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Unwrapping nutrition: Exploring the impact of hospital food and beverage packaging on plate waste/intake in older people

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Unwrapping nutrition: Exploring the impact of hospital food and beverage packaging on plate waste/intake in older people

Abstract

Food and beverage packaging is increasingly used in hospital food service provision. Previous research has identified that the packaging used in New South Wales hospitals can be difficult to open by older adults. As older adults experience high rates of malnutrition, it is important to understand the effects of packaging on actual consumption of food and fluids. The aim of this study was to explore the impact of hospital food and beverage packaging on dietary intakes of 62 independently living older people (65 years and over) in a university simulated hospital ward in NSW, Australia. Participants were allocated to either a breakfast and snack meal or a lunch and snack meal on two occasions one week apart. Meals were served in a shared ward environment and each participant experienced a 'sealed' and 'pre-opened' meal and snack condition. The nutritional status of participants was measured using the Mini Nutritional Assessment - Short Form (MNA®-SF) and intake was estimated through an aggregated plate waste method. Overall findings were not significant for dietary intakes and the 'sealed' versus 'pre-opened' conditions. However, for the seven participants classified by the MNA®-SF as 'at risk' of malnutrition, packaging impeded intake for breakfast ($\eta^2 = -0.34$) and the high protein snack (cheese and biscuits) ($\eta^2 = -0.24$) meals. This finding has implications for the provision of packaged high protein snacks (cheese portions) and breakfast meals for the older inpatient. Further research is required for nutritionally compromised and frail older people in the hospital environment to investigate the impact of packaging on food and beverage consumption in detail.

Keywords

waste/intake, older, nutrition:, exploring, impact, hospital, unwrapping, food, people, beverage, packaging, plate

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TITLE:**UNWRAPPING NUTRITION: EXPLORING THE IMPACT OF HOSPITAL FOOD AND BEVERAGE PACKAGING ON PLATE WASTE/INTAKE IN OLDER PEOPLE****Alison F Bell¹, Linda C Tapsell¹, Karen A Walton¹, Marijka Batterham²**¹ School of Medicine, Faculty of Science, Medicine & Health, University of Wollongong, NSW 2522² National Institute for Applied Statistics Research Australia, University of Wollongong, NSW 2522**Corresponding Author:** Alison Bell abell@uow.edu.au

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Unwrapping nutrition: exploring the impact of hospital food and beverage packaging on plate waste/intake in older people

ABSTRACT

Food and beverage packaging is increasingly used in hospital food service provision. Previous research has identified that the packaging used in New South Wales hospitals can be difficult to open by older adults. As older adults experience high rates of malnutrition, it is important to understand the effects of packaging on actual consumption of food and fluids. The aim of this study was to explore the impact of hospital food and beverage packaging on dietary intakes of 62 independently living older people (65 years and over) in a university simulated hospital ward in NSW, Australia. Participants were allocated to either a breakfast and snack meal or a lunch and snack meal on two occasions one week apart. Meals were served in a shared ward environment and each participant experienced a 'sealed' and 'pre-opened' meal and snack condition. The nutritional status of participants was measured using the Mini Nutritional Assessment - Short Form (MNA®-SF) and intake was estimated through an aggregated plate waste method. Overall findings were not significant for dietary intakes and the 'sealed' versus 'pre-opened' conditions. However, for the seven participants classified by the MNA®-SF as 'at risk' of malnutrition, packaging impeded intake for breakfast ($\eta^2 = -.34$) and the high protein snack (cheese and biscuits) ($\eta^2 = -.24$) meals. This finding has implications for the provision of packaged high protein snacks (cheese portions) and breakfast meals for the older inpatient. Further research is required for nutritionally compromised and frail older people in the hospital environment to investigate the impact of packaging on food and beverage consumption in detail.

Keywords: hospital food service; older adults; packaging; plate waste; dietary intake.

INTRODUCTION

Malnutrition in older adults is well known with prevalence rates in the community at 8-10% and rates of 40-60% in hospitals (Kelly 2000, Brantervik 2005, Norman 2008, Barker 2011, Pereira 2015). Malnourished older inpatients have longer lengths of

stay, increased risk of complications and an increased risk of mortality (Chima 1997, Correia and Waitzberg 2003, Hiesmayr 2009). Supporting these nutritionally compromised older adults presents a challenge to food service systems within hospitals where there are cost pressures and increasing numbers of patients (Garling 2008). An effective and efficient food service should deliver both good value for the hospital and high quality nutrition to the inpatient with minimal waste. Plate waste in hospitals is found to vary between 6-65% with a median of 30% (Williams 2011); and malnutrition rates have historically remained relatively unchanged (Beck 2001, Holyday 2012). In an effort to provide cost effective nutrition to patients, many hospitals are now outsourcing food service so that it becomes a hospitality function rather than a core component of care (Davis 1999, Mibey 2002). This has led to the use of single-serve pre-packed food and beverages as the default method of nutrition provision (Garling 2008). The impact of this increasing use of packed food and beverage products in hospital food service on food waste, dietary intakes and malnutrition is unknown (Bell 2015).

A number of researchers have identified an inability to access this food and beverage packaging as a contributing factor for malnutrition in hospitals amongst older and or disabled people (Schenker 2003, Walton 2006, Manning, Harris et al. 2012, Walton 2012). Within this context of packed food service, the challenge is encouraging dietary intakes in older adults, who have lower appetites and are less able to discern taste and smell (Teo 2001, Nohra 2015). A number of strategies have been found to assist, including serving smaller, energy dense portions and high protein snacks, such as cheese (Gall 1998, Barton 2000, Kondrup 2002); having protected meal times and using smaller serving sizes (Walton 2012). The difficulties that packaging can pose to patients has been recognised by NSW Health, a state government health authority, which was involved in the development of an Accessibility Benchmarking Scale for use in tender specifications (HealthShare NSW Arthritis Australia 2012). Food products must meet an acceptable standard of accessibility to be used by the hospital food service.

In a recent hospital study we demonstrated a reduced ability to open food and beverage packaging by older patients, with 40% reporting difficulty opening both water bottles and tetra paks® (Bell 2013). Subsequent observational laboratory

studies with well, independently living older people (Bell 2016 a) have demonstrated that lying in a hospital bed significantly decreases the older person's pinch grip strength and macro-dexterity; both required for efficient pack opening. The aim of this study is to extend the previous research and determine the impact of packaging on actual consumption of foods served routinely in hospital.

METHODS

Participants

The participants in this study were well older adults living in the Illawarra region of NSW, Australia. A non-probability convenience sample was recruited via newspaper advertisement, flyers distributed to local aged care providers, General Practice (GP) locations and seniors' organisations, as well as an email invitation to the university community and volunteers of the Medical School. Inclusion criteria included being 65 years or older, well (no self-reported limb weakness or cognitive impairment) and living independently in the community. Participants were excluded if they ate a special diet (diabetic; lactose free; low fat; soft; pureed), had a visual deficit not corrected with glasses, had self-reported severe arthritis, a history of Cerebrovascular Accident (CVA) or a diagnosis of dementia. Well independently living older adults were chosen for this study as recruiting older hospital inpatients was deemed impractical due to fluctuating medical conditions and availability.

Participants registered their interest in the study via email or telephone and were sent an information pack. A telephone interview was conducted with tacit approval obtained to gather relevant information to screen for suitability. The pre-screen questionnaire included (i) baseline demographic data and questions about menu choices (based on food served in NSW public hospitals at the time); (ii) normal appetite and diet questions (special diets, food intolerances were excluded); and (iii) transport arrangements.

Participants were required to attend the university on 2 occasions, one week apart, forgo their normal breakfast or lunch meal and remain for 3 hours, so that there was at least a two and half hour time gap between the meal and the snack. Breakfast

was served at 8am, 8.30am and 9am, depending on participant preference. Participants fasted prior to attending breakfast meals. Lunch was served at midday, 12.30pm and 1pm, again depending on participant preference. Participants were asked to eat only a light breakfast prior to attending the study for the lunch meal.

Meals were consumed in a hospital bed in a simulated shared ward hospital environment. A biostatistician advised that the design investigating the effect of packed food service on intake required a sample size of 60 people to be adequately powered ($p < 0.05$ and 80%). Participants were randomly allocated to condition (a) 'pre-opened' or (b) 'sealed' and sample was evenly split to ensure participants were their own controls (if packaged meal pre-opened on occasion 1, the same meal will be sealed on occasion 2 for the individual participant or vice versa). Meals were consistent across the two occasions; that is, if the participant attended breakfast on occasion 1, they also attended breakfast on occasion 2.

Research Setting

The research was conducted in a university simulated hospital ward in NSW, Australia. The facility consisted of 2 by 3 bed shared ward suites and interview rooms. In-situ video recording devices were at each end of the bed with a secondary camera on a tripod positioned to capture the food tray. Beds were coded for 'pre-opened' condition (a) and 'sealed' condition (b) and arranged so that adjacent participants were experiencing different test conditions. Figure 2 shows the room set-up. Ethics approval for the study was obtained from the University of Wollongong (HE13/465).

Figure 2. Simulated hospital shared ward with in-situ cameras and colour coding on beds

Bed Posture

Bed angle and bed table height were standardised for the study. The distance between the mattress and top of bedside table was 27cm to enable leg clearance and reasonable eating height. The bed angle was set at 60° - a 'modified' Fowler's bed position (Metzler 1996) with one standard hospital pillow. Participants were instructed not to change the bed angle or tray table height; they were able to move the tray table closer or further away from themselves for eating comfort. In this way, participants were given the optimum posture for eating in bed.

Food items

A range of regularly used single-serve hospital food and beverage items were sourced from a local hospital and served for breakfast and snack, or lunch and snack. The exception was the sandwiches, which were prepared fresh in the teaching kitchen adjacent to the simulated hospital ward and the individual boxed cereal (with internal plastic bag), which was purchased separately. As such, with the exception of the boxed cereal, all products had been accepted by NSW Health as appropriate for patients to open independently. Breakfast consisted of orange juice, fruit cup (fruit pieces in syrup), individual cereal box, 150ml milk bottle (screw-cap), bread in unsealed plastic bag, margarine serve, condiment (jam or vegemite®),

151 coffee sachet, tea bag, cup hot water for tea/coffee, sugar serve, milk portion for
152 tea/coffee. Figure 3 outlines the packaged items. It should be noted that cereal
153 boxes are no longer routinely used in NSW public hospitals, however they were used
154 to provide consistency with two previous studies by the author.

155
156 The study timing meant that the hospital sandwiches would not have been fresh
157 when needed, and thus they were prepared using typical ingredients on the study
158 days. Breakfast, lunch and snack meals were chosen to reduce participant burden,
159 as an evening meal would have created a large participant burden to attend the
160 university at night. Lunch consisted of a sandwich in plastic triangle pack, individual
161 dessert custard, fruit cup (processed fruit pieces in syrup) and flavoured milk in an
162 individual tetra pak®. Figure 4 shows the lunch items. The snack provided to all
163 participants was a single serve plastic flow-wrapped cheese portion, individual serve
164 plastic flow-wrapped savoury biscuits and health service plastic 600ml bottled water
165 as seen in Figure 5. NSW Health plastic cutlery was provided for the meals for
166 consistency with hospital food service.

167
168 These food items are commonly used in local hospitals and in the community. Food
169 and beverage packs were opened by research assistants at the bedside for
170 participants on the 'pre-opened' protocol. The products were opened in front of the
171 participant to allay any fears of food safety. The research assistants did not discuss
172 the opening process with the participant. Examples of food trays and the common
173 NSW hospital food items provided to the participants for each meal/snack are shown
174 in Figures 3, 4 and 5.

Figure 3. Breakfast tray

Figure 4. Lunch tray

Figure 5. Snack tray

Nutritional Assessment

The validated Mini Nutritional Assessment-Short Form (MNA®-SF) (Guigoz 2006) for people over 65 years was used by a dietitian to establish the nutritional status of each participant. This form was selected as it is a valid and reliable tool suitable for use with well independently living older adults as it has high sensitivity and specificity (Phillips 2010). It consists of 6 scored items distilled from the 18 items in the full MNA® (Rubenstein 2001, Kaiser 2009). A score of 0-7 indicates malnutrition, 8-11 'at risk' of malnutrition and a score of 12-14 indicating normal nutritional status. The form was administered by dietitians experienced in its use at the participant's first visit to the simulated hospital ward. Weights (kg) and heights (m) were also measured using portable SECA scales (SECA 874 +/- 100g) and stadiometer (SECA 217 1mm graduation) in order to determine the participant's Body Mass Index (BMI).

Questionnaires

Assessment of usual food intake and appetite

An appetite and dietary intake questionnaire was conducted before meals with each participant on each research day to capture other influences on intakes. This self-report data was used to determine any changes in participant appetite and health between the two occasions. Participants were asked when they last ate or drank; how they rated their appetite that day ('about normal', 'better than normal', 'worse than normal'); and how they rated their general health ('excellent', 'very good', 'good', 'fair', 'poor'). Participants were also asked to rate the quality and quantity of food provided on the study days ('excellent', 'very good', 'good', 'fair', 'poor').

Packaging assessment

After participants had completed their condition (b) sealed packaging, researchers administered a packaging assessment questionnaire. Participants were asked if they required reading glasses to open packaging and if their vision affected their ability to open packaging. Participants were then asked to rate the ease of opening of the packaged food and beverage items in the study using a 4-point scale: Ratings were 'easy', 'some difficulty', 'difficult', 'impossible'. This pack rating scoring system has been used in previous studies by the author (Bell 2013, Bell 2016 a, Bell 2016 b, Bell 2017).

Video data

The video data was used to calculate both the time taken and the number of attempts to open the packs. Previous research by the authors (Bell 2013, Bell 2016 b) had established criteria for this analysis and experienced researchers reviewed the video data.

Plate waste/Intake

A sample of each item served at each meal was weighed prior to the testing day using a single set of electronic scales (CAS Smart Weighing Scale SW-1; accurate to $\pm 1\text{g}$), in order to determine baseline weights for later comparison. On the research days, the individual trays were photographed pre and post-delivery to the 'hospital ward'. The plate waste from each tray, including beverages, was weighed and recorded after the meal was consumed using an 'aggregated plate waste' (Williams 2011) approach. We have used the difference between the standard weights and post-delivery weight to determine intake, adapting the method used by other food waste researchers (Barton 2000).

Data analysis

Data for all phases were analysed using the Statistical Package for the Social Sciences SPSS V24 (IBM. 2012). Descriptive statistics were developed for data from questionnaires and sealed mealtime recordings. Pearson's correlation coefficient was used to explore potential relationships between time taken to open the packages and dietary intake. Paired samples t-tests were used to compare the differences in food and beverage intake between meals with different pack conditions. The effect of condition (a) pack open or (b) pack sealed within each MNA®-SF status group was determined using the eta squared statistic due to low participant numbers. Cohen (Pallant 2005) states that an eta squared value of 0.01 is a small effect; 0.06 a moderate effect; and 0.14 a large effect.

RESULTS

Participants

Sixty-two participants aged between 66 and 87 years, with a mean age of 73.9 years (SD ± 4.9) completed the full protocol of the study; 45 females with a mean age of

73.6 years (SD ± 4.6) and 19 males with a mean age of 74.6 years (SD ± 5.5). Sixty three participants completed the nutritional screening component, 44 females and 19 males. Three percent of participants had a BMI $< 21\text{kg/m}^2$, while 84% had a BMI $> 23\text{kg/m}^2$. Results for MNA®-SF status and intake are reported on 62 participants with 7 participants in this full protocol group found to be in the 'at risk of malnutrition' on the MNA®-SF assessment, representing 14% (n = 6) of female participants (aged between 72 and 85 years) and 5% (n = 1) of male participants (aged 76 years).

Nearly all participants (n = 60; 94%) were right hand dominant and most (n = 56; 88%) reported needing to wear glasses to open packaging. The majority of participants (n = 59; 92%) ate three meals per day and reported their appetite as 'good' to 'very good' (n = 61; 95%). Most people (n = 52; 83%) reported their health as 'good' to 'excellent'. A small proportion were found to be malnourished (n = 7; 11%). These participants rated their appetite as 'poor' (n = 3), 'good' (n = 3) and 'very good' (n = 1); and their health as 'fair' (n = 2), 'good' (n = 4) and 'very good' (n = 1). As appetite on the testing days may have influenced intake, participants were asked to rate their appetite at each visit. Results are presented in Table 1 for the appetite responses for each category of MNA®-SF.

Table 1. Subject's appetite differences between visit 1 and 2 per nutritional status

MNA ® -SF status	Appetite					
	Normal		Better than normal		Worse than normal	
	Visit 1 (n)	Visit 2 (n)	Visit 1 (n)	Visit 2 (n)	Visit 1 (n)	Visit 2 (n)
Normal nutritional status	53	53	2	0	1	2
At risk of malnutrition	7	6	0	0	0	1
Total	60	59	2	0	1	3

Questionnaires

Participants were asked when they last ate or drank prior to attending each of the study days. Lapsed hours were $M = 11.3$ (SD ± 4.1)hrs and $M = 9.7$ (SD ± 4.7)hrs for

breakfast + snack, Visit 1 and 2; $M = 3.8$ (SD ± 1.3)hrs and $M = 3.5$ (SD ± 1.4)hrs for lunch + snack, Visit 1 and 2.

Participants were also asked to rate the quality and quantity of the food they were given for their meals. The lunch + snack meal was rated as better for both quality and quantity than the breakfast + snack meal with 67 % ($n = 22$) rating lunch + snack as 'very good to excellent' for both quality and quantity compared to 37% ($n = 11$) of breakfast + snack participants on both these factors.

Food Packaging

Four pack types had greater than a mean of 5 opening attempts; the cheese portion, the biscuit portion, the water bottle and the tetra pak®. Three people could not open the water bottle or the biscuit portion at all. The cheese portion had the longest opening time among the packs, with a maximum time of almost 5 minutes ($M = 45$ s); it also had the most number of attempts with a maximum of 46 ($M = 5$). The biscuit portion had a maximum of 32 attempts to open ($M = 6$), with a maximum of 3 minutes ($M = 30$ s). The water bottle had a maximum of 20 attempts at opening ($M = 7$); while taking a maximum of 1 minute ($M = 15$ s). The flavoured milk tetra pak® had a maximum time of 1.1 minutes ($M = 36$ s); as well as a maximum of 13 attempts to remove the straw from the side of the pack ($M = 6$). Items with a mean number of attempts greater than 2.5 also include the fruit cup ($M = 4$) the milk portion ($M = 3$) and the milk 150ml ($M = 3$).

Table 2 reports the ease of opening ratings by the participants. The water bottle, cheese portion, biscuit portion, fruit cup and tetra pak® rated the most poorly of the packs; followed by the 150ml milk and boxed cereal.

Table 2. Ease of opening ratings for food and beverage products; most difficult items highlighted.

Product	N	Easy (%)	Some difficulty (%)	Difficult (%)	Impossible (%)
Juice cup	29	72	28	0	0
Milk 150ml	31	90	3	7	0
Box cereal	31	77	16	7	0
Milk portion	29	83	17	0	0

Coffee sachet	31	97	3	0	0
Sugar sachet	29	97	3	0	0
Bread	30	100	0	0	0
Margarine portion	30	97	3	0	0
Vegemite® portion	29	97	0	3	0
Condiment	28	100	0	0	0
Water bottle	63	76	10	10	4
Cheese portion	63	65	22	11	2
Biscuit portion	59	61	29	5	5
Fruit Cup	60	62	32	5	1
Tetra pak®	31	61	29	10	0
S'wich Triangle	32	100	0	0	0
Custard	32	88	12	0	0

Dietary Intake

There were no significant differences in intakes between the two conditions for any of the meals. The intake for breakfast sealed ($M = 488.4\text{g}$, $SD = 171.1\text{g}$) and intake for breakfast open [$M = 458.9\text{g}$, $SD = 160.6\text{g}$, $t(29) = 1.14$, $p = .265$]; the intake for snack sealed ($M = 282.1\text{g}$, $SD = 139.2\text{g}$) and intake for snack open [$M = 299.4\text{g}$, $SD = 143.3\text{g}$, $t(61) = -.82$, $p = .415$]; and the intake for lunch sealed ($M = 478.0\text{g}$, $SD = 172.4\text{g}$) and intake for lunch open [$M = 485.1\text{g}$, $SD = 167.5$, $t(31) = -.20$, $p = .843$]. There were no significant differences between gender for total intake with the different pack conditions, pre-opened and sealed. About a third ($n = 21$; 33%) of participants lived alone and no relationship was found between living alone and dietary intake.

No significant differences overall were found between the pre-opened and sealed conditions for intake and MNA®-SF status. The mean intake of each group is shown in Table 3, with differences in intake in grams and percentage of mean 'normal' intake. The 'at risk of malnutrition' participants ate less at each meal and in each condition, with the exception of breakfast in the pre-opened condition, where they ate 14% more than the nourished nutrition group. The 'at risk' participants ate 30% less of the sealed snack than the nourished nutrition group, compared to 5% less in the opened snack condition, as measured by plate waste.

Effect size was determined to further explore the differences in intake between the 'at risk' of malnutrition and other participants for the breakfast and snack meals. The sealed packaging condition had a large negative effect on intake for both breakfast and the snack meals. Breakfast [$M = -44.25$, $SD = 71.55$; $t(3) = -1.237$, $p = .304$] with the eta squared statistic ($-.34$); and snack [$M = -82.43$, $SD = 157.90$; $t(6) = -1.381$, $p = .216$] with eta squared statistic ($-.24$).

Table 3. Differences in intake (gm) for the MNA®-SF groups for each meal and each condition

Meal	MNA Status	N	Mean (g)	Std. Deviation (SD) (g)	'at risk' Intake difference (g)	'at risk' Intake difference (%)
B'fast sealed	Nourished	26	491.5	177.6		
	'At risk'	4	468.3	139.5	-23.3	-5
B'fast pre-opened	Nourished	26	447.9	153.5		
	'At risk'	4	512.5	104.4	+64.7	+14
Snack sealed	Nourished	55	299.7	144.1		
	'At risk'	7	209.9	133.4	-89.8	-30
Snack pre-opened	Nourished	56	307.1	142.1		
	'At risk'	7	292.3	150.9	-14.8	-5
Lunch sealed	Nourished	29	480.7	175.5		
	'At risk'	3	452.7	169.0	-28.0	-6
Lunch pre-opened	Nourished	30	495.9	152.4		
	'At risk'	3	427.3	320.0	-68.5	-14

DISCUSSION:

In a previous study, we found that at least 40% of older patients had difficulty opening the food and beverage packs used in their hospital meal service delivery (Bell 2013). Further laboratory studies have found that well, community dwelling older people have similar issues with the packaging served in NSW hospitals (Bell 2016 b). Here we have extended that previous research and found that packaging impedes consumption of high protein snacks in older adults 'at risk of malnutrition' in our exploratory study of well, community dwelling older adults.

These results add strength to our previous research in both hospital and community settings, that older people may find cheese portions, biscuit portions, water bottles, tetra paks®, fruit cups, milk portions and 150ml milk bottles the most difficult packs to open. This research further exposed the problem in terms of time taken, number of attempts to open and ratings of 'openability'. The participants in this study were independently functioning older adults living in the community, motivated and committed to the research, yet they found some of the packaging difficult to open and three people were unable to open the water bottle or biscuit pack at all.

Seven participants (11%) who completed the 2 day protocol were found to be 'at risk' of malnutrition. While this is consistent with the estimate of 10% of community living adults by BAPEN (BAPEN 2006), it was unexpected as the study had a high participant burden. Participants were required to make their own way to the facility at identical times a week apart and eat identical meals, staying at the university for approximately 3 hours on each occasion.

In view of this high level of participant commitment, it is not surprising that no significant differences were found in intakes between the two breakfast and lunch meals for the sealed and pre-opened packaging conditions. However, the sealed pack condition had a large negative effect on the dietary intake of the 'at risk' of malnutrition group for both breakfast and the snack meals. The higher food intake for breakfast in the pre-opened condition suggests that breakfast would be a good meal for encouraging intakes in people 'at risk' of malnutrition.

Energy dense snacks such as cheese portions are an important source of protein for older people, and have been used to encourage intake in malnourished older adults and those at risk of malnourishment (Barton 2000, Walton 2012). However, we found that the packaging of this important item inhibited consumption in the 'at risk of malnutrition' group. Additionally, the tetra pak®, often used to serve high protein, high energy supplements to malnourished older adults presented difficulties for some of the participants, who took a maximum of 13 attempts to remove the straw from the side of the pack.

There are a number of limitations to this study. The participants are self-selected and may not be representative of the wider older adult community. The shared ward environment may have encouraged competition between participants, and it was observed that a number of participants gave verbal 'clues' on opening packages to their neighbours. Errors could have been made in measuring the plate waste in that slight spillage could have occurred transporting meals to and from the test kitchen; and participants elected not to open and eat a number of items (as reflected in the data shown in Table 2). As the water bottle was a large component of the snack meal, differences in consumption over the two conditions could have adversely affected the intake calculation, with participants being inconsistent in their drinking between visits. The simulated hospital ward, however, was air-conditioned and the study took place on two consecutive weeks in May, with mild ambient temperatures.

This study was conducted in a laboratory setting to simulate a hospital and the results may or may not be transferrable to a hospital setting. Additionally, the sampling technique was purposive and judgemental in its approach in order to obtain well, community dwelling adults who would be willing to travel and attend the research. In fact, it is our contention that due to the high participant burden, the participants in this study were more likely to present the 'best case scenario' for both pack opening ability and food intake and consequently the plate waste/intake and openability issues found with these participants would be heightened in a hospital inpatient population.

The results do suggest that there may be an issue with packaging and subsequent food intake amongst people who are 'at risk' or 'malnourished'. This study should be replicated on a larger scale within a hospital or care setting to further investigate the impact of packaging on intake in vulnerable and unwell older people, with separate detailed dietary intake calculations for food (protein and carbohydrate) and beverages. Further studies with community dwelling older adults are also indicated. Packaged food and beverages are everyday items, regularly purchased and used by older consumers. Information from these consumers on pack preferences and reasons why some packs are avoided would be useful for designers and manufacturers of food and beverage packaging and for organisations purchasing packaging as part of their food service, such as care facilities and airlines.

CONCLUSION

This study is unique in investigating the impact of food and beverage packaging on the plate waste/intake of older adults. The impetus for this investigation is four fold. Firstly, as the population ages, older people will become the majority of hospital inpatients. Secondly, food and beverage packaging is increasingly the default method of food service provision, at least in the context of our research (NSW public hospitals). Thirdly, our previous research has shown that food and beverage packaging in hospital can be problematic for older people (Bell 2013, Bell 2016 a, Bell 2016 b). Fourthly, exploring the impact of packed food service on dietary intakes is a critical issue given that malnutrition in hospital is an established and an unfortunate reality (Kelly 2000, Brantervik 2005, Norman 2008, Barker 2011, Pereira 2015).

While this exploratory research with well older people found no overall relationship between packaging and dietary intake, we did find that for the 11% of participants 'at risk' of malnutrition, packaging did indeed impede their dietary intake for breakfast and snack meals. While the low subject numbers are insufficient to establish statistical significance, and the snack meal intake calculations include both food and beverages, the findings illustrate the potential pitfalls of a hospital packed food service in supporting the recovery of older people who are already nutritionally compromised, and highlight the need for detailed studies in this area.

Further research is needed to explore the impact of food and beverage packaging on dietary intakes in a hospitalised population, where many patients are 'at risk' of malnutrition or are indeed malnourished. While food service is unfortunately considered a hospitality function and not a key part of 'clinical care', further examination of the true costs and benefits of such a service needs to be determined by considering system/patient outcomes such as length of stay and readmission rates, not just the cost of food provision.

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