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Original research article

The influence of ethnicity and glucose tolerance status on subjective hunger sensations and prospective food intake in overweight and obese Asian and European Australians

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ABSTRACT

Aims: To examine the influence of ethnicity and glucose tolerance status on subjective sensations and food intake in overweight/obese Asian and European Australians.
Methods: 18 Asians and 26 Europids were classified as normal glucose tolerance (NGT) and impaired glucose tolerance (IGT) based on serial measures of finger-prick glucose following an oral glucose tolerance test (OGTT). Subjective sensations of hunger and satiety were measured before and every 15 min after the OGTT using a visual analogue scale (VAS). Food intake was measured covertly from consumption of a buffet style lunch and from self-maintained 24 h food records. All serial measurements were converted into total area under the curve (TAUC) and comparisons adjusted for age, fat and fat-free mass.
Results: There was a significant difference interaction between ethnicity (ETH) and glucose tolerance (GTT) for subjective fullness, desire for food and prospective food intake. IGT Asians had significantly greater sensations of fullness, but lesser prospective food and desire to eat, as compared to other groups. However there were no differences in calorie and macronutrient intake at buffet lunch or over 24-h.
Conclusion: Interactions between ethnicity and glucose tolerance status in subjective sensations did not transcribe to differences in prospective food intake.

1. Introduction

Overweight and obesity could result from the absence of regulatory processes, which match fuel supply to energy requirements and ensure stability of body composition [1]. Without these processes, body weight and body energy content does not remain stable in most adults for long periods of time due to daily fluctuations in energy intake and energy expenditure [1]. The maintenance of this physiological set point for body weight is complex and involves several mechanisms such as aminostatic and glucostatic controls of feeding, metabolic or nutrient partitioning, input from the sympathetic nervous system, signals from adipose tissue as well as additional behavioral influences [2]. These interactions focus on an axis in which other self-regulated components, namely food intake, nutrient turnover and thermogenesis and body fat store, interact. In addition, genetics and environment also influence these regulatory processes [2,3].

Overweight and obesity can also be regarded as secondary to appetite dysfunction due to insulin resistance and impaired response of glycemic challenges [4]. Glucose has a strong influence in the central regulation of energy homeostasis in which changes in blood glucose level and glucose oxidation will enable the initiation of feeding [5]. In addition, increased food intake is also closely related to accumulation of adipose tissue [6,7]. An increase in fat mass leads to an increase of ghrelin release, a hunger stimulating hormone, which results into excessive food intake. This leads in a vicious cycle among overweight and obese adults [8]. Studies have shown that certain ethnicities have a higher risk of developing obesity. Among Asian ethnicities, Indian and Chinese descent has been shown to have a higher risk of accumulating adipose tissue which could lead to disruption of hunger/satiety sensations and subsequent food intake [9–12].

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In this study, we assessed the influence of ethnicity on subjective hunger/satiety sensations and food intake based on glycemic response among overweight and obese Asians and Europids (European descent) residing in Australia.

2. Subjects

At the time of the study design, there was no publication analyzing the difference between subjective sensations of hunger and satiety in response to glucose. Gregersen et al. showed that a sample size of 25 in each group was sufficient to detect a difference in energy intake of 500 kJ (119 kcal) without prior diet standardization [13].

In this study 44 overweight and obese participants were recruited from advertisements in the local media or by personal approach using the following inclusion criteria: age older than 35 years, BMI >23 kg/m^2 for Asians and >25 kg/m^2 for Europids. Asians descent would include South East Asians (Malaysia, Singapore, and Indonesia) and South Asians (Indian, Bangladesh, Sri Lanka and Pakistan). Europids descent would include all ethnic groups that originated in the United Kingdom and the rest of Europe. Selected participants were non-smokers; consumed less than 2 standard alcoholic drinks per day; had no GI tract abnormalities; were not on medication affecting metabolic rate, body composition or taste/ appetite sensations (i.e. anti-depressants) and were non-shift workers. Personal history of chronic disease, weight stability (defined as having weight fluctuation less than 2 kg over 6 months) and medication use were also recorded. The study received Ethics Approval (HR 109/2010) from Curtin University, Perth, Western Australia, and all study participants provided signed informed consent.

2.1. Protocols

One day prior to the study day, all study participants were provided with 1–2 servings of a ready-to-eat meal for dinner. There were five selections to choose from and overall each meal provided around 1800–2000 kJ in energy and was low in saturated fat (1.6 En %). Participants were requested to arrive at the study location after a minimum of 10–12 h of overnight fasting and an 8-hour sleep with minimum physical activities. They were then accommodated in a dedicated room where they could relax and conduct activities with minimal physical effort (reading, knitting, solving crosswords, listening to music) for the subsequent 2 h between the oral glucose tolerance test (OGTT) and buffet lunch. Participants were requested not to read any materials related to food or cooking, i.e. recipe books and cooking magazines.

3. Material & methods

3.1. Anthropometrics and body composition measurement

Participant's height (without shoes) was measured using a portable stadiometer (Holtain, Crymych, United Kingdom) which was accurate to within 0.5 cm [14]. Weight was measured by digital scale to the nearest 100 g, without heavy clothing [14]. Body Mass Index (BMI) was calculated as the ratio of weight to height squared (kg/m^2).

A midpoint of the right arm between the tip of the acromion and the tip of olecranon when elbow flexed at 90° was determined to measure Mid Upper Arm Circumference (MUAC) [15]. Waist circumference (WC) was measured mid-way between the lowest rib and the iliac crest at the end of gentle expiration, with the subject standing [15]. Hip circumference was measured at the greater trochanters [15]. All circumferences were measured to within 1 mm with plastic tapes. Waist-Hip-Ratio (WHR) was calculated as WC (cm) divided by hip circumference (cm) [15]. All anthropometric measurements were conducted before OGTT.

At the end of the OGTT, fat mass, fat-free mass and bone mineral content was determined using the Lunar Prodigy DEXA instrument (GE Medical System, Madison, WI, USA) with Encore software. All scans were performed when subjects were wearing a light gown and had removed all metal objects. The scans were performed by one trained operator. Scan time period was around 5 min depending on the body size of the study participants. Fat mass, fat-free mass and bone mineral content were reported in term of percentage to body weight [14,16].

3.2. Oral glucose tolerance test (OGTT)

All study participants underwent an OGTT with 75 g anhydrase glucose in 300 ml (GLUCAID ™). Capillary blood glucose samples were taken four times during the study at the following times: baseline, 30-, 60- and 120-min after OGTT. Subjects were also allowed small sips of water during the study time until lunch time. Glucose tolerance was classified into normal glucose tolerance (NGT) and impaired glucose response (IGT) based on WHO classification on fasting level and 2-h post-prandial response. IGT included Impaired Fasting Glucose, Impaired Glucose Tolerance and Type 2 Diabetes Mellitus [17].

3.3. Assessment of appetite

Validated Visual Analogue Scale (VAS) questionnaires were used to measure subjective states of four sensations related to desire to eat before and after meals [18–20]. The study participants were informed on how to use the VAS on four different subjective parameters at baseline, 30-, 60-, 90- and 120-min after OGTT. The VAS was filled before finger prick for blood glucose was taken during coincided time points. The VAS questionnaires consist of the following questions: "How hungry do you feel?" (Not hungry at all = 0 mm to extremely hungry = 100 mm), "How full do you feel?" (Not full at all = 0 mm to extremely full = 100 mm), "How strong is your desire to eat?" (None = 0 mm to very strong = 100 mm) and "How much food do you think you can eat " (nothing at all = 0 mm to an extremely large quantity = 100 mm). They were requested to place an "I" at any point along the scale, and scores were then converted to continous variables from 0 to 100 mm up to 1 decimal in mm [20]. The higher the score in hunger/desire to meat/amount of food to be consumed means that the participants had more intense sensation of hunger/desire to eat/amount of food to be consumed. The higher the score for satiety means that the participants had more intense sensation of satiety which could translate to less food intake.

3.4. Food intake

A buffet lunch was served approximately 30 min on completion of OGTT which consisted of pre-selected choices of ready-to-eat meals from a supermarket: Indian butter chicken & rice; honey beef; beef stroganoff; rice and black pepper beef; and two vegetarian options (Tuscan Tomato Fusili and Neopolitan Penne). In addition, other food such as slices of white bread, vegetables (tomatoes or cucumber), apples, oranges, potato chips, fruit juice and chocolate bars were offered for consumption *ad libitum* which were selected based on high acceptance from a previous study at the same center [21].

Every food item was weighed using Tanita Digital food weighing scales up to 10 mg. The difference between the weighed and leftover food was calculated as actual food intake for lunch which was then recorded for the study [22]. Study participants were also requested to record all food and drinks consumed within 24-h after