child spends less than 2 hours on TV/games/computer per day + Our family limits the amount of TV child watches

FNPA: Healthy Environment; average of 2 items: Our family allows our child to watch TV in their bedroom + Our family provides opportunities for physical activity

FNPA: Family Activity Involvement; average of 2 items: Our family encourages our child to be active every day + Our family finds ways to be physically active together

FNPA: Child Activity Involvement; average of 2 items; My child does physical activity during his/her free time + My child is enrolled in sports or activities with a coach or leader

FNPA: Family Routine; average of 2 items; Our family has a daily routine for our child's bedtime + My child gets 9 hours of sleep a night

Appendix Table 4. Unadjusted and adjusted linear regression examining associations between FNPA factors with dietary intakes in a sample of rural elementary-age children (n=100)

Variable	Undadjusted Associations								
	Fruits (cups/day) per 1,000 kcals			Vegetables (cups/day) per 1,000 kcals			Whole grains (oz/day) per 1,000 kcals		
	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj
FNPA: Total	0.56	.15, .97	0.06	0.21	-.02, .44	0.24	0.04	-.26, .34	0.90
FNPA: Nutrition	0.73	.35, 1.11	0.00***	0.26	.04, .47	0.12	-0.05	-.34, .24	0.88
FNPA: Meal Patterns	0.20	.08, .32	0.02*	0.06	-.01, .13	0.32	0.02	-.08, .11	0.88
FNPA 1: My child eats breakfast	0.29	.08, .51	0.06	0.10	-.01, .22	0.27	0.14	-.02, .29	0.27
FNPA 2: Our family eats meals together	0.20	.02, .38	0.14	0.04	-.06, .14	0.70	-0.06	-.19, .07	0.64
FNPA: Eating Habits	0.13	.01, .26	0.17	0.04	-.04, .11	0.61	-0.04	-.13, .06	0.71
FNPA 3: Our family eats while watching TV	0.15	-.03, .33	0.29	0.00	-.10, .10	0.99	0.00	-.13, .12	0.98
FNPA 4: Our family eats fast food	0.23	-.03, .48	0.25	0.13	-.01, .26	0.25	-0.13	-.31, .05	0.38
FNPA: Food Choices	0.24	.12, .37	0.00***	0.13	.06, .19	0.00***	-0.01	-.11, .08	0.90
FNPA 5: Our family uses microwave or ready to eat foods	0.06	-.22, .33	0.87	0.17	.02, .31	0.12	-0.08	-.27, .11	0.70
FNPA 6: My child eats fruits and vegetables at meals or snacks	0.34	.19, .49	0.00***	0.13	.05, .22	0.03*	0.01	-.11, .12	0.93

Appendix Table 4. (Continued).

FNPA: Beverage Choices	0.03	-.09, .15	0.81	-0.04	-.10, .03	0.52	0.00	-.09, .08	0.98
FNPA 7: My child drinks soda pop or sugar drinks	0.35	.10, .60	0.05	0.09	-.05, .23	0.51	0.22	.04, .40	0.09
FNPA 8: My child drinks low fat milk at meals or snacks	-0.05	-.18, .08	0.71	-0.07	-.14, .001	0.21	-0.06	-.15, .03	0.48
FNPA: Restriction/Reward	0.13	.01, .25	0.17	0.09	.02, .15	0.06	-0.02	-.10, .07	0.88
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.12	-.04, .28	0.37	0.09	.002, .17	0.18	0.02	-.10, .13	0.90
FNPA 10: Our family uses candy as a reward for good behavior	0.14	-.06, .33	0.39	0.08	-.02, .19	0.33	-0.06	-.20, .08	0.67
FNPA: Activity	0.18	-.14, .49	0.54	0.08	-.09, .25	0.65	0.07	-.15, .30	0.76
Variable	Adjusted Associations								
	Fruits (cups/day) per 1,000 kcals^a			Vegetables (cups/day) per 1,000 kcals^b			Whole grains (oz/day) per 1,000 kcals^d		
	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj
FNPA: Total	0.57	.13, 1.02	0.07	0.29	.09, .49	0.05	0.04	-.27, .34	0.90
FNPA: Nutrition	0.71	.31, 1.11	.01*	0.31	.07, .56	0.08	-0.05	-.33, .23	0.88
FNPA: Meal Patterns	0.21	.09, .32	.01*	0.08	.01, .14	0.13	0.02	-.07, .10	0.88
FNPA 1: My child eats breakfast	0.28	.11, .45	.02*	0.10	-.01, .21	0.22	0.14	.03, .24	0.07
FNPA 2: Our family eats meals together	0.22	.05, .39	0.07	0.10	-.000, .19	0.20	-0.06	-.22, .09	0.71

Appendix Table 4. (Continued).

FNPA: Eating Habits	0.12	-.04, .28	0.35	0.04	-.06, .14	0.69	-0.04	-.14, .07	0.75
FNPA 3: Our family eats while watching TV	0.15	-.02, .32	0.27	0.01	-.11, .13	0.95	0.00	-.16, .15	0.98
FNPA 4: Our family eats fast food	0.18	-.19, .56	0.63	0.12	-.09, .32	0.54	-0.13	-.31, .05	0.39
FNPA: Food Choices	0.24	.08, .40	0.04*	0.15	.07, .22	0.00***	-0.01	-.13, .10	0.90
FNPA 5: Our family uses microwave or ready to eat foods	0.08	-.21, .38	0.80	0.20	.05, .36	0.07	-0.08	-.30, .14	0.74
FNPA 6: My child eats fruits and vegetables at meals or snacks	0.33	.17, .50	0.00***	0.17	.07, .26	.01*	0.01	-.13, .15	0.95
FNPA: Beverage Choices	0.04	-.10, .17	0.81	-0.03	-.10, .04	0.67	0.00	-.09, .08	0.98
FNPA 7: My child drinks soda pop or sugar drinks	0.34	.05, .62	0.12	0.11	-.04, .27	0.38	0.22	.03, .41	0.13
FNPA 8: My child drinks low fat milk at meals or snacks	-0.04	-.22, .14	0.82	-0.06	-.14, .02	0.37	-0.06	-.17, .05	0.58
FNPA: Restriction/Reward	0.12	-.06, .29	0.44	0.08	.002, .15	0.18	-0.02	-.11, .08	0.88
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.11	-.08, .30	0.54	0.11	.03, .19	0.07	0.02	-.11, .14	0.90
FNPA 10: Our family uses candy as a reward for good behavior	0.12	-.08, .31	0.52	.03	-.10, .16	0.82	-0.06	-.24, .12	0.75
FNPA: Activity	0.21	-.14, .56	0.51	0.14	.003, .28	0.20	0.07	-.15, .30	0.76

Appendix Table 4. (Continued).

Variable	Undadjusted Associations								
	Dairy (cups/day) per 1,000 kcals			Protein (oz/day) per 1,000 kcals			Added Sugar (tsp/day) per 1,000 kcals		
	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj
FNPA: Total	0.23	-.17, .63	0.53	-0.06	-.56, .43	0.90	-2.68	-3.88, -1.47	0.00***
FNPA: Nutrition	0.34	-.04, .72	0.25	0.12	-.36, .59	0.82	-2.56	-3.72, -1.40	0.00***
FNPA: Meal Patterns	0.05	-.07, .17	0.70	0.08	-.07, .23	0.54	-0.55	-.94, -.17	0.04*
FNPA 1: My child eats breakfast	-0.04	-.25, .17	0.88	0.19	-.07, .44	0.38	-0.43	-1.11, .25	0.50
FNPA 2: Our family eats meals together	0.13	-.04, .30	0.38	0.04	-.17, .25	0.88	-0.81	-1.35, -.27	0.04*
FNPA: Eating Habits	0.00	-.12, .13	0.98	0.06	-.10, .21	0.74	-0.69	-1.07, -.31	0.01*
FNPA 3: Our family eats while watching TV	-0.02	-.19, .15	0.90	0.10	-.11, .30	0.65	-0.82	-1.35, -.29	0.03*
FNPA 4: Our family eats fast food	0.06	-.18, .31	0.81	0.04	-.26, .34	0.90	-1.08	-1.84, -.31	0.05
FNPA: Food Choices	-0.05	-.18, .08	0.71	0.12	-.03, .28	0.33	-0.78	-1.16, -.39	0.00***
FNPA 5: Our family uses microwave or ready to eat foods	-0.02	-.28, .24	0.93	0.12	-.19, .44	0.71	-1.42	-2.22, -.62	0.01*
FNPA 6: My child eats fruits and vegetables at meals or snacks	-0.06	-.22, .09	0.70	0.14	-.05, .33	0.38	-0.66	-1.15, -.17	0.06

Appendix Table 4. (Continued).

FNPA: Beverage Choices	0.24	.14, .34	0.00***	-0.14	-.28, -.01	0.17	-0.18	-.54, .19	0.64
FNPA 7: My child drinks soda pop or sugar drinks	0.06	-.19, .30	0.84	0.12	-.18, .41	0.71	-1.54	-2.28, -.80	0.00***
FNPA 8: My child drinks low fat milk at meals or snacks	0.28	.17, .39	0.00***	-0.20	-.35, -.06	0.05	0.18	-.22, .59	0.67
FNPA: Restriction/Reward	0.04	-.07, .16	0.72	0.03	-.12, .17	0.88	-0.36	-.74, .02	0.22
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.16	.01, .30	0.15	-0.02	-.20, .17	0.93	-0.69	-1.16, -.22	0.04*
FNPA 10: Our family uses candy as a reward for good behavior	-0.14	-.32, .05	0.37	0.09	-.13, .32	0.70	0.16	-.44, .76	0.81
FNPA: Activity	0.05	-.25, .35	0.88	-0.14	-.51, .23	0.71	-1.42	-2.36, -.48	0.03*
Variable	Adjusted Associations								
	Dairy (cups/day) per 1,000 kcals^e			Protein (oz/day) per 1,000 kcals^f			Added Sugar (tsp/day) per 1,000 kcals^g		
	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj	β Coef	95% CI	p-adj
FNPA: Total	0.23	-.26, .72	0.65	-0.06	-.68, .55	0.92	-2.79	-4.43, -1.14	0.01*
FNPA: Nutrition	0.34	-.19, .88	0.48	0.12	-.46, .70	0.88	-2.41	-4.10, -.72	0.05
FNPA: Meal Patterns	0.05	-.14, .24	0.81	0.08	-.08, .25	0.62	-0.56	-1.18, .06	0.23
FNPA 1: My child eats breakfast	-0.04	-.37, .29	0.90	0.19	.02, .35	0.13	-0.43	-1.36, .50	0.66
FNPA 2: Our family eats meals together	0.13	-.08, .33	0.50	0.04	-.23, .32	0.89	-0.83	-1.76, .10	0.25

Appendix Table 4. (Continued).

FNPA: Eating Habits	0.00	-.16, .16	0.98	0.06	-.15, .26	0.81	-0.57	-1.09, -.04	0.15
FNPA 3: Our family eats while watching TV	-0.02	-.27, .23	0.93	0.10	-.17, .36	0.73	-0.67	-1.40, .07	0.25
FNPA 4: Our family eats fast food	0.06	-.24, .37	0.87	0.04	-.40, .48	0.93	-0.86	-1.72, .01	0.20
FNPA: Food Choices	-0.05	-.21, .11	0.77	0.12	-.06, .30	0.45	-0.78	-1.24, -.33	0.01*
FNPA 5: Our family uses microwave or ready to eat foods	-0.02	-.37, .33	0.95	0.12	-.31, .55	0.80	-1.39	-2.28, -.51	0.02*
FNPA 6: My child eats fruits and vegetables at meals or snacks	-0.06	-.26, .13	0.76	0.14	-.08, .36	0.50	-0.64	-1.23, -.05	0.15
FNPA: Beverage Choices	0.24	.12, .37	0.00***	-0.14	-.30, .01	0.24	-0.08	-.53, .37	0.88
FNPA 7: My child drinks soda pop or sugar drinks	0.06	-.25, .37	0.88	0.12	-.27, .50	0.78	-1.35	-2.23, -.48	0.03*
FNPA 8: My child drinks low fat milk at meals or snacks	0.28	.16, .40	0.00***	-0.20	-.38, -.03	0.13	0.20	-.25, .66	0.67
FNPA: Restriction/Reward	0.04	-.09, .18	0.78	0.03	-.16, .22	0.90	-0.39	-.94, .16	0.39
FNPA 9: Our family monitors eating of chips, cookies, and candy	0.16	-.02, .34	0.27	-0.02	-.28, .24	0.95	-0.74	1.42, -.06	0.15
FNPA 10: Our family uses candy as a reward for good behavior	-0.14	-.31, .04	0.35	0.09	-.17, .36	0.74	0.11	-.56, .77	0.88
FNPA: Activity	0.05	-.24, .34	0.88	-0.14	-.58, .30	0.76	-1.66	-2.79, -.52	0.04*

^aClustered for multiple children in families and adjusted for child sex^bClustered for multiple children in families and adjusted for child race/ethnicity, age, and school^cClustered for multiple children in families and adjusted for child age and school^dClustered for multiple children in families^eClustered for multiple children in families

^fClustered for multiple children in families

^gClustered for multiple children in families and adjusted for parent education and school

^hClustered for multiple children in families and adjusted for child race/ethnicity

ⁱSignificant interaction with child age

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

†FDR-adjusted p-value

FNPA: TOTAL; Family Nutrition and Physical Activity total score; average of 20 items coded on 4-pt scale (1, almost never; 2, sometimes; 3, usually; 4, almost always)

FNPA: NUTRITION; FNPA Nutrition component; average of 10 FNPA nutrition items

FNPA: Meal Patterns; Family Meal Patterns; average of 2 items: My child eats breakfast + Our family eats meals together

FNPA: Eating Habits; Family Eating Habits; average of 2 items: Our family eats while watching TV + Our family eats fast food (both items reverse coded)

FNPA: Food Choices; average of 2 items: Our family uses microwave or ready to eat foods (reverse coded) + My child eats fruits and vegetables at meals or snacks

FNPA: Beverage Choices; average of 2 items: My child drinks soda pop or sugar drinks (reverse coded) + My child drinks low fat milk at meals or snacks

FNPA: Restriction and Reward; average of 2 items: Our family monitors eating of chips, cookies, and candy + Our family uses candy as a reward for good behavior (reverse coded)

FNPA: ACTIVITY; FNPA Physical Activity component; average of 10 FNPA physical activity items

