International Journal of Food, Nutrition and Public Health, Vol. 4, No. 2, 2011

DO SOUP PRELOADS REDUCE TOTAL CALORIFIC INTAKE IN OVERWEIGHT AND OBESE SUBJECTS OUTSIDE THE LABORATORY? A PILOT STUDY

Jane Bailey[1] and Joanne Fiona Murray[2]

University of Westminster, UK

Abstract: Others have reported that soup preloads can reduce total energy intake. This pilot study investigates this phenomenon outside the laboratory within an overweight/ obese population. Subjects were used as their own control and divided into three groups: under-/normal weight (n=7), overweight (n=8) and obese (n=8). The subjects consumed three different preloads (no preload, 300 ml of water or 300 g of soup) prior to consuming an identical meal on three separate occasions. Visual analogue scales (VAS) were used to assess hunger ratings before the test, then hunger and satiety ratings were assessed both immediately after and one hour after eating. Any extra energy consumed before their next meal was also documented. The soup preload did not reduce total calorific intake. Satiety one hour after eating was significantly increased following the soup preload compared to no preload particularly in the obese. This could aid adherence to an energy restricted diet.

Keywords: *soup, water, preload, energy intake, hunger, satiety, weight management, calorie control, overweight, obese*

1Jane Bailey, School of Life Sciences, University of Westminster, 115 New Cavendish Street, London W1W 6UW, Email: jbaliey@btinternet.com
2Joanne Fiona Murray, School of Life Sciences, University of Westminster, 115 New Cavendish Street, London W1W 6UW, Email: J.F.Murray@westminster.ac.uk

INTRODUCTION

Feeding is core to our survival and, as a result of past food scarcity, we have evolved physiological mechanisms that promote feeding. This evolutionary trend has genetically predisposed a proportion of western society to weight gain as food is no longer scarce in our modern environment. The mechanisms that promote feeding and satiety are intricate, interdependent and well backed-up however they can be overridden by free choice. The employment of interventions that amplify feedback to the brain and register that we are full may help to speed up a feeling of satiety. Coupling that with interventions that also have a sustained effect, may then lead to reduced energy intake and induce weight loss.

Increased gastric distension and delayed gastric emptying are associated with feelings of satiety (reviewed by Delzenne *et al.*, 2010). Gastric distension is fed back to the brain by way of mechanoreceptors and chemoreceptors found in the stomach wall using neuroendocrine pathways. This feedback then orchestrates other pathways to adapt our feeding behaviour. This mechanism is not easily fooled. Volume and the content of the chyme are monitored constantly. Therefore increasing volume by water alone (as a beverage) is not enough (Rolls *et al.*, 1999) since it will leave the stomach fairly quickly. Conversely, protein takes the longest time to leave the stomach compared to other macronutrients and may provide an increased thermogenic effect (Bowen *et al.*, 2006). Protein slows gastric emptying as the stomach requires more time to break down this macronutrient to its smaller constituents, polypeptides or individual amino acids. Most types of soup combine volume and content: liquid with added food pieces. Preloading the stomach with a soup before a main meal has been shown to reduce the total energy intake of a subsequent meal (Kissileff, 1985; Himaya and Louis-Sylvestre, 1998; Rolls *et al.*, 1999; Mattes, 2005; Flood and Rolls, 2007). Viscosity of the soup preload does not seem to be a determinant in the reduction of energy intake in a subsequent test meal (Flood and Rolls, 2007). Therefore any choice of soup is acceptable but a high protein soup may have a greater effect.

Data gained in a laboratory setting may not translate into normal environmental conditions.

The energy reduction in the subsequent meal may be compensated for with increased feeding later on. The aims of this study were to determine if pre-loading a meal with soup would actually reduce the total energy intake until the next meal and whether such an approach was also effective in people with a Body Mass Index (BMI) in the overweight or obese range. Importantly, this pilot study aimed to test this approach under normal environmental conditions; that is, in "free-living" individuals outside the controlled environment of a laboratory.

METHODS

Ethics

In accordance with the University of Westminster's Research Ethics Sub-Committee's guidance, all subjects were given an information sheet describing the study and given the opportunity to ask any questions they had before giving their informed consent to participate.

Subjects

Subjects of both genders (10 males and 30 females) and both varying age and BMI range were recruited. The ages ranged from 18 to 76 years (mean = 36 ± 12 years). Subjects were classified by BMI with underweight being defined as having a BMI < 18.4 $kg.m^{-2}$, normal a BMI between 18.5 and 24.9 $kg.m^{-2}$, overweight a BMI between 25.0 and 29.9 $kg.m^{-2}$ and obese a BMI > 30 $kg.m^{-2}$. Inclusion criteria included the ability to eat the soup, to be aged over eighteen years and to have no side effects from any medication being taken. Exclusion criteria included being pregnant or breastfeeding for women and people with special dietary needs that would prevent them eating the soup.

Enrolment

At enrolment subjects were given an extensive interview to explain each step of the experiment in detail to make sure they understood what was required. Subjects were told that the purpose of the experiment was to study protein digestion in order not to influence their self reporting. This initial meeting was an essential procedure as the subjects would have to complete the experiment with no supervision. If the subject did not record all the information requested then their data set would not be complete and would have to be excluded because all components were required for the analyses. The height and weight of each subject were measured to calculate BMI. All subjects were given an information pack (which included record sheets for each test) and a sachet of soup.

Experimental design

The experiment used each subject as their own control. Each subject was asked to consume one of three preloads prior to consuming the same test meal on three separate occasions. They were instructed to eat/drink the required preload no more than ten minutes prior to their test meal with minimal consumption of food and beverages two hours before hand. On each occasion each subject was asked to record the same information.

Three preloads were used in a randomised order for each subject. Preloads along with rationale are as follows:

1. Nothing = control for each subject to ascertain normal feeding.
2. 300 ml of water = volume control for the soup.
3. 300 g of soup. “Look What We Found” Free Range Chicken Soup with Fresh Lemon Thyme from Sainsbury’s containing 0.816 MJ per portion.

The subjects were asked to pick a meal of their own choice to repeat for each test occasion. This meal had to be identical in every way possible; that is, exactly the same ingredients, the same weight of each ingredient and the same method of cooking. This meal will be referred to as the test meal for the remainder of the report but it is important to note that the test meal was different for each individual subject. Subjects were asked to use a meal of their choice to eliminate distaste for any food that may be included in a preset test meal. The only stipulation was it had to be a typical example of their usual menu in content and weight and be repeatable. The test occasions were separated by at least a week to decrease the risk of the subjects leaving food out of boredom. Any nutritional information from the packaging of any of the food consumed was attached to their results sheet. Any item of food not accounted for from packaging was analysed for energy content from the Food Standards Agency’s “McCance and Widdowson’s: The composition of foods” (2002). Subjects were asked to rate their hunger on a visual analogue scale (VAS) before consumption of anything. They were then asked to rate their hunger and satiety in the same way directly after and then again one hour after eating. They then detailed any other food or drink consumed until their next meal.

Visual analogue scales

Visual analogue scales (VAS) were used to monitor hunger and satiety before, after and one hour after the preload and test meal (Flint *et al.*, 2000). Each of the following questions was answered using a VAS.

Asked before eating anything:
Question one: how hungry are you?

Asked immediately after consuming the preload and test meal:
Question two: how hungry are you?
Question three: how satisfied are you?

Asked one hour after eating the preload and test meal:
Question four: how hungry are you?
Question five: how satisfied are you?

The VAS started with zero and ended with ten on a 10 cm line with 0 indicating either not at all hungry or satisfied to 10 representing as hungry as possible and 100% satisfied, respectively. The subject was asked to make a mark on the line in response to each question. The distance between 0 and their mark was used to quantify their response.

Energy analyses

Energy analyses for this report were calculated using Dietplan6 (Forestfield Software Ltd., Horsham, West Sussex, UK). Comparisons were made between each preload and the total energy consumed from the meal only, the extra food consumed after the meal and the total energy consumed. Total energy consumption for the three test situations is from (and including) consumption of the preload until the next meal. These comparisons were not only done for the total data set but also within each BMI range sub set.

Statistical analyses

All data sets were analysed using a one way Analysis of Variance (ANOVA) with a level of significance of $p = 0.05$. Any significant differences found were further analysed using Tukey's Honestly Significant Difference (HSD) multiple comparison procedure.

All data are reported as mean ± standard deviation unless otherwise specified.

Results

Subjects

A total of 40 subjects were recruited: 10 males and 30 females. Twelve subjects failed to return any data sets or withdrawal forms and five subjects returned unusable data sets and were therefore excluded from the analyses. Complete data sets for 23 subjects were therefore obtained, which included 7 males and 16 females. The mean age was 35.0 ± 10.9 years. The mean BMI was 29.0 ± 8.0 $kg.m^{-2}$ and a summary of subject numbers and percentages in each cateogory is given in Table 1. For separate BMI category analyses, the two underweight subjects and the seven normal subjects have been amalgamated into one group named "underweight/ normal".

Energy

Mean values for the total energy consumed from the test meal only, the extra food consumed after the test meal and the total energy consumed including the preloads is presented in Table 2. Whilst the preload of soup reduced energy intake of the test meal and subsequent food intake, after adjusting the total energy intake by adding in the energy of the soup preload there were no differences in the total energy intake between the three preloads. BMI had no effect on the total energy consumed when the soup preload was included (Table 3).

Hunger and satiety ratings

Before the preload and the test meal all subjects reported a similar feeling of hunger and whilst the preload and the test meal significantly reduced their feeling of hunger both immediately and one hour after consumption, there was no effect of the preload on the rating of hunger (Figure 1). Immediately following the meal all subjects reported similar feelings of satisfaction regardless of the preload consumed (Figure 2). One hour after the meal the subjects who had consumed the soup preload reported being more satisfied than those who had consumed nothing as a preload (ANOVA, Tukey's HSD: $P = 0.05$; Figure 2). When the effect of BMI on the rating of hunger one hour after the consumption of the preload and the test meal was assessed there was only a difference in those classified as underweight/normal: these subjects felt less hungry after the soup preload compared to after the nothing preload (ANOVA, Tukey's HSD: P = 0.05; Figure 3). The effect of BMI on the rating of satisfaction one hour after the consumption of the preload and the test meal was also assessed and there was only a difference in those classified as obese: these subjects felt more satisfied after the soup preload compared to after the nothing preload (ANOVA, Tukey's HSD: P = 0.05; Figure 4).

Discussion

Several laboratory studies show that preloading the stomach with a food high in volume and low in energy density, especially in the form of a soup, can reduce total energy intake (Kissileff, 1985; Himaya and Louis-Sylvestre, 1998; Rolls *et al.*, 1999; Mattes, 2005; Flood and Rolls, 2007). Two of these studies used only subjects with normal BMI scores (Rolls *et al.*, 1999; Flood and Rolls, 2007), another did not state the BMI of any of the subjects (Kissileff, 1985) whilst the other studies included overweight subjects however only a small proportion of the participants were obese. Furthermore several studies have suggested that preloads high in protein are far more effective at reducing subsequent energy intake than preloads containing the other macronutrients (Johnson and Vickers, 1993; Poppitt *et al.*, 1998). This pilot study aimed to test the reproducibility of reducing energy intake using a high protein soup preload outside the laboratory with a focus on overweight and obese individuals.

Outside a laboratory setting, consuming 300 g of a high protein soup, containing 0.816 MJ, no more than ten minutes prior to a test meal did not reduce total energy intake. The soup preload reduced the energy intake of the snacks eaten prior to the next meal and the subsequent meal but once the energy of the soup was added there was no overall reduction. There appeared to be no effect of BMI on the total amount of energy consumed. Whilst some researchers have reported a decrease in total energy intake following a high protein preload and/or soup preload others have found no effect: for example, when whey protein was given as a preload in healthy young adults there was no effect on total energy intake (Akhaven *et al.*, 2010).

Assuming the perceptions of hunger and satiety (measured using VAS) of each subject had an impact on their feeding behaviour, it would suggest that there was a difference between hunger and satiety triggers to regulate feeding between BMI groups. In under-/normal weight subjects (BMI < 24.9 kg.m^{-2}) the soup preload affected only hunger ratings significantly. In the overweight subjects (BMI between 25 to 29.9 kg.m^{-2}) the soup preload had no effect on either hunger or satiety. In the obese subjects (BMI > 30 kg.m^{-2}) the soup preload affected only satiety ratings significantly. These data suggest a shift with regards to influence from hunger to satiety with increased BMI scores. Whilst soups have been reported as being far more effective in inducing satiety than other foods (Rolls *et al.*, 1999; Flood and Rolls, 2007), the effect of BMI has not been investigated.

One explanation for the shift observed in this study may be because of hormonal changes in glucose metabolism and ghrelin regulation with increased BMI (Shiiya *et al.*, 2002). Increases in BMI are positively associated with insulin insensitivity leading to increased production of insulin without any physiological effect. Therefore in individuals with a higher BMI there may be increased circulating concentrations of both insulin and glucose. Stomach ghrelin expression is increased by insulin induced hypoglycaemia (Toshinai *et al.*, 2001). Before a meal circulating concentrations of ghrelin increase sharply and are followed by a postprandial decrease. Ghrelin circulating concentrations are also affected by BMI (Shiiya *et al.*, 2002). In overweight and obese subjects ghrelin concentrations are reduced in circulation and this may explain why there appeared to be no effect on the perception of hunger in these two groups.

The preload of 300 g of protein soup may have had an increased effect on the subjects with low BMI. Mechanoreceptors monitor stretch and tone of the stomach wall and communicate this to the brain via muscarinic receptors using the neurotransmitter acetylcholine via the vagus nerve (Smith and Morton, 2001; Mazda *et al.*, 2003). Distension is associated with a decrease in hunger scores during distension but not after distension has occurred (reviewed by Delzenne *et al.*, 2010). Stomach volume does not appear to increase with BMI (Park *et al.*, 2007) therefore the effect on satiety exerted through stomach distension after consuming 300 g of soup would not be expected to differ with BMI. There is evidence however that gastric emptying is faster in the obese than the lean (Vazquez Roque *et al.*, 2006) and this may contribute to the differences in hunger and satiety experienced. The composition of the test meal was not analysed and this may have an important effect on gastric emptying times and therefore perceptions of hunger and satiety (Cunningham and Read, 1989).

The difference found between laboratory and in the field results may be due to several factors. Subjects in the laboratory were usually kept in isolation to prevent other subjects influencing their choices and eating behaviour. By contrast, there was no such environmental isolation for the subjects in this study. It has been found that how much a person eats is influenced by their companion's portion size and then adjusted in relation to their companion's BMI; for example, subjects always took a similar portion size to the person they were with but the amount they consumed was reduced if the other person was obese and matched if they were thin (McFerran *et al.*, 2009).

The subject's adherence to the remit of the test and any errors in their self reporting should also be considered. The subjects in this study were not supervised in any way and were asked to report all food and drink consumed with regards to content and amount therefore there was a high reliance on honesty. With a weighed inventory there is the potential that underreporting actual intake may occur (Nelson, 2000): if subjects are aware their diet will be analysed they may underreport food items deemed to be unhealthy (*eg* biscuits and sweets). Energy intake and feeding behaviours are notoriously hard to assess and every method has its advantages and disadvantages. Laboratory based data is not representative of normal environmental conditions and self reporting in normal environmental conditions is open to error and omission of data. In this study the use of a results sheet and a subsequent weighed inventory in the form of a food diary was deemed the best way to obtain genuine data. The subjects had a high burden of responsibility hence this study had a low completion rate (70%) with some data being unusable (12.5%). To relieve subject burden meals could be prepared in a cafeteria setting and monitored by a researcher but this would not be representative of a normal environment. The high burden also had significant effects on the sample size and in future studies initial subject enrolment should be increased to compensate for a high (in this case, 42.5 %) dropout rate. The dropout rate may have been high due to the time of year the experiment was undertaken (just before Christmas) and therefore the timing of implementing such an experiment should be more carefully considered in future.

The data from the VAS ratings on some subjects was contradictory. If the subject had completed the test meal data correctly their data was included even if seemingly inconsistent, therefore the VAS design needed to be clearer. Improvements to design should include the removing the numbers 0 and 10 at either end of the scale and be replacing them with word descriptions; such as, “not at all hungry” and “extremely hungry”. Extending the hunger and satiety VAS ratings to every hour until the next meal to indicate the duration of the effects would be beneficial, as extrapolating the data is not appropriate.

CONCLUSIONS

Although a protein preload especially when delivered as a soup has been shown in laboratory conditions to reduce energy intake, this pilot study illustrates that similar results may not always be readily replicated in free-living subjects. One hour after consuming the soup preload and the test meal the obese subjects felt significantly more satiated than when they had consumed the nothing preload and the test meal. This information may be useful in helping obese individuals to adhere to an energy restriction diet.

BIOGRAPHY

Jane Bailey read her BSc degree in Human Nutrition at the University of Westminster, London and graduated with First Class Honours in 2010. The work described in this report is based on her final year project. In the future she aims to expand her knowledge into the field of dietetics with a special interest in weight loss and exercise.

Joanne Fiona Murray is a graduate of the University of Sydney where she first completed a BSc (Hons) in Agricultural Science specialising in animal production and then completed a PhD. Her research interest has been in exploring the links between nutrition and reproduction. Joanne has been a member of academic staff at the School of Life Sciences since August 2005.

REFERENCES

Akhaven, T., Luhovyy, B.L., Brown, P.H., Cho, C.E. and Anderson, G.H. (2010) 'Effect of premeal consumption of whey protein and its hydrolysate on food intake and postmeal glycemia and insulin responses in young adults', *American Journal of Clinical Nutrition*, Vol. 91(4), pp.966-975.

Bowen, J., Noakes, M. and Clifton, P.M. (2006) 'Appetite regulation hormone responses to various dietary proteins differ by body mass index status despite similar reductions in ad *libitum* energy intake', *The Journal of Clinical Endocrinology & Metabolism*, Vol. 91(8), pp.2913-2919.

Cunningham, K.W. and Read, N.W. (1989) 'The effect of incorporating fat into different components of a meal on gastric emptying and postprandial blood glucose and insulin responses', *British Journal of Nutrition*, Vol. 61, pp. 285-290.

Delzenne, N., Blundell, J., Brouns, F., Cunningham, K., De Graaf, K., Erkner, A., Lluch, A., Mars, M. Peters H.P.F. and Westerterp-Plantenga, M. (2010) 'Gastrointestinal targets of appetite regulation in humans', *Obesity Reviews*, Vol. 11, pp.234-250.

Flint, A., Raben, A., Blundell, J.E. and Astrup, A. (2000) 'Reproducibility, power and validity of visual analogue scales in assessment of appetite sensations in single meal studies', *International Journal of Obesity*, Vol. 24(1), pp.38-48.

Flood, J.E. and Rolls, B.J. (2007) 'Soup preloads in a variety of forms reduce meal energy intake', *Appetite*, Vol. 49(3), pp.626-634.

Food Standards Agency (2002) McCance and Widdowson's "The Composition of Foods", 6th summary edition. Cambridge: Royal Society of Chemistry.

Himaya, A. and Louis-Sylvestre, J. (1998) 'The effect of soup on satiation', *Appetite*, Vol. 30(2), pp.199-210.

Johnson, J. and Vickers, Z. (1993) 'Effect of flavor and macronutrient composition of food servings on liking, hunger and subsequent intake', *Appetite*, Vol. 21(1), pp.25-39.

Kissileff, H.R. (1985) 'Effects of physical state (liquid-solid) of foods on food intake: procedural and substantive contributions', *American Journal of Clinical Nutrition*, Vol. 42 (5 Supple), pp.956-965.

Mattes, R. (2005) 'Soup and satiety', *Physiology and Behavior*, Vol. 83, pp.739-747.

Mazda, T., Yamamoto, H., Fujimura, M. and Fujimiya, M. (2003) 'Gastric distension-induced release of 5-HT stimulates c-fos expression in specific brain nuclei via 5-HT3 receptors in conscious rats', *American Journal of Physiology, Gastrointestinal and Liver Physiology*, Vol. 287(1), pp.G228-G235.

McFerran B., Dahl D. W., Fitzsimmons G. J. and Morales A. C. (2010) 'I'll have what she's having: Effects of social influence and body type on the food choices of others', *Journal of Consumer Research*, Vol. 36, pp.915-929.

Nelson, M (2000) 'Methods and validity of dietary assessment' in J.S. Garrow, W.P.T. James and A. Ralph (Eds), *Human Nutrition and Dietetics*, Chapter 17, 10th Edition, Edinburgh, Elsevier, Churchill Livingstone.

Park, M.I., Camilleri, M., O'Connor, H., Oenning, L., Burton, D., Stephens, D. and Zinsmeister, A.R. (2007) 'Effect of different macronutrients in excess on gastric sensory and motor functions and appetite in normal-weight, overweight, and obese humans', *American Journal of Clinical Nutrition*, Vol. 85(2), pp.411-418.

Poppitt, S.D., McCormack, D. and Buffenstein, R. (1998) 'Short-term effects of macronutrient preloads on appetite and energy intake in lean women', *Physiology and Behavior*, Vol. 64(3), pp.279-85.

Rolls, B.J., Bell, E.A. and Thorwart, M.L. (1999) 'Water incorporated into a food but not served with a food decreases energy intake in lean women', *The American Journal of Clinical Nutrition*, Vol. 70(4), pp.448-455.

Shiiya, T., Nakazato, M., Mizuta, M., Date, Y., Mondal, M.S., Tanaka, M., Nozoe, S., Hosoda, H., Kangawa, K. and Matsukura, S. (2002) 'Plasma ghrelin levels in lean and obese humans and the effect of glucose on ghrelin secretion', *The Journal of Clinical Endocrinology & Metabolism*, Vol. 87(1), pp.240-244.

Smith, M.E. and Morton, D.G. (2001) *Systems of the body: The digestive system*, Edinburgh, Churchill Livingstone.

Toshinai, K., Mondal, M.S., Nakazato, M., Date, Y., Murakami, N., Kojima, M., Kangawa, K. and Matsukura, S. (2001) 'Upregulation of ghrelin expression in the stomach upon fasting, insulin-induced hypoglycemia, and leptin administration', *Biochemical and Biophysical Research Communications*, Vol. 281(5), pp.1220-1225.

Vazquez Roque, M.I., Camilleri, M., Stephens, D.A., Jensen, M.D., Burton, D.D., Baxter, K.L. and Zinsmeister, A.R. (2006) 'Gastric sensorimotor functions and hormone profile in normal weight, overweight, and obese people', *Gastroenterology*, Vol. 131(6), pp.1717-1724.

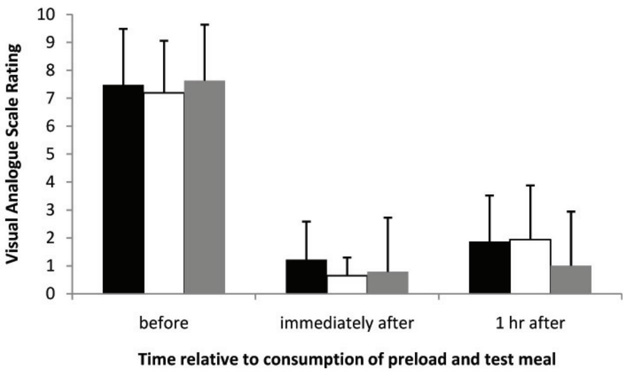

Figure 1. Mean visual analogue scale ratings (± standard deviation) for **hunger** before the preload and test meal were consumed to one hour after. The solid bars represent the preload with nothing, the empty bars the preload with 300 ml water and the grey bars the preload with 300 g soup. There were no differences in hunger ratings between the three preloads.

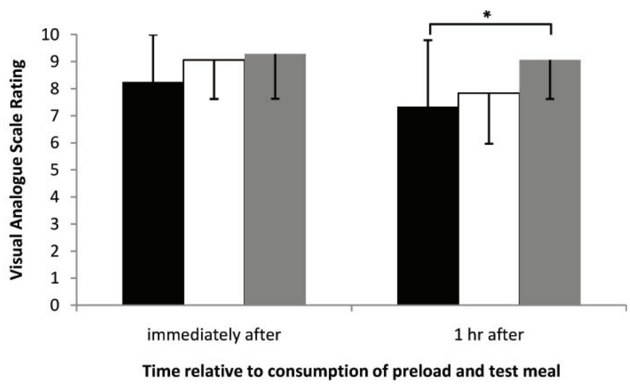

Figure 2. Mean visual analogue scale ratings (± standard deviation) for **satisfaction** immediately and one hour after consuming the preload and test meal. The solid bars represent the preload with nothing, the empty bars the preload with 300 ml water and the grey bars the preload with 300 g soup. Those who consumed the soup preload felt more satisfied one hour after the preload and test meal than those consuming the nothing preload (ANOVA, Tukey's HSD: *P = 0.05).

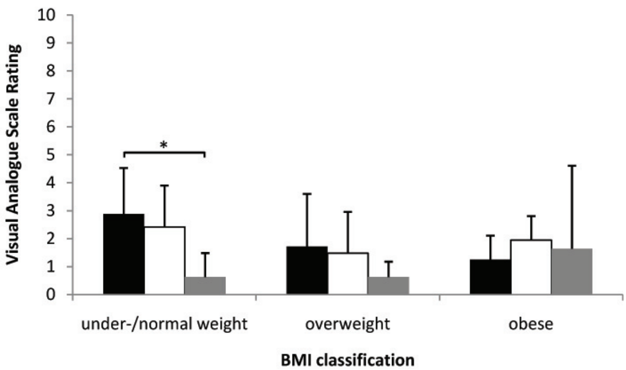

Figure 3. Comparison between subjects of different BMI of mean visual analogue scale ratings (± standard deviation) for **hunger** one hour after the preload and test meal were consumed. The solid bars represent the preload with nothing, the empty bars the preload with 300 ml water and the grey bars the preload with 300 g soup. Only in subjects classified as being underweight/normal for BMI was there a difference in hunger one hour after consuming the soup preload and the test meal compared to when consuming the preload of nothing and the test meal (ANOVA, Tukey's HSD: *P = 0.05).

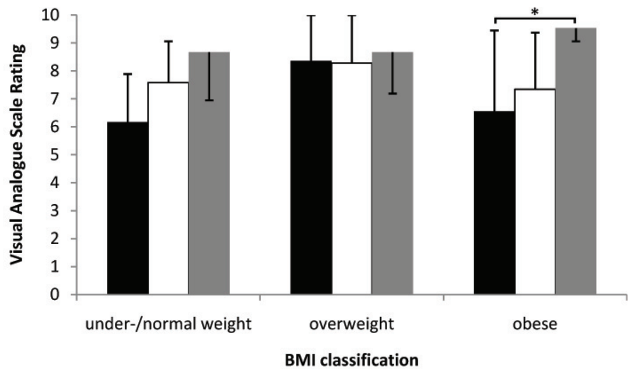

Figure 4. Comparison between subjects of different BMI of mean visual analogue scale ratings (± standard deviation) for **satisfaction** one hour after the preload and test meal were consumed. The solid bars represent the preload with nothing, the empty bars the preload with 300 ml water and the grey bars the preload with 300 g soup. Only in subjects classified as being obese was there a difference in satiety one hour after consuming the soup preload and the test meal compared to when consuming the preload of nothing and the test meal (ANOVA, Tukey's HSD: *P = 0.05).

BMI Category	**Number of Subjects**	**Percentage (%)**
Underweight	2	9
Normal	5	21
Overweight	8	35
Obese	8	35
Total Number of Subjects	**23**	**100**

Table 1. Subject numbers and percentages per BMI category.

	Preload of Nothing	Preload of Water	Preload of Soup
Total energy consumed from meal (MJ)	3.086 ± 0.867	3.002 ± 0.875	2.851 ± 1.013
Extra food consumed after meal (MJ)	1.001 ± 1.361	0.971 ± 1.089	0.678 ± 1.026
Preload (MJ)	0	0	0.816
Total meal and extras (MJ)	**4.087 ± 1.470**	**3.973 ± 1.444**	**4.345 ± 1.369**

Table 2. Comparison of the energy consumed (mean ± standard deviation: MJ) from: the test meal; extra food consumed after test meal and the preload.

BMI Category	Mean total energy intake when the preload was soup (MJ)	Proportion of total energy intake derived from soup preload (%)
Underweight/ Normal	4.141 ± 1.314	19.7 ± 7.8
Overweight	4.819 ± 1.553	16.9 ± 5.6
Obese	4.057 ± 1.269	20.1 ± 7.2

Table 3. There was no effect of BMI on the total amount of energy consumed (mean ± standard deviation: MJ) following the soup preload or the proportion (%) of the total energy consumed derived from the soup preload.