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Does Better School adaptability Lead to Healthier Eating Behaviors?

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Research Article

Keywords: Adolescents, Health diet, School adaptability, Eating behaviors

Posted Date: February 24th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8861061/v1

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Public Health on May 29th, 2026. See the published version at https://doi.org/10.1186/s12889-026-27915-y.

Abstract

The obesity risks associated with unhealthy diets and the critical role of early-life health interventions highlight the urgence to promote adolescents' health eating behaviors. While prior researches largely focus on internal family influences, this paper examines the impact of school adaptability as an external family factor on adolescents' eating behaviors. Using data from the China's Database of Youth Health (DYH), we find that higher school adaptability significantly promotes healthier diets among adolescents, with particularly notable effects for rural and boarding students. Mechanism analysis reveals that school adaptability promotes adolescents' health eating behaviors through emotion, eating habits, and media exposure. These findings offer a new perspective on enhancing adolescents' dietary equality through school adaptability improvement.

1. Introduction

Obesity is a global public health issue that places considerable social and economic burdens on society (Lim et al., 2020). Understanding the factors contributing to obesity has been a central focus in research. Much of the literatures identify unhealthy diets as a primary driver of obesity, leading to numerous studies on dietary interventions to reduce obesity prevalence (Cadario & Chandon, 2020; Lai et al., 2020). Early-life interventions have shown potential for maximizing the impact of health initiatives (Billings & Schnepel, 2018; Macours et al., 2012). Adolescents' nutritional outcomes have lasting effects on health, income, and labor market success in adulthood (Attanasio et al., 2020; Bailey et al., 2024; Norris et al., 2022; Patton et al., 2022). From a cost-benefit perspective, targeting adolescents with healthy dietary interventions offers a promising path to achieve lower costs and higher benefits in obesity prevention.

The social environment significantly influences adolescents' eating behaviors, shaped by their reliance on parental guidance and limited autonomy (Bleich et al., 2018; Cohen et al., 2021; Neufeld et al., 2022). Both school and home constitute central social environments in adolescents' daily lives. However, existing research predominantly examines household-level influences (Bensignor et al., 2024; Hooper et al., 2022; Stewart & Menning, 2009; West et al., 2021) and school food environments (Chen et al., 2021; Cvjetan et al., 2014; Kainulainen et al., 2012) on adolescents' eating behaviors. Few studies investigate how school adaptability affects adolescents' eating behaviors.

To fill this gap in the literature, we estimate the effects and mechanisms of school adaptability on adolescents' eating behaviors. Using data from China's Database of Youth Health (DYH), we assess school adaptability through the School Social Behavior Scales (SSBS-2) score and measure eating behaviors with a food frequency questionnaire (FFQ). To address the problem of endogeneity, we use the average SSBS-2 scores of adolescents in surrounding areas as an instrumental variable and apply instrumental variables two-stage least squares (IV-2SLS) model to analysis the effect of school adaptability on adolescents' eating behaviors. Our finding indicates that higher school adaptability significantly enhances healthy diet scores and reduces unhealthy diet scores among adolescents. Heterogeneity analysis shows that school adaptability has a more pronounced effect on rural and boarding students compared to their urban and non-boarding counterparts. Mechanism analysis reveals that school adaptability influences adolescents' eating behaviors through emotional impact, eating habits, and media exposure.

Our study builds on multiple strands of literature. First, it contributes to understanding the effects of school adaptability on adolescents' outcome. Existing research has examined its impact on adolescents' classroom engagement (Buhs et al., 2006), academic achievement (Malecki & Elliot, 2002; Wentzel, 1993), bullying (Perren & Alsaker, 2006), and mental health (Rivers et al., 2009). However, few studies have explored how school adaptability influences individual eating behaviors. Our research extends this focus by examining its effects on adolescents' eating behaviors.

Second, our study adds to the literatures on school-level influences on adolescents' eating behaviors. Literatures have explored the importance of the effect of school food environment on adolescents' eating behaviors (Cvjetan et al., 2014; Driessen et al., 2014; Kubik et al., 2003). Some studies find that school nutrition interventions can improve students' dietary quality (Chaudhary et al., 2020; Lai et al., 2020). Our study investigates how school adaptability influences adolescents' eating behaviors.

Additionally, a body of research has assessed social factors affecting adolescents' eating behaviors (Ragelienė & Grønhøj, 2020; Wouters et al., 2010). Zhang et al., (2023) examined peer effects on adolescents' eating behaviors. Chansukree & Rungjindarat (2017) analyzed the effect of social cognition on adolescents' eating behaviors. Our research examines the impact of social factors on adolescents' eating behaviors through the lens of school adaptability.

This paper is organized as follows: Section 2 discusses the conceptual framework; Section 3 describes the data, variables, and model; Section 4 presents the results; and Section 5 provides a discussion of the findings.

2. Conceptural analysis

Our central hypothesis posits a correlation between adolescents' adaptability in school and their eating behaviors. In this section, we apply ecological systems theory to explain why school adaptability affects adolescents' eating behaviors. We then discuss three potential mechanisms through which school adaptability may shape adolescents' eating behaviors. Figure 1 presents the conceptual analysis framework.

[Figure 1 **is here]**

Ecological systems theory indicates that adolescents interact with various environments throughout their lives, each exerting differing levels of influence on their behaviors (Ryan, 2001). These systems include the microsystem, mesosystem, exosystem, macrosystem, and chronosystem, typically represented as nested spheres of influence (Darling, 2007). In this framework, the school serves as a key component of the exosystem for adolescents. The mesosystem emphasizes the connections between adolescents and their environments, while the microsystem involves direct influences from classmates and teachers. School adaptability results from adolescents' interactions within the school environment, shaped by factors across the microsystem, mesosystem, and exosystem. Thus, ecological systems theory suggests that school adaptability can impact adolescents' eating behaviors.

First, school adaptability may affect adolescents' emotions, which play a crucial role in shaping healthy eating behaviors. Negative emotions are linked to unhealthy and imbalanced diets, with stress and other

adverse emotions often increasing the intake of unhealthy foods and reducing the consumption of nutritious options (Gardner et al., 2014; Gutjar et al., 2015). Policymakers have also used emotional responses in nutritional interventions to reduce unhealthy food choices among consumers. For example, Cadario & Chandon (2020) classify nudging strategies into cognitive, emotional, and behavioral interventions, with emotional interventions specifically aiming to guide food choices by influencing emotions. A consistent body of evidence shows that social isolation affects eating behaviors largely through emotional pathways (Boniecka et al., 2022). Therefore, adolescents' school adaptability may influence their healthy eating behaviors by shaping their emotional states.

Second, school is a central environment for adolescents' social activities, where individual performance can shape healthy behavior habits (Sallis et al., 2015; Short & Mollborn, 2015). Eating habits are closely linked to eating behaviors: positive habits support healthier diets, while negative habits can lead to imbalanced and unhealthy dietary outcomes. Thus, adolescents' school adaptability may influence their eating behaviors by shaping their eating habits.

Third, advertising and marketing of unhealthy foods play a significant role in shaping adolescents' eating habits. Media exposure has a substantial impact on their dietary choices (Dalton et al., 2017). Manufacturers of unhealthy foods rely heavily on television and online advertising to influence adolescents' food preferences (Oberlander, 2021). School adaptability may be linked to adolescents' exposure to these advertisements. Adolescents with lower school adaptability may avoid social interactions, leading to increased social isolation. This isolation can, in turn, increase the time spent watching television and using the internet, thereby raising their exposure to advertisements for unhealthy foods.

3. Methods

3.1 Data

This study utilizes data from the Database of Youth Health (DYH), developed by Shandong University. DYH provides multi-year cross-sectional survey data focused on middle and high school students in Shandong Province, aiming to support long-term research on adolescent health. The survey employs Probability Proportional to Size (PPS) sampling, selecting 100 schools randomly based on Shandong geographic, population, and socioeconomic characteristics. Schools with fewer than 100 students per grade or fewer than 300 students in total are excluded.

The DYH questionnaire covers adolescents' personal and family backgrounds, friendships, nutrition, school behavior, quality of life, exercise, health risk behaviors, and mental health. Data collection methods include on-site assessments, questionnaires, and data gathering to obtain detailed micro-level information on adolescents. This study primarily uses questionnaire data related to personal and family backgrounds, nutrition and diet, and school behavior from the 2017 and 2020 surveys. Figure 2 shows the sample size distribution.

[Figure 2 **is here]**

3.2 Variables

3.2.1 Dependent variables

The dependent variable in this study is adolescents' eating behavior, measured through diet scores, healthy diet scores, and unhealthy diet scores. Due to the complexity of defining eating behavior and regional variations, no standardized international measure exists. Currently, two primary methods are widely used. The first is dietary indices, such as the Diet Quality Index (DQI) and the Healthy Eating Index (HEI), where higher scores indicate healthier diets (Burggraf et al., 2018). The second method is the FFQ, which records respondents' frequency of consumption for various foods. The effectiveness of FFQ has been validated in numerous studies (Sam et al., 2020).

In this study, we use the FFQ to assess adolescents' eating behavior. The food groups are categorized as healthy foods (e.g., leafy vegetables, red-orange vegetables, fruits, eggs, dairy products) and unhealthy foods (e.g., processed meats, instant noodles, fast foods, sugary beverages)[1]. Adolescents report their intake frequency for each food category on a scale from 1 (never) to 5 (daily consumption). We apply principal component analysis (PCA) to derive common factors representing eating behavior, including overall diet scores, healthy diet scores, and unhealthy diet scores. Higher healthy diet scores and lower unhealthy diet scores indicate better eating behavior.

3.2.2 Independent variables

The independent variable in this study is adolescents' school adaptability, measured using the SSBS-2. The SSBS-2 is a screening tool designed to assess students' social behaviors, including peer relations, self-management/compliance, academic behavior, hostility/irritability, anti-social/aggressive tendencies, and defiant/disruptive behaviors (Raimundo et al., 2012).

3.2.3 Control variables

Based on Zhang et al. (2023), the control variables encompass factors at the individual, household, school, and regional levels. Individual-level factors include gender, age, ethnicity, registration status, residence, and only-child status. Household-level factors cover parental education, income, and family relationships. School-level factors consist of grade level and boarding status. Regional-level factors include economic indicators, population size, average wage, and human capital.

[Table 1 **is here]**

Table 1
Variable names and descriptive statistics

Variables	Definition	Mean	SD
Dependent variable			
Diet scores	Extract common factors and assign weights by PCA.	0	0.725
Health diet scores	Extract common factors and assign weights in health food by PCA.	0	1
Unhealth diet scores	Extract common factors and assign weights in unhealth food by PCA.	0	1
Independent variable			
Social performance	Extract common factors and assign weights in SSBS-2 by PCA.	0	0.708
Control variable			
Male	Male = 1, female = 0	0.508	0.499
Age	Actual age	14.401	1.846
Han race	Han race = 1, others = 0	0.981	0.138
Hukou	Agricultural hukou = 1, others = 0	0.449	0.497
Residence	Rural = 1, others = 0	0.326	0.468
Grade	High school = 1, middle school = 0	0.392	0.488
Only child	Only child = 1, others = 0	0.306	0.461
Father’s education	Above middle school = 1, others = 0	0.360	0.480
Mather’s education	Above middle school = 1, others = 0	0.306	0.461
Household income	A scale from 1 to 5 represents the level of the family income.	2.905	0.640
Family relationship	Parents frequently quarrel = 1, parents do not quarrel = 0	0.092	0.289
Boarding	Boarding = 1, not boarding = 0	0.509	0.499
The economics of city	In (The gross domestic product of city)	8.051	0.554
The population size of city	In (The population size of city)	6.181	0.694
The average wage of city	In (The average wage of city)	11.035	0.103
The human capital of city	In (The number of middle school and high school in city)	5.155	0.681

3.3 Model

3.3.1Baseline regression model

The baseline regression model is as follows:

$$Y_i = \alpha + \beta SP_i + \gamma X_i + \epsilon_i \#(1)$$

Where, Y_i is the outcome of eating behavior for adolescent *i*, SP_i is the score of school adaptability for adolescent *i*, X_i includes all of the control variables, $\epsilon_i$is an idiosyncratic error term.

3.3.2Instrumental variables model

To address potential endogeneity from reverse causality, we follow the method of Dhaliwal et al. (2016) and Krolikowski & Yuan (2017), using the school adaptability scores of other samples in the same area, excluding the target sample, as the instrumental variable. We apply an instrumental variables two-stage least squares (IV-2SLS) model to adjust the baseline regression results. The model specification is as follows:

$$\widehat{SP_i} = \alpha + \beta \bar{SP}_i + \gamma X_i + \epsilon_i \#(2)$$

$$Y_i = \alpha + \beta \widehat{SP_i} + \gamma X_i + \epsilon_i \#(3)$$

Where, Eq. (2) is the first stage regression, Eq. (3) is the second stage regression. $\bar{SP}_i$ is the average school adaptability score of others in the same area, excluding adolescent *i*. $\widehat{SP_i}$ is the fitted values from the first stage regression of the instrumental variable model.

4. Results

4.1 Main results

Table 2 presents the main results. Columns (1), (3), and (5) show the results from Eq. (1), while columns (2), (4), and (6) display results from Eq. (3). The results indicate that higher school adaptability scores are associated with improved diet scores. Specifically, a one standard deviation increase in school adaptability scores raises diet scores by 0.7328 units. To further explore how school adaptability influences diet, we decompose diet scores into healthy and unhealthy diet scores. The results suggest that school adaptability promotes healthy diet scores while reducing unhealthy diet scores.

Table 2
Regression result

Variables	Diet scores		Health diet scores		Unhealth diet scores	
	OLS	IV-2SLS	OLS	IV-2SLS	OLS	IV-2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
School adaptability	0.426***	0.732***	0.268***	0.664***	−0.554***	−0.761***
	(0.006)	(0.060)	(0.009)	(0.089)	(0.009)	(0.081)
Control variable	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y
R2	0.226	0.148	0.082	0.014	0.212	0.193
F	453.87	--	141.98	--	333.23	--
IV	--	0.870***	--	0.870***	--	0.870***
	--	(0.050)	--	(0.050)	--	(0.050)
F-value	--	221.77	--	221.77	--	221.77
Wald X2	--	2838.51	--	1635.15	--	2584.42
Observation	29539					
*Note: *, **, and *** indicate significant at the 10%, 5%, and 1% significance levels, respectively.*						

The first-stage F-value of the IV-2SLS regression is well above 10, indicating the absence of a weak instrumental variable problem (Staiger & Stock, 1997). The regression coefficient of the instrumental variable for school adaptability is significant at the 1% level, satisfying the relevance assumption.

[Table 2 **is here]**

We further break down healthy and unhealthy diet scores into specific food categories, using the consumption frequency of each food type as the dependent variable in the regression analysis. Figure 3 presents the coefficient results. For healthy foods, we find that school adaptability significantly increases the intake of all categories except dairy products. For unhealthy foods, school adaptability significantly reduces the intake of all categories except processed meats.

[Figure 3 **is here]**

4.2 Robustness tests

In this section, we conduct robustness checks to confirm the reliability of the main results. These checks include replacing the independent variables, replacing the regression model, excluding malnutrition and obesity, adding additional control variables, applying propensity score matching, and quantile regression.

4.2.1 Replacing the independent variables

In the baseline regression, we use PCA to extract common factors from the SSBS-2 as the independent variable representing school adaptability. To test robustness, we replace the independent variable by summing and standardizing the SSBS-2 items as an indicator of school social behavior. Column (1) of Table 3 presents the regression results after this replacement. The results indicate that the significance and direction of the coefficients remain consistent with those in the baseline regression.

Table 3
Robustness test

Variables	Replacing the independent variables	Replacing the regression model	Excluding malnutrition and obesity	Adding control variables	Propensity score matching
	(1)	(2)	(3)	(4)	(5)
School adaptability	0.504***	0.757***	0.711***	0.731***	0.462***
	(0.041)	(0.068)	(0.101)	(0.061)	(0.011)
Control variables	Y	Y	Y	Y	Y
Cons	−0.976	−1.181	3.068**	−1.037	--
	(0.719)	(1.418)	(1.556)	(0.729)	--
IV	1.264***	1.264***	0.988***	0.874***	--
	(0.072)	(0.072)	(0.097)	(0.051)	--
Wald X2	2953.46	2136.89	1204.29	2928.47	--
F-value	229.46	237.01	87.16	206.93	--
Observation	29539	29539	10134	29539	PSM

*Note: *, **, and *** indicate significant at the 10%, 5%, and 1% significance levels, respectively. (2) PSM requires the independent variable to be binary, we use the mean of school adaptability scores as the cutoff point to divide it into a dummy variable.*

4.2.2 Replacing the regression model

In the baseline regression, the dependent variable is continuous. For robustness checks, we convert this variable into a binary format based on its mean and apply both Probit and IV-Probit models. Column (2) of Table 3 presents the regression results. The results indicate that the significance and direction of the coefficients are consistent with the baseline regression.

4.2.3 Excluding malnutrition and obesity

Malnutrition and obesity are associated with poor diet. Adolescents with malnutrition and obesity could have strong personal food preferences, and thus introducing sample selection bias and causing endogeneity

problems. Therefore, we exclude samples of adolescents with malnutrition and obesity. Column (3) of Table 3 reports results after excluding samples, and the results are generally consistent with the baseline regression coefficients.

4.2.4 Adding control variables

Since caloric intake and expenditure are interrelated, diet scores primarily reflect intake. To account for caloric expenditure, we included variables related to adolescents' physical activity. Column (4) in Table 3 presents the regression results with caloric expenditure controlled, which remain consistent with the baseline results.

4.2.5 Propensity score matching

Adolescents' school adaptability is influenced by both the school environment and their individual needs. We applied propensity score matching (PSM) to address selection bias and test the robustness of our results. Column (5) in Table 3 presents the average treatment effect on the treated (ATT) based on PSM. The coefficient of school adaptability remains significant and aligns with the baseline regression results, further affirming the robustness of main results.

[Table 3 **is here]**

4.2.6 Quantile regression

The baseline regression assesses the average effect of school adaptability on diet scores. We apply quantile regression to examine this effect across different levels of diet scores. Figure 4 reports the results, which indicate that school adaptability significantly enhances adolescents' diet scores at all quantiles. Furthermore, the positive effect initially increases with the quantile level but begins to decline after a certain point. This suggests that the marginal benefit of school adaptability on diet scores peaks and then decreases beyond a threshold.

[Figure 4 **is here]**

4.3 Heterogeneity analysis

In this section, we perform a heterogeneity analysis based on gender, urban-rural residence, grade, and boarding status. Figure 5 presents the subgroup regression results. The analysis shows no statistically significant differences in the effect of school adaptability on diet scores by gender or grade. However, notable differences emerge between urban and rural areas and between boarding and non-boarding students.

Specifically, the impact of school adaptability is stronger for boarding and rural adolescents compared to their non-boarding and urban counterparts. There is considerable overlap between boarding and rural samples, as rural adolescents are more likely to board, while urban adolescents tend to choose non-boarding. To interpret these heterogeneity results, we focus on adolescents' exposure time to household versus school environments. Boarding adolescents spend more time at school, which may heighten the influence of the school environment and social behaviors within it.

To examine heterogeneous pathways in more detail, we separate the total diet score into healthy and unhealthy diet scores. Heterogeneity analyses are then conducted based on urban-rural residence and boarding status, with results shown in Fig. 6. We find that school adaptability significantly differs between urban-rural and boarding groups only in healthy diet scores, not in unhealthy diet scores. This suggests that the heterogeneity in school adaptability effects across these groups is primarily driven by differences in healthy diet.

This may be attributed to the limited availability of unhealthy foods in the school environment, which improves adolescents' diet scores primarily through healthy diet choices. Adolescents with lower school adaptability may have more access to unhealthy foods outside school. However, the results show minimal variation in unhealthy eating, possibly due to family rules that restrict unhealthy eating when adolescents are outside the school setting.

[Figure 5 **is here]**

[Figure 6 **is here]**

4.4 Mechanism analysis

In this subsection, we examine how school adaptability affects adolescents' emotions, dietary habits, and media exposure within the conceptual framework.

First, adolescents' school adaptability may impact their eating behavior through its influence on emotions. We use the mental health scale as an indicator of adolescents' emotional state, applying it as the dependent variable in Eq. (3). Column (1) of Table 4 presents the results, which indicate that school adaptability can enhance adolescents' mental health scale scores.

Table 4
Mechanism analysis

	Emotions	Dietary habits	Frequency of television watching
Variables	(1)	(2)	(3)
School adaptability	−31.602**	−0.373***	−0.521***
	(13.220)	(0.072)	(0.121)
Control variables	Y	Y	Y
IV	0.501***	0.871***	0.871***
	(0.075)	(0.051)	(0.051)
Wald X2	746.31	516.38	1477.63
F-value	50.03	221.77	221.77
Observation	11585	29539	29539

*Note: *, **, and *** indicate significant at the 10%, 5%, and 1% significance levels, respectively. The dependent variable of column (1) is the mental health scales, and the mental health scales are calculated by the symptom checklist 90 (SCL-90). The dependent variable of column (2) is anorexia and retaliatory eating; we use the question "Do you often feel like you don't want to eat or overeat?" to measure anorexia and retaliatory eating. The dependent variable of column (3) is the frequency of television watching, we use the question "How many hours a day do you watch TV on average?" to measure the frequency of television watching.*

Second, unhealthy dietary habits, such as anorexia and retaliatory eating, can negatively impact adolescents' eating behavior. To examine the effect of school adaptability on these habits, we use anorexia and retaliatory eating as the dependent variable in Eq. (3). Column (2) of Table 4 presents the regression results, indicating that school adaptability can encourage healthier dietary habits among adolescents.

Third, exposure to unhealthy food advertisements can negatively impact adolescents' dietary habits, leading to poor nutrition. Digital media serves as a primary channel for these advertisements, and the digitization of television further influences adolescents' eating behaviors (Oberlander, 2021). Column (5) of Table 4 presents the regression results for school adaptability's effect on adolescents' television watching frequency. The findings indicate that school adaptability significantly reduces the frequency of television viewing among adolescents.

[Table 4 **is here]**

5. Discussion

Unhealthy diets have become a major concern in many countries, including China. This study examines the effects and mechanisms by which school adaptability influences adolescents' eating behaviors. First, we find that school adaptability significantly encourages healthy eating and discourages unhealthy eating among adolescents, with this effect being especially strong among rural and boarding students. Second, we

investigate three potential mechanisms: emotional influence, eating habits, and media exposure. The results indicate that school adaptability promotes healthy eating by enhancing positive emotions, fostering healthy eating habits, and reducing adolescents' media exposure.

An interesting finding is that school adaptability does not significantly increase dairy consumption or reduce processed meat intake. This may be due to differences in food preference intensity, as stronger preferences are harder to alter. Another notable finding is that school adaptability shows significant urban-rural and boarding differences only in healthy diet choices, not in unhealthy ones. This may suggest that increasing healthy food intake is easier than reducing unhealthy food consumption.

This research highlights the positive impact of adolescents' social performance on healthy eating behaviors. Based on these findings, several policy implications can be proposed: First, implementing healthy eating interventions at the school level should address not only external constraints in the school food environment but also adolescents' social performance within the school. Second, school-level factors have a more pronounced impact on boarding and rural adolescents. Rural students often board due to the distance between home and school, and boarding students are more influenced by school-level factors due to their extended time at school. This suggests that policymakers should tailor home-school intervention measures to different groups, placing greater emphasis on school-level interventions for rural and boarding adolescents.

This study offers several advantages. First, prior research on adolescent healthy diets often faces limited external validity due to small sample sizes. In contrast, DYH includes only adolescents, providing robust sample representativeness. Although the sample is drawn from a single province in China, the standardized education model and consistent school policies across the country enhance the external validity of the findings. Second, this study employs the Food Frequency Questionnaire (FFQ) to assess adolescents' eating behavior, distinguishing between healthy and unhealthy eating scores. While the dietary recall method may offer greater precision, it is costly and can lead to significant errors, particularly among adolescents, due to the survey's lack of rigor. The FFQ method is more cost-effective and reduces measurement errors, making it well-suited for evaluating eating behaviors in this age group.

This study has several limitations. First, extensive research underscores that adolescents' behaviors and nutritional outcomes have lasting impacts on health and development in adulthood. Additionally, dietary influences during childhood, infancy, and even the fetal period are crucial to consider. Due to data constraints, however, this study focuses only on adolescents in middle and high school. Second, the DYH data is cross-sectional, spanning different years rather than forming a panel dataset, which may introduce regression bias. Nonetheless, we have sought to mitigate potential endogeneity bias by using instrumental variable models and conducting extensive robustness tests.

Abbreviations

2SLS
two-stage least squares
ATT

average treatment effect on the treated
DQI
Diet Quality Index
DYH
Database of Youth Health
FFQ
food frequency questionnaire
HEI
Healthy Eating Index
IV
instrumental variable
IV-2SLS
instrumental variables two-stage least squares
IV-Probit
instrumental variables Probit
PCA
principal component analysis
PPS
probability proportional to size
Probit
probit model
PSM
propensity score matching
SSBS-2
School Social Behavior Scales, Second Edition

Declarations

Ethics approval and consent to participate

This study involves human participants and was approved by Ethics Committee of Shandong University (20180517). The protocol has been performed with the ethical standards as laid down in the 1989 Declaration of Helsinki and its later amendments or comparable ethical standards. Written informed consent to participate in this study was provided by the participants and their parents and/or legal guardians.

Consent for publication

Not Applicable.

Availability of data and materials

The data used in this study are derived from the *China's Database of Youth Health (DYH)* hosted by the Population Health Data Archive (PHDA) at the National Center for Population Health Data (□□□□□□□□□□□□□). Researchers wishing to obtain these data can apply via the PHDA website at https://www.ncmi.cn/phda/dataDetails.do?id=CSTR:17970.11.A0031.202107.209.V1.0. Data access is subject to the center's data usage policies and approval process.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This work was supported by National Social Science Foundation of China (21AGL022).

Author Contributions

Zongshuo Yin: Conceptualization, Formal analysis, Methodology, Software and Writing – original draft; **Shijiu Yin:** Funding acquisition, Investigation and Writing – review and editing.

Acknowledgements

We thank the Population Health Data Archive (PHDA) for providing access to the DYH data.

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Footnotes

1. The processed meats, instant noodles, and fast foods contain much fat and sodium, the sugary beverages contain much sugar. High intake of processed meats, instant noodles, fast foods, and sugary beverages can increase the risk of health(Qian et al., 2020; Sikander et al., 2017; Stender et al., 2007).

Figures

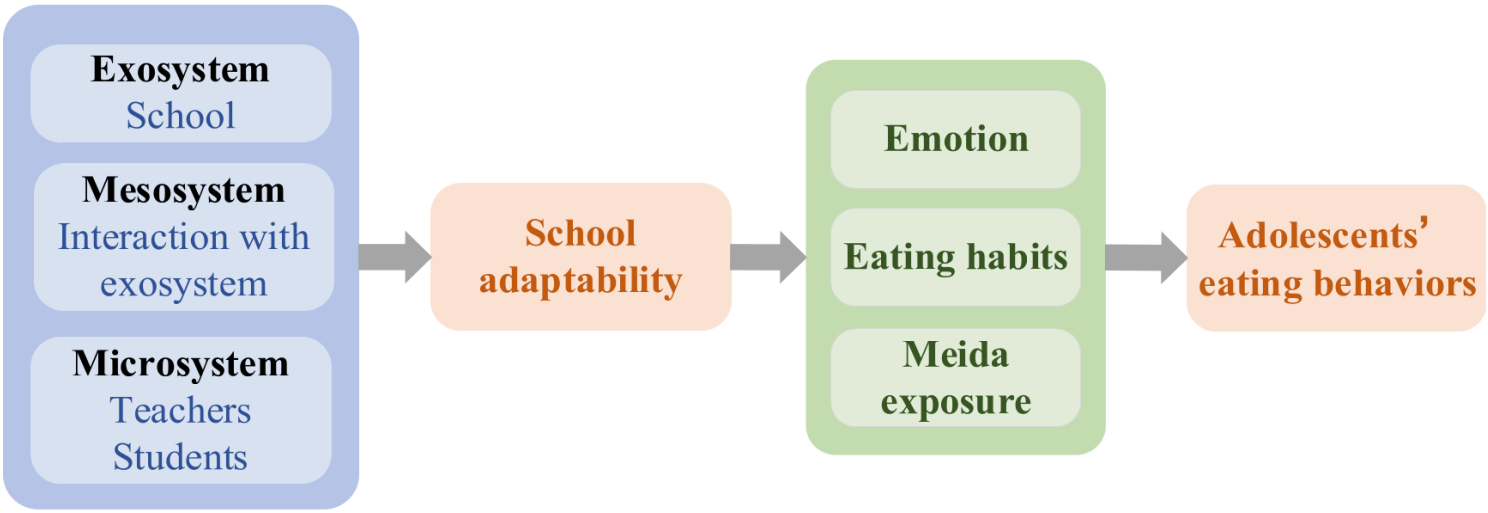


Figure1 The conceptual analysis framework

Figure 1

See image above for figure legend

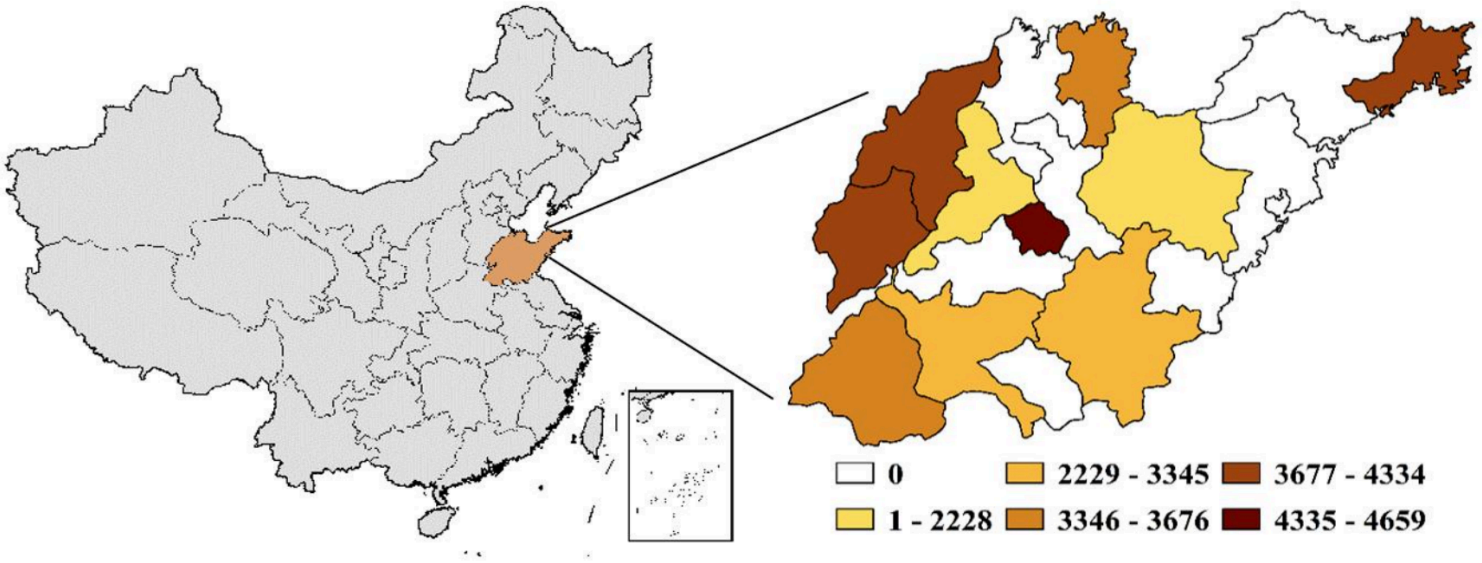


Figure2 The distribution of the sample size.

Figure 2

See image above for figure legend

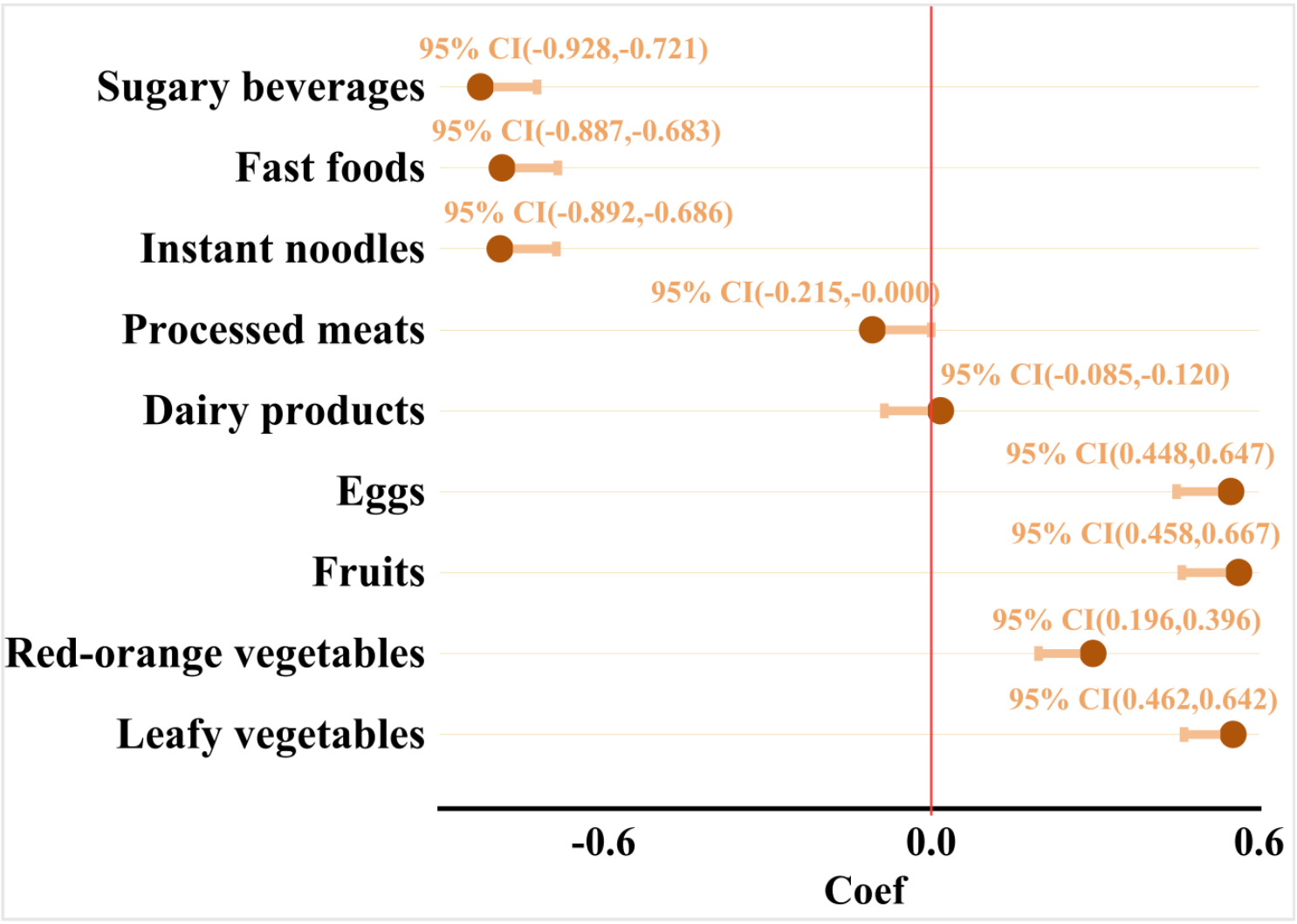


Figure3 The coefficient results

Figure 3

See image above for figure legend

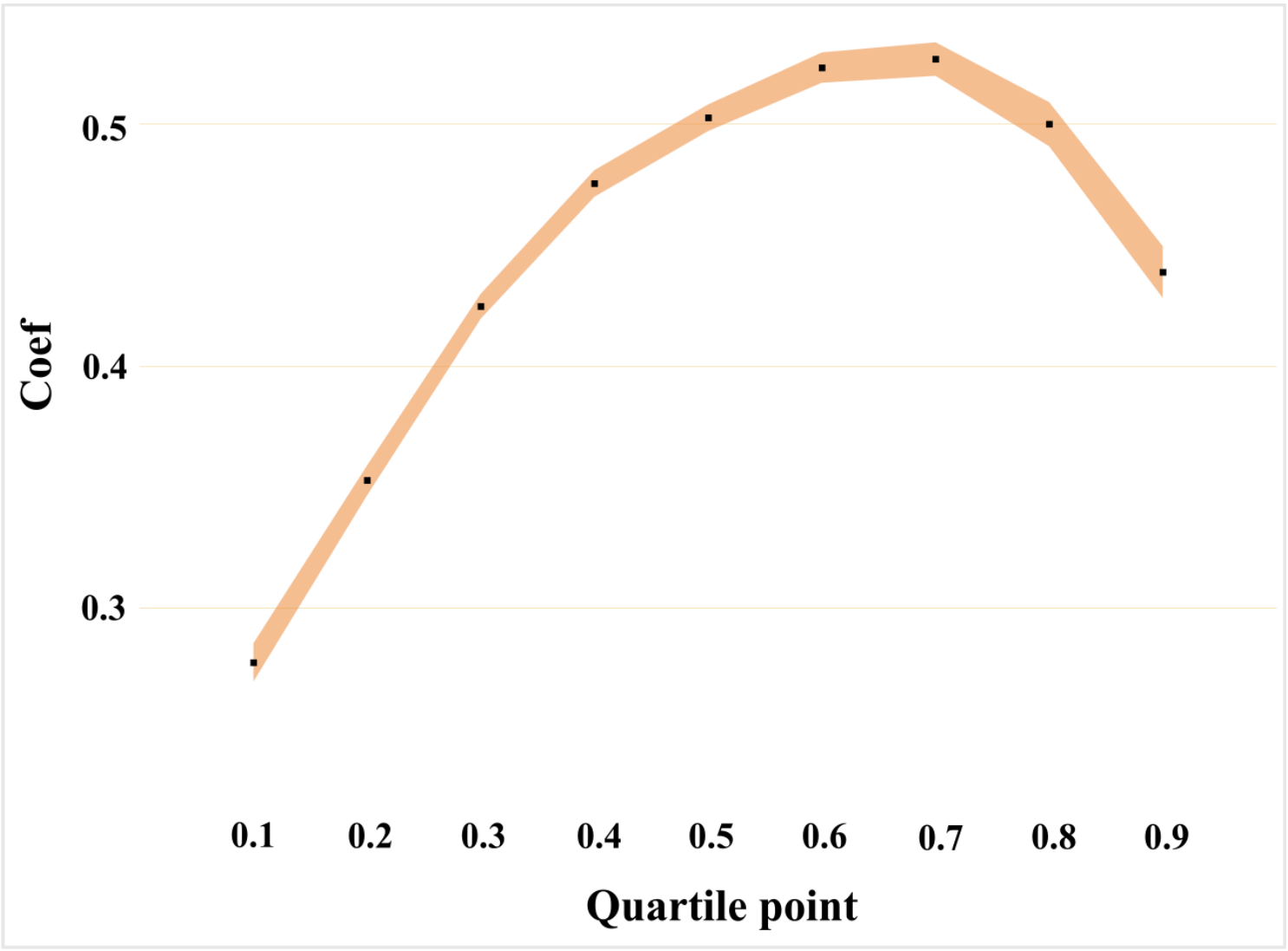


Figure4 Quantile regression

Figure 4

See image above for figure legend

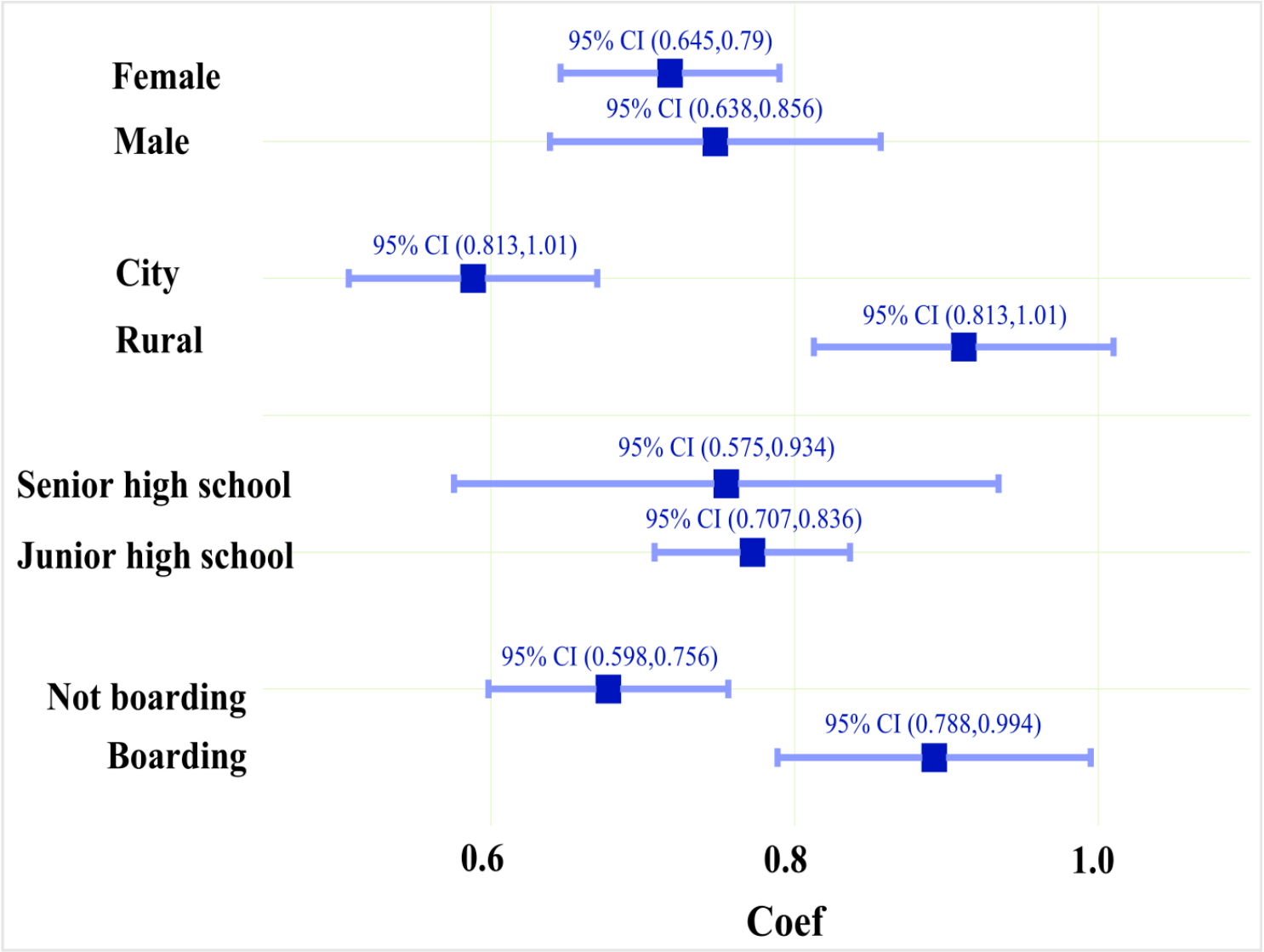


Figure5 Heterogeneity analysis (1)

Figure 5

See image above for figure legend

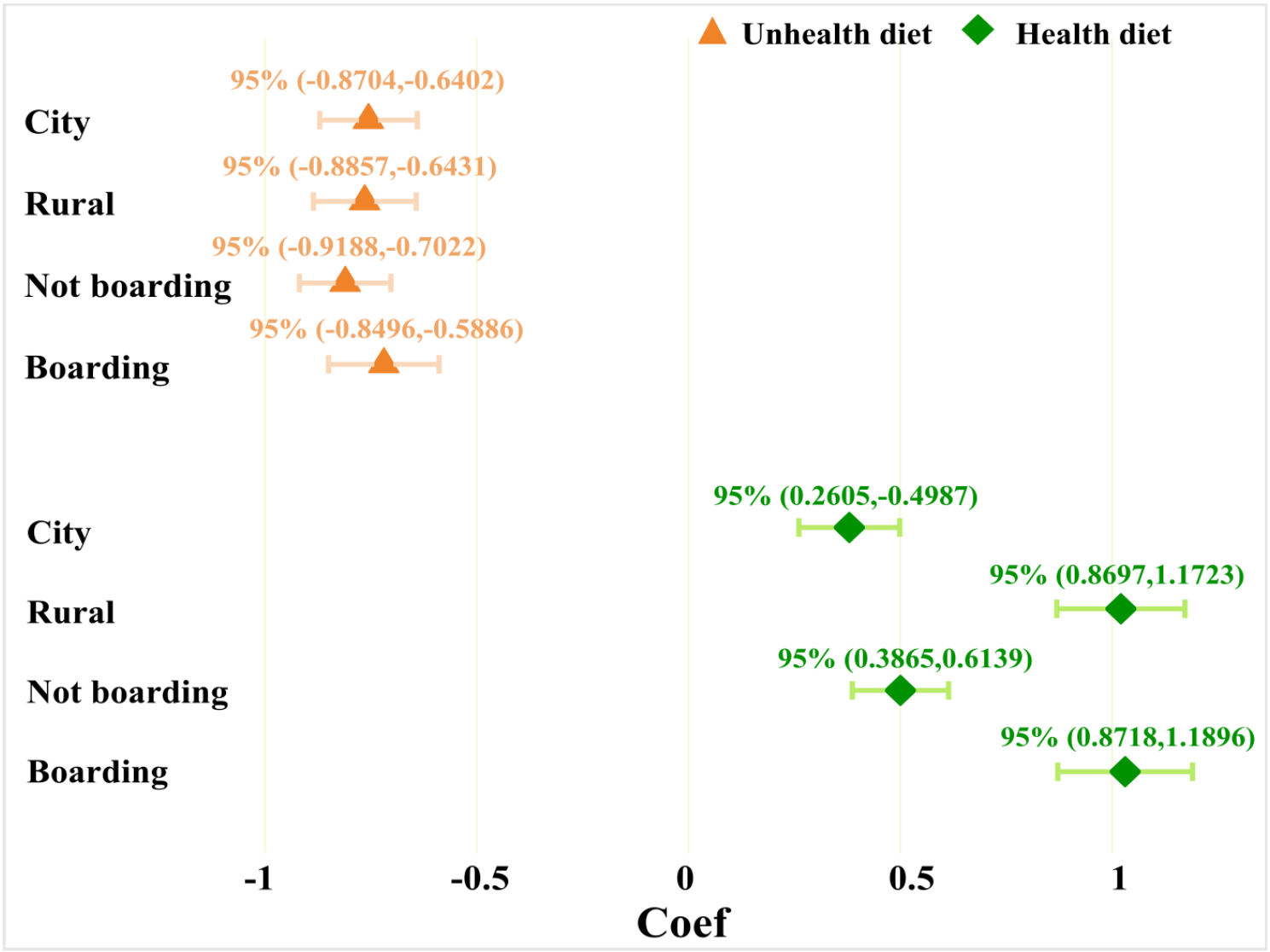


Figure6 Heterogeneity analysis (2)

Figure 6

See image above for figure legend