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Original article

Limited compensation at the following meal for protein and energy intake at a lunch meal in healthy free-living older adults

K.M. Appleton*

Research Centre for Behaviour Change, Department of Psychology, Bournemouth University, Dorset, UK

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SUMMARY

Various interventions have previously been found to increase protein intakes in older adults, but in free-living individuals, compensation for increased intakes at one meal may easily negate these effects resulting in limited long term benefit. This study investigated the impact of adding sauce to an older person's lunch meal on intakes at that meal, at the following meal and overall (lunch + evening meal). Using a repeated measures design, 52 participants consumed both a lunch meal with sauce and the same lunch meal without sauce on two separate occasions, and intake at this meal and at the following meal were measured. In all participants analysed together, the addition of sauce resulted in increased protein intakes at the lunch meal. Individual differences were also found, where for some individuals (n = 26), the addition of sauce resulted in significantly higher protein and energy intakes at the lunch meal (12.3 g protein, 381 kJ) and overall (11 g protein, 420 kJ), compared to the no-sauce condition, while for some individuals (n = 19), the sauce manipulation resulted in lower protein and energy intakes (lunch: 7 g protein, 297 kJ; overall: 7 g protein, 350 kJ). Compensation for earlier intakes was low (0–17%) for both groups. These findings demonstrate the possible value of adding sauce to an older person's meal for increasing intakes, and demonstrate a need for attention to individual differences. This study also confirms previous findings of limited compensation in older adults, but extends earlier studies to demonstrate limited compensation for the protein consumed in a complete meal in healthy older adults.

1. Introduction

Low protein intakes are currently thought to affect 8–77% community-dwelling older adults in the UK, US and across Europe [1–5], with resultant impacts on protein status [6–8], and various conditions associated with ageing, including decreased muscle mass and size, decreased bone mass and bone mineral density, increased incidence of falls, frailty, and osteoporotic fractures, decreased functional abilities, mobility and independence, decreased immune function, increased risk of infection, increased hospital stays, and increased morbidity and mortality [7–17].

Lower food intakes with age are largely attributed to deteriorations in appetite, changes in chemo-sensory abilities, and deteriorations in dentition, manual dexterity, and gastro-intestinal function [18–29], and studies suggest particular impacts on the consumption of protein-rich foods as a result of these changes [19,22,28–30].

Interventions that propose solutions based on these causes have demonstrated improvements in intakes [22,31–33]. We have reported increased protein intakes following the addition of sauces and seasonings to an older person's meal [31,32] as a result of improvements in taste [32], Kossioni et al., report increased protein intakes following the use of smaller cuts or pre-prepared meats by older adults [22], and Kelsheimer et al., report increased protein intakes following the use of specialized tools for older adults [33]. Not all individuals in these studies however, report benefits [22,33], and for interventions to impact on health and functional outcomes moreover, these higher intakes must be repeated and sustained over time. While sustained increases in intakes have been reported in individuals living in environments where intakes can be supervised (hospital and residential settings) [34,35], sustained increases may be more difficult to achieve in free-living individuals, where eating patterns tend to be less supervised, more flexible and less well structured. For these individuals, increases in food intake at a

* Research Centre for Behaviour Change, Department of Psychology, Bournemouth University, Poole House, Fern Barrow, Poole, BH12 5BB, UK. Fax: +44 (0) 1202 965315.
E-mail address: k.appleton@bournemouth.ac.uk.

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single meal as a result of an intervention may easily be negated by decreased consumption at the next meal.

Studies investigating compensation for earlier intakes at a subsequent meal largely suggest that older individuals compensate poorly, and thus that increased intakes at any one eating experience will result in an increased intake overall [36–38]. Giezenaar et al., 2015 [37] report only 1–5% compensation for a between-meal supplement on subsequent meal intake in healthy older men, Keene et al., 1998 [38] demonstrate only 23% compensation in healthy older adults, and we [36] have demonstrated a linear decrease in compensation with increasing age, again in healthy adults, where each increasing year of age was associated with a 2.4% reduction in compensation.

Not all studies however demonstrate low compensation in healthy older adults. Strum et al., 2003 [39] and Zandstra et al., 2000 [40] report 70% compensation and significant decreases in energy intake at a meal 90 min after an ice-cream and a yoghurt preload respectively, compared to control. Individual differences may explain the variety of findings between studies. All these studies furthermore investigate compensation using a between-meal eating experience, often composed of a liquid or semi-solid food, typically also with a low protein content, while a recent systematic review on compensation in a much wider range of studies [41] suggests differing effects over differing time intervals, better compensation for solid as opposed to liquid foods, and likely differences as a result of macronutrient content [41]. While macronutrient content was not investigated in this review, individual studies suggest better compensation for protein-rich foods, compared to other foods [42,43].

Differential effects based on inter-meal time interval, food form, and macronutrient content have implications when generalizing from the above studies to questions of compensation following an intervention to increase protein intake. No studies, as far as we are aware, have investigated compensation for the protein consumed in a complete meal at the next meal in healthy older adults.

The purpose of this investigation was three-fold. Firstly, we aimed to replicate earlier findings that the addition of sauce to an older persons lunch meal can increase protein intakes in healthy older adults at that meal [31,32]. Secondly, we aimed to extend these group-based findings to investigate differences between individuals. Thirdly, we aimed to investigate compensation for any increased intakes at the lunch meal, through the assessment of protein intakes at the following meal and overall (lunch + evening meal). We hypothesised that the addition of sauce to an older persons lunch meal would result in increased protein intakes at the lunch meal, and would have no impact on intakes at the evening meal, as a result of limited compensation, to result in increased protein intakes overall.

2. Methods

The study was conducted over two consecutive meals – a lunch meal and the subsequent evening meal, provided to participants on two separate study days. At one lunch occasion, sauce was added to the lunch meal, while on the other occasion no sauce was added. Intakes at lunches and evening meals were investigated.

2.1. Participants

Adults aged 65 years and over were suitable for the study if they were community-dwelling (i.e. were living in their own homes), were non-smokers, had no known food allergies, had no known taste or appetite abnormalities, were not taking any medication known to impact on taste or appetite, were familiar with and liked all foods in the study, could understand and comply with all study procedures and were able to come to the university for testing. The study was given ethical approval by the Research Ethics Committees of the School of Psychology, Queen's University, Belfast, UK and Bournemouth University, UK. The work was conducted in accordance with the Guidelines of Ethical Conduct from the British Psychological Society, and the Declaration of Helsinki. All participants provided informed consent prior to their involvement in the study.

2.2. Lunch meal

On both study days, the lunch meal provided consisted of oven-baked *Tesco* (*Cheshunt, UK*) chicken pieces (300 g), boiled *Tesco* (*Cheshunt, UK*) sweetcorn (250 g), boiled *Tesco* (*Cheshunt, UK*) carrots (250 g), and *Tesco* (*Cheshunt, UK*) mashed potatoes (325 g). The meal is a standard UK cooked meal that was familiar to all participants, was served hot, and as presented provided 3900 kJ energy, 80 g protein, 22 g fat and 98 g carbohydrate. Large portions were provided to allow *ad-libitum* intake, but unusually large portions were also avoided as these can be off-putting for older individuals [18]. On one study day, 100 g *Tesco* (*Cheshunt, UK*) chicken gravy (212 kJ, 0.3 g protein, 3.3 g fat, 4.0 g carbohydrate) was also provided with the meal. On the other study day, the meal was provided with no sauce or other condiments. Order of sauce/no sauce conditions were randomised between participants. On each study day, participants were instructed to 'consume as little or as much as you wish, please eat until you are comfortably full', and were given 30 min. Water was freely available during the meal. Following the meal, all participants were offered a cup of tea or coffee, as they usually take it. This drink was offered in place of a dessert. All participants received the same drink after both lunch meals.

2.3. Evening meal

On both study days, the evening meal provided consisted of 8 slices *Hovis* (*High Wycombe, UK*) Best of Both bread (304 g), one pot of 'I can't believe it's not butter' spread (*Unilever, London, UK*) (250–500 g), one pot of *Branston* (*Birmingham, UK*) pickle (180–360 g), one pot of Hellman's mayonnaise (*Unilever, London, UK*) (100–200 g), 100 g grated *Tesco* (*Cheshunt, UK*) cheddar cheese, 100 g *Tesco* (*Cheshunt, UK*) sliced ham, 2 *Wall's (Poole, UK)* sausage rolls (120 g), 3 *Tesco's* (*Welwyn Garden City, UK*) mini Pork pies (150 g), 50 g *Florette* (*Staffordshire, UK*) salad leaves, 50 g *Walkers* (*Leicester, UK*) ready salted crisps, 3 Cadbury's (*Premier Foods Group Ltd., London, UK*) individual chocolate swiss rolls (77 g), 3 Mr Kipling's (*Premier Foods Group Ltd., London, UK*) individual apple pies (177 g), 8 *Tesco* (*Welwyn Garden City, UK*) Highland shortbread biscuits (144 g), and 400 g *Princes* (*Liverpool, UK*) Fruit Cocktail in Juice. The foods are standard cold buffet meal and picnic-type foods used in the UK. Excluding the contribution from the sandwich spreads (butter, pickle, mayonnaise), the meal provided 17,890 kJ, 118 g protein, 223 g fat, 202 g carbohydrate. Amount of sandwich spreads provided varied per individual, based on the amount remaining in the pot following previous use. With the exception of the amount of sandwich spreads provided, the meal was identical on both study days, and sandwich spread provision did not differ systematically between conditions. On each study day, participants were instructed to 'consume as little or as much as you wish, please eat until you are comfortably full', and were given 30 min. Water was freely available during the meal.

2.4. Outcome measures

Test meal intake: Food intake at both lunch and evening meal was assessed by weighing all individual food items provided and returned [44,45], and nutrient intakes were calculated based on

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