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## A Study of the Current State of Providing Fruits and Vegetables in Maine's Middle Schools

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A STUDY OF THE CURRENT STATE OF PROVIDING FRUITS AND VEGETABLES IN  
MAINE'S MIDDLE SCHOOLS

by

Renee Pickard

A Thesis Submitted in Partial Fulfillment  
of the Requirements for a Degree with Honors  
(Biology)

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## ABSTRACT

In this research study, I analyzed the nutrition of school lunches in Maine's public and private middle schools. Proper nutrition is a vital component for not only the physical development but the intellectual and academic performance of children, particularly those entering the early stages of puberty. More specifically, nutrients, such as vitamin C, potassium, and folic acid, provided in fruits and vegetables increase immunity, manage blood pressure, and support cell growth and function (Brown, 2017). I conducted this research to determine if Maine's schools are currently meeting the state and federal guidelines overseen by the United States Department of Agriculture (USDA).

The questions posed in this study were: are students in school lunch programs being offered the nutrients they need to support their intellectual development and has the likelihood of meeting dietary nutrient recommendations changed? I used qualitative and quantitative data to answer these questions by researching published lunch menus in different Maine middle schools. Additionally, I explored the behavioral and socioeconomic aspects that may contribute to the menu quality of the 12 schools through reviewing outside literature. After analysis of the lunch menus from middle schools in both urban and rural populations, I determined that Maine schools were more likely to meet the vegetable requirements in school lunches than those for fruits, as eight of the twelve schools served vegetables every day in the month of November. However, only seven schools served fruit daily at lunch, with one school not serving fruit once for the

entire month of November 2022. The population's geographical location and average economic status may have contributed to the availability of fruits and vegetables, as schools located in the southern districts in Maine and those classified as urban were more likely to meet the fruit and vegetable standards at lunch.

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## TABLE OF CONTENTS

INTRODUCTION	1
METHODOLOGY	5
RESULTS	7
DISCUSSION	13
REFERENCES	22
AUTHOR'S BIOGRAPHY	27

## LIST OF TABLES AND FIGURES

Table 1. Mean Data for the 12 Maine Middle Schools Studied	7
Figure 1. Average Fruit Servings in Maine Public Middle Schools	9
Figure 2. Average Vegetable Servings in Maine Public Middle Schools	10
Figure 3. Average Fruit Servings in Maine Private Schools	11
Figure 4. Average Vegetable Servings in Maine Private Schools	12

## INTRODUCTION

Adolescence occurs around the age of 11 and includes many physical and psychological changes. Many of these significant changes affect height, weight, degree of sexual maturation, skeletal mass, and body fat distribution. To support these essential changes, children and young adults between the ages of 11 and 21 need to meet dietary recommendations for key vitamins, minerals, and macronutrients to support their energy needs, as well as for their physical and mental development to occur (Brown, 2017). The required energy needs for female adolescents are approximately 2200 calories per day, while the requirements for males are approximately 2500 to 3000 calories per day (Wahl, 1999). Additionally, adolescents require at least 1300 mg of calcium per day to support continued growth, 600 IUs of vitamin D for absorption of calcium and phosphorus in the intestines, and 300-400 µg of folate for the synthesis of proteins and nucleic acids in cells. Moreover, 8-11 mg of iron for males and 8-15 mg for females is required to support rapid growth, increases in blood volume, and onset of menstruation for females (Brown, 2017).

These nutrients are also vital for the cognitive development of adolescents. They are required for neurogenesis, growth of axons and dendrites in neurons, the formation of synapses, and for some axons to become myelinated (El Soury et al., 2021). Moreover, studies show that the number of calories required by the brain is approximately 20% of the resting metabolic energy expenditure. Therefore, if the resting metabolic rate of one's body requires approximately 1,300 calories per day, then the brain needs approximately 300 calories per day to perform necessary functions (Ray, 2008). However, while this is the average energy requirement for the brain, children and adolescents have much



different caloric needs to support neural development. For instance, one study suggests that when children are around 5 years old their brain's energy consumption peaks at requiring approximately two-thirds of the resting metabolic expenditure. In contrast, during adolescence the energy consumed by the brain decreases drastically, which could be linked to increases in weight gain when caloric intake does not change accordingly (Northwestern University, 2019).

In regard to adolescent mental health, a lack of adequate nutrition can affect an individual's brain chemistry, leading to illnesses such as depression and anxiety (Brown, 2017). Neurogenesis is the process that allows for new neurons to form in the brain. This process supports learning and short-term and long-term memory. In addition to memory, neurogenesis can also play a significant role in mental health. Studies have found that decreased or limited neurogenesis, particularly in regions of the brain such as the hippocampus, can limit the autonomic nervous system's ability to perform mood control through decrease in mass (Eisch and Petrik, 2012). Also, certain nutrients in foods can impact the neural components of the brain. For example, flavonoids found in citrus fruits have been linked to cognitive enhancements. Omega-3 fatty acids in kiwi, such as docosahexaenoic acid (DHA), stimulate neuroplasticity, where structural and functional changes in the brain occur based on new learning experiences. Also, vitamin E, found in olives, spinach, and avocado, reduces cognitive decay as one ages (Gómez-Pinilla, 2008). Furthermore, it has been found that increased frequency of fruit and vegetable consumption has been linked to higher levels of school performance, likely due to a greater abundance of antioxidants, such as carotenoids and alpha-tocopherol (Kim et al.,

2016). Antioxidants can assist with intellect, because they support neuroplasticity through reducing brain atrophy and DNA damage (Ambrogini et al., 2016).

As adequate nutrition is so vital to adolescents' physical and mental health, the meals offered in school systems are subject to state and federal mandates overseen by the United States Department of Agriculture (USDA). As of February 2022, the United States Department of Agriculture (USDA) set guidelines for the National School Lunch Program that state that those in grades six through eight should be served approximately 2 ½ cups of fruit and 3 ¾ cups of vegetables per week with at least a ½ cup of fruit and ¾ cup of vegetables served per lunch (U.S. Department of Agriculture, 2022). Additionally, within the 2 ½ cups of fruit recommendation, up to half of this can come from fruit juice (U.S. Department of Agriculture, 2022). After this increase in fruit and vegetable requirements in 2012, the USDA reported that children in school lunch programs ate 23% more fruits and 16% more vegetables at lunch (U.S. Department of Agriculture, 2019). However, since this reported data, the COVID-19 pandemic that began in the United States in March 2020 caused a significant shift in the accessibility and structure of lunches and school systems overall. According to one study, reported vegetable consumption during the pandemic decreased significantly due to food insecurity and changes in food prices, particularly leading to vegetable consumption mostly occurring through canned, frozen, or other storable vegetables that contain preservatives (Jordan et al., 2021).

When adolescents do not consume the recommended daily servings of fruits and vegetables, they are at an increased risk for developing obesity, hypertension, coronary heart disease, stroke, and even cancer (The Nutrition Source Staff, 2021). My hypothesis

for this thesis is that the current quality of food meal plans in Maine middle schools can be significantly increased to be more likely to provide students with the USDA-recommended daily servings of fruits and vegetables for school lunches.

## METHODOLOGY

An analysis was conducted on the lunch menus for twelve middle schools across the state of Maine during the month of November 2022. November was chosen as the specified analysis month, to determine if the crops of fruits and vegetables during harvest season, such as apples, broccoli, and carrots were able to be further utilized in school lunches (Cesario-DeBiasi and Grassie, 2021). The twelve middle schools (grades 6-8) included in the study can be found in Table 1. These twelve schools were further categorized by whether they were located in an urban or rural environment. For reference, rural areas are those whose populations are fewer than 2,500 individuals and are often also within non-metropolitan counties that contain fewer than 50,000 individuals in their population (Cromartie, 2019; Cromartie, 2020). By this definition, out of the twelve schools, only Rangeley was considered strictly rural, but the populations in Sabattus and Houlton were only barely above that threshold (United States Census Bureau, 2022). As I was relying on published lunch menus, the studied schools were limited to those with an online presence. Therefore, most of the data was sourced from less rural school districts with greater financial resources from a larger population with greater average incomes (United States Census Bureau, 2022).

The lunch menu analysis consisted of determining how many days each week during the month of November fruits and vegetables were offered to students. Moreover, when considering if fruits and vegetables were offered, the data was separated between whether they were offered by themselves or as a constituent of a larger dish, such as smoothies or soups. The USDA does not require fruits and vegetables to be served alone, so it is acceptable for schools to serve fruits and vegetables in many different forms and

dishes, as long as the daily serving recommendation is met (Maine Department of Education, Child Nutrition Staff, 2021). However, the presence of fruits and vegetables was organized in this way to differentiate between solely nutrient-dense options and those with the trade-off of higher caloric quality. Nutrient density is the amount of beneficial nutrients found in a food in relation to its caloric content. Nutrient-rich foods are those that are high in vitamins, minerals, complex carbohydrates, lean protein, and healthy fats. Empty-calorie foods are those that supply energy through calories, but have little to no nutrients (Eufic, 2021). Additionally, fruits and vegetables that are cooked prior to serving, are also more likely to contain reduced fiber content due to breakdown of plant cell walls and fibers during the process (Bell, 2017).

While the USDA recommendations for school lunches do not explicitly state that all fruits and vegetables must be uncooked or served alone, the 2020-2025 Dietary Guidelines for Americans suggests that food group needs, such as those for fruits and vegetables, be met through consumption of nutrient-dense foods and beverages (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). Along with conducting an analysis of the school lunch menus, a review was done of previously published literature. Published data from prior to the pandemic was utilized to further determine the change in fruits and vegetables offered and the economic impact of the pandemic on the school lunch menus.

## RESULTS

The analysis of the 12 school lunch menus revealed that eight schools served vegetables every day and only seven schools served fruit daily at lunch during November 2022. Only one of the two private schools studied met the fruit and vegetable requirements. The schools located in the southern towns in Maine and those urbanized or in urban clusters were more likely to meet the fruit and vegetable standards at lunch. These schools included: Saint Dominic Academy in Auburn, as well as the Freeport, South Portland, Gorham, Presque Isle, and Lewiston public schools.

Table 1: Collected Mean Data for the Maine Middle Schools from the Month of  
November 2022

School	Average Days Per Week with Fruit Served Alone	Average Days Per Week with Fruit Served in Dish	Average Days Per Week with Vegetables Served Alone	Average Days Per Week with Vegetables Served in Dish	Total Average Weekly Fruit Servings	Total Average Weekly Vegetable Servings
<b>Bangor (Public)</b>	3	1.75	4.25	0.25	4.75	4.5
<b>Rangely (Public)</b>	3	1.75	2.75	1.25	4.75	4
<b>Brunswick (Public)</b>	4.75	0	4.75	0.75	4.75	5.5
<b>Freeport (Public)</b>	0	5	5	1	5	6
<b>Oak Hill – Sabattus (Public)</b>	5	0	5	0.5	5	5.5
<b>South Portland (Public)</b>	5	0	5	0.5	5	5.5

<b>School</b>	<b>Average Days Per Week with Fruit Served Alone</b>	<b>Average Days Per Week with Fruit Served in Dish</b>	<b>Average Days Per Week with Vegetables Served Alone</b>	<b>Average Days Per Week with Vegetables Served in Dish</b>	<b>Total Average Weekly Fruit Servings</b>	<b>Total Average Weekly Vegetable Servings</b>
<b>Gorham (Public)</b>	5	0	5	1	5	6
<b>Thornton - Saco (Private)</b>	0.25	0	3	0.75	0.25	3.75
<b>Presque Isle (Public)</b>	5	0.25	5	0.5	5.25	5.5
<b>Houlton (Public)</b>	5	0.25	5	2	5.25	7
<b>Lewiston (Public)</b>	5	0	5	0.5	5	5.5
<b>Saint Dominic - Auburn (Private)</b>	5	0	5	1	5	6

Table 1 indicates the overall comparison between the twelve schools for the average servings of fruits and vegetables each week, both alone and in larger dishes where they might have lost nutrient density. The results indicate that most of the schools were more likely to serve fruits and vegetables alone, including via à la carte and salad bars, than in larger meals, particularly regarding fruit.

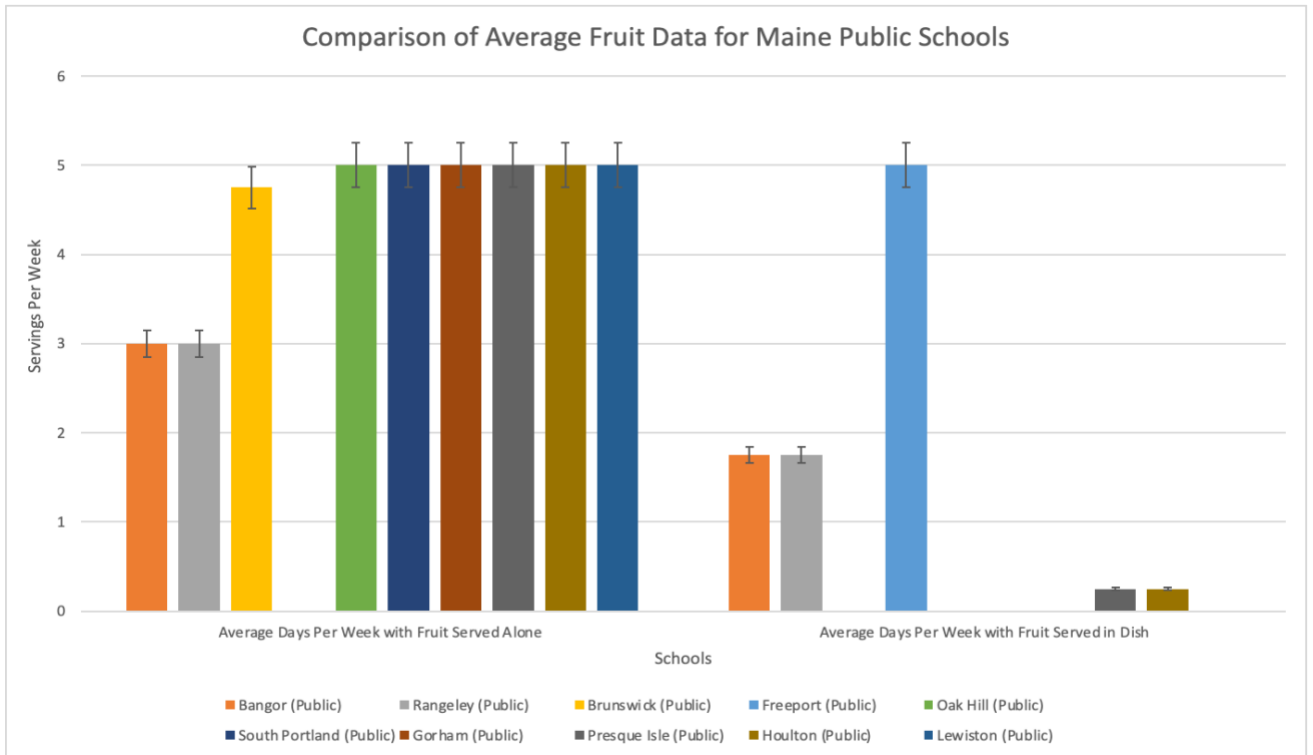


Figure 1: Comparison of Average Fruit Data for Maine Public Schools

Figure 1 shows that the Oak Hill, South Portland, Gorham, Presque Isle, Houlton, Freeport, and Lewiston public schools all met the recommendation that fruit be provided daily, but Freeport never served fruit alone and only in larger, cooked dishes.



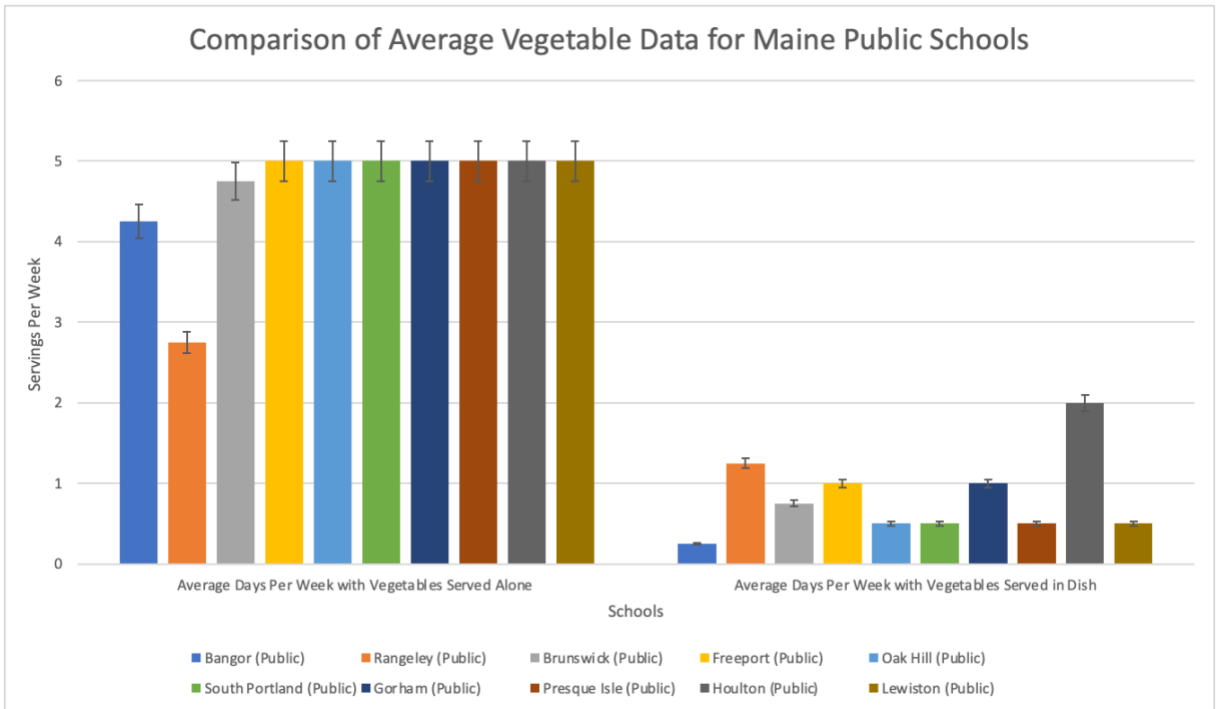


Figure 2: Comparison of Average Vegetable Data for Maine Public Schools

Figure 2 shows that the Oak Hill, South Portland, Gorham, Presque Isle, Houlton, Freeport, and Lewiston public schools all met the recommendation that vegetables be provided daily, and they offered it alone.

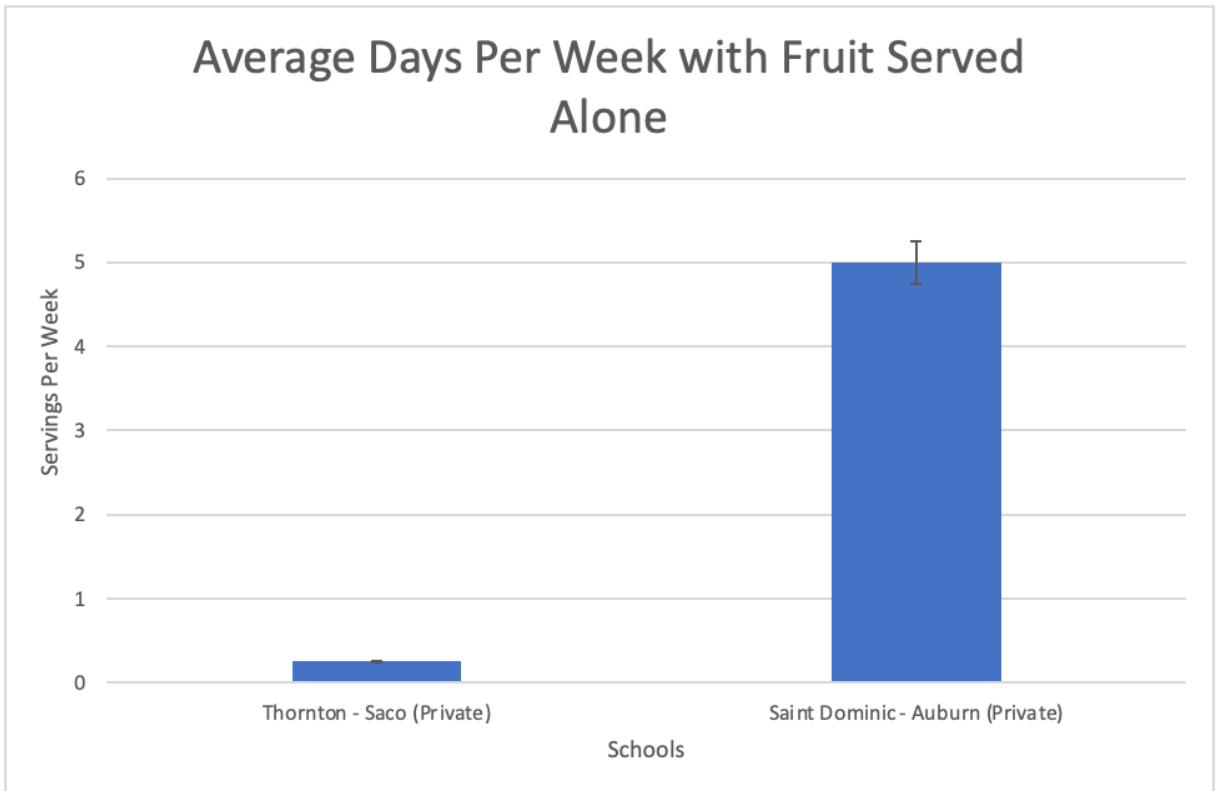


Figure 3: Comparison of Average Fruit Data for Maine Private Schools

Figure 3 compares the average weekly servings of fruits and vegetables in the two private schools studied to the recommendations. Saint Dominic Academy met the recommendations for daily servings of fruits, alone. However, Thornton Academy did not meet any of the recommendations for fruits, either alone or served in larger dish recipes.

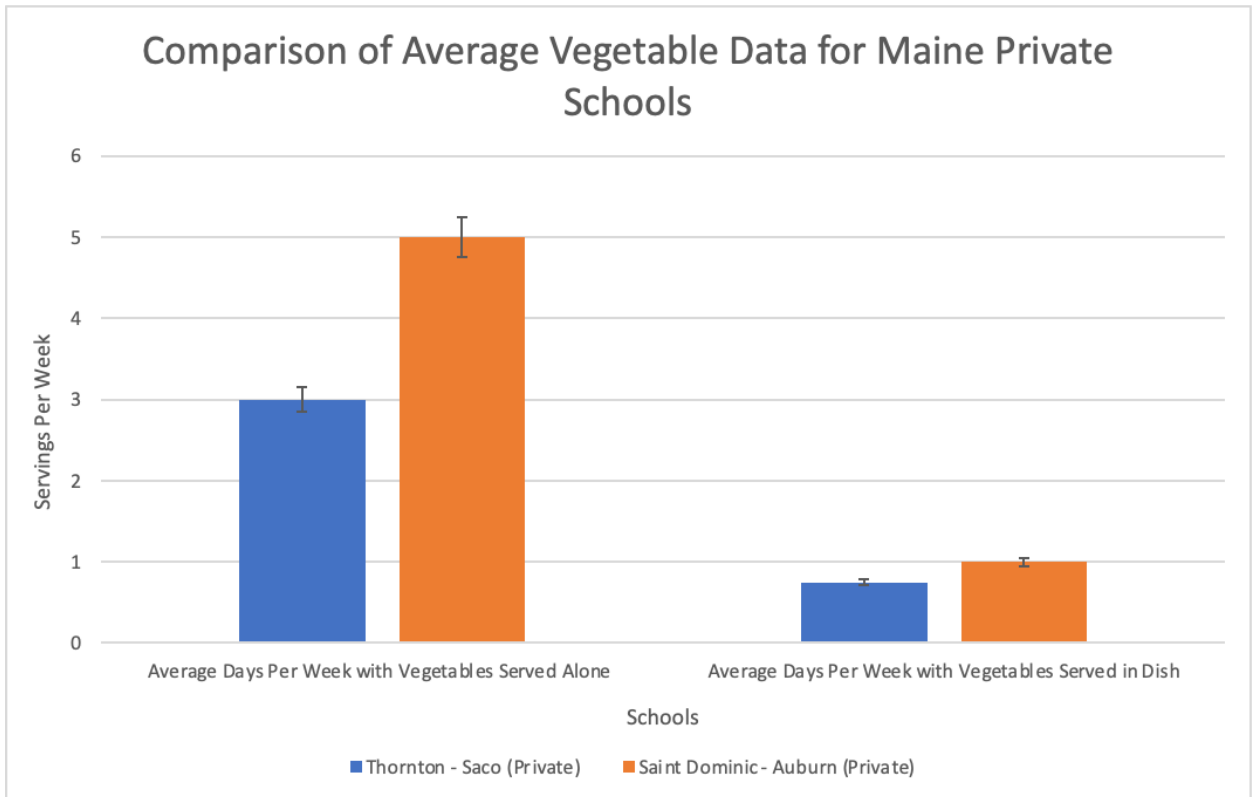


Figure 4: Comparison of Average Vegetable Data for Maine Private Schools

Figure 4 compares the average weekly servings of vegetables in the two private schools studied to the recommendations. Saint Dominic Academy met the recommendation for daily vegetables, particularly for serving them alone. However, Thornton Academy did not meet the recommendation for vegetables, either alone or served in larger dish recipes.

The twelve schools were more likely to meet the vegetable requirements in school lunches than those for fruits. The seven schools that served fruit every day in November 2022 were Oak Hill, South Portland, Gorham, Presque Isle, Houlton, Freeport, and Lewiston. The eight schools that served vegetables every day were Oak Hill, South Portland, Gorham, Presque Isle, Houlton, Freeport, Lewiston, Saint Dominic Academy.

## DISCUSSION

It was hypothesized that Maine's schools serve significantly fewer fruits and vegetables than the USDA recommends for middle school students in grades six through eight. While the results did not support that the differences in fruit and vegetable servings were significant, it was found that only seven of the twelve schools met both the fruit and vegetable requirements for November 2022, as indicated by their online, published lunch menus. November was the month chosen for analysis, because the yields from the harvest season were anticipated to have provided greater opportunities for fruits and vegetable supplies, particularly in rural areas of Maine that have decreased food access. Additionally, many schools may be able to source their fruit and vegetables locally to benefit agricultural workers and to decrease socioeconomic difficulties. The results from my research could be due to a multitude of factors that may relate to the residual impacts of the COVID-19 pandemic, as well as the general location of the schools' communities.

### Types and Quality of Fruits and Vegetables Served

One additional factor that may influence the serving of particular food items in these schools is potential plate waste. When schools see that significant portions of certain foods go uneaten each day, to limit economic burdens that come without direct student consumption, the school may reduce inclusion of those foods into their menus (Buzby and Guthrie, 2002). Therefore, plate waste is a considerable concern for school systems when supplying fruits and vegetables. One study recorded that some middle school students left approximately half of fruit and one-third of served vegetables unconsumed and for waste (Smith and Cunningham-Sabo, 2014). Salad bars have been

deemed an excellent option to provide vegetables to students while leading to a potential decrease in plate waste. Salad bars also allow students to choose servings of vegetables without being limited due to allergies or food preferences. However, the USDA requires that schools measure the amount of each ingredient that is added to the salad bar and how much of each ingredient is left over at the end of each day (U.S. Department of Agriculture, 2019). These measurements are meant to account for the consumption of vegetables by the students, particularly when consuming the minimum requirement of  $\frac{3}{4}$  cup of vegetables per day for each student (U.S. Department of Agriculture, 2019).

Additionally, it was found that the location of the salad bars within schools greatly affected the likelihood of students choosing to consume food from them. For instance, in one study, approximately 98.6% of students took food from a salad bar when it was already in the line for the rest of the food served in the cafeteria. In contrast, only 22.6% of students ate from a salad bar when it was located separately from the regular meal line (Adams, 2016). In my analysis of the 12 school lunch menus in Maine, it was found that the majority of the eight schools that met weekly vegetable recommendations also had a salad bar, such as Oak Hill, Gorham, Freeport, and Houlton (Figure 2). These salad bars can be impractical economically, as many of these salad items will “go bad” very quickly (Messa, 2019). Frozen or canned fruit and vegetable items are not only less expensive to buy in bulk supply, but able to be stored for longer periods of time compared to fresh produce. While salad bars can positively impact the servings of vegetables consumed by adolescents, it has been found that the presence of à la carte and snack bar options in schools has led to a significant decrease in consumption of fruits,

non-fried vegetables, and milk. At the same time, students are more likely to choose sweetened beverages and high-fat options (Cullen, 2004).

As seen in Table 1, more schools offered the recommended servings of vegetables than fruit. However, the average days where fruit was offered, particularly when served alone with greater nutrient density and fiber content, was less frequent. When you put fruits and vegetables through a blender, the fibrous material from the plant that increases satiety and digestion is removed (Zeratsky, 2021). Moreover, it was found that, between 2007 and 2010, 6 out of 10 children did not consume enough fruit daily, even though new guidelines had caused fruit consumption for children to increase by 67%. Additionally, even with better vegetable consumption by adolescents, from 2007 to 2010, 9 in 10 children still did not meet the recommended daily intake of vegetables, and  $\frac{1}{3}$  of the vegetables they ate were white potatoes, often in a fried form (National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity, 2018).

### Geographical Location

The schools located in the southern towns in Maine and those urbanized or in urban clusters were more likely to meet the fruit and vegetable standards at lunch (Figure 1). These schools were located in Auburn, Bangor, Freeport, South Portland, Gorham, Brunswick, and Lewiston. However, rural schools, such as Rangeley, exhibited decreased servings of fruits and vegetables each week and a greater prevalence of high-fat and low-nutrient meal items included in their menu. The success in meeting the USDA recommendations in urbanized school districts is likely due to easy access to and

affordability of resources, such as salad bars (Newman, 2013). Furthermore, optimized fruit and vegetable presence and availability, not only at school or home but in students' neighborhoods, can increase consumption and familiarity with the foods (Moffat et al., 2021).

### Nutrition Education and Outside Influences

The relationship between adolescent fruit and vegetable consumption has been directly linked to parental modeling of behaviors and self-efficacy (Young et al., 2004). During the stage of adolescence, where independence and the first signs of young adulthood rise, viewing the actions and patterns of role models can lead to mimicry of those same actions. Furthermore, when adolescents have goals and confidence in their ability to work toward them, they are more likely to prioritize their own well-being and feel personally compelled to make healthy choices (Young et al., 2004). Some of the key factors that affect the nutritional health of individuals are personal food preferences, food patterns and behaviors, feelings of social support, home environment, school setting, overall community, food security in their household, and their relationship to dieting and body image (Ritchie et al., 2015). Dietary patterns are the combination of foods and beverages that make up an individual's food and beverage intake over time and can affect their overall, long-term health.

Regarding their school environment, nutritional education also impacts adolescents through programs such as gardening, farm field trips, agricultural presentations, class lessons, and even opportunities to taste-test certain foods in an academic setting. Including these programs in school lesson plans has resulted in

increased reports of self-efficacy and decreased adolescent desire for unhealthy food options (Evans et al., 2012). Adolescents tend to gravitate towards the foods with which they are most familiar, particularly those that have been served consistently at home. Therefore, those who grow up in certain cultural or religious environments will also hold different dietary preferences. To ensure that adolescents still consume the necessary nutrients for their health, school systems should consider expanding their lunch menus to include a wider variety of familiar foods for multiple groups of students.

### Impact of the COVID-19 Pandemic and Socioeconomic Factors

Of the twelve schools studied, only six provided meals to their students during the closures caused by the pandemic. Availability of local, national, and international food products has significantly suffered during and following the pandemic (Mead et al., 2020). During the pandemic, many students who relied on school meals were at risk for malnutrition. To combat this issue, since the COVID-19 shutdown and the subsequent return to school months later, Maine schools altered their food availability options by working with distribution sites to reduce food insecurity for their students by providing free meals (Santhanam, 2021). However, these programs reported that the cost of supplying meals to students increased drastically due to the pandemic and made the food quality suffer due to financial restraints (Mead et al., 2020). These accounts from schools are fascinating, as schools that participate in the USDA's National School Lunch Program are supposed to receive a variety of fruits and vegetables, meats, cheese, beans, brown rice, and other whole grains to make up an estimated 20% of their budget for meals (Maine Department of Education, Child Nutrition Staff, 2021). Additionally, these



foods are mostly required to be sourced from local American agricultural businesses, which would be of great economic value during and after the pandemic. Some schools received reimbursement for school lunches during the COVID-19 shutdown, but only if they qualified by having a 50% or more poverty level within their school district.

While schools offered students free meals in Maine during the pandemic, this policy was not extended by USDA during the 2022 through 2023 school year for all K-12 public schools. As the economy has not yet recovered from the COVID-19 pandemic and many adults are unable to make a livable wage while being employed, the return of this financial burden could result in parents and guardians sending less nutritious and inexpensive meals with their children to school instead of those that follow USDA guidelines in the school (Cohen, 2022). The socioeconomic level of the students in the school districts also dramatically impacts both the food offered and the food chosen for consumption by the students. It was found that school systems with higher populations of students from lower socioeconomic groups were less likely to sell healthy foods and beverages (Taber, 2015). Furthermore, even with the new implementation of guidelines by the USDA, schools in locations with greater populations of lower socioeconomic status saw children still choosing the less nutritious items for purchase (Taber, 2015).

### Behavioral Aspects of Adolescent Age Group

Middle school is a crucial time to instill healthy and balanced eating habits because adolescents are independent enough to make decisions and understand their actions. However, they must also create a healthy relationship with food before entering a high school setting where they no longer experience direct, hands-on supervision and

guidance from their teachers and parents. Moreover, during middle school, adolescents often struggle for independence, which frequently leads to the development of health-compromising behaviors, such as dieting, meal skipping, and the use of non-nutritional supplements (Brown, 2017). It was found that the amount of time during their lunch period that students can remain seated, is directly related to the servings of fruits and vegetables consumed (Prescott et al., 2020). Although it is recommended that students have at least 20 minutes to eat their school lunches, there is currently no federal mandate to enforce this as a policy (Prescott et al., 2020). When students are rushed to eat before returning to classes, they are more likely to choose quick, high-calorie food over lower-calorie, but nutrient-dense options, such as fruits and vegetables (Jabs and Devine, 2006).

### Research Limitations

If this study was to be repeated, multiple improvements could be considered. For instance, as twelve school menus were studied, the data only represented a few towns and school districts. Also, only two out of the approximately 150 private schools throughout the state of Maine were observed. Both schools were located in more central to southern locations in Maine with an urbanized environment. Only the lunch menus for one month out of the school year were studied, and data for the same month pre-COVID pandemic was not available for precise menu comparisons. Additionally, as the study was limited to including 12 schools, the sample size was too small to perform statistical analysis that yields any meaningful results.

### Recommendations and Concluding Long-Term Significance of Study

The importance of this research on middle school lunch menus is that it assists in the determination of the current state of adolescent health, the potential long-term effects of the COVID-19 pandemic, future academic and social abilities or changes displayed by younger generations, the success and effectiveness of the implementation of USDA guidelines, and to account for any lack of representation and accommodation for those with alternative dietary requirements or preferences. To improve the inclusion of fruits and vegetables in school lunches, schools should seek to implement working with the neighboring food co-ops in Maine to support local vendors and decrease the limitations of transport that larger companies may have (NFCA, 2023). Furthermore, the USDA should include greater specifics in the type of foods that are allowed to meet the recommendations for schools that participate in federally funded meal plans and should allocate more funds towards supporting school lunches. For instance, currently, only \$0.40 per meal is required by the USDA to be given to schools that participate in the National School Lunch Program (Maine Department of Education, Child Nutrition Staff, 2021).

Beyond that, nutrition and agricultural lessons in school systems should include introducing different fruits and vegetables to allow adolescents to become more familiar and comfortable with them for consumption. It is particularly vital to explore the introduction of fruits and vegetables that are more popular in other geographical locations and cultural groups so that students of different ethnicities are also being served familiar foods. Another way to increase fruit and vegetable consumption would be to incorporate fruits and vegetables into popular foods that many adolescents enjoy, such as including cauliflower crust for pizza or vegetables as pasta noodles. Although the nutrient density is

greater when fruits and vegetables are consumed alone, to ensure that daily recommendations are met and other food groups, such as grains and proteins, are included, variety in how fruits and vegetables are served is essential. Introducing and exposing fruits and vegetables is crucial during adolescence, so finding new and creative ways to serve them in an economically feasible approach should be a foremost priority in Maine schools.

## REFERENCES

1. Adams, Marc A et al. "Location of School Lunch Salad Bars and Fruit and Vegetable Consumption in Middle Schools: A Cross-Sectional Plate Waste Study." *Journal of the Academy of Nutrition and Dietetics* vol. 116,3 (2016): 407-416. doi:10.1016/j.jand.2015.10.011.
2. Ambrogini, Patrizia et al. "α-Tocopherol and Hippocampal Neural Plasticity in Physiological and Pathological Conditions." *International journal of molecular sciences* vol. 17,12 2107. 15 Dec. 2016, doi:10.3390/ijms17122107.
3. Bell, Becky. "Is Raw Food Healthier than Cooked Food?" *Healthline*, Healthline Media, 24 Jan. 2017, <https://www.healthline.com/nutrition/raw-food-vs-cooked-food>.
4. Brown JE. *Nutrition Through the Life Cycle*. 6th ed. Stamford, CT: Cengage Learning; 2017.
5. Buzby, Jean C., and Joanne F. Guthrie. "Plate waste in school nutrition programs." *The Journal of Consumer Affairs* 36.2 (2002): 220-238.
6. Cesario-DeBiasi, Jimmy, and Emily Grassie. "What's in Season?" *Maine Federation of Farmers' Markets* -, Maine Farmers' Markets, 4 Feb. 2021, <https://mainefarmersmarkets.org/shoppers/whats-in-season/>.
7. Cohen, Juliana F W et al. "Implementation of Universal School Meals during COVID-19 and beyond: Challenges and Benefits for School Meals Programs in Maine." *Nutrients* vol. 14,19 4031. 28 Sep. 2022, doi:10.3390/nu14194031.
8. Cromartie, John. "Rural-Urban Continuum Codes." *USDA ERS - Rural-Urban Continuum Codes*, Economic Research Service, 10 Dec. 2020, <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/>.
9. Cromartie, John. "What Is Rural?" *USDA* , Economic Research Service, 23 Oct. 2019, <https://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/what-is-rural/>.
10. Cullen, Karen Weber, and Issa Zakeri. "Fruits, vegetables, milk, and sweetened beverages consumption and access to à la carte/snack bar meals at school." *American journal of public health* vol. 94,3 (2004): 463-7. doi:10.2105/ajph.94.3.463.
11. Eisch, Amelia J, and David Petrik. "Depression and hippocampal neurogenesis: a road to remission?." *Science (New York, N.Y.)* vol. 338,6103 (2012): 72-5. doi:10.1126/science.1222941.

12. El Soury, Marwa et al. “The Role of Dietary Nutrients in Peripheral Nerve Regeneration.” *International journal of molecular sciences* vol. 22,14 7417. 10 Jul. 2021, doi:10.3390/ijms22147417.
13. Eufic. “What Is Nutrient Density?” *EUFIC.org*, Eufic, 1 Nov. 2021, <https://www.eufic.org/en/understanding-science/article/what-is-nutrient-density>.
14. Evans, Alexandra et al. “Exposure to multiple components of a garden-based intervention for middle school students increases fruit and vegetable consumption.” *Health promotion practice* vol. 13,5 (2012): 608-16. doi:10.1177/1524839910390357.
15. Gómez-Pinilla, Fernando. “Brain foods: the effects of nutrients on brain function.” *Nature reviews. Neuroscience* vol. 9,7 (2008): 568-78. doi:10.1038/nrn2421.
16. Jabs, Jennifer, and Carol M Devine. “Time scarcity and food choices: an overview.” *Appetite* vol. 47,2 (2006): 196-204. doi:10.1016/j.appet.2006.02.014.
17. Jordan, Irmgard, et al. “Changes in Vegetable Consumption in Times of COVID-19-First Findings from an International Civil Science Project.” *Frontiers, Frontiers in Nutrition*, 22 July 2021, <https://www.frontiersin.org/articles/10.3389/fnut.2021.686786/full>.
18. Kim, So Young et al. “Dietary Habits Are Associated With School Performance in Adolescents.” *Medicine* vol. 95,12 (2016): e3096. doi:10.1097/MD.0000000000003096.
19. Lange SJ, Moore LV, Harris DM, et al. Percentage of Adolescents Meeting Federal Fruit and Vegetable Intake Recommendations — Youth Risk Behavior Surveillance System, United States, 2017. *MMWR Morb Mortal Wkly Rep* 2021;70:69–74. DOI: <http://dx.doi.org/10.15585/mmwr.mm7003a1>.
20. Lee SH, Moore LV, Park S, Harris DM, Blanck HM. Adults Meeting Fruit and Vegetable Intake Recommendations — United States, 2019. *MMWR Morb Mortal Wkly Rep* 2022;71:1–9. doi: <http://dx.doi.org/10.15585/mmwr.mm7101a1>.
21. Maine Department of Education. “% Free and Reduced School Lunch Report - ED 534 By District.” *Maine.gov*, Child Nutrition Data Reports | Department of Education, 22 Dec. 2022, <https://www.maine.gov/doe/schools/nutrition/CNDataReports>.
22. Maine Department of Education, Child Nutrition Staff. “Back to Basics: An Introduction to School Nutrition Programs in Maine.” *Maine.gov*, Maine Department of Education Child Nutrition, 2021, <https://www.maine.gov/doe/sites/maine.gov.doefiles/inline-files/Handbook%20SY2021.pdf>.

23. Maine Department of Education. "Child Nutrition Policy Guidance - Covid-19." *Maine.gov*, Department of Education, 2020, <https://www.maine.gov/doe/schools/nutrition/covid-19/policy>.
24. Mead, Dave et al., "The Impact of the COVID-19 Pandemic on Food Price Indexes and Data Collection," *Monthly Labor Review*, U.S. Bureau of Labor Statistics, August 2020, <https://doi.org/10.21916/mlr.2020.18>.
25. Messa. "4 Common Salad Bar Implementation Challenges, and How to Overcome Them." *Salad Bars to Schools*, Chef Ann Foundation and Whole Kids Foundation, 23 July 2019, <https://www.saladbars2schools.org/2019/07/4-common-salad-bar-implementation-challenges-overcome/>.
26. Moffat, Laurel F et al. "Perceived Produce Availability and Child Fruit and Vegetable Intake: The Healthy Communities Study." *Nutrients* vol. 13,11 3681. 20 Oct. 2021, doi:10.3390/nu13113681.
27. National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity. "Progress on Children Eating More Fruit, Not Vegetables." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 5 Sept. 2018, <https://www.cdc.gov/vitalsigns/fruit-vegetables/index.html>.
28. National Center for Chronic Disease Prevention and Health Promotion, Division of Population Health. "Obesity." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 10 Aug. 2022, <https://www.cdc.gov/healthyschools/obesity/index.htm>.
29. Newman, Constance. "Fruit and Vegetable Consumption by School Lunch Participants ..." *USDA*, Economic Research Service, Aug. 2013, [https://www.ers.usda.gov/webdocs/publications/45122/39888\\_err154.pdf](https://www.ers.usda.gov/webdocs/publications/45122/39888_err154.pdf).
30. NFCA. "Neighboring Food Co-Ops - Maine." *Neighboring Food Co-Op Association*, Neighboring Food Co-Op Association, 2023, <https://nfca.coop/me/>.
31. Northwestern University. "The brain consumes half of a child's energy -- and that could matter for weight gain: New paper proposes that variation in brain energy expenditure during childhood could be linked to obesity risk." *ScienceDaily*. ScienceDaily, 17 June 2019. [www.sciencedaily.com/releases/2019/06/190617164629.htm](http://www.sciencedaily.com/releases/2019/06/190617164629.htm).
32. The Nutrition Source Staff. "Vegetables and Fruits." *The Nutrition Source*, Harvard T. H. Chan School of Public Health, 3 Mar. 2021, <https://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/vegetables-and-fruits/>
33. Ollinger, Michael, and Joanne Guthrie. "Schools Obtained More Fruits and Vegetables through USDA Foods after School Meal Nutrition Standards Were Updated in 2012." *USDA Economic Research Service*, U.S. Department of

Agriculture, 24 Oct. 2022, <https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=104992>.

34. Prescott, Melissa Pflugh et al. "Elementary and Middle School-Aged Students with Longer Seated Lunch Time Eat More Fruits and Vegetables." *Current Developments in Nutrition* vol. 4, Suppl 2 264. 29 May. 2020, doi:10.1093/cdn/nzaa043\_115.
35. Ray, C. Claiborne. "Brain Power." *The New York Times*, The New York Times, 1 Sept. 2008, <https://www.nytimes.com/2008/09/02/science/02qna.html?smid=url-share>.
36. Ritchie, Lorrene D., et al. "The Healthy Communities Study Nutrition Assessments: Child Diet and the School Nutrition Environment." *American Journal of Preventive Medicine*, vol. 49, no. 4, 2015, pp. 647-652.
37. Santhanam, Laura. "How Maine Is Trying to Take Food Insecurity off Kids' Plates." *PBS*, Public Broadcasting Service, 2 Dec. 2021, <https://www.pbs.org/newshour/health/how-covid-became-an-opportunity-to-feed-more-kids-in-maine>.
38. Smith, Stephanie L, and Leslie Cunningham-Sabo. "Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the US National School Lunch Program." *Public health nutrition* vol. 17,6 (2014): 1255-63. doi:10.1017/S1368980013001894.
39. Taber, Daniel R et al. "Socioeconomic Differences in the Association Between Competitive Food Laws and the School Food Environment." *The Journal of school health* vol. 85,9 (2015): 578-86. doi:10.1111/josh.12288.
40. United States Census Bureau. B01001 SEX BY AGE, 2021 American Community Survey 5-Year Estimates. U.S. Census Bureau, American Community Survey Office. Web. 8 December 2022. <http://www.census.gov/>.
41. U.S. Department of Agriculture. "National School Lunch Program Meal Pattern Chart." *Food and Nutrition Service U.S. Department of Agriculture*, USDA, 24 Feb. 2022, <https://www.fns.usda.gov/nslp/national-school-lunch-program-meal-pattern-chart>.
42. U.S. Department of Agriculture. "Salad Bars in the National School Lunch Program and School Breakfast Program." *Food and Nutrition Service U.S. Department of Agriculture*, USDA, 23 Sept. 2019, <https://www.fns.usda.gov/cn/salad-bars-national-school-lunch-program-and-school-breakfast-program>.
43. U.S. Department of Agriculture. "Tools for Schools: Offering Fruits and Vegetables." *Food and Nutrition Service U.S. Department of Agriculture*, USDA,



20 Mar. 2019, <https://www.fns.usda.gov/cn/tools-schools-offering-fruits-and-vegetables>.

44. U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020-2025*. 9th Edition. December 2020. [https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary\\_Guidelines\\_for\\_Americans-2020-2025.pdf](https://www.dietaryguidelines.gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf).
45. Wahl, R. "Nutrition in the adolescent." *Pediatric annals* vol. 28,2 (1999): 107-11. doi:10.3928/0090-4481-19990201-07.
46. Young, Elizabeth M et al. "Associations between perceived parent behaviors and middle school student fruit and vegetable consumption." *Journal of nutrition education and behavior* vol. 36,1 (2004): 2-8. doi:10.1016/s1499-4046(06)60122-x.
47. Zeratsky, Katherine. "What to Know before You Juice." *Mayo Clinic*, Mayo Foundation for Medical Education and Research, 9 Oct. 2021, <https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/expert-answers/juicing/faq-20058020>.

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