

PLATE WASTE IN SCHOOL LUNCH: BARRIERS, MOTIVATORS AND  
PERSPECTIVES OF EARLY ADOLESCENTS IN THE UNITED STATES

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF  
HAWAI'I AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE  
DEGREE OF

MASTER OF SCIENCE

IN

NUTRITION

MAY 2019

By

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Keywords: Early adolescents, Plate waste, School Lunch

## ACKNOWLEDGEMENT

I am grateful for the guidance of my committee members, assistance from my team members, help from friends, and support from my family, without which I would never have been able to finish my thesis.

First and foremost, I would like to sincerely express my deepest appreciation to my advisor, Dr. Jinan Banna, who introduced me to the nutrition education major. Dr. Banna inspired me to pursue the topic of plate waste, patiently helped me with many programs, and supported me through highs and lows. I truly enjoyed Dr. Banna's teaching and direction on researching the field of plate waste, as it has further opened my eyes to a future in nutrition-related research and careers. Dr. Banna and I often discussed the issues that I had with reporting the results of this study. I was very much enlightened by these discussions, which have provided me with new ideas, clear directions, and problem-solving strategies. Her support and encouragement have been vital for my success in graduate school.

I would also like to express my special gratitude to Dr. Rachel Novotny from the Department of Human Nutrition, Food and Animal Sciences, who is the director of Children's Healthy Living Center of Excellence (CHL Center). Through the direction of her research, I learned how to solve problems that appear during the literature review process.

Special thanks is also extended to my colleague, Chloe Panizza, who collected the data

for the original study upon which this work is based, and assisted with the data analysis. I am grateful for her consistent guidance and explanations, as well as her encouragement.

I would also like to acknowledge my coauthors, Kira Fox, Carol J. Boushey, Carmen Byker Shanks, Selena Ahmed, Susan Chen, Elena L. Serrano, and Julia Zee, Marie K. Fialkowski for their valuable contributions to this study. I would like to thank my wonderful family and friends who have shared their love and laughter with me, and have also been extremely mentally, emotionally, and physically supportive to me.

I cannot be thankful enough for the academic growth and personal skills I have gained at the University of Hawai'i at Mānoa.

## ABSTRACT

**Objective:** The aim of this project was to determine barriers, motivators, and perspectives about plate waste of early adolescents in the National School Lunch Program (NSLP) in Hawai'i, Montana and Virginia.

**Design:** A semi-structured interview guide was developed and pilot tested with three participants. Trained interviewers conducted audio-recorded individual interviews with adolescents (n=47) from Hawai'i, Montana, and Virginia. Interviews were transcribed verbatim. A codebook was devised using existing literature on barriers, motivators, and perspectives on reducing school lunch plate waste in the US. Two researchers coded three transcripts individually using NVivo software to determine interrater reliability and calculated an average Cohen's Kappa coefficient. With an average Cohen's Kappa coefficient of 0.68, the two coders then coded all transcripts independently. New codes were added to the codebook on the basis of emerging themes. Key themes were evaluated by the two coders separately. In discussion, the two agreed on final themes and collectively summarized the results.

**Setting:** Elementary schools implementing National School Lunch Program (NSLP) in Hawai'i, Montana, and Virginia.

**Participants:** Early adolescents (n=47, 9-13 years) from families receiving or eligible to receive the Supplemental Nutrition Assistance Program (SNAP) benefits were recruited to participate.

**Phenomenon of Interest:** Factors influencing plate waste among adolescents and potential plate waste reduction strategies.

**Analysis:** Coders analyzed content and thematic data to identify code categories and themes.

**Results:** The main barriers to the reduction of school lunch plate waste were unsupportive school policy, undesirable food quality, satiation, and social influences. The key motivators to help reduce school lunch plate waste were supportive school policy, including allowing students to share food with peers and save food to eat later; and social influences. Perspectives on the reduction of school lunch waste were: participants found it acceptable to throw away disliked food, unacceptable to throw away wanted food, perceived their peers did not care if food was thrown away, and their parents disliked wasting food.

**Conclusion and Implications:** Results suggest several factors might allow for minimization of school lunch plate waste in the NSLP, including improvements in food quality, food policy and social influences. Under these key themes, strategies to employ may include improving food preparation, food taste, allocating more time for students to finish their lunches, allowing students to self-select food lunch items, and to share and save their leftover foods.

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## LIST OF ABBREVIATIONS

NSLP	National School Lunch Program
US	United States
USDA	United States Department of Agriculture
ChI	Chef Initiative
F2S	Farm to School
F/V	Fruit and Vegetables
OVS	Offer vs. Serve
MA	Meat alternative
USGAO	United States Government Accountability Office
WHO	World Health Organization

## CHAPTER 1. REVIEW OF LITERATURE

With the increasing number of students participating in the National School Lunch Program (NSLP) in the United States, school lunch plate waste has also escalated. This thesis examines potential reasons as to why students discard large amounts of school lunch. For instance, restricted school policies and poor school meal quality are considered to be the main contributing factors that lead to large amounts of lunch plate waste in schools based on existing literature.<sup>1-9</sup>

This first chapter includes a literature review examining school lunch plate waste in US schools, which incorporates school lunch plate waste studies on students participating in NSLP. Special attention is paid to various school policies which, for example, offer students the freedom of food selection, among others. This study also considers food quality as a factor; that is, whether or not food is prepared with high quality ingredients and better flavor.

The objective of this review is to identify and summarize the various factors that relate to school lunch plate waste. The review outcomes will be used to characterize adolescent eating behavior and identify potential interventions to reduce school lunch plate waste.

This literature review focuses on the following aspects of lunch plate waste. First, a historical overview and definition of lunch plate waste is provided. Next, the multifactorial problem of lunch plate waste is described, including nutrition, economics, and environment. This is followed by a review of the factors influencing school lunch plate

waste, including food selection, school policy, and food quality. Finally, previous studies on potentially effective school lunch plate waste reduction interventions are presented and reviewed. A discussion of select characteristics that may be associated with plate waste — such as gender, age, various food types, and race/ethnicity — are included in this review.

This review was conducted using two databases, PubMed and Science Direct, with the following search terms: adolescent, plate waste, and National School Lunch Program. Key nutrition journals were searched independently. Seven articles were extracted from PubMed in the first search, and five articles were identified in a further screening of titles and abstracts. Seventy articles were found in an initial search of the database ScienceDirect, and 66 records remained after the elimination of four overlapping papers across and within the database. Twenty-three articles remained after conducting a screening by title, and a screening of abstracts brought the final number of articles to nine. Two government-level open data sources and twenty-eight additional research articles were identified by reviewing the reference lists of the original articles. This literature review will emphasize only on school lunch plate waste in order to be consistent with the data analysis in chapter two on the same topic.

Table 1 Summary of selected school lunch plate waste studies among adolescents in NSLP

<b>Study</b>	<b>Objectives</b>	<b>Approach</b>	<b>Methods</b>	<b>Factors Examined</b>	<b>Conclusion/Results</b>
Moreno-Black and Stockard, 2018 <sup>10</sup>	<p>To provide insight about the types of items children choose or do not choose from a salad bar</p> <p>To document elementary school children's food selection patterns by examining photographs of 2,903 cafeteria trays</p>	Qualitative, longitudinal and trend study	Digital photography	<p>Food choices</p> <p>Food selection</p> <p>Food environment</p>	<p>Gender and grade levels were the factors influencing fruit and vegetable choices.</p> <p>Item placement did not affect food choices.</p>
Peckham et al., 2019 <sup>11</sup>	To examine NSLP participants' selection and consumption of all five NSLP lunch components: milk, vegetable, fruit, meat/meat alternate (MA), and grain	Quantitative	Digital photography	Food selection based on race, ethnicity, gender, and eligibility for free or reduced-price lunch	Selection and consumption varied by race, ethnicity, gender, and eligibility for free or reduced-price lunch.
Bontrager Yoder et al.,	To assess the effectiveness of Wisconsin Farm to	Quantitative	<p>Survey</p> <p>Food</p>	New food exposure approaches	With increasing prior F2S program exposure, there was no effect on overall dietary

2014 <sup>12</sup>	School (F2S) programs in increasing students' fruit and vegetable (F/V) intake		Frequency Questionnaire (FFQ)		patterns. However, trays from schools with more prior F2S showed increases in the number of F/V consumption.
Baxter and Thompson, 2002 <sup>13</sup>	To use data from observations and interviews to document fourth-graders' preferences for, and consumption of, fruits compared to vegetables available as part of school lunches	Quantitative	Observations Interviews	Students' food preferences	Preferences influence lunch plate waste. As school lunch preferences increased, consumption increased.
Adams et al., 2016 <sup>14</sup>	To compare the amount of fresh F/V self-served, consumed, and wasted by students during lunch at schools with differing salad bar placements: inside or outside of the serving line	Quantitative and cross-sectional comparative study	Logistic Weighing	Salad bar location	Placing salad bars inside the serving line increased F/V selection and consumption.

<p>Tuner et al., 2018<sup>3</sup></p>	<p>To examine whether state laws are associated with two types of school meal-related practices: (a) using promotional strategies (i.e., taste tests, using posters or announcements) and (b) duration of lunch periods</p>	<p>Quantitative and cross-sectional study</p>	<p>Questionnaires  Computer-assisted personal interviews</p>	<p>State-level laws  School-level policies</p>	<p>State-level policy provisions are associated with school practices. Policy development in more states may support school practices that promote lunch participation and consumption.</p>
<p>Chapman et al., 2017<sup>15</sup></p>	<p>To examine the association between the timing of recess (pre-lunch vs. post-lunch recess), the timing of the lunch period, and food consumed by students at lunch</p>	<p>Secondary data analysis from a repeated cross-sectional design</p>	<p>Weighing</p>	<p>Recess time  School Policies</p>	<p>Reverse recess (recess before lunch) was associated with increased fruit consumption and decreased lunch plate waste.</p>
<p>Bontrager Yoder et al., 2015<sup>16</sup></p>	<p>To examine characteristics potentially associated with school lunch fruit and vegetable waste, both overall and pre/post</p>	<p>Quantitative cross-sectional study</p>	<p>Pre- and post-meal digital photographs</p>	<p>Preparation method (raw/cooked)  Food purchasing sources</p>	<p>F2S was associated with lunch plate waste. The longer the duration of prior farm-to-school programs led to more decreased waste.</p>

	implementation of the Healthy, Hunger-Free Kids Act			F2S implementing years  Student preferences  New school pattern requirement	
Zellner and Cobuzzi., 2015 <sup>17</sup>	To study whether a well-liked fruit served at the same time as a less-liked vegetable in a school lunch would reduce consumption and liking for that vegetable compared to when the fruit was served subsequent to vegetable consumption	Quantitative	Observation	Fruit serving timing	Serving the fruit component after the rest of the meal among students receive a government subsidized free school lunch encouraged vegetable consumption for school children.



Schwartz et al., 2015 <sup>18</sup>	To examine food components selection and consumption data from students participating in NSLP in a low-income, urban district from spring 2012 (pre-regulation) to spring 2013 and 2014 (post-regulation) and measure changes over time.	Quantitative and cohort study	Weighing	New school meal policies: increase in whole grains and reduction in sodium, new calorie limits by age group, different food categories for fruits and vegetables	Fruit selection was increased. Vegetable consumption increased, effectively lowering overall vegetable waste. Entrée consumption increased, thereby also decreasing waste.
Cohen et al., 2013 <sup>19</sup>	To examine nutrient losses and economic costs associated with school lunch plate waste. The study also assessed if school foods served were valid proxies for foods consumed by students.	Quantitative 2-year pilot and case-control study	Weighing	Nutrient losses Economic costs	Students consumed less than the required/recommended levels of nutrients. Plate waste was contributing a quarter of the food budget being discarded.
Williamson et al., 2013 <sup>20</sup>	To summarize the findings from two recent cluster randomized	Summarized randomized control studies	Digital photography	School food environment	Significant and consistent correlation between food intake and food selection and

	<p>controlled trials (Wise Mind and LA Health)</p> <p>To investigate the association of participant characteristics and changes in nutrition and healthy eating.</p> <p>To investigate the relationships between the food intake of children and 1) foods selected by the children and 2) food that was uneaten during the lunch meal (plate waste).</p>			<p>School policy</p> <p>Food intake and selection</p>	<p>between food intake and plate waste.</p> <p>The findings from both studies claimed that modification of the school cafeteria environment effected the significant changes in food/nutrient intake and/or health eating.</p> <p>These findings support the recent decision to modify nutrition standards for the NSLP.</p>
Smith et al.,2014 <sup>21</sup>	To (i) evaluate food choices and consumption patterns of elementary and middle school students who participate in NSLP and (ii) compare students' average	Quantitative	Digital photography	Food choices	Both elementary and middle school students wasted about half of their fruits and vegetables.

	nutrient intake from lunch with NSLP standards.				
Cohen et al.,2012 <sup>22</sup>	To evaluate the Chef Initiative, a 2-year pilot study in two Boston middle schools, designed to increase the availability and consumption of healthier school foods.	Quantitative 2-year pilot, case-control study	Weighing	Food options/palatability	ChI schools that provided healthier lunch choices assisted students to consume more and waste less food in school.

## School Lunch Plate Waste: Background, Overview, and Definition

In this thesis, the definition of plate waste is taken from the 2002 report to Congress. The report defines plate waste as “the quantity of edible portions of food served through USDA school nutrition programs, such as the National School Lunch Program (NSLP), that students discard each year.”<sup>23</sup>

According to the document introducing the background of NSLP released by the United States Department of Agriculture (USDA), the number of children involved in NSLP reached about 30 million in 2016.<sup>24</sup> This is a significant increase compared to the first year of the program in 1946, when the number of participating children was about 23.3 million nationwide.<sup>24</sup> The considerable size of NSLP makes the school lunch setting a critical opportunity to influence millions of students’ early development of healthy eating habits and intake of foods.<sup>10,17</sup> Aside from NSLP, no other program holds a consistent and concentrated connection with children across the US.<sup>13</sup> In light of the growing population of adolescents who consume school lunches provided by NSLP, the problems of school lunch plate waste has attracted ongoing attention. Because of the program’s daily involvement of students, there is a growing interest in how efficiently the program runs, as well as its nutritional, economic, and environmental impact.<sup>25</sup> A report to Congress estimated a loss of \$600 million in school plate waste, specifically from vegetable, fruit, entrée, and milk waste.<sup>26</sup> The report articulated that NSLP holds a significant influence over children in terms of improving nutrition, health, physical well-being, and protecting against chronic diseases. The program can also develop good eating behaviors that can limit school lunch plate waste and last through adulthood.<sup>26</sup> The

study by Cohen et. al (2013) was the first to quantify the average amount of nutrients consumed in selected school populations. The results suggested that food discarded during lunch by students consisted of roughly 19% entrees, 47% fruit, 25% milk, and 73% vegetables.<sup>27</sup> This study also estimated that plate waste costs could reach approximately \$1,238,846,400 per year nationally, specifically as a result of plate wasted during school lunch.<sup>24,27</sup> According to Cohen et. al (2013), "Waste costs are important to examine because this subsidized cost may represent part of what students and/or families spend to compensate for the lack of palatable calories consumed at lunch" (p.115).<sup>27</sup> Reducing plate waste could improve students' diets by reducing the consumption of snacks that are high in sugar, sodium, and saturated fat. These snacks are also often low in nutrient density, which can lead to chronic diseases as well as poor eating habits among younger adolescents.<sup>27</sup> There are no quantified results as to how plate waste impacts the environment. However, Hall et al. (2009) assert that plate waste is related to an excess in the consumption of freshwater and fossil fuels.<sup>28</sup> Nonetheless, decomposing wasted food still adds methane and CO<sub>2</sub> emissions to the atmosphere, impacting global climate change.<sup>28</sup> These studies have found that plate waste has an impact not only on the environment but also on nutrition and the economy. Some school lunch plate waste is inevitable, but a substantial amount of plate waste could be an indication that certain students and families are at risk of foregoing the full nutritional benefits of school lunches,<sup>26</sup> inhibit efforts to protect the environment, as well as result in unnecessary monetary losses. Therefore, reducing school lunch plate waste should be a high priority for the NSLP.

## School Lunch Plate Waste: A Review of Factors Contributing to Plate Waste

### *Lunch Recess Time*

Changes in plate waste may be brought about by moving recess time to before lunch in schools.<sup>29</sup> Bergman noted a 13.5% increase in food and nutrient consumption when recess was scheduled before lunch. Their results showed that the comparative plate waste when school lunch was scheduled before rather than after recess is 40.7% vs 27.2%.<sup>29</sup> Price and Just (2015) also evaluated the effect of shifting recess before lunch on food intake in the school setting.<sup>30</sup> Their results support the idea of implementing a school policy of holding recess before lunch, as the study's findings indicated an increase in fruit and vegetable consumption by 0.16 servings per child, which is a 54% increase relative to baseline rates.<sup>30</sup> In 2014, Hunsberger et al. concluded that scheduling lunch time after recess significantly boosted students' milk consumption (42% vs. 25%,  $p < 0.0001$ ). The report assessed that increasing milk consumption by 1.3 oz made students 1.5 times more likely to meet the nutritional standards for calcium ( $\geq 267$  mg,  $p = 0.01$ ) and fat ( $\leq 30\%$  of total energy,  $p = 0.02$ ).<sup>31</sup> However, no difference in entrée, vegetable, and fruit intake occurred as a result of the change of school lunch scheduling.<sup>31</sup> Strohbehn et al. (2016) argued that lunch scheduling was only one of the factors contributing to plate waste. This study suggested that recess before lunch did not significantly increase food consumption; in contrast, the results showed that entrée, fruit, and vegetable waste was greater when lunch was provided before recess (reverse recess).<sup>32</sup> Another study (Chapman et al. 2017) assessed factors associated with reverse recess in school and yielded results that supported moving lunch to after recess to increase food consumption in school. According to this article, lunch before recess, which

was typically scheduled to start from 11:55am and end at 12:15pm, contributed to smaller lunch consumption.<sup>6</sup> While the consumption of entrée, vegetables, and milk remained the same, fruit consumption noticeably increased when lunch started after recess.<sup>6</sup> Having students eat lunch after recess encouraged them to utilize energy, and consume food slowly rather than rushing through lunch in order to play.<sup>31</sup>

Studies have also assessed school policies regarding lunch time, as restricted and insufficient time to finish lunch may be another cause of food and milk waste (Bergman et al. 2004).<sup>29</sup> Lunch duration of less than 20 minutes has been shown to result in substantial losses in elementary and middle school students' milk, entrée, and vegetable intake.<sup>1,8</sup> Students consumed more foods when they were given 30 rather than 20 minutes to eat.<sup>29</sup> Tuner et al. (2017) advocated for increasing the length of lunch periods, as students spend time on being directed and seated, waiting in the lunch line, eating and cleaning up, all of which can influence their consumption.<sup>3</sup>

### *Lunch Selection/Menu*

Moreno-Black and Stockard (2017) noted that children's food decisions were tightly associated with their eating behavior, nutrient consumption, and physical well-being.<sup>10</sup> Smith and Cunningham-Sabo (2014) hypothesized that school lunch consumption is far from meeting the national meal standards for nutrients like vitamin A, C, E, and fiber due to the lack of sufficiently high-quality food intake in school.<sup>21</sup>

A 2-year pilot study aimed at examining the long-term impact of a Chef program at schools

in Boston (2012) revealed that the school environment had a significant influence on students' dietary habits, food selection and preferences, and diet quality.<sup>2,33</sup> The study suggested that enhancing the school menu's dietary quality and palatability to provide healthier and tastier menu options in the school cafeteria, including more fruits, vegetables, and whole grains, would encourage healthier food consumption among students.<sup>33</sup> The study design consisted of two study groups, including two Chef Initiative (ChI) schools and two control Boston public schools. The ChI schools hired a chef to instruct cafeteria staff to provide healthier menus, as well as more flavorful, high nutrient meal options. The pilot study concluded that ChI schools and control schools had a similar percentage (61.6% VS 57.3%; P=0.63) of food consumption.<sup>33</sup> However, there was an increased rate of whole grain selection and vegetable consumption at ChI schools. Milk and chocolate milk consumption remained high at ChI schools and matched control schools. Based on this study, improved diet quality, healthier food choices in schools, and menu altering could contribute to better health in order to better help NSLP run efficiently and to help children meet nutrient standards (Cohen et al. 2013).<sup>33</sup>

#### *New School Meal Regulation*

Schwartz et al. (2015) generated a study on the possible changes new school meal regulations could bring to fruit and vegetable (F/V) consumption and total plate waste. New policies for NSLP were implemented in the 2012-13 school year.<sup>34</sup> The regulations recommended changes including increasing whole grains, restricting calorie based on different age groups, and decreasing sodium.<sup>34</sup> Fruit and vegetables (F/V) were considered two different food categories, so various vegetable options would need to be



offered each week along with increasing food serving sizes.<sup>34</sup> Previous policies required students to take any three of the five lunch components. The policy now suggests one of the three components must be fruits or vegetables.<sup>34</sup>

Schwartz et al. (2015) conducted research before (spring 2012) and after (spring 2013 and 2014) policy changes. This study showed positive changes that suggested that, with new lunch regulations, students consumed more fruit, discarded less of the entrée and vegetables, and consumed the same amount of milk.<sup>34</sup> Fruit consumption rate increased to 66% after the implementation of the new policies, compared to 54% consumption beforehand, and remained high, at 74%, after the changes. Entrée intake levels also increased, from 71% to 84%. No data was presented to show a significant increase in vegetable consumption, although the authors claimed that vegetable waste was reduced.<sup>34</sup>

### *Food Quality*

Bontrager Yoder et al. found that food preparation method/food quality influences the amount of plate waste in their 2015 study.<sup>16</sup> F/V waste and consumption differed by preparation method (raw/cooked) and by local vs. conventional sourcing.<sup>16</sup> The results showed that raw vegetables were wasted less frequently than cooked vegetables. Conventionally sourced food items were wasted less than those that were locally sourced, and salad bar items were wasted more than main menu foods.<sup>16</sup>

School Lunch Plate Waste: Potential Reduction Interventions

Smith and Cunningham-Sabo (2013) measured the percentage of F/V consumed and summarized possible strategies for improving food consumption.<sup>21</sup> They estimated that only 45% and 34% of vegetables were selected by elementary and middle school students, respectively.<sup>21</sup> Approximately one-third of vegetables were unconsumed.<sup>21</sup> The report indicated that nearly 50% of fresh fruit and 37% of canned fruit were wasted. The authors identified the need for more multi-faceted school lunch plate waste strategies in the future, based on their study's results. These interventions included assemblies on nutrition education, the development of marketing strategies, modification of student behaviors, and cost comparisons to better assess lunch plate consumption. These interventions could be further implemented with schools' cooperation by teaching cooking in the classroom, and with ongoing cafeteria strengthening.<sup>21</sup> Promoting vegetable selection among students, along with providing tailored messaging at the school level might bring positive outcomes of establishing healthier eating behaviors in students and reducing plate waste. Furthermore, research found that changing the lighting and location of food, coupled with verbal encouragement may help sustain adolescent food intake during lunch at the recommended levels.<sup>21</sup>

### *Improving Food Quality*

Food quality and acceptability improvement was viewed as an effective strategy to increase plate consumption and minimize school lunch plate waste, according to the 2002 final report to Congress.<sup>26</sup> This strategy was classified into the following three practices:

- 1) Implementing local produce and fresh foods:

In their 2015 study, Bontrager Yoder et al. tested the actual usage of locally sourced fresh

food items in schools and concluded that intervention is an not effective solution for reducing plate waste; on the other hand, the 2002 final report to Congress argued that locally sourced foods can bring great benefits and increase consumption among students, thereby reducing plate waste. Although no mechanism was provided and the results were not explained in the report, they claim that the use of local fresh food supplies boosts F/V consumption by offering students the opportunity to enjoy locally-grown, nutritious salads, based on their reviews of previous plate waste studies. This change might sound pricey; however, replacing imported foods with local foods eliminates the unnecessary traveling periods and distances of food products. Locally provided foods proved to beneficial to schools and students by reducing the units of energy used for preservation and transportation. Additionally, some local options even eliminate the need for packaging and benefit local food suppliers.<sup>26</sup>

## 2) Using commercial food supply companies and their products:

Subcontracting with commercial food chains generates financial savings, enhances food quality, and improves the nutritional value of school lunches. Trademarked meals decreased plate waste by providing high quality food.<sup>26</sup> The use of brand-name foods, including fast foods, in the NSLP to plan, prepare, and serve schools meals has become more popular.<sup>35</sup> Although schools participating in using food service management companies appear to be motivated primarily to save money, it has been cited by cafeteria managers as a strategy to reduce plate waste by potentially increasing food acceptance.<sup>36</sup> However, there is no data on the effects of these plate waste strategies even though their usage has been increasing.<sup>26</sup> USDA regulations allow schools to use foodservice management companies, but leave the final decision up to the schools.

### 3) Reinforcing student input:

Involving students in school clubs or menu planning as a way of promoting Nutrition Advisory groups could strengthen students' awareness of and acceptance for school nutrition programs.<sup>26</sup>

#### *Embedding Nutrition Education*

Increasing lunch plate consumption requires a combination of methods from experimental nutrition education programs, cooking classes, and school cafeteria assistance and reinforcement.<sup>21</sup> Such an intervention involving implementing nutrition education through cooking classes was described in the study titled "Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the US National School Lunch Program," published in 2013 by Smith and Cunningham-Sabo.<sup>21</sup> The Cookshop Program by Liquori et al. (1998) showed that equipping students with actual cooking skills, such as meal preparation and tasting tasks, supported students in attaining first-hand experience with the foods that will be served for lunch.<sup>37</sup> This demonstrated a decrease in lunch plate waste.<sup>37</sup>

#### *Incorporation of Salad Bars in School Food Service*

Adams et al. (2016) discovered that exposure to the salad bar inside of the serving line yielded a greater frequency of students' fresh fruit and vegetable (F/V) selection, because it required students less effort to find favorable F/V, which resulted in greater consumption.<sup>38</sup> They found that 98.6% of students self-served F/V when it was inside the serving line compared to only 22.6% of students who self-served F/V when the salad bar

was outside serving lines.<sup>38</sup> The default setting of a salad bar inside of the lunch line significantly reduced F/V waste amount by five times more compared to the outside setting. The research study highly recommended the incorporation of salad bars inside the lunch service area as the ideal plate waste solution.<sup>38</sup>

### *Serve Fruit as Dessert*

Zellner and Cobuzzi (2015) found that serving fruit as dessert after vegetables increased vegetable consumption in a private school in Philadelphia. Eight- to ten-year-olds African-American students who qualified for government subsidized free school lunches were observed. The chef-prepared and menu-controlled lunch tray observed was part of the Vetri Foundation for Children's Eatiquette program. The results demonstrated that 40% of the students left kale on their plates when fruit was provided with the meal, while 55% of the students ate all the kale or requested a second plate of kale when fruit was served as a dessert after the rest of the meal. The article hence reinforced their recommendation to provide fruit after the rest of the meal, because treating fruit as dessert can increase vegetable intake.<sup>17</sup> These findings can inform future vegetable and fruit reduction strategies.

### *Promoting "Tasting Challenge" Programs*

Programs such as "taste tests" offered in schools have been shown to positively affect students' food consumption by increasing children's liking for F/V.<sup>39</sup> In Colorado, a "tasting challenge" program was conducted in four elementary schools. Harnessing the students' willingness to try new foods, the program successfully enabled students to try edamame

and jicama.<sup>40</sup> A taste study completed in New Jersey with 2,945 children found that the percentage of students who liked the tested food significantly increased from 55.8% to 65.2%. Two tastings were conducted in two enhanced nutrition lessons presented by a volunteer with taste-testing activities.<sup>41</sup> The acceptance rate went up as well among those who had tried or liked the foods before. The food tasting event benefited new food item consumption, increasing food consumption and ultimately resulting in minimizing plate waste.<sup>41</sup>

### *Implementing “Farm to School” Programs*

According to National Farm to School Network, a farm to school (F2S) program involved students in the community, allowing them to gain hands-on experiences through school gardening and cooking classes.<sup>42</sup> Being involved in farm field trips and participating in nutritional, purchasing, agricultural, and health education empowered students to make wise food choices while increasing healthy and local food consumption.<sup>42</sup> A study conducted with 1,117 students from 9 schools who had more than 2 years of F2S programming demonstrated a reduction in discarded unfavorable F/V at lunch and mediated F/V consumption.<sup>43</sup> Another study by Izumi (2015) also established a positive association between F2S programs and food consumption,<sup>44</sup> although further research is still needed to support the effectiveness of reducing plate waste through F2S programs.

### *Enhancing Staff Training*

Research has shown plate waste to be reduced by interventions if they involve companion training programs for cafeteria staff to create more flavorful lunches. Chief Initiative (ChI)

programs in schools which hired professional chefs to deliver healthier and higher quality menu selection options. ChI programs enabled an increase in whole grain and vegetable selection among students.<sup>2,33</sup>

### *Using Appropriate Marketing Strategies*

Hanks et al. (2016) showed positive evidence that marketing can promote selecting vegetables in the school cafeteria by simply applying vinyl banners under the salad bar and displaying concise video segments in the dining area.<sup>45</sup> The researchers measured the frequency of children taking vegetables only from the salad bar. When exposed to this marketing environment, more students visited the salad bar. The banner alone stimulated an increase in students who took food from the salad bar from 12.6% to 24.0%(P=.04). Schools that displayed both television segments and vinyl banners saw an increase of students' vegetable intake from the salad bar from 10.2% to 34.6% (P< .001).<sup>45</sup>

### *Engaging State-Level Laws with Concomitant School Policy Practices*

Previous studies have recommended potential strategies related to school-level changes to reduce plate waste, including offering taste tests, marketing the salad bar through banners or videos, and allowing students more eating time.<sup>1,3,6,10,21,29,39,45</sup> However, Tuner et al. (2018) questioned the feasibility of actually achieving interventions in schools.<sup>3</sup> This study therefore suggested a promising mechanism of incorporating the assistance of state laws, which promote the implementation of beneficial school-level strategies, to ensure plate waste reduction strategies are employed at the school level.<sup>3</sup> State law must support the facilitation of the reduction of plate waste and guarantee improved lunchtime

experiences in schools, such as ensuring schools allow students to have sufficient time for adequate consumption across the U.S.<sup>3</sup>

### *Offer Versus Serve Strategy*

The Offer Versus Serve (OVS) policy requires students to select at least three out of five menu components offered by NSLP in order to be qualified for a reimbursable lunch, according to Buzby and Guthrie (2002).<sup>26</sup> Under the regulation of OVS, students are allowed to choose the food components that they prefer, thereby reducing plate waste.<sup>26</sup> Although the OVS modification may hinder students from making nutritionally balanced meal decisions due to the fact that only desirable foods were selected based on students' personal preferences rather than nutritional content, it is undebatable that the goal of cutting the quantity of plate waste was met.<sup>26</sup>

### *Additional Literature on Children's Eating Behaviors*

#### *Nutritional Well-being*

Despite recent recognition of the substantial amount of plate waste in schools and the interventions that have been established, most American children's consumption of F/V is still far below the recommended levels.<sup>13</sup> Studies have concentrated on determining influences on food selection, specifically regarding F/V waste in NSLP among adolescents. Schwartz et al. (2015) measured elementary and middle school students' F/V waste and found that levels had reached 34% and 49%, respectively.<sup>34</sup> Insufficient F/V intake can seriously impair children's overall health, cause chronic diseases such as diabetes, and increase the risk of developing obesity.<sup>17</sup> Multiple studies have pointed out



that the causes of obesity are complex and multifactorial.<sup>43,46,47</sup> However, childhood obesity is most often associated with excessive saturated fat consumption, which can contribute approximately 10% in additional energy intake, as well as high sodium, sugar, and trans fats intake, which is compounded by limited F/V intake during school lunches<sup>33,48,49</sup>.

Peckham et al. (2018) identified several other factors that may impact plate waste in the NSLP: race/ethnicity, gender, grade, food selection, and household income level.<sup>50</sup> Such analyses are considered important because they can also determine the child's weight and likelihood of childhood obesity.<sup>50</sup> Evidence has shown that children's weight status and weight gain vary across demographic groups.<sup>50-52</sup> For instance, Hales et al. (2017) showed the prevalence of obesity was lower among non-Hispanic Asian adults (12.7%) compared with all other race and Hispanic-origin groups. Studying the dietary knowledge of different demographic groups will clarify distinct food preferences and energy intake, which is necessary to aid the process of planning and implementing school nutrition policies to fight the problem of prevalent obesity.<sup>50</sup>

Children's food-related decision-making processes and school lunch menu selections determine their food intake and preferences and represents their overall health.<sup>10,53</sup> Poor food selection can lead to a higher risk of developing childhood obesity, due to children often choosing foods that look good but may lack nutrient density.<sup>10</sup>

### *Demographic Correlates of Dietary Intake*

It is important to consider other influences on dietary intake such as demographics when addressing plate waste. For example, gender was shown to be associated with children's food preferences.<sup>10,54,55</sup> Kimura et al. (2014) performed a study to evaluate food preferences or interests in children within different genders. Students in this study were asked to choose any 10 from 36 pictures on the panel depicting 10 different foods and 26 other things. The number of foods chosen determined the food interest score. The results showed that boys have significantly higher saturated fatty acid scores than girls. The scores reflecting food interest or fat preference were significantly higher in boys than girls.<sup>10,55</sup> The study also revealed that food interest score are positively correlated with energy density, fat energy content, and saturated fatty acid score. Meanwhile, Johnson et al. (2015) showed that boys tend to consume more fast food, starches, and desserts than girls.<sup>10,55,56</sup> Cooke and Wardle (2005) also noted that girls tend to prefer F/V , while boys tend to prefer fatty and sugary foods, meat or processed meat, and eggs.<sup>10,57</sup> Lehto et al. (2015) found that girls are more inclined to eat vegetables than boys.<sup>10,58</sup> The results of these studies suggest that boys tend to waste more fruits and vegetables and girls tend to consume less protein-rich foods.

F/V consumption was also compared across different age/grade groups. Younger students were more likely to select vegetables and choose to eat more and therefore waste less.<sup>10</sup> Fruit selection and consumption data in different age groups, on the other hand, showed no differences.<sup>10</sup>

Haas et al. (2003) and Drewnowski and Specter (2004) asserted that consumption of

substantial F/V is essential to help low-income populations. Their results also indicated that African-Americans experience higher risks for obesity than others.<sup>17,59,60</sup> Peckham et al. (2018) specified the differences among demographic groups as follows: black students' intake of energy was 33 fewer calories than white students, including 28 fewer calories chosen from milk and 9 fewer calories chosen from vegetables.<sup>50</sup> Black students were found to get calories more often from meat/meat alternatives. These findings indicate that black students have less healthy food selections.<sup>50</sup> Peckham et al. (2018) suggested that lunch plate waste serves as an indicator of potential nutrient deficiencies in children, and inadequate energy from milk leads to decreases in black students' calcium and vitamin D consumption.<sup>50</sup> On the other hand, Hispanic students typically choose more calories from protein and grains, but 30 fewer calories from milk, while the total number of calories consumed between Hispanic and white students is the same.<sup>50</sup> The reasons for this were addressed by Levitt, Wilt and Shaukat (2013), who noted that lactose intolerance is more prevalent in Hispanics.<sup>50,61</sup> In addition, students participating in NSLP who receive reduced-price or free lunch selected fewer calories from F/V across race/ethnicities compared to those who paid for their lunches.<sup>50</sup> Peckham et al. (2017) found that calories selected from entrées, a combination of meat and grain components, differed by demographic and socioeconomic groups.<sup>62</sup> Factors such as limited lunch periods, lunch before recess, etc. were identified. As demographic influences on food consumption have been identified, it is recommended that school plate waste researchers include these characteristics in their research.<sup>50</sup>

Future studies are needed to strengthen the current research and to examine other

factors that may be related to school lunch plate waste. Possible factors include food quality, plate acceptability, OVS, and modification of school polices. Comparison of plate waste across demographic factors such as race, ethnicity, gender, and age groups is especially recommended.

## Summary

F/V waste was widely considered the major component of plate waste. Previous researchers have made efforts to measure plate waste and report substantial waste in the NSLP, as well as provide possible interventions, such as rescheduling lunch time and providing more palatable choices. Their findings have consistently shown that complete plate waste elimination is a complicated and difficult task to achieve; yet it is possible to reduce plate waste. Identifying factors contributing to plate waste is essential to minimizing plate waste and maximizing lunch meal programs' impact on young people's nutritional status. Therefore, close future examination of additional feedback from children on potential barriers and motivators regarding plate waste reduction is needed to generate more awareness of the problem of plate waste.

The following chapter will examine the barriers to, motivators for, and perspectives of students regarding plate waste reduction.

## CHAPTER 2. BARRIERS, MOTIVATORS, AND PERSPECTIVES ON MINIMIZING PLATE WASTE

### Introduction

Poor diet is particularly of concern for low-income students eligible for federally assisted meal programs such as Supplemental Nutrition Assistance Program (SNAP), who have been shown to be at increased risk for diet-related conditions such as overweight and obesity.<sup>63</sup> School is an important setting for promotion of a healthy diet, as students consume a significant number of daily calories in this setting. While students may be provided meals meeting the dietary guidelines at school, school lunch plate waste may negatively impact dietary intake and lead to inadequate intake of key nutrients. Plate waste not only impacts lunch quality and students' nutritional intakes in school but also causes problems beyond schools such as excess methane and CO<sub>2</sub> emissions in the environment, which may impact global climate change.<sup>28</sup> Besides the nutritional and environmental cost of plate waste, the economic cost of plate waste nationally is over \$600 million per year.<sup>26</sup> Hence, it is important that foods served in schools meet the nutrition standards and that plate waste is minimized to help optimize students' nutrient intakes and minimize environmental and economic costs.<sup>64</sup> Completely eliminating school lunch plate waste is likely unrealistic; however, understanding factors related to reduction of plate waste is important for efficiency, cost and nutritional intake of students.<sup>65</sup>

No known studies have explored barriers, motivators, and perspectives on reduction of plate waste in schools through interviews with low-income children eligible for SNAP. Identifying factors contributing to plate waste in school has the potential to improve food

consumption. Understanding barriers and motivators for plate waste reduction may result in improvements in participants' eating behaviors, tailored nutrition education programs, and minimization of school lunch plate waste.<sup>9</sup> This study is designed to document barriers, motivators, and perspectives about plate waste in schools towards informing strategies to reduce plate waste.

## Methods

### *Participants and Recruitment*

Participants were early adolescents, 9-13 years old from families receiving or eligible to receive SNAP benefits in Hawai'i, Montana, and Virginia. Households that receive SNAP benefits were eligible to receive free school meals. Researchers at each institution had previously collaborated on school plate waste research.<sup>65</sup> This multi-site recruitment process benefits the study to learn about a diverse range of experiences of students' lunch consumption and offer a high quality and more multiethnic and representative sample. Non-SNAP receiving students were not included in this study and it is not stated in this research if there are significant differences in plate waste between those eligible and those ineligible for SNAP. Congress emphasized the importance of linking children in SNAP households to school meals by requiring all school districts participating in the NSLP to directly certify their students for free school meals. Each site had its own recruitment process. In Hawai'i, students were recruited from elementary schools implementing federally assisted meal programs such as NSLP by contacting after-school programs and then approaching parents when they came to pick up their children, as well as through distributing flyers. The children were recruited from three public schools across

different grade levels, which were K-6 (314 student enrolled in 2016-2017, urban), K-8 (423 student enrolled in 2016-2017, urban), and K-12 (359 students enrolled in 2018, rural). At this site, all students received free or reduced cost meals. In Virginia, participants were recruited with the help of a community member in a rural area in which most schools had high rates of free and reduced meal programs. The Montana site data came from two elementary schools. Both had 250 students and were located in an urban-rural area. In one of the schools, 18% of students were eligible for free and reduced-price lunch in the NSLP and used offer vs. serve (OVS). The other school was oriented with OVS but only 11% of students were eligible for free and reduced-price lunch through the NSLP. Parents and participants signed consent and assent forms at all three sites, respectively. This study was approved by the Institutional Review Boards at the University of Hawai'i, Montana State University, and Virginia Polytechnic Institute.

## Procedures

### *Semi-structured Interviews*

At each site, trained research assistants conducted interviews using a semi-structured interview guide, which was originally pilot-tested with three participants at the Hawai'i recruitment site. The Virginia and Montana sites then adopted the pilot-test results. Interviews were selected as the data collection method rather than focus groups given that the researchers were interested in concepts that may be unique to individual students, such as personal perspectives, as well as those of peers and parents on plate waste. Sample size was determined by data saturation, which indicates the point at which no new information can be retrieved from the data.<sup>66</sup> The interview guide was developed by

the lead researcher in Hawai'i by reviewing existing literature on school lunch plate waste in the US. Existing literature was reviewed for factors associated with plate waste in quantitative studies and any proposed strategies to reduce plate waste. This interview guide then became a *joint*, shared interview guide for both the Virginia and Montana sites. The lead researchers at each institution had conducted numerous qualitative studies previously to develop their extensive experience in qualitative data collection. The lead researchers trained research assistants at each site. Following each interview, two researchers from the Hawai'i site listened to the recorded interview independently to see if there were any new ideas emerging from the interviews. If there were any new ideas, these were added as new codes to the code book. Once there were no new ideas emerging from the interviews, the researchers concluded they had reached data saturation. Data saturation occurred after interviewing 27 participants at the Hawai'i site, and after 10 interviews at both the Virginia and Montana sites. These interviews were conducted concurrently. The interview guide was further reviewed and approved by the lead researchers in Montana and Virginia. Examples of questions asked are, "When you finish lunch, is there ever food left on your plate? If so, why? What type of food is usually left on your plate? What happens to this food? Why?" Interviewers followed up with probes as to why food was discarded. The interview guide focused on prompting students to state their perceptions regarding factors contributing to school lunch plate waste. Appendix A provides an example of the questions posed with regards to lunch at school. All one-to-one interviews with the participants were audio-recorded. Once the interviews were finished, one researcher listened and transcribed the interviews and a second researcher checked that each interview was transcribed correctly. Once transcribed, all



transcripts were imported into Nvivo qualitative data analysis software version 10 (QSR International Inc., Burlington, MA, USA).

## Data Analysis

Directed content analysis was used to analyze interview transcripts using NVivo. The research assistant at the Hawai'i site used the final codebook to create nodes in an Nvivo file. Each site received a copy of this Nvivo file to import all their transcripts for the first round of coding. One researcher in Virginia and a second researcher in Hawai'i coded three randomly selected transcripts to ensure inter-rater reliability, and achieved a mean Cohen's Kappa coefficient of 0.68. The two researchers then independently coded all transcripts using the shared codebook and evaluated key themes using the method described previously. These two researchers then independently examined these codes and merged similar codes into a higher-order category, which then became the final set of codes. The final higher-order categories were "social," "policy," "hunger" and "quality" for both the barriers and motivators. For instance, codes from students claiming lunch plate waste was related to food texture, food taste, and the smell of food were merged under the higher-order category "quality." The higher-order categories for perspectives included "It's OK to waste food," "Against plate waste," and "Neutral to plate waste." The two researchers agreed on the higher-order categories and independently looked for the key themes emerging by reading the quotations in each higher-order category. In discussion, the two agreed upon final themes and summarized results regarding main barriers, motivators, and participant perspectives on plate waste. Validity was ensured using two strategies: 1) Use of a shared codebook containing operational definitions of

codes; 2) Discussion and debate of key themes identified between the lead researcher and the two research assistants.

## Results

### *Participants' Characteristics*

In total, 47 interviews were conducted with adolescents from Hawai'i (n=27), Montana (n=10) and Virginia (n=10) in the US. Race of adolescent participants included White, Native Hawaiian or other Pacific Islander, Asian, Hispanic, Black/African American, and American Indian or Alaskan Native. Table 2 provides a characteristic profile of study participants. The majority of study participants were Non-Hispanic White (59.5%), whereas Black/African American and Indian or Alaska Native were the least dominant populations in this study. Approximately 30% of participants were 10 years old.

**Table 2** Characteristics of Adolescents Ages 9-13 in Hawai'i, Montana, and Virginia (n=47)

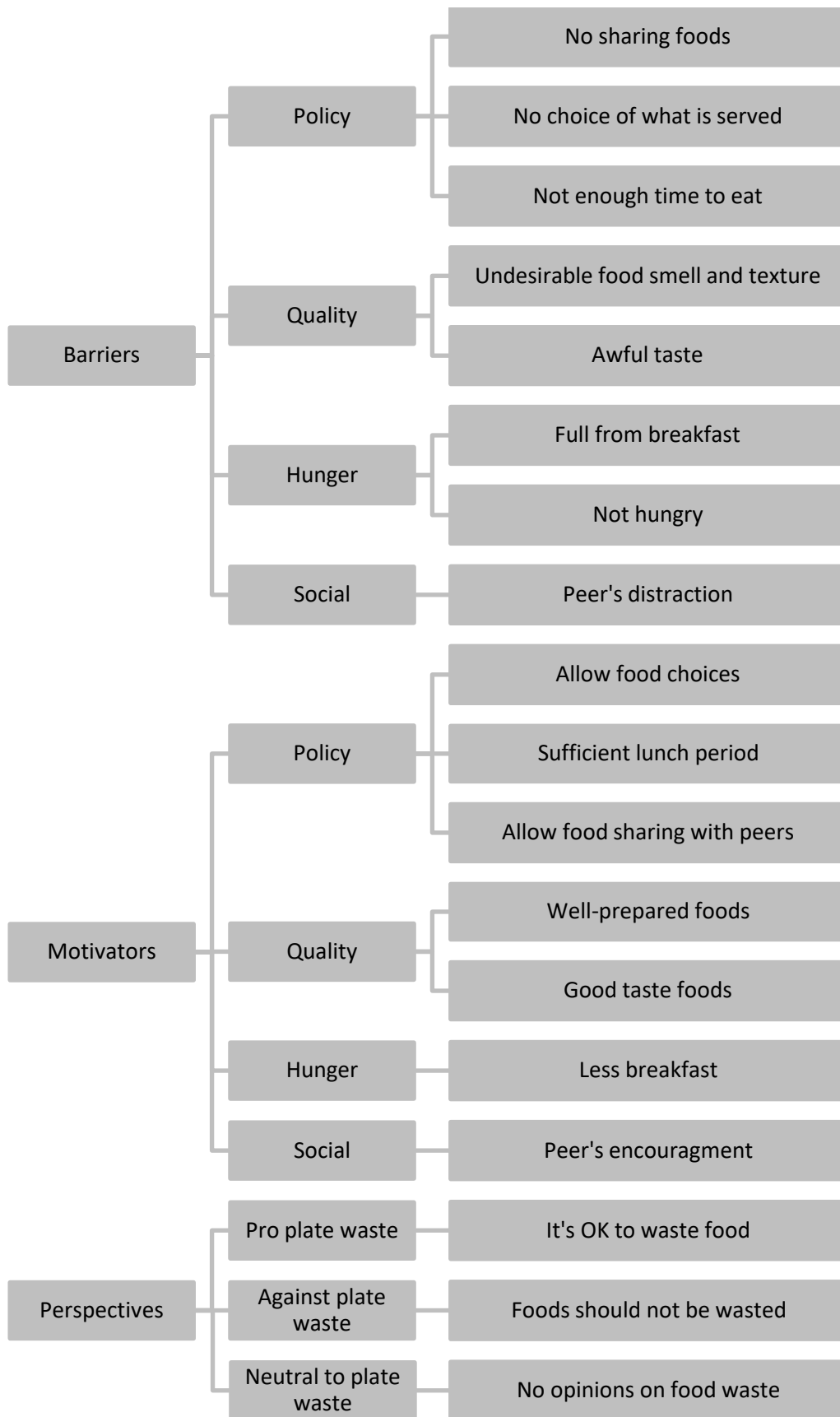
	n	%
<b>Age, mean (<math>\pm</math> S.D.)</b>	11 ( $\pm$ 1.58)	
<b>Age, y</b>		
9	9	19.1
10	14	29.9
11	10	21.3
12	5	10.6
13	9	19.1
<b>Child ethnicity</b>		
White (non-Hispanic)	28	59.5
Native Hawaiian or other Pacific Islander	2	4.3
Asian	5	10.6
Hispanic	3	6.4
Black/African American	1	2.1
American Indian or Alaska Native	1	2.1
Two or More Races	7	15
<b>Mother's Education Level</b>		
Did not complete high school	8	17.0
Completed high school	10	21.3

<b>Completed post high school training, excluding college (trade school or business school)</b>	6	12.8
<b>Completed some college/community college</b>	15	31.9
<b>Graduated from a four-year college or university</b>	7	14.9
<b>Other</b>	1	2.1
<b>Mother employment</b>		
<b>Employed for wages</b>	21	44.7
<b>Self-employed</b>	10	21.3
<b>Out of work and looking for work</b>	1	2.1
<b>A homemaker</b>	6	12.8
<b>A student</b>	6	12.8
<b>Unable to work</b>	3	6.4
<b>Household income</b>		
<b>Less than \$10,000</b>	3	6.4
<b>\$10,000 to \$19,000</b>	11	23.4
<b>\$20,000 to \$29,000</b>	13	27.7
<b>\$30,000 to \$39,000</b>	9	19.1
<b>\$40,000 to \$49,000</b>	5	10.6
<b>\$50,000 to \$59,000</b>	1	2.1
<b>\$60,000 to \$69,000</b>	3	6.4
<b>Did not answer</b>	2	4.3

### *Themes Related to Reduction of School Lunch Plate Waste*

Based on the data, themes and various sub-themes related to plate waste reduction were identified. Figure 1 outlines these themes and sub-themes. The key themes and minor themes of barriers, motivators, and perspectives regarding reducing school lunch plate waste were identified by counting students' responses. The most frequently occurring comments from different students were categorized as major themes and the infrequently mentioned factors were categorized as minor themes.

Figure 1 Themes and sub-themes on the reduction of school lunch plate waste as a result of 47 one-on-one interviews with early adolescents (9 – 13 Years) from Hawai'i, Montana, and Virginia.



### *Barriers to Reduction of School Lunch Plate Waste*

The key barriers to reducing school lunch plate waste were food quality, and school policy influences. Table 3 presents a selection of quotations from students of barriers on reduction of school lunch plate waste. The minor barriers were hunger and social influences. Participants often commented negatively on the taste and texture of food served, stating food was “weirdly cooked,” “always really salty and mushy,” “prepared in a clumpy and soggy way,” “spoiled-tasting or burnt,” and “pieces make me choke.” Some participants also commented that the school “should have non-GMO.”

Comments regarding the influence of school policy on lunch time plate waste were coded into two sub-categories. The first category was policies affecting how food was prepared and served in these schools. Many participants commented they had no choice as to what types of foods were served for lunch. The second category included policies affecting how food was disposed of once the participant had finished eating. Participants commented that once they had finished eating they were not able to share their unwanted food with friends, they could not save their leftovers, uneaten food had to be discarded in the trash, and there were no opportunities to compost leftover food. Regarding the barrier of hunger, some participants said they had leftover food at lunch because they were still full from breakfast. Social influence was also a minor barrier identified. For example, participants mentioned they were unable to finish their food because they were distracted by peers.

**Table 3 Key Barriers for Plate Waste Reduction in Early Adolescents Ages 9-13 years (n=47) in Hawai'i, Montana, and Virginia**

Key Barriers	Representative Response Quotes from Participants*
<b>Poor food preparation and cooking methods</b>	<p>“I don’t know. It’s clumpy and soggy.”</p> <p>“I think the way they prepare the meat is good most of the time but sometimes it has too much seasoning on it or just doesn’t look like edible.”</p> <p>“Well, not as much nutrients and the food fills me up.”</p> <p>“Because they just give us gross food. Last time they burnt the carrots.”</p> <p>“Sometimes they cook nasty stuff.”</p>
<b>No food choices at lunchtime</b>	<p>“Usually the cafeteria decides how much we are served. We don’t usually get seconds, but only if there’s a lot more than usual then we’re allowed to have seconds.”</p> <p>“The lunch lady puts the food on my plate.”</p> <p>“It was all on the plate.”</p> <p>“They just give the lunch to us”</p> <p>“They just give you a tray of food.”</p> <p>“They don’t let us choose.”</p> <p>“The lunch ladies give it to us.”</p> <p>“We don’t decide.”</p>
<b>Cannot save any leftovers because of school rules</b>	<p>“If they catch you trying to save food, you are get in trouble. I never once got caught because I used to just roll up the bread in a ball and either hold it, put it in your pocket or put it in your mouth.”</p> <p>“I think at school because they don’t like to save it.”</p> <p>“Because sometimes they’re not hungry and they have nowhere to save it.”</p> <p>“The school doesn’t really save it for anybody else. They just throw it because they just make us empty at a certain time. The stuff that we have left we put it on our tray and we go dump our tray. It gets thrown away.”</p>
<b>No sharing with others because of school rules</b>	<p>“We don’t have the opportunity to share with other people if they want my lunch.”</p> <p>“They say, ‘No sharing food!’”</p>
<b>School rules require students to throw food away</b>	<p>“Throwing food away is the rule to go to recess.”</p> <p>“They have to throw it out.”</p> <p>“We walk over to the garbage can, dump it, and then put our tray in a pile.”</p>

\* Quotations have been edited to correct grammar

*Motivators for Reduction of School Lunch Plate Waste*

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The main challenges of minimizing lunch plate waste were identified as school policy and food quality. Strategies can be informed by students' negative responses to school lunch policy and food quality as motivators to reduce plate waste. These students' responses can be summarized as the following: (1). Regulate school policies to permit self-selection of foods at lunch time. (2). Investigate food sharing options with peers among students. (3). Allow uneaten, intact food items to be redistributed or saved for later. (4). Accommodate high quality, wide variety and well-prepared nutrient dense foods. (5). Improve food quality and variety (6). Involve students in taste-test programs. According to their responses, the key motivators for reducing plate waste in these schools were identified as school policy and food quality. Social influence was regarded as a minor factor (Table 4). Participants commented that they had no leftovers if the food was healthy and if they liked the taste. In regard to school policy, participants commented that if their school allowed them to share their uneaten food this may help to reduce plate waste. Composting or giving leftovers to animals were also highlighted as ways to reduce the amount of plate waste thrown into the trash. Lastly, participants commented they finished their food if influenced positively to do so by their peers.

**Table 4 Key Motivators for Plate Waste Reduction in Early Adolescents Ages 9-13 years (n=47) in Hawai'i, Montana, and Virginia**

Key Motivators	Representative Response Quotes from Participants*
<b>Self-select foods at lunchtime</b>	<p>“They could probably let us choose what goes on our plate, and how much is put onto our plate.”</p> <p>“They could just have a bunch of sauces, and then like private schools where you get to pick your food.”</p> <p>“You’d eat more of your food if you got to choose what you could.”</p> <p>“Maybe have a few different choices.”</p>

	<p>“In the morning go around to kids and ask them, ‘What kind of foods do you like?’”</p> <p>“They should give us a choice of drinks. They should give us a juice box or milk.”</p>
<b>Save food in the cafeteria</b>	<p>“Probably put the rice back in the rice cooker if they haven’t touched that.”</p> <p>“If they don’t drink the milk, they can save it.”</p> <p>“You can put the leftovers next to the trash cans and someone else can take it. Maybe they put it in the fridge until it expires and then to the trash. If there is too much, they give the leftover food to the employees so they can take it home, or even give it back to the cafeteria.”</p>
<b>Share food with peers</b>	<p>“I didn’t want to eat, because the boys were making me mad, and I got distracted.”</p> <p>“Because my friends don’t like food waste so I make sure I eat everything too.”</p> <p>“We could give it to the people that like the food at school.”</p> <p>“But that could be given to somebody else.”</p> <p>“Someone ends up asking for it so I give it to them.”</p>
<b>Allow students to save food</b>	<p>“Some kids save it because they just hold it in their hands so that they can eat it at recess.”</p> <p>“We wait until schools over to eat it.”</p> <p>“They say you can take left over food, but you can’t eat it in class. You can eat it after class.”</p>
<b>Improve food quality and variety</b>	<p>“Instead of having rice every day, change it up and make it more interesting by providing us with new foods”</p> <p>“More variety. You get a little bored with the same lunch.”</p> <p>“It’s always really salty and mushy. They should get fresh food. When you get the food the day before, and then the other day you cook.”</p> <p>“At least make it look better and stuff so people can actually eat more and not throw away or throw away less food.”</p> <p>“Maybe buying better ingredients.”</p>

\* Quotations have been edited to correct grammar

### *Perspectives on Reduction of School Lunch Plate Waste*

Key themes emerged around what participants perceived their parents' and peers' perspectives were on plate waste and their own personal perspectives on plate waste. The majority of participants said their parents disliked wasting food; for example, a participant said she tried to save or finish all her food because her parents disliked wasting



food. Participants commented that their peers tend to waste food or they were unsure how their peers felt about wasting food. For example, common quotes were “they don’t care,” and “I don’t know.” Personally, participants believed it was acceptable to throw away undesirable food and it was unacceptable to throw away wanted food (Table 5). Lack of awareness about the importance of not wasting food in school can create an obstacle to healthy eating behaviors in students. Students may also be influenced by their peers to not care about plate waste, thus leading to an increase in lunch plate waste.

Plate waste is child, school, community, and food service related. Palatability, taste preferences, lunch duration, school policies and coordination are factors related to plate waste. Improving food quality and allowing food choice in schools may allow for minimization of school lunch plate waste.

**Table 5 Key Perspectives on Plate Waste in Early Adolescents Ages 9-13 years (n=47) in Hawai‘i, Montana, and Virginia**

<b>Key Perspectives</b>	Representative Response Quotes from Participants and their Responses for their Peers and Parents*
<b>It’s OK to waste food</b>	“I wouldn’t mind because if I didn’t like it, it would probably be better because they can be compost too.” “It might have tasted good but then I just threw it away?” “No foods are really okay to throw away, but I don’t feel bad about throwing my school lunch away.” “My peers don’t care. They just throw it away and go away.” “There are so many kids. It’s very likely some of them don’t care.” “My parents don’t care.”
<b>Against plate waste</b>	“Well, I feel bad because across the street we have people that do not get to eat everyday, so I try to eat as much as I can.” “I feel bad because it’s wasting.” “I don’t have any specific foods that I would feel bad about throwing in the trash, but I think everything.”

“My peers feel bad about throwing food in the trash.”

“I’m sure some of my peers feel bad about it, but most probably don’t think about it.”

“My mom doesn’t really like wasting food, and sometimes my mom’s boyfriend doesn’t either. He said, ‘You should eat all that food on your plate because you should be happy that you have food.’”

**Neutral to plate waste**

“I don’t really care about food because again I am not a fat person. I don’t really care. I would say I care about people that are starving but I don’t eat that much food.”

“I feel sad and happy at the same time.”

“It feels neutral about throwing food away.”

“I think my friends feel a little bit bad, but I don’t know about other people.”

“Probably neutral but I don’t know about others.”

“My parents do mind because there is starving children, but they don’t mind. It’s 50:50.”

\* Quotations have been edited to correct grammar

## Discussion

This study highlights some of the key barriers, motivators and perspectives about school lunch plate waste among early adolescents from low-income families. Findings may inform practices in the National School Lunch Program (NSLP), a federally assisted meal program in the United States (US) that began providing low-cost and free school lunch meals to students in 1946.<sup>24</sup> It is estimated that 30.4 million students participated in the low-cost or free lunches program in 2016.<sup>24</sup> In 2010, the Healthy, Hunger-Free Kids Act (HHFKA) was passed, which allowed the United States Department of Agriculture (USDA) to make critical improvements to the foods served in the NSLP.<sup>67</sup> In response to the HHFKA, the USDA released new nutrition standards for the NSLP and School Breakfast Programs (SBP) in 2012-2013.<sup>68</sup> These nutrition standards focused on reducing sodium and saturated fat in school meals, as well as increasing whole grains and fiber.<sup>68,69</sup> These standards also set minimum requirements for protein, calcium, iron, vitamin A, and

vitamin C in school meals.<sup>69</sup>

While the aforementioned changes to the nutrition standards linked to the HHFKA were important, the standards are based on the assumption that all foods and beverages served in the NSLP are consumed.<sup>9,68</sup> Previous studies provide evidence of a significant amount of plate waste— the edible portion of foods served, but not consumed— in the NSLP.<sup>26,65</sup> The NSLP set new standards for minimum and maximum levels of energy (kcal) intakes, and placed restrictions on total and saturated fat. Recently, the program also set the minimum levels for protein, calcium, iron, vitamin A, and vitamin C.<sup>2,68</sup> However, previous research has found that foods being served but wasted in the NSLP lead to inadequate intakes of calcium, iron, zinc and vitamins A and C.<sup>21,26,70</sup>

These findings may help to inform future strategies to help reduce plate waste in the NSLP. Poor food quality was repeatedly reported as a barrier to reducing plate waste, and desirable food quality was mentioned as a motivator to reducing plate waste. Previous studies have also found that improving the palatability of food helps to reduce plate waste and increase nutrient consumption at school lunch.<sup>19</sup> Studies have also suggested integrating more fresh and local produce into school lunches may increase the consumption of food in schools.<sup>16,71</sup>

School policy was also identified as a key barrier and motivator to reducing lunchtime plate waste. Previous studies also found school policy influenced plate waste in the NSLP.<sup>8,20,65,72,73</sup> For example, allowing students enough time to eat lunch has been

highlighted in many studies as a strategy to both reduce plate waste and increase nutrient consumption.<sup>8,15,29,32,74</sup> Cohen et al reported students who have less than 20 minutes to eat lunch consume 12% less of their entrées, milk and vegetables than students having at least 25 minutes to eat lunch.<sup>8</sup> Also, extending students' lunch periods to allow adequate time to finish lunch reduced plate waste from 43.5% to 27.2%.<sup>32</sup> Additional research has reported inadequate time to finish lunch not only increases plate waste, but leaves students feeling hungry.<sup>27</sup> This inadequate energy intake drives students to look for salty and/or sugary snacks and beverages from nearby vending machines and food establishments.<sup>27,75</sup> The studies suggest that those involved in writing school policies should allow reasonable and sufficient lunch times for students to be directed and seated, wait in the lunch line, eat and clean-up.<sup>3</sup>

The Cornell Center for Behavioral Economics in Child Nutrition Programs is the home of the Smarter Lunchrooms National Office, which provides tools, training and support to schools in the US to help improve students nutrient intake.<sup>76</sup> This program also recommends extending the lunch time period and increasing the variety of food served in the NSLP, allowing students to serve themselves, and offering ready-to-eat or sliced fruit and vegetables to improve nutrient intakes.<sup>76</sup> These suggestions are in line with the barriers and motivators participants expressed in the current study, with majority mentioning they had no choice as to what foods were served at school lunch. Previous research also concluded plate waste was lower when students were allowed to select their own lunch components.<sup>9,14,26,77</sup> For example, when schools offered a variety of fruits and vegetables, and different flavored milks, this increased the consumption of these

items and decreased plate waste.<sup>78,79</sup> Encouraging students to keep food items for after-school activities, prepack foods for students who do not have enough time to eat, and share unopened foods such as packaged milk also help to optimize food intake and reduce plate waste.<sup>80</sup> These ideas are also in line with the barriers participants expressed in the three states included in the current study. However, saving food could also cause serious problems related to food safety for students who do are not able to properly store their uneaten foods in school.<sup>81</sup> The World Health Organization (WHO) reported that 2.2 million people are killed by food- and waterborne diarrheal diseases annually, of which 1.9 million are children. Therefore, future research on effective and safe approaches for applying food saving strategies is needed.<sup>82</sup>

### *Strengths and Limitations*

The present study has a number of strengths and limitations. Previous studies provide quantitative evidence and measurements of substantial plate waste in the NSLP as well as plate waste-related economic loss.<sup>19,20,26</sup> However, little attention was paid to assessing factors contributing to plate waste and developing strategies based on children's personal perceptions. The strengths include being an innovative qualitative study involving interviewing students about their barriers, motivators, and perspectives on reducing plate waste at school lunch. Students with different ethnic backgrounds were interviewed in three states across the US, which collectively enhances the applicability of this study to other schools and students in the US. A limitation of this study was only students were interviewed; therefore, perspectives from other key stakeholders, e.g. parents and teachers; within the context of this sample are not known. In addition, only

children eligible for SNAP were recruited. Thus, we were not able to assess the differences in plate waste between children eating school lunch eligible and ineligible for SNAP. Another limitation is that we did not assess the impact of the identified barriers, motivators and perspectives on plate waste. Further analytical studies are required to investigate this. Lastly, although the sample was recruited from different NSLP-qualifying elementary and middle schools across three US states, the specific foods they serve and how the foods are served are unique to each school. Therefore, the results from the children interviewed in this study may not be representative of the plate waste behaviors of children outside of this group.

#### Implications for Research and Practice

Plate waste is a problem among adolescents in the US. The nutritional, environmental, and economic consequences of plate waste should draw the government and schools' attention. The current study is the first perception-focusing research to interview children about their perceived barriers, motivators and perspectives which resulted in recognizing and reporting plate waste at school lunches a problem. The interpretation of barriers, motivators and perspectives on reduction of plate waste of early adolescents have critical implications for establishment of future plate waste reduction strategies. Clearer understanding of individual perceptions of school lunch plate waste among students could potentially help schools embed nutrition education that may reduce plate waste.

The study results reporting students' views and perceptions of school lunch plate waste is essential in maximizing the nutritional status of youth. Results of this research based

on students' views of school lunch could be used as a valuable reference for training programs for cafeteria staff to better address students' emotional and nutritional needs to increase school lunch consumption. Schools with trained staff who are familiar with students' needs could better direct and assist children to develop healthier eating behaviors. For example, previous studies which compared schools have trained chefs with control schools showed that schools with trained chefs promoted increased whole grain and vegetable selection among students.<sup>2,33</sup> The study results could also be a good resource for developing nutrition education curricula for children. These education curricula should aim to improve the coordination and communication between state policy makers and school cafeteria staff to educate children in schools about the impact and the importance of reducing school lunch plate waste.

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## APPENDICES

### Appendix A

#### **Lunch at school**

- o At school, do you get your lunch through the school lunch program? Or, do you bring your lunch from home or buy it somewhere to take to school?
- o How do you decide what you are going to eat?
- o Who puts the food onto your plate?
- o Who decides how much you are served?
- o When you finish lunch, is food ever left on your plate?
  - [If yes, ask:
    - Why is there food left on your plate?
    - What type of food is usually left on your plate? Why?
    - What happens to this food? Why? [Follow up with probes as to why food is not saved, composted, or other]
  - [If leftovers are saved, ask:
    - Are these saved leftovers eventually thrown into the trash? Why or why not?
- Are there any other reasons you throw these saved leftovers into the trash? [Keep asking until no further reasons.]