



Research report

Reproducibility of subjective appetite ratings and *ad libitum* test meal energy intake in overweight and obese males^{*}



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ABSTRACT

Background: To determine whether changes in appetite and energy intake (EI) can be detected and play a role in the effectiveness of interventions, it is necessary to identify their variability under normal conditions. We assessed the reproducibility of subjective appetite ratings and *ad libitum* test meal EI after a standardised pre-load in overweight and obese males. **Methods:** Fifteen overweight and obese males (BMI 30.3 ± 4.9 kg/m², aged 34.9 ± 10.6 years) completed two identical test days, 7 days apart. Participants were provided with a standardised fixed breakfast (1676 kJ) and 5 h later an *ad libitum* pasta lunch. An electronic appetite rating system was used to assess subjective ratings before and after the fixed breakfast, and periodically during the postprandial period. EI was assessed at the *ad libitum* lunch meal. Sample size estimates for paired design studies were calculated. **Results:** Appetite ratings demonstrated a consistent oscillating pattern between test days, and were more reproducible for mean postprandial than fasting ratings. The correlation between *ad libitum* EI on the two test days was $r = 0.78$ ($P < 0.01$). Using a paired design and a power of 0.8, a minimum of 12 participants would be needed to detect a 10 mm change in 5 h postprandial mean ratings and 17 to detect a 500 kJ difference in *ad libitum* EI. **Conclusion:** Intra-individual variability of appetite and *ad libitum* test meal EI in overweight and obese males is comparable to previous reports in normal weight adults. Sample size requirements for studies vary depending on the parameter of interest and sensitivity needed.

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Introduction

Appetite and energy intake (EI) are often measured in the laboratory using visual analogue scales (VAS) and *ad libitum* test meals respectively. To assess whether these methods are sensitive to detect changes in appetite and EI, it is important to determine their reproducibility. The reproducibility of subjective appetite ratings (Arvaniti, Richard, & Tremblay, 2000; Barkeling, Rossner, & Sjoberg, 1995; Flint, Raben, Blundell, & Astrup, 2000; Gonzalez, Veasey, Rumbold, & Stevenson, 2012; Raben, Tagliabue, & Astrup, 1995; Stratton et al., 1998) and *ad libitum* EI (Arvaniti et al., 2000; Gregersen

et al., 2008; Nair et al., 2009) has been studied in normal weight adults. Overall, it appears that while the reproducibility will vary depending on the parameter reported, VAS demonstrates a good degree of intra-individual reproducibility (see Stubbs et al., 2000 for a comprehensive review). Similarly, EI at an *ad libitum* meal has been shown to be reproducible in normal weight males (Flint et al., 2007). Surprisingly, despite being frequently assessed in response to interventions in overweight and obese individuals, little information exists on the reproducibility of these measures in this population.

Given some evidence that gut peptide (Valera Mora et al., 2005) and appetite (Barkeling et al., 1995) responses may vary according to body composition, it is possible that the reproducibility of appetite and EI will be different in overweight and obese individuals. For example, a range of factors such as the reward value of food, social desirability, eating behaviour characteristics (e.g. disinhibition) and even exercise (King, 1999) may be more likely to influence appetite ratings and EI in overweight and obese individuals (Barkeling, King, Näslund, & Blundell, 2007; Barkeling et al., 1995). Barkeling et al. (1995) compared VAS ratings in normal weight and obese individuals and demonstrated that while hunger sensations were more reproducible in obese men, desire to eat sensations were less reproducible. However, in this study, VAS ratings were only measured immediately before and after the test meal. In the majority

Abbreviations: AUC, area under the curve; CR, coefficient of repeatability; CV, coefficient of variation; EI, energy intake; TFEQ, Three Factor Eating Questionnaire; VAS, visual analogue scale.

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of studies, VAS are generally completed before, immediately after a test meal and then periodically at regular intervals (varying from 15 to 30 min up to hourly) usually for 3–5 h, or until the start of the next meal (Blundell et al., 2010). To the best of our knowledge the reproducibility of postprandial (3–5 h) appetite ratings between two separate days has not been previously documented in overweight and obese individuals.

With regard to *ad libitum* EI, EI at lunch was previously reported to be highly reproducible in eight overweight/obese individuals using the preload paradigm (Lara, Taylor, & Macdonald, 2010). However, the *ad libitum* lunch meal was provided at a relatively short interval (90 min) after the preload in this study (Lara et al., 2010). The reproducibility could be influenced by the time interval (Rolls et al., 1991). Therefore, there is a need for further understanding of the reproducibility of subjective appetite ratings and *ad libitum* EI in overweight and obese individuals under standardised conditions. This knowledge can be used to inform appropriate sample sizes for the design of studies investigating changes in these parameters in the pathogenesis or treatment of obesity.

The aims of the present study were to (i) determine the reproducibility of VAS for appetite ratings and *ad libitum* EI following a more typical inter-meal interval, (ii) calculate minimum sample sizes required to detect hypothetical changes in appetite ratings and *ad libitum* EI in prospective studies, and (iii) examine relationships amongst the various appetite measures, in overweight and obese males.

Subjects and methods

Subjects

Fifteen overweight and obese men [BMI 30.3 ± 4.9 kg/m², percent body fat $32.1 \pm 8.0\%$, age 34.9 ± 10.6 years] participated. Nine were classified as overweight and six obese by BMI. Eating behaviour was assessed using the Three Factor Eating Questionnaire (Stunkard & Messick, 1985). Height was measured without shoes to the nearest 0.5 cm and weight to the nearest 0.01 kg. Body composition was measured using air displacement plethysmography (Bodpod, Concord, CA). None of the participants had a history of gastrointestinal disease or surgery, significant illness, or were taking any medication known to affect appetite or EI. All participants indicated they were willing to consume study test meals described on a screening questionnaire. The study received ethical approval from the Queensland University of Technology Research Ethics Committee.

General design

Each participant participated in two identical test days 7 days apart. The participants were instructed to refrain from strenuous exercise and alcohol during the 24 h prior to each test day. Participants were provided with a standardised evening meal (McCain Beef Lasagne (2447 kJ) to consume as their main meal) at home prior to the test day and then fasted for 12 h overnight. An identical process was followed prior to the second test day, and prior food intake on the test day was checked by diet recall.

Fixed breakfast

On the test morning the participants were provided with a fixed pancake breakfast spread with butter and strawberry jam [1676 kJ (400 kcal); 15 g (15%) PRO, 17 g (37%) fat, 48 g (48%) CHO] with 250 ml of water. This meal was used to be consistent with the other studies in this series of studies on gastric emptying. Breath samples were given as described between breakfast and lunch (Horner, Byrne,

Cleghorn, & King, 2014). The participants remained in the laboratory in sedentary activities throughout.

Appetite

Subjective appetite sensations were measured before and after the fixed breakfast, and periodically during the postprandial period using an electronic appetite rating system (Gibbons, Caudwell, Finlayson, King, & Blundell, 2011). Participants were asked to rate sensations of hunger, fullness and desire to eat on 100 mm visual analogue scales, anchored at each end with the statements not at all and extremely. Postprandial area under the curve (AUC) was calculated using the trapezoidal rule, and 5 h mean values calculated by averaging the 6 post-breakfast ratings.

Palatability

Six questions concerning sweet, savoury, tasty, pleasant, filling and satisfying ratings of the test meals were assessed on a 100 mm scale using an identical electronic appetite rating system (Gibbons et al., 2011) immediately post consumption of the fixed breakfast and *ad libitum* lunch meals.

Ad libitum energy intake

Five hours after the fixed breakfast, the participants were provided with an *ad libitum* pasta lunch meal (pasta, tomato sauce and cheese; 47% CHO, 35% fat, 18% PRO, energy content 7.6 kJ/g) and water. The meal was provided in a large serving dish with utensils and a plate and the participants were instructed to help themselves to as much as they wished until comfortably full. Water intake was recorded and the amount of food consumed was determined by weighing the meal before and after consumption. EI was calculated using the manufacturers' nutrient values.

Statistical analysis

Data are expressed as mean \pm SD unless otherwise stated. The Bland and Altman method (Bland & Altman, 1986), coefficient of repeatability (CR), Pearson correlation coefficients and coefficient of intra-subject variation (CV_{intra}) were calculated to assess the reproducibility and allow comparison with others. The CV_{intra} was calculated as $CV_{intra} = SD_d/(m\sqrt{2})$ where SD_d is the standard deviation of the differences between the repeated tests and m is the mean of the repeated tests (Deane et al., 2010; Lartigue et al., 1994). The coefficient of repeatability ($CR = 2 \times SD$) for the mean differences between visits 1 and 2 was calculated (Bland & Altman, 1986). The CR indicates the absolute variability of the method whereas the CV measures the relative variability (Gregersen et al., 2008). Pearson correlations were used to determine test–retest correlations and to determine relationships between variables. Based on the standard deviations observed in these parameters, sample size calculations to detect a hypothetical treatment effect with 80% power were calculated using Graph Pad StatMate version 2.0 for Mac (GraphPad Software, San Diego, CA, USA). Sample size calculations were undertaken by selecting the “compare two means (paired t test)” option in the software, entering the observed SD of the difference between pairs and the level of significance of 0.05. Statistical analysis was performed using PASW Statistics 18.0 (SPSS Inc., Chicago, IL, USA). Significance was set at $P < .05$.

Results

All participants ($n = 15$) completed all components of the study. TFEQ scores for dietary Restraint, Hunger and Disinhibition were 7 ± 3 , 6 ± 3 , and 8 ± 3 respectively.

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