

# **Tackling Obesity in Aged-Care Homes: The Effects of Environmental Cues**

## **Structured Abstract**

### **Purpose**

Obesity among elderly consumers precipitates undesirable health outcomes. This study aims to investigate the effects of environmental cues on food intake of elderly consumers in an aged-care facility.

### **Design/Methodology**

A longitudinal study conducted over 17-weeks *in situ* within an aged-care facility with 31 residents investigated how auditory (soothing music), olfactory (floral-scented candle) and visual (infographic on health benefits of the main meal component) cues influenced food intake quantity during a meal, while accounting for portion size effect.

### **Findings**

Analysing the cross-sectional results of individual treatments and rounds did not reveal any consistent patterns in the influence of the three environmental cues. Longitudinal analyses, however, showed that the presence of auditory and olfactory cues significantly increased food intake, but the visual cue did not. Moreover, the portion size effect was strong.

### **Research Implications**

Extending research into environmental factors from a commercial to a healthcare setting, this study demonstrates how the presence of auditory and olfactory, but not cognitive cues increased food intake behaviour among elderly consumers. It also shows that a cross-

sectional approach to such studies would have yielded inconclusive or even misleading findings. Merely serving more would also lead to higher food intake amount.

### **Practical Implications**

Environmental factors should be a part of healthcare providers' arsenal to manage obesity. They are practical and relatively inexpensive to implement across different healthcare settings. However, the same environmental factors would have opposite desired-effects with normal or underweight residents, and hence aged-care facilities need to separate the dining experience (or mealtime) of obese and other residents. Quantity served should also be moderated to discourage overeating.

### **Originality/Value**

While studies into managing obesity, particularly among older adults, have mainly focused on techniques such as pharmacotherapy treatments with drugs, dietary management, or even lifestyle change, less attention has been given to the influence of environmental cues. Our study, executed *in situ* within an aged-care facility, provided evidence of the importance of considering the impact of environmental factors on food intake to help reduce obesity.

### **Classification**

Research paper

**Keywords:** Portion size, music, floral-scent, energy intake, obesity, elderly consumers

# Tackling Obesity in Aged-Care Homes: The Effects of Environmental Cues

## Introduction

Population aging is a global phenomenon. In 2019, the United Nations (2019) reported that over 700 million individuals were aged 65 years and over, a figure that is projected to double to 1.5 billion by 2050. An aging population places a heavy burden on public and private healthcare systems (Beard and Bloom, 2015; Frasca *et al.*, 2017; Fried and Paccaud, 2011; Garbarino *et al.*, 2018), and older adults incur disproportionately high health and medical expenditure compared to other age groups (O’loughlin *et al.*, 2016; Oliver, 2015; Sharma *et al.*, 2016; Wang and Chen, 2014). Ageing of the population has led to an increasing number of older adults moving into residential aged-care facilities, which are then faced with developing systems to best manage the health needs of their residents.

In developed countries (Elia, 2001; Kennedy *et al.*, 2004), a key risk factor that underpins poor health and premature mortality among the elderly is obesity (Donini *et al.*, 2012; Elia, 2001; Kennedy *et al.*, 2004; Silva *et al.*, 2020; Wang *et al.*, 2018). Treatments for obesity among older adults have primarily focused on pharmacotherapy (Li and Cheung, 2009), manipulation of food preferences (Reed *et al.*, 1997), calorie restriction (Horani and Mooradian, 2002; Kmiec, 2006), food literacy and education (Dibb and Carrigan, 2013; Wijayaratne *et al.*, 2018), and even lifestyle change (Elia, 2001; Kennedy *et al.*, 2004). **This study sought to evaluate the role of environmental cues on food intake among elderly consumers in an aged-care facility, thus offering new insights into a potentially novel strategy to address obesity in such settings.** This study makes three important contributions:

**First**, limited attention has been accorded to the role of environmental factors. Unlike physiological factors that relate to food directly (e.g., calorie management) or require individuals’ active participation (e.g., lifestyle change or pharmacotherapy), environmental

factors are extrinsic cues that act psychologically, or even subliminally, through visual (e.g., dining ambience), auditory (e.g., music) or olfactory (e.g., non-food fragrance) sensory channels (Prescott, 1999; Proserpio *et al.*, 2017; Rolls and Rolls, 1997; Stroebele and De Castro, 2004). Thus, a key contribution of this study is to extend research into managing obesity among elderly consumers beyond traditional streams (such as pharmacotherapy treatments with drugs, dietary management, or even lifestyle change) by taking a marketing approach and considering the roles of environmental cues.

**Second**, studies into the influence of environmental factors on food intake have mostly been performed in commercial settings such as restaurants, and in general supported the efficacy of a range of environmental factors in influencing consumers' eating behaviour (Koh and Pliner, 2009; Piqueras-Fiszman *et al.*, 2011; Piqueras-Fiszman and Spence, 2015; Spence, 2015; Spence and Piqueras-Fiszman, 2014), although some studies found no effects (e.g., Buckinx *et al.*, 2017; Choi and Lee, 2019). Unlike commercial settings, healthcare settings operate differently in that customer satisfaction through the dining experience is not their primary aim. Also, healthcare settings often have limited budgets for meals and operate under constraints (Clancy *et al.*, 2019; Hugo *et al.*, 2018). While commercial food services focus on the overall dining experience, where food quality, presentation and the overall dining ambience are the prime considerations, healthcare organisations generally serve food with limited variety and on a fixed schedule that aims to maintain health (Farrer *et al.*, 2019). Considering these differences and the practical limits of what aged-care settings can or cannot do, it remains unclear how low-cost environmental cues may impact food intake and thus potentially impact on obesity. Residents in aged-care facilities depend on the facility to provide them with all of their meals, so identifying strategies that might alter food intake has the potential to impact significantly on the obesity of residents. Hence, by conducting this study in-situ within an actual aged-care home not only enhances the external validity of this

study, but offers important practical recommendations that would help aged-care facilities manage obesity within their homes.

**Third**, a reason regarding the conflicting findings of past studies into the effects of environmental cues on food intake behaviour may be that these studies primarily used a single-shot cross-sectional approach (see Table 1 below). As various factors such as mood swings or feelings of wellness may vary appetite, a longitudinal approach would likely reduce the impact of such random and transient factors (Rindfleisch *et al.*, 2008). Also, portion size effects (PSE), the phenomenon that individuals consume more food simply because they are served more (Herman *et al.*, 2015; Young and Nestle, 2012), may be a crucial determinant of food intake (Hetherington and Blundell-Birtill, 2018; Zuraikat *et al.*, 2019). Thus, a **final** contribution of this study is to account for PSE while carrying out the study longitudinally over a 17-week period.

## **Literature Review**

### ***Obesity among Elderly Consumers in Developed Countries***

While obesity is a global health problem across all stages of life (Amarya *et al.*, 2014; Donini *et al.*, 2012), decreased physical activity with resultant decreased energy expenditure predispose the elderly to obesity (Elia, 2001; Han *et al.*, 2011; Kennedy *et al.*, 2004). In turn, obesity exacerbates premature mortality through increased risks of a range of diseases including cardiovascular diseases (Wang *et al.*, 2018), diabetes (Frasca *et al.*, 2017) and mental disorders (Silva *et al.*, 2020).

Given these negative health consequences of obesity, various approaches have been recommended for managing obesity among the elderly (as it is beyond the scope of this study to review each of these approaches in depth, we refer readers to the systematic reviews and meta-analyses cited below for further information). Pharmacotherapy has proven effective in

treating overweight elderly patients (Singh and Singh, 2020). Lifestyle interventions aimed at increasing physical activity have also been proposed as an approach to combating obesity, especially due to decreased mobility among older adults (Lin *et al.*, 2017). As excessive dietary intake is strongly tied to obesity, managing energy intake based on reducing intake of some nutrients or reducing overall caloric intake is another common intervention for obesity in older people (Silchenko and Askegaard, 2020; Weinheimer *et al.*, 2010). Often, these approaches are used in combination (Kennedy *et al.*, 2004; Li and Cheung, 2009).

While obesity among elderly consumers is prevalent globally (Malenfant and Batsis, 2019), the problem is particularly acute in developed countries (Elia, 2001; Kennedy *et al.*, 2004). For example, a recent study examining obesity among elderly Japanese residents (> 64 years old) over a 44-year (1973-2016) period reported that BMI has trended upwards in both men and women, with an average annual increase of 2.2% (Tarui *et al.*, 2020). Similarly, an Australian government report indicates that as high as 71% of adults aged over 65 are obese (AIHW, 2020). The World Health Organisation (2021) contends that the fundamental cause is increased energy intake, particularly Western diet that is high in fat and sugar (Rakhra *et al.*, 2020), coupled with decreased physical activities from more sedentary lifestyle.

### ***The Effects of Environmental Cues on Obesity***

Although obesity is, at least in part, heritable and genetically determined (e.g., Reed *et al.*, 1997), much evidence points to obesity being primarily the consequence of consuming excess calories (Bleich *et al.*, 2008; Donini *et al.*, 2012; Han *et al.*, 2011; Weinheimer *et al.*, 2010). Thus, managing obesity can be achieved, either directly or indirectly, by influencing the amount and type of food consumed. Before the 1960s, physiological signals were considered the primary regulators of food intake (e.g., Anand, 1961). Since then, various

studies have explored the influence of environmental factors on food perceptions and consumption behaviour, particularly in commercial settings such as restaurants (Koh and Pliner, 2009; Piqueras-Fiszman *et al.*, 2011; Piqueras-Fiszman and Spence, 2015; Spence, 2015; Spence and Piqueras-Fiszman, 2014). Unlike intrinsic factors of food (e.g., smell, taste or appearance), environmental factors are extrinsic cues that form part of the surroundings which act psychologically through sensory channels, such as what people see or hear (Prescott, 1999; Proserpio *et al.*, 2017; Rolls and Rolls, 1997; Stroebele and De Castro, 2004).

The assertion that eating behaviour may be influenced by external factors may be gleaned from Mela's (2006) model of eating desire, which demonstrates that food intake and desire are influenced by a series of external stimuli. External stimuli concern environmental cues; for example, the appropriateness (portion), dining/eating situation (environment and overall surroundings, conditions or experience) and time/frequency. Similarly, Blundell *et al.* (2010) eating behaviour model explains the efficacy of environmental cues on food consumption and proposes the factors that drive food choice and food intake. One of the major factors is sensory processes (e.g. auditory, olfactory, visual senses). Environmental factors have been shown to influence eating behaviour more than physiological factors (Woods, 2009).

Consistent with the model of eating desire (Mela, 2006) and eating behaviour (Blundell *et al.*, 2010), Verstuyf *et al.* (2012) further explained that sensory cues trigger physiological reactions (e.g., hunger) which then influence food intake. This explanation is consistent with Mehrabian and Russell's (1974) model of environmental influences on human behaviour, which proposes that environmental stimuli influence human behaviour through affective states of pleasure, arousal or dominance, and the generation of these affective states often occurs without conscious effort. In particular, three sensory stimuli or cues, auditory,

olfactory and visual, have been identified (Prescott, 1999; Proserpio *et al.*, 2017; Rolls and Rolls, 1997; Stroebele and De Castro, 2004). These cues, and their influence on eating behaviour, are discussed in the section below.

*Auditory cues.* Sounds in the dining environment can affect individuals' eating behaviour and food consumption when dining. For example, Spence *et al.* (2019) suggested that music enhances hedonic effects of taste, thereby leading to increased consumption. Similarly, North *et al.* (2003) found that restaurant diners ordered and ate more when music was played in the background. Two reasons have been proffered for this effect. First, musically induced arousal stems from the assumption that customers' moods influence attitudes and purchasing intentions. Second, knowledge activation effects refer to how music activates knowledge about a given product, which leads to consumers preferring the products (North and Hargreaves, 2010). Studies show that the effects of auditory cues on consumption of food and drink can even be influenced by characteristics such as the genre, tempo, or volume of the played music (Forsyth and Cloonan, 2008; Jacob, 2006). This can be explained by theories of eating behaviour (Mehrabian and Russell, 1974; Verstuyf *et al.*, 2012), which posit that such sensory cues heighten states of pleasure and thus increase appetite.

In healthcare settings with elderly patients, music has also been shown to improve patients' mood and diminish their agitation, thereby encouraging them to eat more (Swartz *et al.*, 1992; Thomas and Smith, 2009). For example, Elliott and Poly (1999) studied elderly consumers in long-term care facilities, and demonstrated that music improved residents' mood by 50% and increased food intake by 47%; the authors reasoned that listening to music could have possibly reduced dementia patients' agitation and stress and thus encouraged them to consume more food.

*Olfactory cues.* Similar to the effects of auditory cues, olfactory cues in the dining environment can enhance the enjoyment of the dining experience and reduce negative

emotions (Asmus and Bell, 1999; Holst *et al.*, 2017). Consumer research has previously studied how scent affects consumers' behaviour and ambient odours affect shoppers' emotion in the retail environment. They found ambient scent induced positive affect and enhanced shoppers' evaluation. As such, retail industry has witnessed a growing trend in using scented products or fragrance (e.g. air fresheners, sanitising agents, toothpaste, cosmetics products) in their shops (Ali *et al.*, 2015; Michon *et al.*, 2005).

Research in healthcare settings has found similar results, where olfactory cues have been linked to increased food intake (Elliott and Poly, 1999). Olfactory cues boost affective information processing, and increase appetitive valence of food (Kohler *et al.*, 2007; Soudry *et al.*, 2011). For example, Guéguen and Petr (2006) showed that dispersing a lavender fragrance among restaurant patrons led them to spend on average €3.5 more per person compared with a no-fragrance control condition. Indeed, studies have shown that the effects of olfactory cues on food intake may even occur subliminally or unconsciously (Krishna and Schwarz, 2014).

*Visual cues.* It is well-established in marketing communication research that images and contextual information on packaging influence consumers at the point of purchase (Hoek *et al.*, 2017; Krishna and Schwarz, 2014; Underwood and Klein, 2002). Similarly, in a dining environment, objects such as visual artefacts, decoration, crockery and cutlery may appeal to individuals and consequently influence food intake (Spence and Piqueras-Fiszman, 2014).

Elliott and Poly (1999) created a home-like environment in aged-care homes through the use of visual artefacts such as tablecloths, vases and flowers. Similarly, Holst *et al.* (2017) used freshly painted walls, coloured tray mats, and tablecloths, while Solve Elmståhl (1987) changed the ambience in a geriatric ward by decorating the dining room in a 1940s theme, which was evocative of most of the elderly patients' childhood surroundings. These studies all reported positive effects of these visual cues on increasing food intake.

Visual materials, such as infographics, menus and information boards (Bhat *et al.*, 2016) may also influence eating behaviour by communicating information or messages with the aim to enhance an individual's understanding and decision-making ability (Mccrorie *et al.*, 2016). There is evidence that visual messages of health claims may be effective in influencing individuals' food consumption (Carrillo *et al.*, 2014; Higgs, 2016; Karnal *et al.*, 2016; Papiés and Hamstra, 2010; Verstuyf *et al.*, 2012). However, drawing on research regarding congruency in advertising messages (Angell *et al.*, 2016; Segev *et al.*, 2014; Stipp, 2018), the visual cue would only be effective when the visual content is related to the food being consumed. For example, messages regarding the health benefits of fish would increase the consumption of fish, but not necessarily other food. This postulation was consistent with consumer behaviour research, which suggested that exposing consumers to information congruent with a product, rather than incongruent, would elicit higher product evaluation (Noseworthy *et al.*, 2014; Van Ooijen *et al.*, 2017).

Thus, the process of gaining nutritional knowledge and health information during the food decision-making process can positively motivate eating behaviour and increase food intake (Bublitz *et al.*, 2010; Provencher and Jacob, 2016; Vindigni *et al.*, 2002).

In summary, Table 1 highlights key studies regarding the use and influence of environmental factors in influencing elderly consumers in healthcare settings.

Insert Table 1 here

### ***Ineffective Environmental Factors***

Despite evidence pointing to the influence of environmental factors in shaping consumers' eating behaviour, the outcomes are inconclusive as some studies have reported no effects in both commercial and healthcare settings (Buckinx *et al.*, 2017; Choi and Lee, 2019;

Divert *et al.*, 2015; also see Table 1). For example, Kaiser *et al.* (2016) examined the influence of various music genres on food intake and found no links to eating behaviour. Similarly in an aged-care setting, Owings (1990) reported that visual cues (different coloured trays) had no significant effect on food intake. Similarly, Buckinx *et al.* (2017) varied room temperature, sound, space, lighting, and comfort and found no effect on food intake among elderly aged-care residents.

A key question that arises is why similar cues work in some situations but not in others. A review of extant studies pointed to three key issues that may explain these conflicting results. First, the majority of studies, as shown in Table 1, used a single-shot cross-sectional approach (for exceptions see Bhat *et al.*, 2016; Holst *et al.*, 2017; Mcdaniel *et al.*, 2001). Measuring food intake among elderly consumers in healthcare settings is problematic because acute issues such as mood, feelings of wellness, variations in appetite, or consumption of food prior to the main (experiment) meal might confound the effects of environmental cues. A longitudinal approach collecting data from the same group of participants on multiple occasions would likely reduce the impact of such transient factors affecting the results (Rindfleisch *et al.*, 2008).

The second issue concerns portion size effects (PSE), the phenomenon that individuals consume more food simply because they are served more (Herman *et al.*, 2015; Young and Nestle, 2012). For example, Zlatevska *et al.*'s (2014) meta-analysis revealed that doubling the food portion size resulted in a 35% increase in food intake. We argue that a key reason for the conflicting results is that obesity studies in healthcare settings have mostly failed to account for the PSE. Yet, PSE may be the most crucial determinant of food intake (Rozin *et al.*, 2003), and its effects may be difficult to consciously combat and eliminate (Hetherington and Blundell-Birtill, 2018; Zuraikat *et al.*, 2019).

Third, some studies have suggested that environmental factors work not because the sensory signals boost affective information processing and increase appetitive valence of food, but due to people staying longer during the dining occasion, thus leading them to eat more (Stroebele and De Castro, 2006). It is thus important to control for the interactions of environmental factors and meal duration. Finally, as noted earlier, commercial settings differ substantially from healthcare settings. Given the conflicting results of previous studies, issues with cross-sectional study designs, and a lack of accounting for PSE and meal duration, it remains unclear what the independent effects of environmental cues are on food intake of elderly consumers in aged-care homes, and how these environmental factors may be contributing to obesity.

## **Methods**

### ***Context and Participants***

Like many other developed countries, Australia has an aging population (O'loughlin *et al.*, 2016; Oliver, 2015; Wang and Chen, 2014). In 2015, the percentage of those aged over 65 years was 15% (3.6 million people), which was more than twice the global average and projected to grow to 23% by 2050 (Ofori-Asenso *et al.*, 2018). To cater to the increasing cohort of older adults who experience difficulties in living independently, the number of residential aged-care residents increased from approximately 162,200 to more than 244,300 (i.e. ~50% increase) in the decade from 2010-2019 (Australian Government Department of Health, 2020). Besides providing accommodation, care and medical assistance to residents, residential aged-care is usually the sole supplier of food for residents. Therefore, residents are highly dependent on their care facility to provide them with meals to meet their daily

nutritional requirements. Thus, aged-care homes can play a crucial role in managing obesity among their residents.

An Australian aged-care home with 31 elderly consumers ( $N=31$ ; female=21; aged range 69 to 100 years,  $M=86.77$ ,  $SD=7.63$ ) agreed to participate in this study. Full human ethics approval was granted by the home university of the researchers (approval number 201440) prior to the start of the experiments. Via a written consent form, all residents in the facility were asked for their voluntary participation in research to monitor their food intake over 17 weeks. Residents either read the consent form or were told verbally by staff of the aged-care facility. The consent form was also made available for family members visiting the residents. All 31 residents had agreed to participate. Statistical power analysis indicated that this sample size in a repeated-measure procedure with four replications (three treatments and one control) was sufficient to detect a small effect size (0.24) with a power of 0.80 at an alpha of 0.05 (Cohen, 1988; Faul *et al.*, 2007).

### ***Stimuli Selections***

Following the typology of human sensory channels proposed by Stroebele and De Castro (2004), we conducted three pretests to identify suitable stimuli to serve as auditory, olfactory and visual environmental factors. For the auditory cue, a convenience sample of university staff ( $n = 23$ ) was asked to listen to three soundtracks and select which one they would most prefer to listen to when dining and eating seafood so that the music will likely be noticed during mealtimes. As the music genre preference might vary across residents, all three soundtracks contained neutral soft instrumental music with the sound of ocean waves. The soundtrack used in the main experiment was chosen by 53% ( $n = 12$ ) of the participants.

For the olfactory cue, a convenience sample of university staff ( $n = 17$ ) was exposed to the smell of four commercially purchased scented candles for approximately 10 seconds

each. The participants then indicated their most preferred candle when dining and eating seafood so that the scent will likely be noticed during mealtimes. The chosen candle (camelia and lotus fragrance) was preferred by 71% (n = 14) of the participants.

Finally, for the visual cues, we followed Bhat *et al.* (2016) by using infographics containing images and health messages regarding the benefits of consuming fish. Twenty-five participants were shown three designs of infographic cards, and asked to rate each card (on a 1-7 scale) how well the card represented health benefits of eating fish. The infographics (see Annex I) with the highest rating (mean = 5.2; SD = 1.3) was chosen. While other studies have manipulated aspects through things such as painting the walls or changing cutlery sets, such manipulations were not feasible in the current study as it was carried out *in situ* in an operating aged-care home over a period of 17 weeks.

### ***Experiment Design***

The experimental design used a within-subject, repeated measures crossover design, in which each resident was exposed to all three treatments (auditory, olfactory and visual) and a control condition (i.e. no treatment) over a period of 17 weeks. Participants were exposed to each treatment and control condition on three occasions; that is, each resident received three control conditions and thrice of each of the three treatments. The benefit of a within-subject design is that each individual acts as their own control, which reduces the impact of differences between individuals that might affect the outcome (Gray *et al.*, 2003; Poulton, 1982). Repeating each experimental condition on three occasions reduces the impact of any acute event at a single session that might influence the outcome, thus providing a more valid insight into the impact of each condition on food intake (White and Arzi, 2005).

The facility where the experiments took place had two dining rooms: Dining Room 1 hosted 15 residents and Dining Room 2 hosted 16 residents; residents stayed with the same room throughout the experiment (see Figure 1a).

Insert Figure 1 here

According to Krosnick and Alwin (1987), response-order effects could occur when experiments are conducted in the same order. To minimise potential response biases, we randomised all three treatments between the two dining rooms and in such a way that each week would only involve one single treatment in a single dining room (see Table 2 for the design and schedule)

Insert Table 2 here

### ***Experiment Procedure***

A meal consisting of fish and chips, which was served for lunch every Friday, was used as the experimental meal. Fish and chips was chosen because it was a meal that was reported by facility staff to be generally well-liked by all residents, so all residents would be willing to participate in the study. The primary outcome was energy intake calculated from food consumed during the meal, and hence it was necessary that the test meal be appealing to all residents so they would be willing to consume it.

Each Friday, other than when it was a control condition, paid assistants organised the treatments (music, candle or infographic card) before residents entered the dining room and the lunch service commenced. For example, music was played, candles were lit, or infographic cards were placed on the tables. The same food—fish and chips—was served as

the main dish throughout the 17 weeks of the experiment, to reduce potential confounding that might otherwise arise from using different foods on each occasion. Throughout the experiments, the room temperature was maintained at a comfortable temperature (24–26°C).

During the lunch service, all residents were served a drink and the following food components: fish (crumbed/fried), starch (fried potato chips) and salad. An electronic kitchen scale (Salter Model 1014) was used to separately weigh and record individual food components during serving (See Figure 1b). Each weighed component represented the *portion served* (in grams) for the component. A label containing an ID number was placed under each resident's dish to ensure that we could later identify and accurately measure the amount of food consumed by each resident. After the residents had finished eating, the remaining portion of each food component was weighed separately to determine the amount of each component that was consumed. Subtracting the portion remaining from the portion served yielded the *portion consumed* (in grams). For drinks, each residents' choice of drink (e.g. juice, wine, coffee, tea) and the volume consumed was recorded (see Figure 1b). Using FoodWorks 10 (Xyris software), the weight of each food component consumed (in grams) and drink consumed (in millilitres) were used to calculate energy-intake (in kJ).

Some studies have suggested that environmental factors work not because the sensory signals boost affective information processing and increase appetitive valence of food, but due to people staying longer during the dining occasion, thus leading them to eat more (Stroebele and De Castro, 2006). It is thus important to determine if meal duration influences food-intake amount. Residents' meal duration was recorded as the time taken from when their food was served to the time they left the dining room. However, meal duration did not significantly impact energy intake ( $\beta=-0.0002$ ,  $p=0.715$ ; 95% CI: -0.001~0.001), and hence we omitted meal duration from subsequent analyses. Also, a manipulation check was performed at the end of the meal service in the first week of each experimental manipulation

in which residents were asked whether they had noticed the cues (i.e., music, scented candle or infographic card). Without exception, all residents reported noticing the cues. The same question was not repeated after the first week.

## Results

First, we considered the results of analysis of variance (ANOVA) tests for each round independently, and without controlling for portion served as a covariate. The results revealed that compared to the portion consumed, for Round 1 ( $F=3.594$ ,  $df=3$ ,  $p=0.017$ ) visual cue significantly influenced food intake ( $p=0.011$ ), auditory cue was marginally significant ( $p=.1$ ) and olfactory cue was not (all  $p=.257$ ). For Round 2, ( $F=3.21$ ,  $df=3$ ,  $p=0.027$ ), only visual cue was significant but negatively ( $p=0.04$ ). For Round 3 ( $F=1.299$ ,  $df=3$ ,  $p=0.279$ ), none of the three cues were significant (all  $p>.1$ ). Figure 2 illustrates the aggregate mean values of the energy intake for the three treatments over the three rounds. A visual inspection of the figure similarly shows that there were no consistent patterns regarding the treatments or rounds. Collectively, the results meant that had we conducted this study with a cross-sectional approach, and without controlling for portion size effect, we would have reported different results depending on when the study was carried out, thereby providing an inaccurate or incomplete picture of how environmental factors may influence food intake.

Insert Figure 2 here

Next, we performed repeated-measures linear mixed-effects models (LMM) using Stata software (version 16). Given the nature of this study's main experiment, some data were missing because some aged-care residents were occasionally absent from lunch for various reasons. LMM has the advantage of being able to accommodate missing data,

coupled with the ability to model nonlinear and individual characteristics longitudinally (Krueger and Tian, 2004). In our model, energy intake for each treatment type was the repeated-measures dependent variable over the three rounds, the treatment-type was the fixed-effects variable, and participant was the random-effects variable. Portion served as a covariate. Running the LMM analyses with the two covariates yielded the results in Table 3. The results indicated that both auditory and olfactory cues were effective in increasing the elderly's food intake, but visual cues were not. Specifically, compared to the control group, the presence of auditory cues ( $\beta=181.96$ ,  $p=0.028$ ; 95% CI: 19.14~344.77) led to an increase of 182kJ in energy consumed. Similarly, compared to the control group, the presence of olfactory cues ( $\beta=165.12$ ,  $p=0.044$ ; 95% CI: 4.25~325.99) resulted in an increase of 165kJ in energy consumed. Visual cues ( $\beta=32.26$ ,  $p=0.702$ ; 95% CI: -132.41~196.94) had no significant impact on additional energy consumed, compared to the control group.

Insert Table 3 here

Next, we looked at the LMM results for the two covariates. The total amount of energy served ( $\beta=0.73$ ,  $p < 0.001$ , 95% CI: 0.66~0.80) positively influenced energy intake. On average, the raw  $\beta$  coefficient explained that a one kJ increase in energy content of the served meal resulted in a 0.73 kJ increase in energy consumed. Finally, research suggests repeated exposures to cues could bias response (Campbell and Keller, 2003; Montoya *et al.*, 2017). Because the participants were longitudinally exposed thrice to each cue type, latent growth modelling (Duncan *et al.*, 2013) was performed to uncover any potential trend arising from repeated exposure. Across all treatments and controls, the modelling results (all  $p > 0.118$ ) revealed no underlying trend over the time in which participants were exposed to

the cues; that is, repeatedly exposing the participants to the same cue type did not result in any changes in energy intake over the exposure period.

## Discussion

Population aging is a global phenomenon and, an aging population places a heavy burden on public and private healthcare systems. Therefore, it is important to understand and learn how to manage key risk factors that underpin poor health and premature mortality among the elderly. The particular risk factor of interest to this study is obesity. Against this backdrop, this study examined how environmental cues influenced food intake, a key driver of obesity, among elderly consumers. The study was conducted in situ within a residential aged-care facility over a period of 17 weeks.

Overall, the findings showed that while auditory and olfactory cues may increase food intake, visual cues did not. Moreover, portion served mattered to food intake. The finding regarding portion served supported extensive evidence regarding the phenomenon of portion size effects (PSE), which observes that individuals consume more food simply because they are served more (Herman *et al.*, 2015; Young and Nestle, 2012). Regarding the lack of impact of visual cues, a possible reason may be our choice of infographics cards as the visual cue—which was similarly used by Bhat *et al.* (2016)—as opposed to other mechanisms such as painting the wall or using cutlery with different colour (Holst *et al.*, 2017). From a practical perspective, executing our study in an operating aged-care home amongst actual residents limited us from being able to use cues that would cause disruption to the facility's normal operations.

Also, to enhance generalisability, we intentionally selected cues (music, candles and infographics) that are portable and could be implemented easily across different types of

healthcare facilities. The visual infographics might have failed because the health benefit contents of the card might be triggering cognitive information processing, rather than appealing unconsciously through sensory channels. It is also plausible that the elderly consumers may have reduced processing resources such as working memory and attention to perform daily tasks (Stöckel *et al.*, 2017), and hence were less affected by the infographics information. In addition, the presence of PSE may explain the confounding results of past studies that did not account for portion served. Similar to other researchers (Herman *et al.*, 2015; Young and Nestle, 2012), we found significant associations between portion served and portion consumed across all treatments and also for all experiment rounds. The following sections further discuss the theoretical and managerial implications gleaned from the findings.

### ***Theoretical implications***

A key theoretical contribution of this study is in extending research into the effects of environmental cues on food intake. Extant research into the effects of environmental factors in stimulating food intake has mainly focused on modifying the dining atmosphere to mimic a home environment to lift elderly consumers' nostalgia and subsequently satisfaction (e.g., Elmståhl *et al.*, 1987). For those that studied sensory cues, they typically investigated the effectiveness of a single cue type (e.g., Fiegel *et al.*, 2014). Yet, research suggests the consumer response to food is multisensorial such that individual sensory cue may act differentially (Auvray and Spence, 2008; Spence and Piqueras-Fiszman, 2014). By comparing the different cues based on humans' sensory elements and cognitive health claims, this research contributes to academic evidence by testing the efficacy of two sensory cue types (auditory and olfactory) and a cognitive cue type (visual).

Our findings further suggest that conflicting results of past studies regarding environmental factors may be due to the use of cross-sectional approach. We show that while the results on individual rounds and treatment differed, longitudinal analyses yielded a more consistent and complete picture. In addition, the PSE plays a significant role in considering the measurement of environmental cues. Previous research studies have largely neglected the interaction between the PSE and environmental cues, which may have led to an inaccurate interpretation of the true effects of environmental cues. As Figure 2 illustrates, no consistent patterns or trends could be discerned when the data were analysed cross-sectionally as three independent experimental rounds, and without controlling for PSE. For instance, visual cue positively influenced food intake in Round 1, negatively influenced food intake in Round 2, and was not significant in Round 3. However, once we controlled for PSE and analysed the data longitudinally by tracking the food intake of individual participants, we were able to show consistently significant effects of auditory and olfactory cues, and consistently non-significant results for the visual cue. Collectively, the results support our postulation that not controlling for portion size or not tracking the eating behaviour of elderly consumers over time, would yield an inaccurate or incomplete picture of how environmental factors may influence food intake.

Research regarding the relationship between environmental cues and food intake has predominantly taken place in commercial settings—less research has been performed in the healthcare domain. The present study aimed to determine the effects of environmental factors—specifically auditory, olfactory and visual cues—on food intake of elderly consumers in a healthcare setting. While commercial food services are profit oriented (e.g. fast-food chain, cafeteria and full-service restaurants) and their primary aim is to gain a return from the food and services they provide (Dipietro, 2017), healthcare settings (e.g. hospitals and aged care providers) offer food services alongside care and treatment services that are

often cost oriented. In these settings, food services are usually given a certain budget to cover the cost of food and service operations (Agarwal *et al.*, 2016). Given the differences between commercial and health care settings, this study extends previous research regarding the effectiveness of environmental cues from a commercial (restaurant) setting to a healthcare setting concerning the issue of obesity in aged care.

### ***Managerial implications***

The findings regarding the influence of environmental cues would give aged-care facilities another avenue to help tackle obesity among their residents. Our results show that an increased portion size, as well as the presence of olfactory or auditory environmental cues may result in elderly consumers eating more. Hence, in order to better control over-eating and obesity, and potentially achieve cost savings on food service, healthcare settings like aged-care homes should control portion sizes and not provide such environmental-based sensory stimulations during dining. While the dining environment need not be bland or dull, neither should the environment be manipulated with cues that would appeal to or create heightened response of auditory or olfactory sensory channels. If such cues can indeed lift elderly consumers' mood or reduce depressive mindset (Swartz *et al.*, 1992; Thomas and Smith, 2009), they can and should instead be used in other non-meal settings within a facility. Understanding the role of PSE would allow aged care providers to optimise the amount of food served, depending on specific residents' health requirements (Heikkilä *et al.*, 2016; Strotmann *et al.*, 2017). Food serving portion significantly influenced food intake of elderly in aged care. To minimise the risk of obesity, food amounts should be specifically tailored for

the residents. The facility should work with nutritionists to strategise the right food amount according to the suitable portion size.

Interestingly, while this study concerns obesity with elderly consumers, malnutrition is as big, if not a bigger, a problem with this same cohort (Amarya *et al.*, 2015; Carrier *et al.*, 2007). Similar to obesity, malnutrition is a risk factor to various diseases among the elderly, and a primary cause of malnutrition is inadequate food intake (Harris and Sharma, 2018; Sharma *et al.*, 2016). Since all elderly consumers dined in the same room (i.e., environment), manipulating sensory cues in the environment would aid one group (e.g., reducing food intake among obese residents) and harm the other (reducing food intake among the malnutrition residents). This suggests that aged-care facilities need to pre-identify residents who are obese or suffering from malnutrition, and separate them in different dining environments or stagger their meal-time. The environmental cues can then be manipulated for each group separately. That said, we acknowledge that in terms of dietetic management of obesity, dieticians sometimes do not recommend adults over 65 years of age to lose weight unless they are morbidly obese (e.g., see Morley *et al.*, 2010). At this age, more muscle than fat is lost, making older adults more prone to falls, resulting in a high rate of mortality. Because of this, healthcare settings often try to preserve what muscles residents have by maintaining an obese weight. In such situations, environmental cues can be used without separating dining rooms.

A separate but noteworthy issue is that the overall macronutrient intake of the food item served in this study (fish and chips) was not consistent with the dietary guidelines for older adults, according to the Australian Dietary Guidelines for older adults (Nutrition Australia, 2013). Macronutrient analyses showed that a typical meal of fish and chips contains at least 12%–16% protein, 21%–47% fat and 46%–51% carbohydrates. These contrast with the recommended intake of 30%–36% of protein, 4%–6% of fat and 58%–66%

of carbohydrates (Nutrition Australia, 2013). Bearing in mind that this food item is standard on the facility's menu, it suggests that aged-care homes should deliberately design menus for obese residents. This example highlights the issue that a factor in unintentional weight gain in residents is the low daily budget, and the food service facilities that control costs by using pre-prepared food, freezing and defrosting on site. Food that can handle this preparation and budget typically has high caloric content with little fresh produce, thus contributing to the weight gain.

### **Conclusion and Future Research**

Aging populations and the associated health issues linked with obesity are prevalent particularly in the developed world, and have created enormous challenges and cost burden for society (Donini *et al.*, 2012; Elia, 2001; Kennedy *et al.*, 2004; Silva *et al.*, 2020; Wang *et al.*, 2018). Managing obesity through regulating food intake is an effective way to manage obesity among the older population. While research into tackling obesity has focused primarily on approaches including pharmacotherapical treatments with drugs (Li and Cheung, 2009), diet management, and lifestyle change (Elia, 2001; Kennedy *et al.*, 2004), we have shown in this study that managing environmental factors may also be effective. Additionally, this approach of managing environmental factors is highly feasible and practical, especially when aged-care homes are typically operating under strict budget constraints. For example, Clancy *et al.* (2019) reported that on average, Australian aged-care facilities budget about \$8 per resident per day for catering, including food and drinks, supplements, and all other catering supplies (also see Hugo *et al.*, 2018).

While this study has demonstrated the effects of environmental factors on food intake among elderly consumers in an aged-care home, further research can help extend the generalisability of and shed further light on our findings. While we needed to keep the food

item (fish and chips) constant throughout the experiments to minimise response bias, anecdotal discussions with the participating aged-home staff revealed that this item is generally liked by the residents. An ensuing question is thus whether the same effects could be replicated with food that is liked less.

We failed to detect any effects with our visual cue, and speculated that the infographic card might not appeal through sensory channels. Future research should use visual cues (flower arrangements) that are more likely to appeal through sensory channels than via cognitive processing. Also, we tested the environmental cues individually, rather than in combinations, and it would be useful to determine any additive or multiplicative effects through the simultaneous use of multiple cues.

Importantly, we did not measure the residents' mood and emotions, particularly at dining time. Although our longitudinal design coupled with within-subjects analyses would have reduced bias from potential heterogeneity in affectivity feelings, it is useful to measure this as a potential determinant of food intake. It would be useful to also have a record of each individual's weight to see if the noted effects are consistent across the various weight categorisations. Contextually and theoretically, future research can be extended to another important group of consumers, i.e., children, to understand the efficacy of marketing cues in reducing obesity. Such experimental research can be conducted in childcare centres or schools. We also acknowledge that obese individuals can be malnourished and suffer from sarcopenic obesity. These residents would be on a high energy and protein diet to stabilise their weight, even if they are obese. Given this, a limitation is our simplistic separation of obese and healthy weight residents, as malnutrition transcends BMI. Future studies with more nuanced metrics would be useful for deepening our understanding of these issues.

To conclude, as the global population ages (United Nations, 2019), obesity among elderly consumers is a critical issue that is endemic in many societies (Donini *et al.*, 2012;

Elia, 2001; Kennedy *et al.*, 2004; Silva *et al.*, 2020; Wang *et al.*, 2018). However, research has not yet adequately explored different approaches to help combat this problem, and our review suggests that more research is needed from a marketing perspective especially given the confounding findings in existing studies. In this regard, this longitudinal study provides further evidence that geriatric obesity may be tackled by drawing on how environmental cues may influence food intake quantity. While this approach *alone* is unlikely to resolve the obesity problem, it provides aged-care homes with another tool at their disposal, with the aim to provide better health outcomes and quality of life to their elderly consumers.

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## Annex I. Visual Infographic Cues Used in the Experiments

***Fish*** is a good source of omega-3 fatty acids which are good for brain and heart health.

In fact, fish contains about 10-20 times more omega-3 than beef.



**Figure 1.**

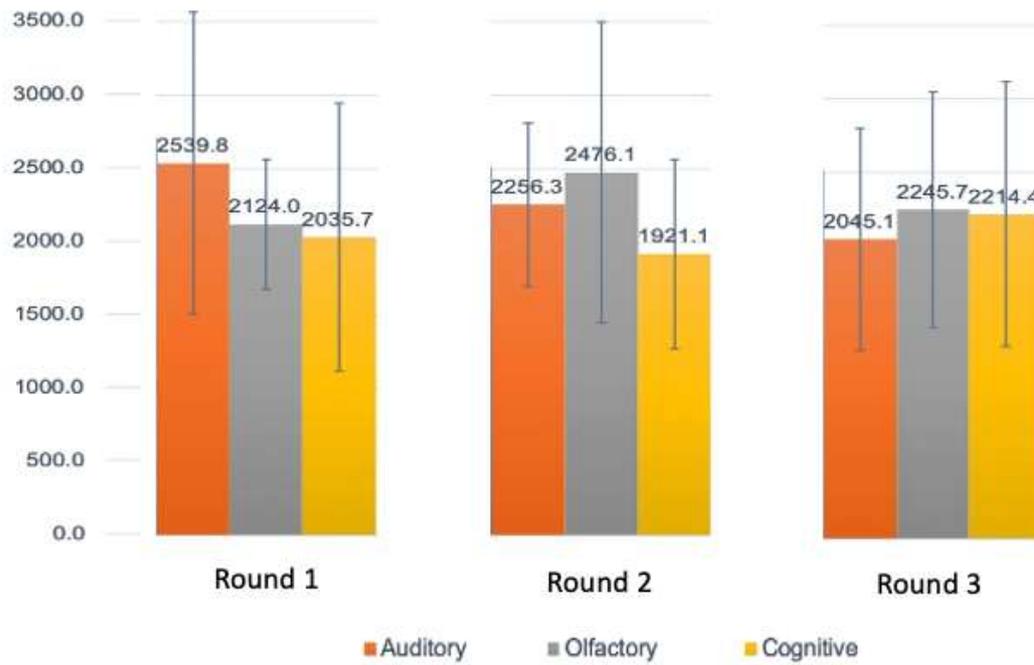
**a) View of Dining Room**



**b) Weighing of Food Components and Measurement of Drinks**



**Figure 2.**  
**Energy Intake (kJ) across Treatments and Rounds**



**Table 1.**  
**Review of Studies Quantifying the Effective of Environmental Factors on Elderly Consumers' Food Intake in Healthcare Settings**  
 (\* + = Positive Effect, 0 = No Effect)

Studies	Location	Participants	Treatment Type	Treatment	Study Duration	Food Intake (%)	Effect*
Elmståhl, Blabolil, Fex, Küller, and Steen (1987)	Swedish hospital geriatric long-term care facility	16 ( <i>M</i> = 80 years)	Visual	1940s décor	Four months (daily energy intake recorded once a week)	Up to 25% increase (1,379 kcal pre-experiment)	+
Ragneskog, Bråne, Karlsson, and Kihlgren (1996)	Swedish nursing home	25 with dementia ( <i>M</i> = 80 years)	Auditory	1. soothing music 2. 1920/30s music 3. pop/rock 1980s music	One-week control before intervention, two-week intervention for each music followed by two-week control during dinner	8% increase (443 g with music v. 409 g control)	+
Elliott and Poly (1999)	Long-term care facilities	15	Auditory, olfactory, visual	Home-mimicking environment (soothing music, cinnamon and apple heated scent, bright lighting with natural effects, coloured placemats and napkins)	Five-week crossover (control v. intervention weeks)	Correlation for increased food intake in music (47%) and fragrance (53%) but no effect for neither lighting nor colour	+/0
McDaniel et al. (2001)	Veterans extended care unit	16 with Alzheimer's disease (61–81 years)	Auditory, visual	Lighting (bright lights v. dimmed lights), noise (relaxing music v. no music)	Two five-day phases (breakfast and lunch): phase 1 contained less noise, bright lighting and no music and phase 2 contained more noise, relaxing music and dimmed lighting	6% increase in total food energy (6,167 kcal in phase 2 v. 5,837 kcal in phase 1)	+

Nijs (2006)	Dutch nursing homes	178 ( <i>M</i> = 77 years)	Visual	Family-style meal (e.g. used tablecloths, silverware, china, flowers, pre-plated meals)	Six months	Increased daily intake of 991 kJ between control and intervention groups—intervention group baseline (5,979 kJ) increased by 483 kJ and control group baseline (6,285 kJ) decreased by 420 kJ after six months	+
Thomas and Smith (2009)	US nursing home	12 with dementia ( <i>M</i> = 84 years)	Auditory	Familiar background music	24 lunch meals	20% (667 kcal without music, 797 kcal with music)	+
Bhat et al. (2016)	US skilled nursing facilities	254 (60–100 years)	Auditory, visual, Visual	Environmental changes to dining services (e.g. music, improved menu, food on request, food information available, buffet-style services)	Five months	16% (67%–77% food intake)	+
Owings (1990)	US long-term care facility	70–90 years	Visual	Coloured tray covers (i.e. red, yellow, black and white)	Eight weeks	No effect	0
Divert et al. (2015)	French nursing home	42 residents ( <i>M</i> = 87 years)	Visual, auditory	Two experimental conditions: (1) participants' chosen décor and (2) participants' chosen music	12 meals into two factors x three conditions served every 2 weeks Cross-sectional	No effect	0
Holst et al. (2017)	Denmark hospital wards containing elderly patients with various diseases	Baseline measurements of ( <i>n</i> = 30, <i>M</i> = 63 years) followed by a measurement after intervention ( <i>n</i> = 37, <i>M</i> = 67 years)	Visual, auditory	Improved environment (i.e. freshly painted walls, coloured tray mats, tablecloths, vase and soothing background music) and other interventions (i.e. improved menu, buffet-style serving and educated nurse and food service staff)	Three months	No effect	0

**Table 2.**  
**Main Experiment Design and Schedule**

<b>Round</b>	<b>Timeline</b>	<b>Dining Room 1</b>	<b>Dining Room 2</b>
<b>First Round</b>	Week 1		Treatment 2
	Week 2	Treatment 1	
	Week 3		Treatment 3
	Week 4	Treatment 2	Treatment 1
	Week 5	Treatment 3	
<b>Control 1</b>	Week 6	No Treatment	No Treatment
<b>Second Round</b>	Week 7	Treatment 1	
	Week 8		Treatment 2
	Week 9	Treatment 2	Treatment 3
	Week 10		Treatment 1
	Week 11	Treatment 3	
<b>Control 2</b>	Week 12	No Treatment	No Treatment
<b>Third Round</b>	Week 13	Treatment 3	Treatment 2
	Week 14	Treatment 1	Treatment 3
	Week 15	Treatment 2	
	Week 16		Treatment 1
<b>Control 3</b>	Week 17	No Treatment	No Treatment

**Table 3.**  
**Outcomes of Treatments on Energy Intake (with Covariates)**

<b>Treatment</b>	<b><math>\beta</math> Coefficient*</b>	<b>SE</b>	<b>z</b>	<b>p-value</b>	<b>95% CI</b>	
<b>Auditory</b>	181.96	83.07	2.19	0.028	19.14	344.77
<b>Olfactory</b>	165.12	82.08	2.01	0.044	4.25	325.99
<b>Visual</b>	32.26	84.02	0.38	0.701	-132.41	196.94

\* The raw  $\beta$  coefficient explained a one-unit decrease or increase in overall energy intake. For example, there was an increase of 181.96 kJ of overall energy intake under the auditory treatment compared to the control condition.