CHAPTER 1

General Introduction
Supersize Me

The controversial 2004 documentary “Supersize Me” follows American independent film maker Morgan Spurlock eating only McDonald’s for a thirty day period [1]. The film documents this lifestyle’s dramatic effect on Spurlock’s physical and psychological well-being; and explores the fast food industry’s corporate influence, including how it encourages poor nutrition to make profit. Spurlock based the title of his documentary on McDonald’s slogan to “supersize” their ordered food, for little additional cost. In doing so, larger portions of high palatable foods are more appealing to buy, and who wouldn’t want that?

The term “Supersize Me” reflects perfectly peoples’ living in a tempting food environment in which individuals are exposed to large food portions, and are encouraged to eat large amounts of food. Compared to 30 years ago, the portion size of many foods and beverages eaten both inside and outside the home has increased significantly [2]. An important consequence of enlarged food portions of calorie-containing foods is that it increases people’s energy intake [3]. Persistently consuming more calories from foods than are expended leads to a positive energy balance that in turn, results in weight gain. Many people are unaware that food portions regularly exceed the recommended amounts and think that the type of food rather than the portion size determines energy intake [4]. Moreover, the food environment is arranged so that it seduces consumers to buy larger portions for attractive prices [5]. The studies presented in this thesis sought to provide insight into the portion size food environment (in the supermarket and home environment), and to develop and evaluate a comprehensive intervention to improve overweight and obese individuals’ ability to deal with the supersized food environment.

Overweight & obesity

Over the past 30 years, prevalence of overweight and obesity has substantially increased in developed countries [6], which has important health implications. Height and weight increased progressively, particularly during the 19th century. During the 20th century, populations began to gain proportionally more weight than height and by the year 2000, the number of adults with excess weight surpassed the number of those who were underweight
According to recent data (2013), the worldwide prevalence of obesity (body mass index [BMI] ≥ 30) among adults (>20 years) is 11%, while approximately 35% of adults are overweight (BMI ≥ 25-30) [6]. In the Netherlands, 48.0% of adults (19-65 years) are overweight (including obesity) [8]. The Dutch prevalence of overweight reflects an increase of approximately 15% compared to the 1980's [9]; however this growth has stabilized over recent years [10]. Moreover, the Netherlands is one of the European countries with the lowest overweight prevalence [10]. The increased overweight and obesity rates are present among all age, gender, and ethnic groups although disparities exist. [11]. In the Netherlands, Antilleans (+/- 20%) have the highest prevalence of obesity, while native Dutch (+/- 11%) have the lowest prevalence [12]. On average, a larger percentage of men are overweight than women [11]. However, among all ethnicity groups, women have higher obesity rates than men [12]. Moreover, there is an inverse relationship between socio economic status and overweight and obesity. The prevalence of obesity is 1.5 times higher among individuals with a low socio-economic status than with a high socio-economic status. In the Netherlands, approximately 64% of men with a low socio-economic status are overweight, whereas 52% of men with a high-socio economic status are overweight [13]. Among Dutch adults, the prevalence of overweight and obesity is positively associated with age [14].

The high prevalence of overweight and obesity represent a major public health problem as excess weight is associated with an increased incidence of type 2 diabetes mellitus, cardiovascular disease, osteoarthritis and some cancers [15]. Furthermore, obesity is associated with excess mortality [16] and has been recognized as a disease [17]. Overweight and obesity are associated with an impaired health-related quality of life, even in the absence of co-morbidities [18]. Consequently, overweight and obesity are major drivers in healthcare costs. For example, a review among European countries that used health economic models to determine the medical cost of obesity indicated that between 2.1% and 4.7% of total national health care costs were attributable to obesity [19, 20].

The etiology of obesity is multi-factorial and highly complex. However at the simplest level, weight gain is the result of disturbed energy balance (energy intake vs. energy expenditure) and the ‘energy intake’ side of the balance has been recognized as a dominant driver of the rise in obesity [21, 22]. Multiple factors contribute to an increase in energy intake. Important reinforcing factors range from individual (neurobiological, physiological, psychological) to
wider sociological, ecological, cultural drivers (e.g., culture and economics of food production and food consumption) [23, 24]. However, the changed food environment is seen as an important contributor to the obesity epidemic [25].

The food environment

The increased prevalence of overweight and obesity has paralleled changes in the food environment of developed countries [7, 26]. For centuries people struggled to overcome food scarcity and hunger as they were dependent on the success of crops, which was influenced by seasonal variation [27]. The onset of the industrial revolution was crucial to stable food production and led to an increase in the availability of dietary energy [7]. However, after World War II, noticeable changes in agricultural policies (e.g., subsidies), farmer practices (e.g., factory farming), and technical innovations (e.g., irrigation) [26, 28, 29] highly influenced changes in the food environment [26]. A major driver of increased food availability was the governmental financial support to grow as much and cheap as possible crops (e.g., corn and soybeans). By subsidizing the growth of these so-called “cash-crops”, they could be sold for an amount that was less than their production costs [30]. However, these subsidized crops were used as the basis for the production of processed, high-palatable foods. For example, among other things, the production of corn is used to produce high-fructose corn syrup; a main ingredient of U.S. sugar sweetened beverages and sweetened snacks. Subsidization of crops also benefitted the meat and dairy industry that profited from cheap feed for their livestock [26].

The technical, political and organizational developments of the food environment resulted in a farm-system that was less labor-intensive and more efficient [30], accelerating growth and, eventually resulting in the mass production of foods [31]. Moreover, these changes resulted in a market concentration and a domination of the market by a small number of sellers (oligopolies). Large food chains and corporations replaced local food systems and small farms, which drove the production of cheap, unhealthy, high-processed foods [30]. Moreover, the big food companies dominated the market and made large profits because food industry oligopolies acquired the power to set prices and determine the terms and conditions of their market sectors. Also, the dominators on the market became very active politically, lobbied
against regulations that for example favored public health. Such changes within the food environment, and the influence of the food sector in the food market have been emphasized as starting points of market failure in the context of obesity\(^1\). Moreover, these developments of the food environment have led to the onset of the massive and cheap food production, resulting in a production of more calories than were needed. For example, compared to the period between 1900-1980, the average caloric availability of an adult in the US was 3200 calories per person, which is substantially lower than the 3900 kilocalories per person available in 2000 [26]. Because of the overproduction of calories, strategies and tactics were developed by the food industry to sell these excess calories. In doing so, the way of promoting foods became an important focus from the late 20\(^\text{th}\) century onwards. Especially, the start of food marketing became an important factor influencing individuals’ purchase behaviors, food choices and energy intake, even for the most independent-minded consumer [31, 32]. One of the techniques used to sell these abundant calories was supersizing food portion size.

### Supersizing of the portions

Since the 1970’s, the fast-food industry has used the supersizing of food portions as marketing strategy. By means of supersizing, larger portions were offered for a relatively lower price, which was attractive for consumers because of the ‘more-value-for-money’ principle. Supersizing was adopted by the packed food industry during the 1980’s and 1990’s as a way of promoting sales. Since this time, food portions of products eaten outside as well as inside the home started to increase, with greater availability of more large sized portions. To illustrate, in the mid-1950s, McDonald’s offered only one size of French fries; that size is now labelled “Small” and is one third the weight of the largest size available in 2001. The “Large” size for 2001 weighs the same as the 1998 “Supersize” product, and the 2001 “Supersize” weighs nearly an ounce more [2]. Food portions of products for in-home consumption have also increased; in 1987 the size of a family bag of a certain brand of chips contained ‘only’ 175 g, whereas the content of this bag is currently 300 g [33] (Figure 1).

Portion sizes of ingredients in recipes in cookbooks have also increased [34, 35].

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\(^{1}\) A market (the mechanism of supply and demand) fails when it fails to deliver the best output to society. Of course, obesity and its related co-morbidity is not a favorable output to society, but in terms of economics, the market fails because obesity put long-term burden on (future) healthcare costs.
The U.S. leads the world in terms of the expanding food portions and cultural differences need to be considered when understanding the impact of increased portion sizes. This notion is for example reflected by the term “French paradox”, which is used to define the contradiction between France's rich cuisine, yet slender population. This paradox can partly be explained by the portion sizes served in France compared to the U.S. For example, portion sizes are significantly smaller in French restaurants and supermarkets than in their American counterparts [36]. While cultural differences exist, the increase in portion sizes has also been observed in non-American countries such as the Netherlands [33, 37].

![Image of portion size comparison]

**Figure 1** Changes in food portion sizes over the years [illustrations based on study results 2, 33 and authors’ observations]

**The effect of large portion sizes**

The increase in portion sizes over recent years has influenced the amount of food people select and consume. As food portion sizes have increased, so too has the norm about ‘adequate’ portion sizes. For example, young adults selected on average 190 mL of orange
juice in the 1980’s whereas this amount increased to 272 mL juice among a comparable population in the early 2000’s [4]. In a restaurant study, significantly more chefs aged above 51 years served their guests smaller portions compared to chefs younger than 51 years old. For example, 21% percent of chefs over age 51 years served strip steaks that were 120g (4 oz) or smaller, compared with only 8% of chefs under age 51 years [38]. An amusing and extraordinary study showed that the portion sizes of the courses that were presented on 52 of the best-known paintings of the Last Supper increased by 69% in the most recent version [39]. The results of such studies indicate that people perceive larger portions than recommended as an appropriate amount to consume.

In addition to a disturbed perception of what amount of food is ‘appropriate’ to consume, large food portions promote passive overconsumption [40], which indicates that individuals have no deliberate intention to over-consume on large food portions [41]. Effects of at least 30% higher consumption levels due to portion size are frequently reported [e.g., 42-47], with larger effects for larger portion sizes. A review and meta-analysis showed that doubling a portion led on average to an increase in consumption of 35% [48]. Also, studies have demonstrated a positive association between the portion size served and the amount consumed, irrespective of hunger or satiety [3, 44, 49, 50]. Furthermore, research has shown that the effect of portion size on energy intake can persist over several days, with no indication of meal-to-meal compensation [51, 50]. Moreover, people consumed more out of large food packages than out of small packages, independent of the perceived taste or food quality [45, 52]. This phenomenon has been observed for both packages of high-convenience foods (e.g., the amount of chips consumed increases as the package size increases), and for packages of foods that requires preparation before consumption (e.g., a portion of spaghetti that needs to be removed from the package to be cooked) [53]. Even the container size, independently of the portion size, influenced the amount consumed [54]. The risk for overconsumption resulting from large food portions is enhanced by the extent to which people are eating mindlessly. The more people are distracted (e.g., watching television or eating with others), the larger their intake [55-57].

To help consumers define an adequate amount to consume, so-called serving sizes are described on pre-packaged food. A serving-size describes the amount of food that is appropriate to consume in one sitting and provides insight in the amount of calories per
serving [58], for example, a 250 mL glass of soft-drink (106 kcal), one cookie (65 kcal) or a piece of cake (130 kcal). However, because clear regulations are lacking, different serving sizes for comparable products may be communicated. Also, consumers have indicated that serving size information is unclear and not helpful in making decisions for appropriate portion sizes [59]. Although describing serving size on the package is one of the efforts made to support consumer decision making, several other environmental and individual approaches have been suggested to reduce the impact of increased food portions on energy intake [60].

Environmental interventions targeting portion size

According to the ecological model the ANGELO-framework (Analysis Grid for ENvironments Linked to Obesity), two levels (macro and micro) of the environment exist in which environmental interventions aimed at food portions can be executed [61]. The macro level food environment refers to parties (e.g., agriculture, politics, and industries) that influence food availability. The micro level food environment is characterized by relative small settings (e.g., supermarkets, restaurants, school canteens, home), which typically involve food [61].

At the macro-environmental level, national authorities (e.g., the Netherlands Food and Consumer Product Safety Authority), and national (e.g., Ministry of Economic Affairs, Ministry of Economic Affairs) and international governments (e.g., the European Union) and authorities (e.g., European Food Safety Authority (ESFA)) are responsible for food policies and regulations. Such policies and regulations influence the availability of food-products and the communication of nutrition information of pre-packed foods. For example, in many countries (e.g., in the Netherlands) it is mandatory by law to display the content of the package and nutritional information of the product per 100 g or mL (e.g., a bottle of soft-drink contains 1.5 liter, and has 40 kcal/100 mL). Interventions at the macro-environmental level are suggested to have greater impact on behavior at the population level, but are also more difficult to accomplish in practice. Such interventions (i.e., regulations to restrict a maximum food portion that is for sale) may be desirable from a public health perspective (e.g., limiting energy intake) but may infringe on personal values (e.g., a need for autonomy and freedom of choices), and are not popular among policy makers who try to avoid paternalistic interventions and conflict with the interest of other parties (e.g., making more profit when
selling larger portions). For example, the attempt of New York’s former major Bloomberg to ban the sale of single-serve sugar-sweetened beverages larger than 16 oz (+_ 475 mL) in New York restaurants, movie theatres and mobile food vendors [62] was stopped by the New York Country Supreme Court shortly before the regulation would be implemented (March 2013); the regulation was judged to be ‘arbitrary and capricious because it applied to some but not all food establishments in the city’. Despite this court judgment, the impact of the industry lobby must not be ignored as in cinema’s soda accounts for 20 percent of the profits, and 98 percent of these profits come from sales of large portion sizes of more than 16 oz. [63]. Since October 2013, the State’s highest court reviewed Bloomberg’s soda cap [64], which was officially rejected in June 2014. The court stated that the city’s Board of Health “exceeded the scope of its regulatory authority” in enacting the soda ban proposal [65].

Micro-environmental interventions aimed at portion size have also been developed and evaluated for effectiveness [66-73]. For example, a study in worksite cafeterias where small portions (~ 2/3 the weight of the standard portion) of a hot meal were introduced alongside standard portions indicated that approximately 10% of the consumers replaced the regular meal with a small meal [66]. Although this experiment did not determine the effect on actual energy intake, other studies assessing the effect of smaller portions on energy intake have shown mixed effects on its effectiveness. While portion size reduction of a hot meal led to a decrease in energy intake in a controlled laboratory setting [3], limiting portion sizes of hot meals in a university dining facility did not impact visitor’s energy intake [71]. Interventions regarding portion size labelling have showed limited effects on portion size selection or energy intake [68, 70, 74], although one study found that non-dieters ate significantly less of a snack food when confronted with dual-column labelling, which contained both single serving and entire package nutritional information [73]. Moreover, removing value size pricing\(^2\) to eliminate the financial benefit of buying large portions had little effect on the selection or consumption of smaller food portions or lower energy intakes. Nevertheless, it was emphasized that repeated exposure may be required in order to achieve an effect [69, 72]. While environmental strategies to decrease portion sizes appear to be the most commonsense approach to impact population level energy intake, a tension between public health regulations and feasibility to implement in real life makes this approach complex.

\(^2\) Value size pricing means that the price per unit decreases as the portion size increases
Moreover, research on the effectiveness of micro level initiatives has yielded mixed results and whether these interventions will have beneficial effects in the long term is still unknown. Although an ongoing effort to explore different approaches to create a more portion size friendly food environment is needed, an alternative solution is to improve people’s self-regulation abilities in controlling and maintaining adequate intake in an environment rich with foods in large portions [60].

**Individual interventions**

Although the food environment is arranged to encourage consumers to buy larger portions for attractive prices [5], it is important to acknowledge that there are individual differences in the susceptibility to develop obesity in this food abundant environment. In the Netherlands, 52% of the Dutch adults have a healthy weight [8], which suggests they are able to control their energy intake despite the food abundant environment. Although a few people will maintain a healthy weight without conscious effort, the majority have to exert effort to maintain a healthy weight by limiting their energy intake and/or increasing their levels of physical activity [75]. This is illustrated, for example, by the constantly large number of individuals on a diet [76]. Without oversimplifying the complex and multi-factorial obesity problem, self-regulation capacity may influence individual’s response to the obesogenic environment. Self-regulation refers to all efforts to steer attention, emotions and behaviors to achieve beneficial long-term goals (i.e., weight loss), even when there are short-term temptations (i.e., a nice cookie) or conflicting long-term goals [77].

As overweight and obesity results from a persistent chronic positive energy balance, it is assumed that overweight and obese individuals are less capable to regulate energy intake adequately to match their energy expenditure. Indeed, there is some evidence that obese individuals are less able to self-regulate compared to healthy weight controls [78]. Poor self-regulation has also been shown to predict weight gain [79]. Good self-regulation skills, on the other hand, may be beneficial in dealing with a food rich environment [80]. Therefore, improving self-regulation of portion size selection and intake may be considered essential in educational interventions aimed at weight loss or weight-maintenance.
To date, some educational interventions targeting portion size have been conducted [60]. These interventions were developed to improve individuals' portion size estimation skills or to educate people about appropriate portion sizes [81-84]. Although knowledge and awareness about food portions are important prerequisites for behavioral change, these basics are insufficient to achieve changes in actual consumption [85, 86]. Self-regulation of portion size selection and intake, and the ability to cope with the supersized food environment is also required. Educational interventions should thus focus on providing people with the appropriate knowledge, skills and strategies needed to control the selection and consumption of adequate food portion sizes in an environment that seduces people to do otherwise [75]. Moreover, self-regulation skills could include alteration of the home environment so that it supports adequate portion control behavior [87]. Also skills regarding portion control might be of additional support in supporting individual’s self-regulation of food portions [60]. However, to date no such comprehensive individual approaches are available.

**Aim and outline of this thesis**

The aim of this thesis is to provide insight into the current macro and micro level portion size food environment and to develop and evaluate a comprehensive educational intervention to improve overweight people’s ability to deal with a supersized food environment. The first part of this thesis (chapters 2 and 3) focuses on the macro and micro portion size food environment. Chapter 2 provides insight into the current international serving size regulation in supermarkets of four high-income countries, with reference to non-alcoholic beverages. Chapter 3 provides insight into the in-home presence of micro environmental factors associated with surplus portion size selection and consumption.

The focus of the second part of this thesis is on the development and evaluation of a comprehensive intervention aimed at portion size. This intervention aims to 1) increase portion size awareness; 2) enhance self-regulation skills regarding portion control; 3) improve portion and energy-density control cooking skills; and 4) support people in creating a portion size friendly home environment. The program is directed at improving peoples’ ability to control and maintain adequate portion size selection and intake, thereby resisting environmental stimuli by which one is triggered to select large food portions. Chapter 4
describes the development and evaluation of an interactive tool to improve portion size awareness. Chapter 5 describes the development and evaluation of behavioral strategies to enhance self-regulation skills regarding portion control. Chapter 6 provides insight in the effectiveness of the comprehensive intervention ‘PortionControl@HOME’ (including both the elements described in chapters 4 and 5) on body mass index and portion control behavior. The last part of this thesis, chapter 7, summarizes the main findings of the studies, discusses their relevance for public health practice as well as making suggestions for future research and methods.
REFERENCES


