

STRATEGIES TO CONTROL PORTION SIZE  
IN THE FOOD ENVIRONMENT

by

Katie Jolene Bates

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

Master of Science

in

Health and Human Development

MONTANA STATE UNIVERSITY  
Bozeman, Montana

April 2015

©COPYRIGHT

by

Katie Jolene Bates

2015

All Rights Reserved

DEDICATION

I dedicate my thesis and everything I do to my beautiful mother, Linda Dawn Ward. Thank you for your unwavering support and instilling the importance of hard work and determination. Your kind, positive words have been a constant source of motivation and strength during moments of despair and discouragement. Without you, I would not be the person that I am today.

## ACKNOWLEDGEMENTS

First and foremost, I wish to thank Dr. Carmen Byker Shanks, for her endless support, encouragement, and tutelage throughout my collegiate career. Your drive and discipline has been a constant inspiration to me. I am so fortunate and grateful to have such an intelligent, ambitious, and wonderful advisor and mentor. Without you, none of this would have been possible. Thank you for your unrelenting faith in me, for your wisdom, and for helping me realize my potential.

Additionally, I would like to thank Dr. Alison Harmon and Melody Anacker for serving on my committee, their generous time and expertise, and providing constructive feedback and valuable insight on my thesis.

Thanks also go to my dearest friend Britnie Bree. You are a true blessing and words cannot express my gratitude for being someone I can always confide in, rely on, and trust. Thank you for being my person. Last, but certainly not least, I would like to thank all of my colleagues in the Sustainable Food Systems graduate program. A special thanks to Mica Jenkins, Lacy Stephens, and Bailey Houghtaling for their unyielding support, advice, and friendship. Thank you for accompanying me on this venture, I wish you all the very best on your future endeavors. Many thanks to all those involved for helping me achieve my goals; you will always be remembered and sincerely appreciated.

## TABLE OF CONTENTS

1. INTRODUCTION .....	1
Modern Obesity Epidemic and Public Health Response.....	1
Influence of Portion Size .....	2
Food Environmental Strategies .....	6
Statement of the Problem .....	7
Statement of the Purpose .....	7
Inclusion Criteria.....	7
Limitations.....	8
Conclusion.....	9
References .....	10
2. ENVIRONMENTAL STRATEGIES THAT INFLUENCE PORTION SIZE AND ENERGY INTAKE: A SYSTEMATIC REVIEW .....	13
Contribution of Authors and Co-authors.....	13
Manuscript Information Page.....	14
Abstract .....	15
Introduction .....	15
Methods .....	17
Data Sources and Search Strategy .....	17
Data Extraction .....	18
Data Selection and Quality .....	18
Results .....	19
Plate Size.....	19
Design and Methodology .....	20
Results.....	20
Container Size.....	21
Design and Methodology .....	22
Results.....	22
Addition of Low-Energy Dense Foods Pre Entrée .....	23
Design and Methodology .....	23
Results.....	23
Portion Size and Energy Density .....	24
Design and Methodology .....	24
Results.....	25
Visual Cues .....	26
Design and Methodology .....	27
Results.....	27

## TABLES OF CONTENTS - CONTINUED

Nutrition Labeling.....	28
Design and Methodology .....	28
Results.....	28
Discussion .....	30
Limitations for Future Research .....	32
Conclusion .....	33
References .....	43
3. PLACEMENT OF A TAKE-OUT CONTAINER DURING MEAL INFLUENCES ENERGY INTAKE.....	47
Contribution of Authors and Co-authors .....	47
Manuscript Information Page .....	48
Abstract .....	49
Methods .....	51
Participants.....	51
Procedure and Experimental Design.....	51
Measures .....	52
Statistical Analysis.....	52
Results .....	53
Discussion .....	55
Limitations .....	56
Conclusion .....	57
Acknowledgements .....	58
Funding and Sponsorship.....	58
Declaration of Interest .....	58
References .....	60
4. CONCLUSION.....	64
REFERENCES CITED.....	68

## LIST OF TABLES

Table	Page
2.1. Characteristics of studies focusing on environmental strategies that influence energy intake .....	33
3.1. Demographics, anthropometric, characteristics of to-go container study sample (n = 50) .....	56

LIST OF FIGURES

Figure	Page
2.1. PRISMA flow diagram of systematic review of all relevant articles with an experimental design that focused on the eating environment to test factors outside of individual behavior that influence portion size and energy intake.....	32

## ABSTRACT

The purpose of this research is to examine the impact of increasing portion sizes on the food environment and the implications for obesity, to synthesize and evaluate the efficacy and availability of research experiments that focus on managing portion sizes and energy intake in the food environment, and to conduct a controlled laboratory experiment to examine if the presence of a take-out container given with a meal reduces energy intake. The systematic review, conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, was conducted to synthesize research experiments that focused on the food environment to influence portion size and energy intake. Across studies, the majority of food environment strategies were effective in decreasing portion size and energy intake among participants. Fifty college students completed a randomized study in a well-controlled laboratory. Independent t-tests confirmed that when a take-out container was given with the test meal, it led to a significant difference in energy intake. No significant correlation was found between BMI and energy intake. This research illustrates that providing an environmental cue such as a take-out container could decrease how much a person eats in one eating occasion. Future research should examine if the take-out container cue remains an effective strategy in a restaurant or other type of foodservice and if it has the same affect on energy intake over an extended period of time. It would also be prudent for other researchers to test other portion control strategies in the food environment in order to determine factors that may lead to decreased energy intake for consumers when eating away from the home.

## CHAPTER ONE

## INTRODUCTION

Modern Obesity Epidemic and the Public Health Response

In the past several decades, public health interventions have focused on changing health behaviors in order to curb the obesity epidemic through individually targeted strategies such as nutrition education through the 5-A-Day Campaign (CDC, 2014), nutrition and menu labeling (U.S. Food and Drug Administration, 2014), and the Dietary Guidelines of Americans (2015). As obesity has come to the forefront of public health concerns, these well-meaning policies have made a relatively small impact on people's food choices, making it apparent that consumer education alone, is not enough to change this negative trend. Today more than 34% of adults and nearly 17% of children and adolescents are characterized as obese in America (Centers for Disease Control and Prevention [CDC], 2014). Moreover, annual allocation of healthcare resources related to obesity and the associated comorbidities are projected to exceed \$150 billion in the U.S. (Hurt, Kulisek, Buchanan, & McClave, 2010).

Obesity may be influenced by a multitude of factors, including biological, behavioral, lifestyle, genetic, cultural and environmental (U.S. Department of Health and Human Services [USDHHS], 2013). Although complex, weight gain is caused by an excess of energy intake over expenditure or positive energy balance at the most basic level (Young & Nestle, 2002). The fact that obesity rates have more than doubled in the past thirty years across all demographic and socioeconomic groups (CDC, 2011) is in

large part due to individual behaviors combined with environmental factors that contribute to a positive energy balance and lack of physical activity (Huang, Drewnowski, Kumanyika, & Glass, 2009). Factors that influence what people eat in the food environment include the abundance and accessibility of inexpensive, energy dense, and palatable foods (Huang et al., 2009), large food portions distorting people's perceptions of what constitutes a suitable serving (Steenhuis & Vermeer, 2009), increased number of eating occasions (Duffey & Popkin, 2011), and the proliferation of fast-food establishments (Faith & Kral, 2006). Hence, these food environment influences should be a large focus for the prevention and treatment of obesity (CDC, 2014; USDHHS, 2013). Current individual based health efforts are difficult to achieve in an environment that discourages physical activity and encourages the over consumption of calories (Hill, 2009). Cultivating healthier eating behaviors and reversing the prevalence of obesity requires a combination of individual based efforts with healthy environmental cues (Huang et al., 2009; Mitchell, Catenacci, Wyatt, & Hill, 2012).

### The Influence of Portion Size

Although a direct correlation has yet to be identified, research suggests that increased portion sizes have occurred in tandem with rising obesity rates (Rolls, 2014). Young & Nestle (2012) suggest that sizeable portions not only influence eating behaviors through the increase of daily calories, but also lead people to underestimate caloric intake. Since portion sizes have become a major contributor to weight gain by

contributing to excess energy intake, intervention studies designed to alleviate this environmental stimulus can support the adoption of healthier food choices (Rolls, 2014).

Food portions in restaurants have nearly tripled in the past thirty years (USDHHS, 2013). This phenomenon has occurred simultaneously with other food outlets as package sizes have also increased (Schwartz & Byrd-Bredbenner, 2006). Marketplace food portions have set food consumption standards and as such, food portions have increased inside of the home as well (Ello-Martin, Ledikwe, & Rolls, 2005). These “super-size” portions have become readily available and since they exceed federal guidelines, have led to passive over consumption (Swinburn & Egger, 2002). It is well documented that large food portions promote passive over-consumption (Diliberti et al., 2004; Rolls et al., 2004; Rolls et al., 2006; Williams et al., 2014), and since they have more calories than smaller portions, have contributed to the upward surge in overweight and obesity rates (Steenhuis & Vermeer, 2009).

Furthermore, food consumed outside of the home has increased significantly in the past few decades (Lachat et al., 2011; You, Zhang, Davy, Carlson, & Lin, 2009). Following the 2007 recession, a massive decline occurred in the amount of total disposable income, and with it, the decline spent on the total food budget, which is now around 9.99% (USDA, 2015). The primary cause of this is a declining share of income spent on food at home since more and more people are turning towards prepared convenience foods (USDA, 2015). Americans consume about 32% of their total calories from food outside the home (Story, Kaphingst, Robinson-O’Brien, & Glanz, 2008). According to the USDA (2014), food spending away from the home has risen to nearly

43%. In the 1970's, the allocated food budget for foods consumed outside of the home was around 20% (Harnack, Jeffery, & Boutelle, 2000), depicting the importance of these foods in the diet today. Also, the more foods eaten away from the home, the more people are exposed to oversized portions (Ledikwe, Ello-Martin, & Rolls, 2005). Although foods consumed outside of the home are often affordable and convenient, they are also typically higher in fat and energy and lower in essential micronutrients (Hillier-Brown et al., 2014; Lachat et al., 2011). The nutritional implications of these convenience foods, coupled with the frequency in which they are consumed, have further added to the confusion of what constitutes a healthy diet. The increased consumption of large portions of energy dense foods have created an environment that encourages poor dietary patterns and has contributed to the increased waistlines of Americans (Hillier-Brown et al., 2014). If obesity rates continue on this upward trend, an even greater percentage of the population will experience the complications of obesity, such as heart disease, diabetes, and cancer (Hurt et al., 2010).

As the marketplace continues to be inundated with an influx of restaurants and fast food chains, in order to stay competitive, restaurants have adapted by increasing food portions as the cost of food is relatively low when compared to labor and processing (Young & Nestle, 2012). Offering bigger portions for better value or 'value pricing' has become so popular with consumers; restaurants are fighting to differentiate themselves in the marketplace by offering even more food for a lower cost (Wansink & Ittersum, 2007). Thus, the ultimate driver in determining the portion sizes that restaurants offer is consumer demand, especially in fast food chains or lower scale restaurants, since the food

cost is relatively inexpensive (Wansink & Ittersum, 2007). According to a study by Condrasky, Ledikwe, Flood & Rolls (2007), when 300 executive chefs were surveyed, they responded that the other two prominent factors that determine portion sizes are the presentation of foods and food cost. As such, restaurants have both responded and influenced consumer expectations about portion sizes (Wansink & Ittersum, 2007).

Strategies, such as offering smaller portion sizes, have the potential to invite people to select healthier servings, yet are not commonplace in many restaurants today (Riis, 2014). Since value perception has shaped consumer expectations when eating out, restaurants, and rightfully so, are hesitant to implement smaller portions into foodservice operations because of the risk to expectations and subsequent profitability (Riis, 2014). Therefore, environmental strategies that target control of portion sizes by the consumer are needed until restaurants offer smaller sizes.

A few restaurants are paving the path for such a strategy by offering positive pricing initiatives (Chandon & Wansink, 2012). For example, T.G.I. Friday's made its "Right portion, Right price" menu a permanent fixture since it was so popular and California Pizza Kitchen implemented a "Small Cravings" program as well (Young & Nestle, 2012). Applebee's began to offer half-size portions for 70% of the price at participating locations, but only for salads (Chandon & Wansink, 2012; Young & Nestle, 2012). According to Story et al. (2008), the primary objective of restaurant managers is to maximize profits. Therefore, the primary incentive that would drive restaurants to offer healthy food options would be consumer demand. Positive pricing strategies could be a

win-win for consumer and restaurants alike if restaurants offer more smaller portion options for a lower cost as it may stimulate more consumers to eat out.

### Food Environment Strategies

The external environment has a profound impact on what and how much people eat (Story et al., 2008). Story et al. (2008) define the food environment as the settings in which people eat and procure food such as at home, restaurants, worksites, and other food retailers. Individual behavior change becomes even more difficult when the food environment is perforated with barriers to select healthy food choices. A variety of environmental factors may influence higher energy intakes, such as portion size (Diliberti et al., 2004), package size (Marchiori, Corneille, & Klein, 2012), salience of food (Wansink, Painter, & Lee, 2006), ambiance (Stroebele & Castro, 2004) and consumption of appetizing and energy dense foods (Ello-Martin, Ledikwe, & Rolls, 2005). Environmental factors such as these are highly problematic as they can contribute to excessive energy intake (Drewnowski & Rolls, 2005) without a person even being aware of it (Wansink, 2004).

Clinical studies suggest that portion size is a strong environmental factor influencing energy intake (Steenhuis & Vermeer, 2009). A few well-controlled trials have illustrated that when subjects are given larger portions of food their food intake will increase (Diliberti et al., 2004; Rolls et al., 2004; Rolls et al., 2006; Steenhuis & Vermeer, 2009; Williams et al., 2014; Young & Nestle, 2002). As an example, in a study that lasted a period of eleven days, Rolls et al. (2007) found that increasing portion sizes

by 50% resulted in an average intake increase of over 400 kcals. This occurred for both men and women and weight had no bearing on food intake (Rolls et al. 2007).

### Statement Of The Problem

In order to guide consumers to select appropriate serving sizes from available portion sizes, perhaps the most practical and effective solution at this time is to develop strategies that focus on manipulating the current food environment. Research by Rolls (2014), supports that when people encounter sizeable portions of appetizing and energy dense foods at restaurants, individuals need to adopt strategies to limit food intake. Since the number of calories in the amount of food consumed is an integral tenant for weight gain or loss (Alpert, 2011), practical and effective tools need to be evaluated and disseminated in order to help people achieve and maintain a healthy weight.

### Statement of Purpose

The purpose of this research was threefold: 1) examine the impacts of increasing portion sizes in the food environment, 2) synthesize and evaluate the efficacy and availability of research focusing on managing portion sizes and energy intake in the food environment, and 3) conduct a controlled laboratory experiment to examine if the presence of a take-out container given with a meal reduces energy intake.

### Inclusion Criteria

The systematic review of literature presented in Chapter 2 was limited to studies that utilized adult populations and focused on environmental intervention strategies that influenced portion size and energy intake. For the research presented in Chapter 3, convenience sampling was used and, as such, participation was limited to adult college students.

### Limitations

These findings were limited to the demographic profile of the university from which the students were recruited and participation was contingent upon being enrolled in college. Therefore, the sample was representative of college students so the findings may not be generalizable to the general population. The researchers attempted to diversify the target population by recruiting different ages, genders, and majors. However, the majority of the participants recruited were between the ages of 18 and 24 and nearly half of the sample was Community Health students, rendering the sample relatively homogeneous. Also, since men typically have higher energy needs than women and subsequently tend to eat more, this may have affected the results since they were served the same amount of the test meal. However, the researchers tried to eliminate this possible limitation by recruiting an equal number of men and women.

Conclusion

Well-controlled research experiments should focus on manipulating the food environment in order to facilitate positive behavior changes in regard to healthier food choices. If proven successful, these tools could be implemented in restaurants of any form to help consumers engage in eating more suitable portions for specific energy needs. Public health interventions should focus on promoting an environment that supports healthy eating.

## REFERENCES

#

Alpert, P.T. (2011) Portion size: A disconnect among Americans? *Home Health Care Management & Practice*, 24(1), 59-61. doi: 10.1177/1084822311422562

Centers for Disease Control and Prevention. (2014). Fruits and vegetables. Retrieved from <http://www.cdc.gov/nutrition/everyone/fruitsvegetables/>

Centers for Disease Control and Prevention. (2014, September). Overweight and obesity: Adult obesity facts. Retrieved from <http://www.cdc.gov/obesity/data/adult.html>.

Centers for Disease Control and Prevention. (2011, May). Obesity: Halting the epidemic by making health easier. Retrieved from <http://www.cdc.gov/chronicdisease/resources/publications/aag/obesity.htm>.

Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*, 12(3), 562-568. doi:10.1038/oby.2004.64

Drewnowski A., Rolls B.J. (2005). How to modify the food environment. *Int J Behav Nutr Phys Act*, 135(4), 898-899.

Faith, M.S. & Kral, T.V.E. (2006). *Social environmental and genetic influences on obesity and obesity promoting behaviors: Fostering Research Integration*. Institute of Medicine: Washington, DC: The National Academies Press. Available from <http://www.ncbi.nlm.nih.gov/books/NBK19924/>.

Hurt, R.T., Kulisek, C., Buchanan, L.A., & McClave, S.A. (2010). The obesity epidemic: Challenges, health initiatives, and implications for gastroenterologists. *Gastroenterol Hepatol*, 6(12), 780-792.

Harnack, L.J., Jeffery, R.W., & Boutelle, K.N. (2000). Temporal trends in energy intake in the United States: an ecologic perspective. *Am J Clin Nutr*, 71(6), 1478-84.

Huang, T.T., Drewnowski, A., Kumanyika, S.K., & Glass T.A. (2009). A systems-oriented multilevel framework for addressing obesity in the 21<sup>st</sup> century. *Prev Chronic Dis*, 6(3), 1-10.

Lachat, C., Nago, E., Verstraeten, R., Roberfroid, D., Van Camp J., Kolsteren, P. (2011). Eating out of the home and its association with dietary intake: a systematic review of the evidence. *Obesity Reviews*, 13, 329-346. DOI: 10.1111/j.1467-789X.2011.00953.x

- Ledikwe, J.H., Ello-Martin, J.A., & Rolls, B.J. (2005). Portion sizes and the obesity epidemic. *J Nutr*, 135(4), 905-909.
- Mitchell, N., Catenacci, V., Wyatt, H.R. & Hill, J.O. (2012). Obesity: Overview of an epidemic. *Psychiatr Clin North Am*, 34(4), 717-731.  
doi: [10.1016/j.psc.2011.08.005](https://doi.org/10.1016/j.psc.2011.08.005)
- Office of Disease Prevention and Health Promotion. Scientific report of the 2015 dietary guidelines advisory committee. Updated April 5, 2015. Accessed March 23, 2015. Retrieved from <http://www.health.gov/dietaryguidelines/2015-scientific-report/>.
- United States Department of Agriculture/Economic Research Service. (2014). Food-away-from-home. Updated October 29, 2014. Accessed April 4, 2015. Retrieved from <http://www.ers.usda.gov/topics/food-choices-health/food-consumption-demand/food-away-from-home.aspx>.
- Rolls, B.J. (2014). What is the role of portion control in weight management. *Int J Obes (Lond)*, 38, S1-S8. doi:10.1038/ijo.2014.82
- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006). Larger portion sizes lead to a sustained increase in energy intake over 2 days. *J Am Diet Assoc*, 106(4), 543-549.  
doi:10.1016/j.jada.2006.01.014
- Rolls, B.J., Roe, L.S., Meengs, J.S., & Wall, D.E. (2004). Increasing the portion size of a sandwich increases energy intake. *J Am Diet Assoc*, 104(3), 367-372.  
doi:10.1016/j.jada.2003.12.013
- Schwartz, J., Byrd-Bredbenner, C. (2006). Portion distortion: Typical portion sizes selected by young adults. *J Am Diet Assoc*, 106(9), 1412-1418.  
doi:10.1016/j.jada.2006.06.006
- Steenhuis, I.H.M & Vermeer, W.M. (2009). Portion size: review and framework for interventions. *Int J Behav Nutr Phys Act*, 6, 58. doi:10.1186/1479-5868-6-58
- Story, M., Kaphingst, K.M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annu Rev Public Health*, 29, 253-272. DOI: 10.1146/annurev.publhealth.29.020907.090926
- U.S. Department of Health and Human Services. (2013). Larger portions sizes contribute to U.S. obesity problem. Accessed April 4, 2015. Retrieved from <http://www.nhlbi.nih.gov/health/educational/wecan/news-events/matte1.htm>.
- U.S. Food and Drug Administration. (2014). Guidance Documents & Regulatory Information by Topic. Labeling & Nutrition. Retrieved from

<http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm385663.htm>.

- Wansink, P. & Wansink, B. Does food marketing need to make us fat? A review and solutions. *Nutr Rev*, 70(10), 571-593. doi: 10.1111/j.1753-4887.2012.00518.x.
- Wansink, B. & Ittersum, K.B. (2007). Portion size me: Downsizing our consumption norms. *J Am Diet Assoc*, 107(7), 1103-1106. doi:10.1016/j.jada.2007.05.019
- Wansink, B., Painter, J.E., & Lee Y.K. (2006). The office candy dish: proximity's influence on estimated and actual consumption. *Int J Obes (Lond)*, 30(5), 871-875. doi:10.1038/sj.ijo.0803217
- Williams, R.A., Roe, L.S., & Rolls, B.J. (2014). Assessment of satiety depends on the energy density and portion size of the test meal. *Obesity*, 22(2), 318-324. doi: 10.1002/oby.20589
- Young, L.R., Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *Am J Public Health*, 92(2), 246-249.
- Young, L.R., Nestle, M. (2012). Reducing portion sizes to prevent obesity. A call to action. *Am J Prev Med*, 43(5), 565-8. doi: 10.1016/j.amepre.2012.07.024
- You, W., Zhang, G., Davy, B.M., Carlson, A., & Lin, B-H. (2009). Food consumed away from home can be a part of a healthy and affordable diet. *J Nutr*, 139(10), 1994-1999. doi: 10.3945/jn.109.107615

CHAPTER TWO

ENVIRONMENTAL STRATEGIES THAT INFLUENCE PORTION SIZE AND  
ENERGY INTAKE: A SYSTEMATIC REVIEW

Contribution of Authors and Co-Authors

Manuscript in Chapter 2

Contributions: Conceived and implemented study design. Led the acquisition of data and drafting of the manuscript. Edited additional drafts for final submission.

Co-Author: Dr. Carmen Byker Shanks

Contributions: Conceived and implemented study design. Provided field expertise and guidance throughout the drafting process. Provided critical revision for final submission.

Manuscript Information Page

#

Kate J. Bates, Dr. Carmen Byker Shanks

Appetite

Status of Manuscript:

Prepared for submission to a peer-reviewed journal

Officially submitted to a peer-review journal

Accepted by a peer-reviewed journal

Published in a peer-reviewed journal

Elsevier Ltd.

Submitted April 2015

**Abstract**

There is a strong parallel between increasing portion sizes and rising rates of obesity in the United States. Past strategies designed to decrease consumer portion size have focused on improving individual food choices, such as through increasing nutrition education. In order to impact obesity rates, it is crucial that an equal emphasis is placed on strategies designed to control the food environment in an attempt to prevent overeating and corresponding weight gain. The purpose of this systematic review, conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, was to synthesize research experiments that focused on the food environment to influence portion size and energy intake. Of the 19 articles included in the review, three examined plate size, three examined container size, one examined the addition of low-energy dense foods pre meal, seven examined energy density and portion size, two examined visual cues, and three examined nutrition labeling. Across studies, the majority of food environment strategies were effective in decreasing portion size and energy intake among participants. It is recommended that further studies be conducted in order to test the efficacy of manipulating the food environment to ultimately guide consumers in eating appropriate amounts of food and influence obesity rates.

**Introduction**

Despite decades of nutrition education, people continue to eat more and exercise less (Centers for Disease Control and Prevention [CDC], 2012). As a result, adult obesity

and nutrition-related chronic disease rates have steadily increased in the US (World Health Organization, 2014; CDC, 2014).

Studies suggest a strong association between increased portion sizes and the prevalence of overweight and obesity in adults (Rolls, 2003; Rolls, 2014). Portion sizes have increased exponentially across multiple vendors; from fast food outlets and restaurants to food consumed inside the home (Rolls, 2003). The portions of prepackaged ready-to-eat foods found in grocery stores and supercenters have also increased (Schwartz & Byrd-Bredbenner, 2006). Large portions of inexpensive food have distorted people's perceptions of what a typical meal should comprise (American Dietetic Association, 2009). This distortion is contributing to increased energy intake of meals, especially when the food is consumed outside of the home.

Since portion size is directly connected to the energy density of food (Alpert, 2011), practical and effective research and policy tools need to be evaluated and disseminated to help people achieve and maintain a healthy weight. For example, research by Ledikwe, Ello-Martin, & Rolls (2005) finds that when people encounter sizeable portions of appetizing and energy dense foods, individual behavior strategies exist to limit food intake, such as reducing overall energy intake and increasing satiety of a meal by consuming lower energy density foods like fruits and vegetables prior to an entrée. Policies exist that are designed to reduce caloric intake through nutrition education as well (Downs, Lowenstein, & Wisdom, 2009). For example, the Affordable Care Act mandates nutrition labeling in restaurants and vending machines for certain

companies and the Nutrition Labeling and Education Act mandates specific nutrient and health claims on packaging (U.S. Food and Drug Administration, 2014).

More recent studies are focusing on the eating environment to test factors outside of individual behavior and nutrition education that influence the portion size of food intake (Story, 2008). Such environmental strategies include influences that compliment individual behavior or nutrition education, such as plate size (Rolls, Roe, Halverson, & Meengs, 2007; Wansink, B. Ittersum, & Painter, 2006), energy density of foods (Ello-Martin, Ledikwe, & Rolls, 2005), ambiance (Stroebele & Castro, 2004), adding high water content to foods (Rolls, Bell, & Thorwart, 1999), and adding a salad to the food environment prior to consumption of a meal (Rolls, Roe, & Meengs, 2004). The present systematic literature review was conducted in order to understand the relationship of portion size and corresponding environmental strategies designed to reduce energy intake for adult populations.

## **Methods**

### *Data Sources and Search Strategy*

The authors conducted a systematic review according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009). The following databases were used to search for peer-reviewed literature: Science Direct, Web of Science, ProQuest Agricultural Science Collection, Springer Journal, and Google Scholar. Database searches were conducted in September and October of 2014. The following key words were used in varying combinations as an initial search step: portion size, energy intake, restaurants, intervention, strategies, and menu. Articles were

selected for review based on the title and abstract first, and then the full article. Articles were included in the systematic review if they met the following criteria: full peer-reviewed journal article, participants over the age of 18, focused on portion size and food consumption, and environmental intervention strategies being tested in a controlled lab or a natural setting. Dates of publication were restricted to 2004 onward. All studies involving children or adolescents under the age of 18, reviews of literature, or intervention strategies that focused on individual behavior were excluded from this review. Although review articles were excluded, the references were examined to ascertain if any other additional studies were relevant for inclusion in the review. Unpublished data were not included in the review.

#### *Data Extraction*

Table 1 indicates the following data extracted from each resulting article: author and year of publication, the design of the study, objective of study, subjects, methods, and specific outcomes of each study. Data extraction was initially conducted by the first author and then independently by an additional author. Any disputes were discussed and resolved by both authors for final inclusion list.

#### *Study Selection and Quality*

The authors included all articles with an experimental design that focused on the eating environment to test factors outside of individual behavior that influence portion size and energy intake. Individual behaviors that influence what people consume are defined according to Story et al. (2008) as cognitions, e.g. attitudes, preferences,

knowledge and values, skills and behaviors, lifestyle, biological, e.g. genes, gender, and age and demographics. Environmental strategies include any factors that can be categorized in macro-level environments (e.g. societal and cultural norms and values), physical environments (e.g. at home or work sites), and social networks (e.g. family, friends or peers) (Story, 2008). We defined environmental intervention strategies as those that included modifications to the setting of the experiment, in which the subjects were required to take part, in order to test impact on energy intake.

## **Results**

The initial keyword search yielded 231,586 results (See figure 1 PRISMA flow diagram). Of these articles, 231,501 were excluded based on inclusion and exclusion criteria. Of these results, the title and abstract of 85 potentially relevant articles were reviewed. After further exclusion, 49 full-text articles were screened for eligibility. Three of these studies were found via reviewing reference lists in selected articles. After screening each full article, 19 final articles were included for review and included in the data table. Articles outside of the inclusion criteria included studies that focused on specific disease states, explicit demographics, fast food outlets, studies pre 2004, and duplicates. Articles with irrelevant abstracts or reviews were also excluded. Studies that focused on children subjects were excluded as children generally have better satiety clues than adults. The characteristics of the 19 studies are presented in Table 1. Studies were stratified into six different environmental strategies including plate size, container size, addition of low-energy dense foods pre meal, energy density and portion size, visual cues, and nutrition labeling.

### *Plate Size*

Studies yielded in this review indicated that plate size had mixed results on the effect of energy intake (Libotte, Siegrist, & Bucher, 2014; Rolls, Roe, Halverson, & Meengs, 2007; Wansink, Ittersum, Painter, 2006). Two studies suggested that plate size had no significant effect on energy intake, while another study indicated that providing a larger bowl and spoon notably increased energy intake (Wansink et al., 2006).

### *Design and methodology.*

Three studies existed that examined the influence of plate or bowl size on energy intake. All of the studies used participants over the age of 18 and two of the studies had an equal representation of male and female participants (Libotte et al., 2014; Rolls et al., 2007). Studies were conducted in a controlled laboratory (Libotte et al., 2014; Rolls et al., 2007) and natural setting (Wansink et al., 2006).

### *Results.*

One study conducted three separate experiments with participants (n=119) in a controlled laboratory setting and focused on the effect of a smaller plate on energy intake at meals (Rolls et al., 2007). In the first experiment, the researchers tested the difference in energy intake when participants served their own food using a larger plate (22 and 25 cm in diameter), versus a smaller plate (17 cm) (Rolls et al., 2007). The second experiment focused on the perception of the amount of food on the plate and eating utensil size (standard spoon and soup spoon) when served the same meal on two different size plates (22 and 16 cm). The third study tested the effect of plate size on energy intake

when participants served themselves from a buffet offering a variety of foods (Rolls et al., 2007). In all three experiments conducted in this study, plate size showed no significant effect on energy intake of a meal (Rolls et al., 2007).

In the second plate size experiment, participants (n=83) served themselves a meal from a buffet containing 55 food items to test if plate size (27 cm or 32 cm) had any effect on meal composition and/or total energy intake of a meal (Libotte et al., 2014). Results indicated that plate size had no effect on energy intake, but the larger plate did entice participants to select a sizeable amount of vegetables. Therefore, researchers in this study suggest that using a larger plate size could be an effective strategy to guide individuals into increasing the amount of vegetables they serve themselves in a buffet style setting (Libotte et al., 2014).

In another study, researchers examined if nutrition experts (n=85) were given larger bowls and eating utensils at an ice-cream social, if they would consume more and acknowledge the bigger portion size they served themselves when compared to those that were given a smaller bowl (Wansink et al., 2006). Subjects that received the larger bowl and spoon consumed 31% more and even though experts in the field of nutrition, they did not perceive their portions to be any bigger than those subjects who received a smaller bowl (Wansink et al., 2006).

### *Container Size*

Overall, studies in this review indicated that container size does influence food consumption volume (Marchiori, Corneille, & Klein, 2012; Stroebele, Ogden, & Hill, 2009; Wansink & Kim, 2005).

*Design and methodology.*

Three studies examined the effect of container size on meal consumption. Study samples ranged from 59 participants (Stroebele, Ogden, & Hill, 2009) to 158 participants (Wansink & Kim, 2005). One of the studies utilized a 2 x 2 between-subjects design (Wansink & Kim, 2005), one used a crossover study design (Stroebele et al., 2009), and the other tested three conditions in a controlled laboratory setting (Marchiori et al., 2012).

*Results.*

In one controlled laboratory experiment, participants (n=88) were given three different conditions (medium portion of M&M's in small or medium container and large portion of M&M's in large container) to test the relationship between portion size and container size (Marchiori et al., 2012). The researchers found that energy intake increased by 129% when portion sizes were kept constant and container sizes differed and 97% when larger portion sizes were available in a larger container size. This study suggests that container size influences food intake regardless of portion size (Marchiori et al., 2012).

Another study examined whether portion-controlled snack packages (100 kcal packs) resulted in less consumption when compared to larger snack packages (187g to 368.5g) when the amount of food provided was held constant (Stroebele et al., 2009). Participants consumed 186.9 fewer grams of snacks when receiving the smaller snack package sizes (Stroebele et al., 2009).

Wansink and Kim (2005) tested if container size determines the amount of energy intake, despite research that suggests that taste primarily dictates consumption volume (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998). Researchers randomly gave moviegoer participants (n=158) a medium (120g) or large (240g) container of fresh or stale popcorn upon entry into a movie theatre. Upon exit, participants completed a questionnaire to ascertain their perception of palatability of the popcorn (Wansink & Kim, 2005). Results indicated that container size increased consumption volume for both fresh (45.3%) and stale (33.6%) popcorn (Wansink & Kim, 2005). Thus, palatability had an effect.

#### ***Addition of Low-Energy Dense Foods Pre Entrée***

One study found that adding a salad to the food environment pre entrée service decreases overall energy intake of the entrée.

#### ***Design and methodology.***

One study investigated the effect of adding a salad to the food environment and its potential influence on satiety and energy intake (Rolls, Roe, & Meengs, 2004). Utilizing a randomized crossover design, adult women (average age, 26.3 years) were tested with seven experimental conditions (Rolls, Roe, & Meengs, 2004). Researchers used visual analog scales to rate hunger and satiety immediately following the experiment (Rolls, Roe, & Meengs, 2004).

*Results.*

On seven separate occasions, the subjects were served lunch in a laboratory, where they were required to eat a salad, or no salad in the control condition, followed by a pasta dish (Rolls, Roe, & Meengs, 2004). The salads varied in energy density (0.33, 0.67, or 1.33 kcal/g) and portion size (150 or 300g) and were served prior to the pasta entrée (Rolls, Roe, & Meengs, 2004). The researchers found that consuming a salad prior to an entrée enhances satiety and thus reduces total meal energy intake, yet the effect is dependent on the energy density and portion size of the added food (Rolls, Roe, & Meengs, 2004). In other words, they found that adding a large portion of low-energy dense food to the food environment prior to serving an entrée is an effective strategy for increasing satiety and reducing overall energy intake of a meal (Rolls, Roe, & Meengs, 2004).

*Portion Size and Energy Density*

Studies in the review yielded mixed results about the impact of manipulating portion size and energy density of foods on energy intake (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Rolls, Roe, Meengs, & Wall, 2004; Rolls, Roe, & Meengs, 2006a; Vermeer, Alting, Steenhuis, & Seidell, 2009; Vermeer, Steenhuis, Leeuwis, Heymans, & Seidell, 2011).

*Design and methodology.*

Five studies examined the effects of portion size (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Rolls, Roe, Meengs, & Wall, 2004; Rolls, Roe, & Meengs, 2006a) and

energy density (Rolls, Roe, & Meengs, 2006b; Williams, Roe, & Rolls, 2014) on food intake. Two other studies specifically examined the impact of pricing strategies on portion size choices (Vermeer et al., 2009; Vermeer et al., 2011). Study samples ranged from 24 participants (Rolls et al., 2006b) to 308 participants (Vermeer et al., 2011).

*Results.*

Three studies (Diliberti et al., 2004; Rolls et al., 2004; Rolls et al., 2006a) found that increasing the portion sizes (baked pasta entrée: 248g, 377g; deli-style sandwiches: 6, 8, 10, or 12 inch; varied menu: either 100%, 150%, or 200% of baseline amount) increased the energy intake of a meal served to subjects in a controlled setting. In two of these studies, researchers observed that there was no difference in hunger ratings or satiety reported by subjects among the varied portions that were served (Rolls, Roe, Meengs, & Wall, 2004; Rolls et al., 2006a). Diliberti et al. (2004) found that participants who unknowingly purchased the larger (377g) portion of pasta consumed 43% more and although they rated the larger portion a better value than the standard portion (248g), there was not a significant difference in ratings of appropriateness of size between the two conditions and in the amount of food they had consumed in relation to their usual intake.

Two studies tested the influence of energy density and portion size on energy intake. Rolls et al. (2006b) found that a 25% reduction in energy density and portion size led to decreases in overall energy intake (231 kcal/d) while Williams et al. (2014) found that increasing both energy density (1.66 kcal/g) and portion size (450 or 600g) led to increased energy intake of a meal ( $187 \pm 21$  kcal). In both studies, feelings of satiety after

consumption of the test meal did not vary, despite a considerable difference in energy intake across all experimental conditions (Rolls et al., 2006b; Williams et al., 2014).

The other two studies had a similar objective, which was to determine the effect of pricing in relation to portion size on food choices of consumers (Vermeer et al., 2009; Vermeer et al., 2011). In one study, researchers utilized a questionnaire to study the impact of proportional pricing on ordering behavior of high caloric fast foods, which were soft drinks (250, 400, or 500 ml) and chicken nuggets (6, 9, or 15 pieces) in one experiment and a hot meal in the other (Vermeer et al., 2009). In the first experiment, no effects of pricing were found, yet researchers did observe that overweight participants were more likely to select the smaller size of soda and chicken nuggets (Vermeer et al., 2009). Conversely, in the second experiment in participants of a healthy weight, proportional pricing increased the likelihood of selecting the reference size meal (Vermeer et al., 2009). In the other study, a smaller size meal was proportionally priced and placed next to the same meal in a larger size across 25 worksite cafeterias (Vermeer et al., 2011). Results indicated that while proportional pricing did not have a significant effect on consumer choice, a fair amount of people still opted for the smaller meal, suggesting it may be an effective strategy to encourage consumers to employ portion control when eating outside of the home (Vermeer et al., 2011).

### ***Visual Cues***

Studies found that accurate visual cues are essential in guiding people in eating the appropriate amounts of food to meet nutrient needs and not in excess, which can lead

to overeating and subsequent weight gain (Scheibehenne, Todd, & Wansink 2010; Wansink, Painter, & North, 2005).

*Design and Methodology.*

Two studies focused on the influence of visual cues related to portion size in determining food consumption and possible effect on satiety (Scheibehenne et al., 2010; Wansink et al., 2005). Sample sizes ranged from 47 participants utilizing a between-subject design (Wansink et al., 2005) to 64 participants in a controlled, double blind study (Scheibehenne et al., 2010). All participants were over the age of 18.

*Results.*

In one study, visual cues for food consumption and satiety were tested by serving participants lunch in a restaurant that was set up to serve the test meal in complete darkness (Scheibehenne et al., 2010). In the other study, participants were served soup in a bowl that was engineered to continuously, yet inconspicuously, refill during the test meal (Wansink et al., 2005). Wansink et al. (2005) suggest that portion size can affect energy intake by influencing visual cues or consumption norms and subsequently, the amount of food consumed in one eating occasion. Both studies reported that illusive visual cues increased the amount of food participants consumed when compared to the control group by 36% (Scheibehenne et al., 2010) and 73% (Wansink et al., 2005). Furthermore, researchers in both studies found that misleading visual cues related to portion size can influence intake volume without affecting satiety cues (Scheibehenne et al., 2010; Wansink et al., 2005). In other words, regardless of increased food intake,

participants did not report a difference in satiation after the test meal across all conditions (Scheibehenne et al., 2010; Wansink et al., 2005).

### ***Nutrition Labeling***

Mixed results were found in yielded review studies concerning the impact of nutrition labeling on portion size and energy intake (Brochu & Dovidio, 2013; McCann et al., 2013; Roberto, Larsen, Agnew, Baik, & Brownell, 2010).

#### *Design and Methodology.*

Three studies examined the impact of nutrition and menu labeling (Brochu & Dovidio, 2013; McCann et al., 2013; Roberto et al., 2010) on food choices and subsequent intake. Subject pools ranged from 47 participants (McCann et al., 2013) to 303 participants (Roberto et al., 2010). All of the subjects were over the age of 18. Participants completed visual analog scales (VAS) before and after the test meal to assess factors such as hunger, meal satisfaction, and satiety (McCann et al., 2013; Roberto et al., 2010).

#### *Results.*

Two studies specifically examined the effect of nutrition/menu labeling on caloric intake of a test meal, with varying results (McCann et al., 2013; Roberto et al., 2010). McCann et al. (2013) found that when foods were labeled low-fat/low energy (LFLE) when compared to foods labeled high fat/energy (HFHE), the meal enjoyment in the LFLE actually increased, which led to increased energy intake as well. These results transpired even when participants received the exact same meal (in terms of energy and

macronutrient content), with the exception that they were provided with manipulative nutrition information (Baseline: 668 calories, LFLE: 334 calories, and HFHE: 1002 calories) prior to consumption (McCann et al., 2013). Conversely, Roberto et al. (2010) reported that participants given calorie labels consumed 14% fewer calories at a test meal than those who were provided a menu with no calorie labels. Additionally, Roberto et al. (2010) discovered that calorie labels made more of an impact when they added a recommended daily caloric requirement to the nutrition label. To specify, participants who received both conditions consumed an average of 250 fewer calories during the study dinner and for the remainder of the day than participants in the calorie label only and no label groups (Roberto et al., 2010). McCann et al. (2013) also found that total daily intake was significantly higher in the LFLE condition than the HFHE condition, which suggests a cognitive disinhibition of foods labeled as low fat can essentially negate the benefits of such labels if people are consuming more food as a result.

An additional study examined the influence of weight-based stereotype threat (how stigma can lead to diminished self-efficacy) and menu labeling on food choice in relation to BMI (Brochu & Dovidio, 2014). The results were twofold: 1) by associating weight with poor eating habits, participants with a BMI (>27) ordered more calories off a conventional restaurant menu, which confirmed the stereotype threat and 2) participants in the weight-based stereotype condition ordered a greater number of calories as BMI increased (Brochu & Dovidio, 2014). However, when presented with a calorie labeled menu, participants did not order more calories as a function of BMI, which indicated that menu labeling diminished the stereotype threat effect (Brochu & Dovidio, 2014).

## **Discussion**

This review identified studies that focused on specific strategies to manipulate the food environment in order to test factors outside of individual behavior that influence portion size and energy intake. Plate size largely had no significant effect on energy intake (Libotte et al., 2014; Rolls et al., 2007), with the exception of one study that reported that providing a larger bowl and eating utensil markedly increased energy intake (Wansink, et al., 2006). All other studies including container size (Marchiori et al., 2012; Stroebele et al., 2009; Wansink & Kim, 2005), addition of low-energy dense foods pre-entrée (Rolls, Roe, & Meengs, 2004), energy density and/or portion size (Diliberti et al., 2004; Rolls, Roe, Meengs, & Wall, 2004; Rolls et al., 2006a; Rolls et al., 2006b; Vermeer et al., 2009; Vermeer et al., 2011), visual cues (Scheibehenne et al., 2010; Wansink et al., 2005), and nutrition labeling (Brochu & Dovidio, 2013; McCann et al., 2013; Roberto et al., 2010) significantly impacted consumption volume and energy intake.

In contrast to the majority of plate size studies, the experiments that were conducted involving container size found that when larger containers or packages were provided to subjects, they typically consumed more food (Marchiori et al., 2012; Stroebele et al., 2009; Wansink & Kim, 2005). When larger containers were provided to subjects, they typically consumed more even when subjects reported that they disliked the taste and found the food unfavorable (Wansink & Kim, 2005).

It is well documented that when energy intake and/or portion size increases, so does the amount of food intake (Diliberti et al, 2004; Rolls et al., 2004; Rolls et al.,

2006a; Rolls et al., 2006b; Williams et al., 2014; Vermeer et al., 2009; Vermeer et al., 2011). One study found that the addition of low-energy dense foods pre entrée decreases the overall amount of energy consumed during a meal (Rolls, Roe, & Meengs, 2004). Alternatively, Vermeer et al. (2011) suggest that consuming less energy during a meal may result in subjects either compensating with additional food intake outside of that eating occasion, which could lead to positive varied consumption patterns or it could possibly negate the effects of engaging in portion control by increasing overall daily energy intake.

Studies involving the influence of visual cues on energy intake confirm other research that consumption is contingent on portion size (Scheibehenne et al., 2010; Wansink et al., 2005). Scheibehenne et al. (2010) illustrates that this effect is further exacerbated when visual cues are impaired, as it can reduce self-monitoring, without effecting satiety, and consequently lead to overeating. Therefore, the results of these studies are indicative that accurate visual cues are essential in guiding individuals in determining the appropriate amount of food to eat and may even play a bigger role in satiety than internal cues (Scheibehenne et al., 2010; Wansink et al., 2005).

Nutrition labeling does play a role in the perception of meal satisfaction, satiety, and ratings of hunger. Still, people often confuse the term serving size, which is a standardized unit of measuring foods used in dietary guidance with the term portion size, which is the amount of a single food item a person consumes in one eating occasion (CDC, 2006). Therefore, menu labeling needs be clearly implicit and have general

guideline information in order to effectively be used as public health intervention to guide people in improving dietary choices and reducing energy intake.

Although motivating and facilitating behavior change on an individual level should be increasingly emphasized, this strategy will not be effective without taking into account the impact of the food environment. The proposed 2015 Dietary Guidelines validate that environmental strategies compliment individual-based efforts to improve dietary choices and consumption volume, therefore further studies testing these environmental factors would be highly beneficial (US Department of Agriculture & US Department of Health and Human Services, 2015).

#### *Limitations and future research*

Studies that examine environmental factors and its influence on portion size are relatively scarce. Although, recent progress have been made, as evidenced by studies mentioned in this review, additional studies are needed that examine the factors outside of individual behavior so that the general population can successfully implement these strategies and apply healthier eating behaviors. A few researchers tested environmental manipulations multiple times over the course of a few days or weeks (Rolls et al., 2006a; Rolls et al., 2006b; Williams et al., 2014), however the majority of the studies failed to examine the influence of environmental factors and energy intake over an extended period of time. Future studies would benefit from the assessment of long-term intake and the use of repeated test measures to confirm efficacy of these strategies. Also, several of the studies in this review used relatively small sample sizes. Although there are benefits to utilizing this condition, it is recommended that future studies emphasize larger sample

sizes with randomization and control groups in order to generalize research to more diverse populations.

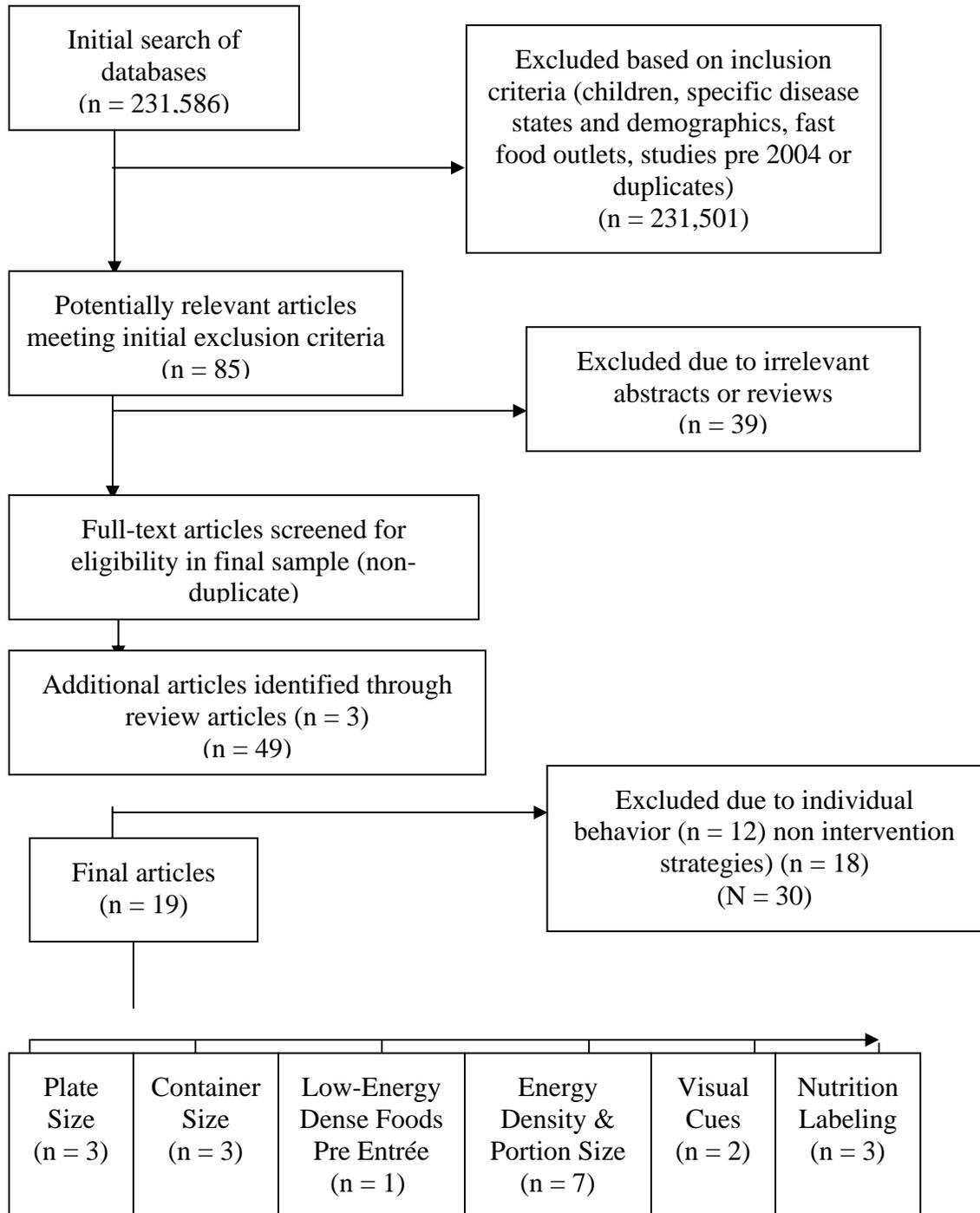
### *Conclusion*

Recently, strides have been made in the development of studies that focus on environmental factors that affect food intake (Brochu & Dovidio, 2014; Diliberti et al., 2004; Libotte et al., 2014; Marchiori et al., 2012; McCann et al., 2013; Roberto et al., 2010; Rolls et al., 2007; Rolls, Roe, Meengs, & Wall, 2004; Rolls et al., 2004; Rolls et al., 2006a; Rolls et al., 2006b; Scheibehenne et al., 2010; Stroebele et al., 2009; Wansink & Kim, 2005; Wansink et al., 2006; Wansink et al., 2005; Williams et al., 2014; Vermeer et al., 2009; Vermeer et al., 2011). However, as the prevalence of obesity continues to rise, surprisingly few intervention studies aiming to reverse the negative influence of portion size have been conducted (Steenhuis & Vermeer, 2009). Thus, further studies are warranted in all areas described in this review in order to test the effectiveness of intervention strategies designed to combat the current food environment.

There are multiple studies that suggest a strong correlation with increasing portion sizes and the prevalence of overweight and obesity. Laboratory based studies have shown that environmental influences contribute to the amount of energy intake and thus, strategies designed to help individuals select more appropriate portion sizes would compliment nutrition education. Well-controlled trials need to be investigated further in order to aid individuals in managing portion control in a food environment inundated with large portions. Effectively helping consumers in reducing the portion size of their food can be one successful strategy in fighting the obesity epidemic.

## FIGURES

Figure 2.1. PRISMA flow diagram of systematic review of all relevant articles with an experimental design that focused on the eating environment to test factors outside of individual behavior that influence portion size and energy intake.



**TABLES**

Table 2.1. Characteristics of studies focusing on environmental strategies that influence energy intake

Author (Year)	Design	Subjects	Methods	Specific Outcomes
Plate Size				
Libotte, Siegrist & Bucher (2014)	Controlled laboratory experiment	83 participants (41 males and 42 females)	Participants were individually invited to serve themselves a lunch from a buffet containing 55 replica food items, using either a standard size plate (27 cm) or a large plate (32 cm).	The results of the experiment suggest that plate size had no significant effect on the total energy intake of the meal. However, participants using the large plate served themselves significantly more vegetables.
Rolls, Roe, Halverson, & Meengs (2007)	Three cross-over experiments	First study: 45 subjects Second study: 30 subjects Third study: 44 subjects	First study: Served three plate sizes (17, 22, or 26 cm) & large course main dish to subjects.  Second study: Subjects were served an equal amount of food presented on each of the two larger plates.  Third study: Subjects used each of the three plate sizes and selected from a buffet of five foods matched for energy density.	Results showed that plate size had no significant effect on energy intake. The mean differences in intake using the smallest and largest plates in the three studies were 21±13g, 11±13g, and 4±18g respectively, equivalent to 34 kcal,
Wansink,	2x2 between-	85 nutrition	Subjects were	When nutrition

Ittersum & Painter (2006)	subjects design	experts	randomly given either a 17oz or 34 oz bowl and either 2oz or 3oz ice cream scoop. After serving themselves, they completed a brief survey.	experts were given a larger bowl, they served themselves 30% more without be aware of it. Their servings increased by 14.5% when they were given a larger serving spoon.
Container Size				
Marchiori, Corneille, & Klein (2012)	Randomly assigned to three conditions	88 undergraduate students (61 Belgian, 25 male subjects; mean age of 20)	Participants were served 1) a medium portion size of M&M's in a small container (200g) or 2) medium portion size in large container (600g), or 3) a large portion in a large container (n = 20).	The larger container increased intake by 129% (199 kcal) despite holding portion size constant, while controlling for different confounding variables.
Stroebele, Ogden, & Hill (2009)	Randomized two-period cross-over study	59 Participants (41 Women and 18 Men)	Participants were randomly assigned to receive either 100 kcal packs or standard size packages of snacks for one week.	Participants consumed an average of 186.9 fewer grams of snacks per week when receiving 100 kcal snack packs compared to standard size packages of snacks. The results suggest that portion-controlled packaging reduces total intake from the provided snacks.
Wansink & Kim (2005)	2x2 between-subjects experimental design	158 moviegoers (57.6% male; 28.7 years)	Subjects were randomly given a 120 g or 240 g of free popcorn that	Moviegoers were given fresh popcorn in the 240 g containers

			was either fresh or stale.	consumed 45.3% more than subjects given 140g containers. Subjects given the 33.6% of the 240 g.
Satiety				
Rolls, Roe, & Meengs (2004)	Within-subjects randomized crossover design	42 Women (Ages 19-45; Mean age 26)	Subjects were required to consume a first-course salad of varying energy densities (0.33, 0.67, or 1.33 kcal/g & sizes (150 or 300g).	Consuming low energy dense salads reduced meal energy intake by 7% for 150g portion and 12% for 300g portion; for high energy dense salads, 8% for 150 g portion and 17% for large.
Energy Density & Portion Size				
Diliberti et al. (2004)	Between-subjects, parallel group design	180 subjects	In a cafeteria-style restaurant on different days, the size of pasta entrée pasta available was varied from 248g to 377g. The entrée price was not changed & the subjects were unaware of the size difference.	Portion size had a significant effect on intake of the entrée. Subjects who purchased the 377g portions increased their energy intake of the entrée by 25% (159k cal).
Rolls, Roe & Meengs (2006a)	Within-subjects crossover design with three experimental conditions	32 Adults (16 women and 16 men; ages from 19-37 years; BMI from 20 to 29).	Subjects ate varied portion sizes (100%, 150%, or 200%) breakfast, lunch, and dinner at scheduled times in private cubicles in the laboratory on 2 consecutive days in each of the three weeks. Subjects were also provided with	Increasing portions by 50% increased daily energy intake by 16% (women: 335 kcal/d; men 812 kcal/d). Energy intake did not differ between the 2 days of each week. Daily ratings of fullness were lowest in the 100% portion condition, but did

			snack for consumption outside the laboratory.	not differ significantly in the 150% or 200% conditions.
Rolls, Roe, & Meengs (2006b)	Crossover design	24 women (aged 19-45 years old)	Each subject participated in 4 different experimental conditions. Subjects were provided all of their meals and snacks for 2 consecutive days across all 4 sessions. All foods were varied between a standard (100%) level and a reduced (75%) level of both portion size and energy density.	Reductions in both the portion size and the energy density of all food items that were served over 2 d led to significant and sustained decreases in energy intake. No interaction between the 2 experimental factors were observed, which indicated that their effects on intake were independent and additive.
Rolls, Roe, Meengs & Wall (2004)	Within-subject design with repeated measures	75 Young adults (37 females and 38 males)	Participants were served one of four sizes of a deli-style sandwich (6,8,10, or 12 in), of which they could eat as much as they wanted for a total of 4 weeks.	The majority of individuals consumed the entire 6-in sandwich. When served the 12-in sandwich, compared to the 8-in sandwich, females consumed 74 kcals and men 186 kcals.
Williams, Roe & Rolls (2014)	Crossover design	46 Women	The women were served a pasta lunch on 6 days; on 4 of the days the pasta was preceded by a compulsory salad (0.33 kcal/g). The pasta dish varied between standard	Serving the higher-energy-dense pasta increased test meal intake by 153±19 kcal and serving the larger portion of pasta increased test meal intake by 40±16 kcal. The salad decreased

			and increased levels of both energy density (1.25 or 1.66 kcal/g) & portion size (450 or 600 g).	meal intake by 123±18 kcal.
Vermeer, Alting, Steenhuis, & Seidell (2009)	*Observational	291 consumers (study 1: 66.4% female, mean age = 25.22 years; study 2: 65.7% female, mean age 35.85 years)	Two questionnaire studies were conducted to assess the impact of proportional pricing on people's selection of high caloric food and drink items. Study #1 (n=150) was conducted in a fast food restaurant and Study #2 (n=141) in a worksite cafeteria. Three different food products (i.e. soft drink, chicken nuggets in Study #1 and a hot meal in Study #2 with corresponding prices were displayed on pictures in the questionnaire. The subjects were asked to choose a portion size of the food items.	No main effects of pricing were found. However, in Study #1, a trend was found for overweight fast food restaurant visitors being more likely to choose the smaller portion of chicken nuggets and less likely to choose large soft drink sizes.  In Study #2, the majority (86%) of the subjects chose the reference size. For subjects with a healthy weight, proportional pricing led to an increase of 13.5% that chose the reference size.
Vermeer, Steenhuis, Leeuwis, Heymans, & Seidell (2011)	Longitudinal randomized controlled trial	308 consumers (mean age = 39.18 years, 50% women)	Smaller portions of the same hot meals were offered in addition to the existing size in 25 worksite cafeterias. The	The ratio of small meals sales in relation to large meals was 10.2%. No effect of proportional pricing was found. The

			meals were either proportionally priced or value size prices was employed. Daily sales of small and the total number of meals, consumers' self reported compensation behavior and frequency of purchasing small meals was measured.	consumer data indicated that 19.5% of the participants who had selected a small meal often-to-always purchased more products than usual in the worksite cafeteria. Small meal purchases were negatively related to being male.
Visual Cues				
Scheibehenne, Todd & Wansink (2010)	*Double blind controlled study, convenience sampling	96 Participants (51 female, 74 students; mean age 24 years)	Participants were served two main courses by restaurant staff in a "dark" restaurant where they ate in complete darkness.	Half of the participants unknowingly received much larger "super-size" portions, which led them to eat 36% more food.
Wansink, Painter & North (2005)	Between subjects design	54 participants (BMI 17.3-36 kg/m <sup>2</sup> ; 18-46 years of age)	Participants in groups of four were served soup and told to eat ad libitum. A soup apparatus was placed in a modified restaurant-style table in which two of four bowls slowly and imperceptibly refilled as subjects ate. Two at the tables received a normal bowl, while the others received	Participant's who ate from the self-refilling bowls consumed more soup than those eating from normal bowls. Despite consuming 73% more, they did not believe they had consumed more, nor did they perceive themselves as more sated than those eating from normal bowls. Results were unaffected by BMI.

			the self-refilling bowl.	
Nutrition Labeling				
McCann et al. (2013)	Repeated measure design	47 subjects (24 men & 23 women; aged 18-65 years)	Subjects were served an identical lunch meal on three separate days, but the information they received prior to consuming the lunch was manipulated as follow: “baseline”, “high fat/energy”, and “low fat/energy.”	Food and energy intake significantly increased in the low fat/energy condition compared to both baseline and high/fat energy condition. The subjects consumed an additional 3% (162 kJ) energy under the low/fat energy condition compared to baseline.
Brochu & Dovidio (2013)	*Observational	Study 1: 176 Participants (92 women, 83 men, 1 unknown; 142 self-identified as white; ages 18-63)  Study 2: 367 participants (205 women, 159 men, 3 unknown; self-identified as white; ages 18-82)	To examine the effect of weight-based stereotype threat on food choice as a function of body mass index (BMI): In Study 1, by measuring the total number of calories ordered by participants in their dinner selections from a restaurant menu.  In Study 2, to investigate the interactive influence of weight-based stereo threat and menu labeling on food choice as a function of BMI,	In Study 1, participants under stereotype threat ordered food containing more calories from a conventional menu that did not present calorie information as BMI increased, whereas no association between BMI and calories was found in the control (no threat) condition.  In Study 2, participants under stereotype threat ordered more calories from a conventional menu as BMI increased, whereas no association between

			participants were randomly assigned to one of the two conditions based on established manipulations of task diagnosticity and identity salience.	BMI and calories was found among participants who ordered from a calorie menu, demonstrating that menu labeling eliminated the stereotype threat effect.
Roberto et al. (2010)	*Double-blind controlled; random selection	295 Participants (147 males and 148 females; mean age $30.5 \pm 12.4$ years; BMI $(25.2 \pm 6.1 \text{ kg/m}^2)$ )	Participants in a study dinner were randomly assigned to either 1) a menu without calorie labels 2) a menu with calorie labels, or 3) a menu with calorie labels and a label stating the recommended daily caloric intake for an average adult. Food choices and intake were measured.	Participants in both calorie label conditions ordered fewer calories than those in the no calorie labels condition. When calorie labels were combined, that group consumed 14% fewer (average of 250 kcals) calories than the no calorie labels group.

\*Study design not specified in manuscript.

**REFERENCES**

#

Alpert, P.T. (2011) Portion size: A disconnect among Americans? *Home Health Care Management & Practice*, 24(1), 59-61. doi: 10.1177/1084822311422562

American Dietetic Association. (2009). *Position of the American Dietetic Association: Weight Management*. Retrieved from <http://www.andeal.org/files/files/WeightManagement.pdf>

Brochu, P.M. & Dovidio, J.F. (2013). Would you like fries (380 calories) with that? Menu labeling mitigates the impact of weight-based stereotype threat on food choice. *Social Psychological and Personality Science*, 5(4), 414-421. doi: 10.1177/1948550613499941

Centers for Disease Control and Prevention: Division of Nutrition and Physical Activity. (2006). Do increased portion sizes affect how much we eat? [http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/portion\\_size\\_research.pdf](http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/portion_size_research.pdf)  
Published May 2006. Accessed February 8, 2014.

Centers for Disease Control and Prevention. (2014, September). Overweight and Obesity. Adult obesity facts. <http://www.cdc.gov/obesity/data/adult.html>

Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*, 12(3), 562-568. doi:10.1038/oby.2004.64

Downs, J.S., Loewenstein, G., Wisdom, J. (2009). Strategies for promoting healthier food choices. *American Economic Association*, 99(2), 159-164. doi: 10.1257/aer.99.2.159

Ello-Martin, J.A., Ledikwe, J.H., & Rolls, B.J. (2005). The influence of food portion size and energy density on energy intake: implications for weight management. *Am J Clin Nutr*, 82(1), 236S-241S.

Glanz, K., Basil, M., Maibach, E., Goldberg, J., & Snyder D. (1998). Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *J Am Diet Assoc*, 98(10), 1118-1126. doi:10.1016/S0002-8223(98)00260-0

Ledikwe, J.H., Ello-Martin, J.A., & Rolls, B.J. (2005). Portion sizes and the obesity epidemic. *J Nutr*, 135(4), 905-909.

- Liberati, et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analysis of studies that evaluate healthcare interventions: Explanation and elaboration. *BMJ*, 339, b2700. doi: 10.1371/journal.pmed.1000100
- Libotte, E., Siegrist, M., & Bucher T. (2014). The influence of plate size on meal composition. Literature review and experiment. *Appetite*, 82(1), 91-96. doi:10.1016/j.appet.2014.07.010
- Marchiori, D., Corneille, O., & Klein, O. (2012). Container size influences snack food intake independently of portion size. *Appetite*, 58(3), 814-817. doi:10.1016/j.appet.2012.01.015
- McCann, M.T., Wallace, J.M., Robson, P.J., Rennie, K.L., McCaffrey, T.A., Welch, R.W., Livingstone, B.E. (2013). Influence of nutrition labeling on food portion size consumption. *Appetite*, 65(1), 153-158. doi:10.1016/j.appet.2013.02.013
- Roberto, C.A., Larsen, P.D., Agnew, H., Baik, J., & Brownell, K.D. (2010). Evaluating the impact of menu labeling on food choices and intake. *Am J Public Health*, 100(2), 312-318. doi: 10.2105/AJPH.2009.160226
- Rolls, B.J. (2003). The supersizing of America: Portion size and the obesity epidemic. *Nutr Today*, 38(2), 42-53.
- Rolls, B.J. (2014). What is the role of portion control in weight management? *Int J Obes*, 38, S1-S8. doi: 10.1038/ijo.2014.82.
- Rolls, B.J., Bell, E.A., & Thorwart, M.L. (1999). Water incorporated into food but not served with a food decreases energy intake in lean women. *Am J Clin Nutr*, 70(4), 448-455.
- Rolls, B.J., Roe, L.S., Halverson, K.H., & Meengs, J.S. (2007). Using a smaller plate did not reduce energy intake at meals. *Appetite*, 49(3), 652-660. doi: 10.1016/j.appet.2007.04.005
- Rolls, B.J. Roe, L.S., & Meengs, J.S. (2004). Salad and satiety: Energy density and portion size of a first-course salad affect energy intake at lunch. *Appetite*, 104(10), 1570-1576. doi:10.1016/j.jada.2004.07.001
- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006a). Larger portion sizes lead to a sustained increase in energy intake over 2 days. *J Am Diet Assoc*, 106(4), 543-549. doi:10.1016/j.jada.2006.01.014

- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006b). Reductions in portion size and energy density of foods are additive and lead to sustained decreases in energy intake. *J Am Diet Assoc*, *106*(4), 543-549.
- Rolls, B.J., Roe, L.S., Meengs, J.S., & Wall, D.E. (2004). Increasing the portion size of a sandwich increases energy intake. *J Am Diet Assoc*, *104*(3), 367-372. doi:10.1016/j.jada.2003.12.013
- Schwartz, J., Byrd-Bredbenner, C. (2006). Portion distortion: Typical portion sizes selected by young adults. *J Am Diet Assoc*, *106*(9), 1412-1418. doi:10.1016/j.jada.2006.06.006
- Story, M., Kaphingst, K.M., Robinson-O'Brien R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and Environmental Approaches. *Ann Rev Public Health*, *29*, 253-272. doi: 10.1146/annurev.publhealth.29.020907.090926
- Stroebele, N. & De Castro, J.M. (2004). Effect of ambience on food intake and food choice. *Nutrition*, *20*(9), 821-838. doi:10.1016/j.nut.2004.05.012
- Stroebele, N., Ogden, L.G., & Hill, J.O. (2009). Do calorie-controlled portion sizes of snacks reduce energy intake? *Appetite*, *52*(3), 793-796. doi: 10.1016/j.appet.2009.02.015
- U.S. Food and Drug Administration. (2014). Guidance Documents & Regulatory Information by Topic. Labeling & Nutrition. Retrieved from <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm385663.htm>.
- Wansink, B. (2004). Environmental factors that increase food intake and consumption volume of unknowing consumers. *Annu Rev Nutr* *24*, 455-479. doi: 10.1146/annurev.nutr.24.012003.132140
- Wansink, B., Ittersum, K.V., & Painter, J.E. (2006). Ice cream illusions: Bowls, spoons, and self-served portion sizes. *Am J Prev Med*, *31*(3), 240-243. doi:10.1016/j.amepre.2006.04.003
- Wansink, B., & Kim J. (2005). Bad popcorn in big buckets: Portion size can influence intake as much as taste. *J Nutr Educ Behav*, *37*(5), 242-245.
- Wansink, B., Painter, J.E., & North, J. (2005). Bottomless Bowls: Why visual cues of portion size may influence intake. *Obes Res*, *13*(1), 93-100. doi: 10.1038/oby.2005.12

Williams, R.A., Roe, L.S., & Rolls, B.J. (2014). Assessment of satiety depends on the energy density and portion size of the test meal. *Obesity*, 22(2), 318-324. doi: 10.1002/oby.20589

World Health Organization. (2014). Media Centre: Obesity and overweight. <http://www.who.int/topics/obesity/en/> Updated August 2014. Accessed October 28<sup>th</sup>, 2014.

Vermeer, W.M., Alting, E., Steenhuis, I.H.M, & Seidell, J.C. (2009). Value for money or making the healthy choice: The impact of proportional pricing on consumers' portion size choices. *Eur J Public Health*, 20(1), 65-69. doi: 10.1093/eurpub/ckp092

Vermeer, W.M., Steenhuis I.H.M., Leeuwis, F.H., Heymans, M.W., & Seidell, J.C. (2011). Small portion sizes in worksite cafeterias: Do they help consumers to reduce their food intake? *Int J Obes*, 35(9), 1200-1207. doi: 10.1038/ijo.2010.271

CHAPTER THREE

PLACEMENT OF A TAKE-OUT CONTAINER  
DURING MEAL INFLUENCES ENERGY INTAKE

Contribution of Authors and Co-Authors

Manuscript in Chapter 3

Author: Kate J. Bates

Contributions: Conceived and implemented study design. Led the acquisition of data and drafting of the manuscript under the mentorship of CBS. Edited additional drafts for final submission.

Co-Author: Dr. Carmen Byker Shanks

Contributions: Conceived and implemented study design. Provided field expertise and guidance throughout the drafting process. Obtained funding and provided critical revision for final submission.

48#

Manuscript Information Page

#

Kate J. Bates, Dr. Carmen Byker Shanks

Eating Behaviors

Status of Manuscript:

Prepared for submission to a peer-reviewed journal

Officially submitted to a peer-review journal

Accepted by a peer-reviewed journal

Published in a peer-reviewed journal

Elsevier Ltd.

Submitted April 2015.

**Abstract**

A growing body of research suggests that increased portion sizes are contributing to the rising rates of obesity. However, studies that focus on environmental cues to promote portion control are relatively limited. Thus, a randomized study was conducted in a controlled laboratory setting to determine if the presence of a take-out container, given at the start of a meal, would prompt experimental group participants to decrease the portion of food consumed and reduce energy intake. Outcomes were analyzed using descriptive statistics, independent t-tests, and analysis of covariance. Results showed that placing a take-out container with the test meal led to a significant difference in energy intake ( $p = 0.000$ ) when compared to the control group. Participants ( $n = 25$ ) who were given a take-out container with their test meal consumed an average of 90 kcals less than participants ( $n = 25$ ) who were not given the condition. These findings suggest that a take-out container may be utilized as an effective environmental cue for guiding consumers to control serving size when faced with over-sized portions at restaurants or other food outlets.

**1. Introduction**

Portion sizes have increased, which has coincided with rising obesity rates (Duffey & Popkin, 2011). Restaurants and other food vendors have increased portion sizes in order to appeal to a consumer's economic sensibilities (Centers for Disease Control and Prevention [CDC], 2006). Influences of this nature have shaped the food environment and promoted the overconsumption of energy dense foods (Poelman, Vet,

Velema, Seidell, & Steenhuis, 2013) and the ideal setting for weight gain (Drewnowski & Rolls, 2005).

People have grown accustomed to larger portion sizes and “super-sizing” in marketplaces and at home (Lucas, 2008) and often have difficulty estimating appropriate serving sizes (Alpert, 2011). Understanding the distinction between serving size and portion size is an integral component to weight management (Steenhuis & Vermeer, 2009). A serving size represents the recommended portion for consumption of a specific amount of food during one meal, while a portion size is the actual amount of food consumed at one time (United States Department of Agriculture [USDA], 2002).

Eating away from home is on the rise and is a large contribution to the American consumer’s diet (Lachat et al., 2011). Strategies that cue the consumer to eat within recommended serving size guidelines amidst increased portion sizes offered in the restaurant setting need to be considered. Research in the past decade has focused on food environment factors that affect food intake and consumption volume, such as plate size (Libotte, Siegrist, & Bucher, 2014; Rolls, Roe, Halverson, & Meengs, 2007; Wansink, B. Ittersum, & Painter, 2006), energy density of foods (Ello-Martin, Ledikwe, & Rolls, 2005), visual cues (Scheibehenne, Todd & Wansink 2010; Wansink, Painter & North, 2005), and eating a salad prior to consumption of a meal (Rolls, Roe, & Meengs, 2004). However, cues signaling consumers to eat within recommended serving sizes in order to save part of an over portion-sized entrée for another meal has yet to be thoroughly investigated.

This study examined if the presence of a take-out container given at the beginning of a meal would reduce serving size consumption. It was hypothesized that energy intake of a meal would decrease if a take-out container was provided. If the hypothesis is supported, providing a take-out container simultaneously with a meal may be an effective strategy to guide portion control, thus becoming a practical weight management tool that virtually any food venue or individual can adopt.

## **2. Methods**

### *2.1 Participants*

Participants were recruited from a large university in the Northwestern United States via campus courses, flyers, word of mouth, and snowball sampling. Individuals were eligible to participate if they were enrolled at the university, over the age of 18, and free of any allergies or dietary restrictions. Participation was voluntary and the incentive to partake in this study was a free meal. Participants enrolled through campus courses ( $n = 26$ ) received extra credit points from their instructor. The subjects were told that purpose of the study was to analyze health behavior and food intake. The Institutional Review Board approved all aspects of this study.

### *2.2 Procedure and experimental design*

This research experiment was carried out in the behavioral [blinded] Lab at [blinded] University and used a posttest randomized group design. Subjects signed up for a designated time slot and were asked not to eat at least three hours prior to the test. One night a week, for eight weeks in the fall 2014, 6 to 8 participants were served the lasagna

test meal in the laboratory at staggered times. Experimental sessions took place at dinnertime, between 5:30 and 8 pm. Participants provided informed consent and were directed to sit alone in a sectioned cubicle to avoid distractions. Participants were randomly assigned to the control group ( $n = 25$ ), in which the participants were advised to eat ad libitum, or the experimental group ( $n = 25$ ), in which the participants were advised to eat ad libitum, presented with a take-out container with their meal, and casually told that they could use the container if desired. All participants were served vegetable lasagna and a glass of water. The portion size of the lasagna was predetermined to be representative of the average portion of the same or similar food item served at a typical American chain restaurant ( $M = 432$  g) (USDA MyPlate, 2014). The weight of each meal was measured ( $M = 418$  g,  $SD = 37.33$ ) to ensure that participants received approximately the same portion size. After the meal, participants answered a brief survey to collect demographic information and anthropometrics while researchers weighed post meal weights.

### *2.3 Measures*

The researchers weighed pre- and post-weights (in grams) of each meal to ascertain the total grams consumed, saved, or wasted within 0.1 g. Each plate and take-out container was weighed. The exit survey requested demographic information including, age, gender, ethnicity, education level, and self-reported weight and height.

### *2.3 Statistical Analysis*

All weights were recorded using OXO digital food scale; accurate to 0.1 g. Data was entered into Microsoft Excel (version 14.0, Microsoft Corporation, Redmond, WA,

2010). Kilocalories were calculated by converting from grams via Food Processor (version 9.7.5, ESHA Research, Salem, OR). The participant's body mass index (BMI) at the time of the study was calculated based upon self-reported responses using the standardized BMI equation (World Health Organization, 2015). BMI was divided into four classifications ( $< 18.5$  = Underweight,  $18.5 - 24.9$  = Normal,  $25 - 29.9$  = Overweight, and  $30+$  = Obese), according to Centers for Disease Control (2015) designations.

Data was analyzed with the use of SPSS Statistics software, version 21 (IBM Corp., Armonk, NY). Descriptive statistics were calculated to assess mean gender, age, BMI, and race. Independent samples t-test was conducted to determine whether the control group consumed more food than the experimental group. Grams of food consumed were converted to kilocalories to assess energy intake. A one-way between subjects ANOVA was conducted to test if there was a correlation between the participant's energy intake and BMI classification. In order to test if men in the experimental group consumed more than women in the experimental group and if men in the control group consumed more than women in the control group, independent sample t-tests were conducted. Gender and energy intake was analyzed when the control and experimental groups were combined via ANOVA analyses. Results were considered significant if the  $p$  values were  $< 0.05$ .

### **3. Results**

Fifty participants were recruited for the study: 34 females and 26 males, with a mean age range of 18-24 ( $SD = 15.25$ ), a mean BMI of  $23.87 \text{ kg/m}^2$  ( $SD = 3.62$ ), and a

majority (88%) Caucasian. All 50 participants recruited for the study completed the experiment. See Table 1 for participant demographics.

The amount of food consumed between the experimental ( $M = 250$  g,  $SD = 106.46$ ) and control ( $M = 340$  g,  $SD = 87.84$ ) group was significantly different ( $p = 0.000$ ). Thus, those individuals who were given the take-out container with their meal consumed an average of 90 kcals (26%) less than their counterparts.

There was no significant difference found between participant's energy intake and BMI ( $F(3, 46) = .69$ ,  $p = .562$ ).

Results showed that there was a significant difference found in the amount of food consumed between males ( $M = 480$  kcals,  $SD = 137.32$ ) and females ( $M = 238.75$  kcals,  $SD = 119.56$ ) in the experimental group;  $t(7) = 3.184$ ,  $p = .015$ . There was also a significant difference found in the amount of food consumed between males ( $M = 539$  kcals,  $SD = 86.34$ ) and females ( $M = 428$  kcals,  $SD = 121.73$ ) in the control group;  $t(9) = 3.197$ ,  $p = .011$ . A significant difference was found between energy intake and gender of experimental and control groups combined ( $F(1, 48) = 11.57$ ,  $p = .001$ ). Overall, men (504 kcals) consumed more than women (365 kcals). When comparing the same gender between the two conditions, men consumed less on average in the experimental group ( $M = 480$  kcals,  $SD = 137.32$ ) than the control group ( $M = 536$  kcals,  $SD = 97.09$ );  $t(7) = 1.45$ ,  $p = .190$ . On average, women consumed significantly less in the experimental group ( $M = 299$  kcals,  $SD = 131.12$ ) than women in the control group ( $M = 421$  kcals,  $SD = 123.35$ );  $t(16) = 2.49$ ,  $p = .024$ .

#### **4. Discussion**

The results of this study demonstrate that when a take-out container is given at the start of a meal, overall energy intake in that single eating occasion may decrease. Significant differences between test groups suggest that this may be an effective strategy to engage individuals in eating more suitable portions. The findings are consistent with other strategies that manipulate the food environment in order to decrease overall energy intake of a meal. For example, a study by Rolls, Roe, & Meengs (2004) found that adding a large portion of low-energy dense food prior to serving an entrée was effective in increasing satiety and reducing overall energy intake of a meal.

No correlation was found between BMI and energy intake in our study. Other research on BMI and its influence on energy intake have yielded mixed results. Several well-controlled studies have shown that energy intake is unaffected by BMI (Diliberti et al., 2004; Rolls et al., 2007; Rolls et al., 2004). However, McCann et al. (2013), found that male participants with higher BMI's (>25) consumed the most energy when they perceived the meal they were eating to be low fat/energy. Vermeer, Alting, Steenhuis, & Seidell (2009) found that overweight and obese participants selected more appropriate size in high caloric foods when faced with proportional pricing. Therefore, it may be advantageous for future studies to test the take-out container intervention with a larger sample size to determine if this strategy would also have influenced energy intake for higher BMI populations.

Our findings indicate that gender greatly influenced energy intake. Men consumed more on average than women across both conditions. Across multiple studies,

men typically consume more than women (McCann et al., 2013; Rolls et al, 2007; Rolls, Rolls, & Meengs, 2006; Rolls et al, 2004). Men typically have higher energy needs than women and so including an equal number of genders was an important part of this studies methodology.

This strategy could be implemented at restaurants or other food outlets when people are faced with over-sized, energy dense food portions. Although some food venues may find this strategy costly, consumers can choose to bring their own personal to-go box when eating away from home. Current research suggests that small changes in either the diet, such as reducing food portions, or physical activity may be the most sufficient strategy to prevent excess weight gain (Hill, Wyatt, & Peters, 2012). Thus, simple efforts, such as requesting a take-out container at the beginning of a meal, to either serve as a portion control cue or to be used to box up a portion of the oversized meal prior to consuming, could be a simple, yet effective strategy in guiding consumers to practice portion control.

#### **4.1 Limitations**

Although the findings are promising, this study is not without limitations. First, the sample size was pilot in nature. As such, the findings may not be generalizable to the overall population since the convenience sample was college students. The researchers worked hard to diversify the target population by recruiting an equal representation of ages, genders, and majors. Using a laboratory setting has advantages for controlling potential confounding factors, however, when conditions are completely controlled, it is

often not representative of real world conditions. Therefore, future studies would benefit to test the hypothesis of this study in a natural setting.

## **4.2 Conclusion**

Well-controlled trials that focus on manipulating the food environment need to be developed in order to aid individuals in implementing portion control. For example, the effects of placing a to-go container in the food environment should also be tested in the long term, as consumers may become desensitized to the tool after time. Ultimately, this study provides researchers, professionals, and the food industry alike with a food environment strategy to support the adoption of healthier eating behaviors.

## **ACKNOWLEDGMENTS**

The authors wish to thank Mica Jenkins for her role as laboratory assistant.

### **Funding and Sponsorship**

Internal funding from Montana State University was provided for this study. The funding source did not have any role in the study design, collection, analysis, or interpretation of data, manuscript writing, or the decision to submit the paper for publication.

### **Declaration of Interest**

The authors declare that they have no conflicts of interest.

**TABLES**

Table 3.1. Demographics, anthropometric, characteristics of to-go container study sample (n = 50)

Characteristic		Control (n = 25)	Experimental (n = 25)
Gender %	Male	36	28
	Female	64	72
Age Range % (SD)	18-24 (%)	12.7 (7.6)	13.4 (7.4)
	25-34 (%)	11.5 (2.1)	15.6 (8.1)
	35-44 (%)	17.5 (9.2)	7.0
	45-55 (%)	0	3.0
	55+ (%)	0	11.0 (2.8)
BMI <sup>a</sup> M (SD)	Underweight	17.5 (3.7)	0
	Normal weight	22.6 (1.5)	21.6 (1.2)
	Overweight	28.5 (1.2)	26.7 (2.3)
	Obese	32.1 (1.4)	32 (2.2)
	Average BMI	23.8 (3.6)	23.9 (3.7)
Race/ Ethnicity %	Caucasian	88	88
	American Indian	10	12
	Hispanic	2	0
Majors %	Education	12	8
	Nursing	8	0
	Engineering	20	4
	Community Health	52	60
	Biology	4	12
	Exercise Science	4	16

<sup>a</sup> BMI, Body Mass Index; underweight (< 18.5 kg/m<sup>2</sup>); normal weight (BMI 18.5-24.9 kg/m<sup>2</sup>); overweight (BMI 25-29.9 kg/m<sup>2</sup>); obese (BMI > 30 kg/m<sup>2</sup>).

## REFERENCES

- #
- Alpert, P.T. (2011) Portion size: A disconnect among Americans? *Home Health Care Management & Practice*, 24(1), 59-61. <http://dx.doi: 10.1177/1084822311422562>
- Centers for Disease Control and Prevention. (2015). About BMI for adults. [http://www.cdc.gov/healthyweight/assessing/bmi/adult\\_bmi/](http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/)
- Centers for Disease Control and Prevention. (2006). Do increased portion sizes affect how much we eat? Research to Practice Series, No. 2. [http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/portion\\_size\\_research.pdf](http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/portion_size_research.pdf)
- Centers for Disease Control and Prevention & USDA. (2002). How much are you eating? Dietary Guidelines for Americans: Home and Garden Bulletin, No. 267-1. [http://www.cnpp.usda.gov/sites/default/files/dietary\\_guidelines\\_for\\_americans/2000DGBrochureHowMuch.pdf](http://www.cnpp.usda.gov/sites/default/files/dietary_guidelines_for_americans/2000DGBrochureHowMuch.pdf).
- Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*, 12(3), 562-568. <http://dx.doi:10.1038/oby.2004.64>
- Drewnowski, A. & Rolls, B.J. (2005). How to modify the food environment. *J Nutr*, 135(4), 898-899.
- Duffey, K.J. & Popkin, B.M. (2011). Energy density, portion size, and eating occasions: Contributions to increased energy intake in the United States, 1977-2006. *PLoS Med*, 8(6), e1001050. <http://dx.doi:10.1371/journal.pmed.1001050>
- Ello-Martin, J.A., Ledikwe, J.H., & Rolls, B.J. (2005). The influence of food portion size and energy density on energy intake: implications for weight management. *Am J Clin Nutr*, 82(1 Suppl), 236S-241S.
- Hill, J.O., Wyatt, H.R., & Peters, J.C. (2012). Energy balance and obesity. *Circulation*, 126(1), 126-132. <http://dx.doi: 10.1161/CIRCULATIONAHA.111.087213>
- IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.
- Lachat, C., Nago, E., Verstraeten, R., Roberfroid, D., Van Camp J., Kolsteren, P. (2011). Eating out of the home and its association with dietary intake: a systematic review of the evidence. *Obesity Reviews*, 13, 329-346. <http://dx.doi/10.1111/j.1467-789X.2011.00953.x/>

- Libotte, E., Siegrist, M., & Bucher T. (2014). The influence of plate size on meal composition. Literature review and experiment. *Appetite*, 82(1), 91-96. doi:10.1016/j.appet.2014.07.010
- Lucus, D. (2008). Portion Distortion. *Journal of Preventative Cardiology*, 11(2), 121-122.
- McCann, M.T., Wallace, J.M., Robson, P.J., Rennie, K.L., McCaffrey, T.A., Welch, R.W., Livingstone, B.E. (2013). Influence of nutrition labeling on food portion size consumption. *Appetite*, 65(1), 153-158. doi:10.1016/j.appet.2013.02.013
- Poelman, M.P., de Vet, E., Velema, E., Seidell, J.C., & Steenhuis, I.H. (2014). Behavioral strategies to control the amount of food selected and consumed. *Appetite*, 72, 156-65.
- Rolls, B.J., Morris, E.L., & Roe, L.S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *The American Journal of Clinical Nutrition*, 76(6), 1207-1213.
- Rolls, B.J., Roe, L.S., Halverson, K.H., & Meengs, J.S. (2007). Using a smaller plate did not reduce energy intake at meals. *Appetite*, 49(3), 652-660. <http://dx.doi:10.1016/j.appet.2007.04.005>
- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006). Larger portion sizes lead to a sustained increase in energy intake over 2 days. *J Am Diet Assoc*, 106(4), 543-549. <http://dx.doi:10.1016/j.jada.2006.01.014>
- Rolls, B.J. Roe, L.S., & Meengs, J.S. (2004). Salad and satiety: Energy density and portion size of a first-course salad affect energy intake at lunch. *Appetite*, 104(10), 1570-1576. <http://dx.doi:10.1016/j.jada.2004.07.001>
- Scheibehenne, B., Todd, P.M., & Wansink, B. Dining in the dark. (2010). The importance of visual cues for food consumption and satiety. *Appetite*, 55(3), 710-713. <http://dx.doi:10.1016/j.appet.2010.08.002>
- Steenhuis, I.H.M & Vermeer, W.M. (2009). Portion size: review and framework for interventions. *Int J Behav Nutr Phys Act*, 6, 58. <http://dx.doi:10.1186/1479-5868-6-58>
- USDA MyPlate Website. Calories Count Chart for Mixed Dishes. (2013). Retrieved from <http://www.choosemyplate.gov/food-groups/downloads/MixedDishes.pdf>.
- Wansink, B. (2004). Environmental factors that increase food intake and consumption volume of unknowing consumers. *Annual Review Nutrition*, 24, 455-479. <http://dx.doi:10.1146/annurev.nutr.24.012003.132140>

- Wansink, B., Ittersum, K.V., & Painter, J.E. (2006). Ice cream illusions: Bowls, spoons, and self-served portion sizes. *American Journal of Preventative Medicine*, 31(3), 240-243. <http://dx.doi:10.1016/j.amepre.2006.04.003>
- World Health Organization. (2015). BMI classification. Retrieved from [http://apps.who.int/bmi/index.jsp?introPage=intro\\_3.html](http://apps.who.int/bmi/index.jsp?introPage=intro_3.html).
- Young, L.R., Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *Am Jour Public Health*, 92(2), 246-249.
- Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*, 12(3), 562-568. doi:10.1038/oby.2004.64
- Drewnowski, A. & Rolls, B.J. (2005). How to modify the food environment. *J Nutr*, 135(4), 898-899.
- Ello-Martin, J.A., Ledikwe, J.H., & Rolls, B.J. (2005). The influence of food portion size and energy density on energy intake: implications for weight management. *Am J Clin Nutr*, 82(1 Suppl), 236S-241S.
- Duffey, K.J. & Popkin, B.M. (2011). Energy density, portion size, and eating occasions: Contributions to increased energy intake in the United States, 1977-2006. *PLoS Med*, 8(6), e1001050. doi:10.1371/journal.pmed.1001050
- IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.
- Lachat, C., Nago, E., Verstraeten, R., Roberfroid, D., Van Camp J., Kolsteren, P. (2011). Eating out of the home and its association with dietary intake: a systematic review of the evidence. *Obesity Reviews*, 13, 329-346. DOI: 10.1111/j.1467-789X.2011.00953.x
- Libotte, E., Siegrist, M., & Bucher T. (2014). The influence of plate size on meal composition. Literature review and experiment. *Appetite*, 82(1), 91-96. doi:10.1016/j.appet.2014.07.010
- Lucus, D. (2008). Portion Distortion. *Journal of Preventative Cardiology*, 11(2), 121-122.
- McCann, M.T., Wallace, J.M., Robson, P.J., Rennie, K.L., McCaffrey, T.A., Welch, R.W., Livingstone, B.E. (2013). Influence of nutrition labeling on food portion size consumption. *Appetite*, 65(1), 153-158. doi:10.1016/j.appet.2013.02.013

- Poelman, M.P., de Vet, E., Velema, E., Seidell, J.C., & Steenhuis, I.H. (2014). Behavioral strategies to control the amount of food selected and consumed. *Appetite*, 72, 156-65.
- Rolls, B.J., Morris, E.L., & Roe, L.S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *The American Journal of Clinical Nutrition*, 76(6), 1207-1213.
- Rolls, B.J., Roe, L.S., Halverson, K.H., & Meengs, J.S. (2007). Using a smaller plate did not reduce energy intake at meals. *Appetite*, 49(3), 652-660.  
<http://dx.doi:10.1016/j.appet.2007.04.005>
- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006). Larger portion sizes lead to a sustained increase in energy intake over 2 days. *J Am Diet Assoc*, 106(4), 543-549.  
[doi:10.1016/j.jada.2006.01.014](http://dx.doi:10.1016/j.jada.2006.01.014)
- Rolls, B.J. Roe, L.S., & Meengs, J.S. (2004). Salad and satiety: Energy density and portion size of a first-course salad affect energy intake at lunch. *Appetite*, 104(10), 1570-1576. [doi:10.1016/j.jada.2004.07.001](http://dx.doi:10.1016/j.jada.2004.07.001)
- Scheibehenne, B., Todd, P.M., & Wansink, B. Dining in the dark. (2010). The importance of visual cues for food consumption and satiety. *Appetite*, 55(3), 710-713. <http://dx.doi:10.1016/j.appet.2010.08.002>
- Steenhuis, I.H.M & Vermeer, W.M. (2009). Portion size: review and framework for interventions. *Int J Behav Nutr Phys Act*, 6, 58. [doi:10.1186/1479-5868-6-58](http://dx.doi:10.1186/1479-5868-6-58)
- USDA MyPlate Website. Calories Count Chart for Mixed Dishes. (2013). Retrieved from <http://www.choosemyplate.gov/food-groups/downloads/MixedDishes.pdf>.
- Wansink, B. (2004). Environmental factors that increase food intake and consumption volume of unknowing consumers. *Annual Review Nutrition*, 24, 455-479.  
<http://dx.doi:10.1146/annurev.nutr.24.012003.132140>
- Wansink, B., Ittersum, K.V., & Painter, J.E. (2006). Ice cream illusions: Bowls, spoons, and self-served portion sizes. *American Journal of Preventative Medicine*, 31(3), 240-243. <http://dx.doi:10.1016/j.amepre.2006.04.003>
- Young, L.R., Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *Am Jour Public Health*, 92(2), 246-249.

## CHAPTER 4

## CONCLUSION

Obesity has been on the rise, and reflects profound changes in society and in behavior patterns (Faith & Kral, 2006). As weight related problems have increased, awareness has heightened (Puhl & Heur, 2010). There have been multiple government initiatives to increase nutrition education in order to support the adoption of healthier eating behaviors (Dietary Guidelines of America, 2015; U.S. Food and Drug Administration, 2014). Still obesity rates continue to rise (CDC, 2014). The food environment has a profound impact on dietary intake and has presented barriers to successful individually based approaches to obtaining a healthy diet and weight (Story et al., 2008). In order to develop interventions directed at reversing the trends of obesity, an in-depth understanding of the current food environment is needed.

Portion size is only one of the environmental forces that can increase food intake (Popkin, Duffey, & Gordon-Larsen, 2005) and the profound effects on weight gain have been duly noted (USDHHS, 2013). One of the most significant hurdles is the confusion surrounding what constitutes an appropriate serving to consume at one time. As an example, a recommended serving of pasta is approximately  $\frac{1}{2}$  cup; nevertheless, restaurants will commonly serve  $3\frac{1}{2}$  cups of pasta in one dish (Lucas, 2008). The USDA Dietary Guidelines (2014) recommends that individuals consume about 6 ounces of starch daily. As a consequence, if the average consumer ordered pasta at a restaurant, they may consume more than their daily allotment of starch in one meal. To further add

to the confusion, the competitive landscape of restaurants and other foodservice operations have produced a setting in which people expect large portions of food in order to receive optimal economic value (Gase et al., 2014). Federal dietary serving size standards are clearly less than portion sizes commonly offered. Thus, clear and consistent definitions surrounding portion and serving size need to be established and communicated to the public between federal agencies and away from home food venues so that individuals are better equipped to make sound dietary decisions.

Despite the robust effects of portion size on weight gain, the present literature review demonstrated there are limited studies that focus on manipulating the food environment to guide individuals in eating more suitable amounts. Therefore, the present research investigated a strategy that has never been tested before in a controlled setting, in an attempt to examine if providing a take-out container with a meal would impact energy intake. Results showed that individuals who were given the take-out container consumed less than those who did not. This research illustrates that providing an environmental cue such as a take-out box could decrease how much a person eats in one eating occasion. People can either use this tool to box up a portion of the larger immediately upon receiving the meal in order to aid in self-regulation of healthful eating amounts or it may serve as an empowering reminder throughout the meal that some of the food may be taken home and saved for another meal. In other words, as a cue, the box could be influential to engage in mindful eating. This external cue may affect people in different ways depending on the values that are important to them. For example, some

may be motivated to save cost, some to eliminate food waste, and others to reduce the amount of calories consumed in one meal.

One of the most significant areas for future research is to examine the effect of this strategy in a natural setting to test if this condition will have the same effect on calorie intake. This potential portion control tool is of virtually no cost to the consumer and if utilized habitually, it can help showcase consumer demand, and pose as a driver to provide foodservice operations with the motivation to provide a greater range of portion sizes.

The limitations to this current thesis should be addressed in future research about portion size and food environments. The bulk of studies that were included in the literature review tested environmental manipulations on the food environment and took place over the course of one day or a few days to a two-week period at the most. Thus, future experiments should test strategies of this nature, including the take-out container cue, over an extended period of time to ascertain if the influences continue to have a strong effect on food intake. Limitations in recruitment of participants may have affected the results of the experiment, as the demographic and anthropometric profile was as a whole not representative of the general population. Thus, future studies should recruit a higher number of participants of both genders and within a broader context to gain improved generalizability of the results. Also, it is recommended that men be served a greater portion of the test meal in order to account for the greater energy needs of men. Future research should test environmentally based strategies in a more natural setting,

such as a restaurant, in order to determine if the take-out container cue would decrease energy intake when additional confounding factors are introduced.

In comparison to other studies that examine the influence of unobtrusive environmental factors on energy intake, this study mirrors the ideals behind the current small-changes approach, which supports that even small changes in energy intake can prevent weight gain and may be more sustainable than drastic lifestyle modification (Hill, 2009). People seem more adept at making small changes in relation to diet and physical activity, thus perhaps a combination of small changes in the lifestyle, such as using a take-out container to control marketplace portion sizes, can amount to enough meaningful change to prevent weight gain and improve overall health.

Although personal responsibility is important and efforts to increase and clarify nutrition education are highly encouraged, food choices are undeniably influenced by environmental factors (Story & Larson, 2009). Optimal health and nutrition is less likely to be achieved if public health interventions continue to focus on the individual. This research supports evidence that by combining individual based efforts with strategies that address the current food environment, it may prove a more successful strategy at promoting sustainable behavior change.

## REFERENCES CITED

- Alpert, P.T. (2011) Portion size: A disconnect among Americans? *Home Health Care Management & Practice*, 24(1), 59-61. doi: 10.1177/1084822311422562
- American Dietetic Association. (2009). *Position of the American Dietetic Association: Weight Management*. Retrieved from <http://www.andeal.org/files/files/WeightManagement.pdf>
- Brochu, P.M. & Dovidio, J.F. (2013). Would you like fries (380 calories) with that? Menu labeling mitigates the impact of weight-based stereotype threat on food choice. *Social Psychological and Personality Science*, 5(4), 414-421. doi: 10.1177/1948550613499941
- Centers for Disease Control and Prevention. (2015). About BMI for adults. [http://www.cdc.gov/healthyweight/assessing/bmi/adult\\_bmi/](http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/)
- Centers for Disease Control and Prevention. (2014). Fruits and vegetables. Retrieved from <http://www.cdc.gov/nutrition/everyone/fruitsvegetables/>
- Centers for Disease Control and Prevention & USDA. (2002). How much are you eating? Dietary Guidelines for Americans: Home and Garden Bulletin, No. 267-1. [http://www.cnpp.usda.gov/sites/default/files/dietary\\_guidelines\\_for\\_americans/2000DGBrochureHowMuch.pdf](http://www.cnpp.usda.gov/sites/default/files/dietary_guidelines_for_americans/2000DGBrochureHowMuch.pdf).
- Centers for Disease Control and Prevention. (2011, May). Obesity: Halting the epidemic by making health easier. Retrieved from <http://www.cdc.gov/chronicdisease/resources/publications/aag/obesity.htm>.
- Centers for Disease Control and Prevention: Division of Nutrition and Physical Activity. (2006). Do increased portion sizes affect how much we eat? [http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/portion\\_size\\_research.pdf](http://www.cdc.gov/nccdphp/dnpa/nutrition/pdf/portion_size_research.pdf)  
Published May 2006. Accessed February 8, 2014.
- Centers for Disease Control and Prevention. (2014, September). Overweight and obesity: Adult obesity facts. Retrieved from <http://www.cdc.gov/obesity/data/adult.html>.
- Chandon, P. & Wansink, B. (2012). Does food marketing need to make us fat? A review and solutions. *Nutr Rev*, 70(10), 571-593. doi: 10.1111/j.1753-4887.2012.00518.x.

- Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*, 12(3), 562-568. doi:10.1038/oby.2004.64
- Downs, J.S., Loewenstein, G., Wisdom, J. (2009). Strategies for promoting healthier food choices. *American Economic Association*, 99(2), 159-164. doi: 10.1257/aer.99.2.159
- Drewnowski A., Rolls B.J. (2005). How to modify the food environment. *Int J Behav Nutr Phys Act*, 135(4), 898-899.
- Duffey, K.J. & Popkin, B.M. (2011). Energy density, portion size, and eating occasions: Contributions to increased energy intake in the United States, 1977-2006. *PLoS Med*, 8(6), e1001050. <http://dx.doi:10.1371/journal.pmed.1001050>
- Ello-Martin, J.A., Ledikwe, J.H., & Rolls, B.J. (2005). The influence of food portion size and energy density on energy intake: implications for weight management. *Am J Clin Nutr*, 82(1), 236S-241S.
- Faith, M.S. & Kral, T.V.E. (2006). *Social environmental and genetic influences on obesity and obesity promoting behaviors: Fostering Research Integration*. Institute of Medicine: Washington, DC: The National Academies Press. Available from <http://www.ncbi.nlm.nih.gov/books/NBK19924/>.
- Gase, L., Dunning, L., Kuo, T., Simon, P., & Fielding, J.E. (2014). Restaurant owner's perspectives on a voluntary program to recognize restaurants for offering reduced-sized portions, Los Angeles County, 2012. *Prev Chronic Dis*, 11, E44.
- Glanz, K., Basil, M., Maibach, E., Goldberg, J., & Snyder D. (1998). Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *J Am Diet Assoc*, 98(10), 1118-1126. doi:10.1016/S0002-8223(98)00260-0
- Harnack, L.J., Jeffery, R.W., & Boutelle, K.N. (2000). Temporal trends in energy intake in the United States: an ecologic perspective. *Am J Clin Nutr*, 71(6), 1478-84.
- Hill, J.O. (2009). Can a small-changes approach help address the obesity epidemic? A report of the joint task force of the American Society for Nutrition, Institute of Food Technologists, and International Food Information Council. *Am J Clin Nutr*, 89(2), 477-484.
- Hill, J.O., Wyatt, H.R., & Peters, J.C. (2012). Energy balance and obesity. *Circulation*, 126(1), 126-132. [http://dx.doi: 10.1161/CIRCULATIONAHA.111.087213](http://dx.doi:10.1161/CIRCULATIONAHA.111.087213)

- Huang, T.T., Drewnowski, A., Kumanyika, S.K., & Glass T.A. (2009). A systems-oriented multilevel framework for addressing obesity in the 21<sup>st</sup> century. *Prev Chronic Dis*, 6(3), 1-10.
- Hurt, R.T., Kulisek, C., Buchanan, L.A., & McClave, S.A. (2010). The obesity epidemic: Challenges, health initiatives, and implications for gastroenterologists. *Gastroenterol Hepatol*, 6(12), 780-792.
- IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.
- Lachat, C., Nago, E., Verstraeten, R., Roberfroid, D., Van Camp J., Kolsteren, P. (2011). Eating out of the home and its association with dietary intake: a systematic review of the evidence. *Obesity Reviews*, 13, 329-346. DOI: 10.1111/j.1467-789X.2011.00953.x
- Ledikwe, J.H., Ello-Martin, J.A., & Rolls, B.J. (2005). Portion sizes and the obesity epidemic. *J Nutr*, 135(4), 905-909.
- Liberati, et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analysis of studies that evaluate healthcare interventions: Explanation and elaboration. *BMJ*, 339, b2700. doi: 10.1371/journal.pmed.1000100
- Libotte, E., Siegrist, M., & Bucher T. (2014). The influence of plate size on meal composition. Literature review and experiment. *Appetite*, 82(1), 91-96. doi:10.1016/j.appet.2014.07.010
- Lucus, D. (2008). Portion Distortion. *Journal of Preventative Cardiology*, 11(2), 121-122.
- Marchiori, D., Corneille, O., & Klein, O. (2012). Container size influences snack food intake independently of portion size. *Appetite*, 58(3), 814-817. doi:10.1016/j.appet.2012.01.015
- McCann, M.T., Wallace, J.M., Robson, P.J., Rennie, K.L., McCaffrey, T.A., Welch, R.W., Livingstone, B.E. (2013). Influence of nutrition labeling on food portion size consumption. *Appetite*, 65(1), 153-158. doi:10.1016/j.appet.2013.02.013
- Mitchell, N., Catenacci, V., Wyatt, H.R. & Hill, J.O. (2012). Obesity: Overview of an epidemic. *Psychiatr Clin North Am*, 34(4), 717-731. doi: [10.1016/j.psc.2011.08.005](https://doi.org/10.1016/j.psc.2011.08.005)
- Office of Disease Prevention and Health Promotion. Scientific report of the 2015 dietary guidelines advisory committee. Updated April 5, 2015. Accessed March 23, 2015. Retrieved from <http://www.health.gov/dietaryguidelines/2015-scientific-report/>.

- Poelman, M.P., de Vet, E., Velema, E., Seidell, J.C., & Steenhuis, I.H. (2014). Behavioral strategies to control the amount of food selected and consumed. *Appetite*, 72, 156-65.
- Popkin, B.M., Duffey, K., & Gordon-Larsen, P. Environmental influences on food choice, physical activity and energy balance. *Physiol Behav*, 86(3), 603-613.
- Puhl, R.M. & Heuer, C.A. (2010). Obesity stigma: Important considerations for public health. *Am J Public Health*, 100(6), 1019-1028.
- Roberto, C.A., Larsen, P.D., Agnew, H., Baik, J., & Brownell, K.D. (2010). Evaluating the impact of menu labeling on food choices and intake. *Am J Public Health*, 100(2), 312-318. doi: 10.2105/AJPH.2009.160226
- Rolls, B.J. (2003). The supersizing of America: Portion size and the obesity epidemic. *Nutr Today*, 38(2), 42-53.
- Rolls, B.J. (2014). What is the role of portion control in weight management. *Int J Obes (Lond)*, 38, S1-S8. doi:10.1038/ijo.2014.82
- Rolls, B.J., Bell, E.A., & Thorwart, M.L. (1999). Water incorporated into food but not served with a food decreases energy intake in lean women. *Am J Clin Nutr*, 70(4), 448-455.
- Rolls, B.J., Morris, E.L., & Roe, L.S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *The American Journal of Clinical Nutrition*, 76(6), 1207-1213.
- Rolls, B.J., Roe, L.S., Halverson, K.H., & Meengs, J.S. (2007). Using a smaller plate did not reduce energy intake at meals. *Appetite*, 49(3), 652-660. doi: 10.1016/j.appet.2007.04.005
- Rolls, B.J. Roe, L.S., & Meengs, J.S. (2004). Salad and satiety: Energy density and portion size of a first-course salad affect energy intake at lunch. *Appetite*, 104(10), 1570-1576. doi:10.1016/j.jada.2004.07.001
- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006a). Larger portion sizes lead to a sustained increase in energy intake over 2 days. *J Am Diet Assoc*, 106(4), 543-549. doi:10.1016/j.jada.2006.01.014
- Rolls, B.J., Roe L.S., & Meengs, J.S. (2006b). Reductions in portion size and energy density of foods are additive and lead to sustained decreases in energy intake. *J Am Diet Assoc*, 106(4), 543-549.

- Rolls, B.J., Roe, L.S., Meengs, J.S., & Wall, D.E. (2004). Increasing the portion size of a sandwich increases energy intake. *J Am Diet Assoc*, *104*(3), 367-372. doi:10.1016/j.jada.2003.12.013
- Scheibehenne, B., Todd, P.M., & Wansink, B. Dining in the dark. (2010). The importance of visual cues for food consumption and satiety. *Appetite*, *55*(3), 710-713. <http://dx.doi:10.1016/j.appet.2010.08.002>
- Schwartz, J., Byrd-Bredbenner, C. (2006). Portion distortion: Typical portion sizes selected by young adults. *J Am Diet Assoc*, *106*(9), 1412-1418. doi:10.1016/j.jada.2006.06.006
- Steenhuis, I.H.M & Vermeer, W.M. (2009). Portion size: review and framework for interventions. *Int J Behav Nutr Phys Act*, *6*, 58. doi:10.1186/1479-5868-6-58
- Story, M., Kaphingst, K.M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annu Rev Public Health*, *29*, 253-272. DOI: 10.1146/annurev.publhealth.29.020907.090926
- Story, M. & Larson, N. A review of environmental influences on food choices. *Ann Behav Med*, *38*, Suppl 1, S56-73.
- Stroebele, N. & De Castro, J.M. (2004). Effect of ambience on food intake and food choice. *Nutrition*, *20*(9), 821-838. doi:10.1016/j.nut.2004.05.012
- Stroebele, N., Ogden, L.G., & Hill, J.O. (2009). Do calorie-controlled portion sizes of snacks reduce energy intake? *Appetite*, *52*(3), 793-796. doi: 10.1016/j.appet.2009.02.015
- United States Department of Agriculture/Economic Research Service. (2014). Food-away-from-home. Updated October 29, 2014. Accessed April 4, 2015. Retrieved from <http://www.ers.usda.gov/topics/food-choices-health/food-consumption-demand/food-away-from-home.aspx>.
- U.S. Department of Health and Human Services. (2013). Larger portions sizes contribute to U.S. obesity problem. Accessed April 4, 2015. Retrieved from <http://www.nhlbi.nih.gov/health/educational/wecan/news-events/matte1.htm>.
- U.S. Food and Drug Administration. (2014). Guidance Documents & Regulatory Information by Topic. Labeling & Nutrition. Retrieved from <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm385663.htm>.

- USDA MyPlate Website. Calories Count Chart for Mixed Dishes. (2013). Retrieved from <http://www.choosemyplate.gov/food-groups/downloads/MixedDishes.pdf>.
- Vermeer, W.M., Alting, E., Steenhuis, I.H.M., & Seidell, J.C. (2009). Value for money or making the healthy choice: The impact of proportional pricing on consumers' portion size choices. *Eur J Public Health*, 20(1), 65-69. doi: 10.1093/eurpub/ckp092
- Vermeer, W.M., Steenhuis I.H.M., Leeuwis, F.H., Heymans, M.W., & Seidell, J.C. (2011). Small portion sizes in worksite cafeterias: Do they help consumers to reduce their food intake? *Int J Obes*, 35(9), 1200-1207. doi: 10.1038/ijo.2010.271
- Wansink, B. (2004). Environmental factors that increase food intake and consumption volume of unknowing consumers. *Annu Rev Nutr* 24, 455-479. doi: 10.1146/annurev.nutr.24.012003.132140
- Wansink, B. & Ittersum, K.B. (2007). Portion size me: Downsizing our consumption norms. *J Am Diet Assoc*, 107(7), 1103-1106. doi:10.1016/j.jada.2007.05.019
- Wansink, B., Ittersum, K.V., & Painter, J.E. (2006). Ice cream illusions: Bowls, spoons, and self-served portion sizes. *Am J Prev Med*, 31(3), 240-243. doi:10.1016/j.amepre.2006.04.003
- Wansink, B., & Kim J. (2005). Bad popcorn in big buckets: Portion size can influence intake as much as taste. *J Nutr Educ Behav*, 37(5), 242-245
- Wansink, B., Painter, J.E., & Lee Y.K. (2006). The office candy dish: proximity's influence on estimated and actual consumption. *Int J Obes (Lond)*, 30(5), 871-875. doi:10.1038/sj.ijo.0803217
- Wansink, B., Painter, J.E., & North, J. (2005). Bottomless Bowls: Why visual cues of portion size may influence intake. *Obes Res*, 13(1), 93-100. doi: 10.1038/oby.2005.12
- Williams, R.A., Roe, L.S., & Rolls, B.J. (2014). Assessment of satiety depends on the energy density and portion size of the test meal. *Obesity*, 22(2), 318-324. doi: 10.1002/oby.20589
- World Health Organization. (2015). BMI classification. Retrieved from [http://apps.who.int/bmi/index.jsp?introPage=intro\\_3.html](http://apps.who.int/bmi/index.jsp?introPage=intro_3.html).

- World Health Organization. (2014). Media Centre: Obesity and overweight. <http://www.who.int/topics/obesity/en/> Updated August 2014. Accessed October 28<sup>th</sup>, 2014.
- Young, L.R., Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *Am J Public Health, 92*(2), 246-249.
- You, W., Zhang, G., Davy, B.M., Carlson, A., & Lin, B-H. (2009). Food consumed away from home can be a part of a healthy and affordable diet. *J Nutr, 139*(10), 1994-1999. doi: 10.3945/jn.109.107615
- Young, L.R., Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *Am Jour Public Health, 92*(2), 246-249.
- Young, L.R., Nestle, M. (2012). Reducing portion sizes to prevent obesity. A call to action. *Am J Prev Med, 43*(5), 565-8. doi: 10.1016/j.amepre.2012.07.024