Medium-Chain Triglycerides Increase Energy Expenditure and Decrease Adiposity in Overweight Men

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Abstract

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Objective: The objectives of this study were to compare the effects of diets rich in medium-chain triglycerides (MCTs) or long-chain triglycerides (LCTs) on body composition, energy expenditure, substrate oxidation, subjective appetite, and ad libitum energy intake in overweight men.

Research Methods and Procedures: Twenty-four healthy, overweight men with body mass indexes between 25 and 31 kg/m^2 consumed diets rich in MCT or LCT for 28 days each in a crossover randomized controlled trial. At baseline and after 4 weeks of each dietary intervention, energy expenditure was measured using indirect calorimetry, and body composition was analyzed using magnetic resonance imaging.

Results: Upper body adipose tissue (AT) decreased to a greater extent ($p < 0.05$) with functional oil (FctO) compared with olive oil (OL) consumption (-0.67 ± 0.26 kg and -0.02 ± 0.19 kg, respectively). There was a trend toward greater loss of whole-body subcutaneous AT volume ($p = 0.087$) with FctO compared with OL consumption. Average energy expenditure was 0.04 ± 0.02 kcal/min greater ($p < 0.05$) on day 2 and 0.03 ± 0.02 kcal/min (not significant) on day 28 with FctO compared with OL consumption. Similarly, average fat oxidation was greater ($p = 0.052$) with FctO compared with OL intake on day 2 but not day 28.

Discussion: Consumption of a diet rich in MCTs results in greater loss of AT compared with LCTs, perhaps due to increased energy expenditure and fat oxidation observed with MCT intake. Thus, MCTs may be considered as agents that aid in the prevention of obesity or potentially stimulate weight loss.

Key words: body composition, magnetic resonance imaging, energy expenditure, medium-chain triglycerides, weight loss

Introduction

The prevalence of overweight and obesity has been increasing worldwide. In the U.S., the prevalence of overweight has increased from 25.4% to 33.3% in the adult population from National Health and Nutrition Examination Study II to phase I of National Health and Nutrition Examination Study III (1,2). Therefore, it is apparent that strategies designed to prevent or treat obesity are of paramount importance. Medium-chain triglycerides (MCTs)[1] have been proposed previously as a tool in the prevention of human obesity (3,4) due to their effects on fat deposition in animals. When compared with long-chain triglyceride (LCT) consumption, MCTs are known to increase energy expenditure (EE) in humans (5–11) and are associated with lower body weight (BW) gain and fat depot size (3,4,12,13) in growing animals. Recent findings (10,14), however, have failed to demonstrate convincing results regarding the long-term benefits of MCT consumption on BW in humans.

From our previous research in women (9,10), there is evidence to support the hypothesis that women do not respond to MCT intake as strongly as men. In fact, previ-

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[1] Nonstandard abbreviations: MCT, medium-chain triglyceride; EE, energy expenditure; BW, body weight; LCT, long-chain triglyceride; OL, olive oil; VAS, visual analog scale; CNRU, Clinical Nutrition Research Unit; FctO, functional oil; MRI, magnetic resonance imaging; AT, adipose tissue; LT, lean tissue; TEF, thermic effect of food; PP, postprandial; RMR, resting metabolic rate.

ously published studies that have been conducted in men (5,7,8) report greater differences in EE between MCT and LCT consumption than those observed by our group when studying women (9,10). Because long-term controlled feeding studies examining the effects of MCTs on EE and body composition have not been conducted in men, the present objective was to assess whether feeding men diets rich in MCT or olive oil (OL), as a source of LCT, would result in greater EE and weight loss after 4 weeks. We hypothesized that MCT consumption would result in greater EE and weight loss compared with OL over a 28-day feeding period. In addition, it is suggested that MCT consumption may lead to increased levels of satiety and, thus, lower caloric ingestion than with LCT consumption (15–18). Therefore, a secondary objective was to determine if appetite ratings on a visual analog scale (VAS) and food intake at an ad libitum intake lunch session would be altered by the type of fat contained in the diet.

Research Methods and Procedures

Subjects

Subjects were recruited by advertisement in local newspapers and were required to have a body mass index between 25 and 31 kg/m^2 and fasting plasma total cholesterol and triglycerides concentrations below 7.0 mmol/L and 3.0 mmol/L, respectively. Exclusion criteria were reported history of cardiovascular disease, diabetes, hypertension, gastrointestinal disorders, and unusual eating patterns. The study protocol was reviewed and accepted by the Human Ethical Review Committee of the Faculty of Agriculture and Environmental Sciences of McGill University, and all subjects signed informed consent forms before entrance into the protocol.

Study Design

The study employed a randomized crossover controlled feeding design with periods of 28 days each, separated by a 4-week washout period. The research was conducted at the Mary Emily Clinical Nutrition Research Unit (CNRU) of McGill University. Subjects were required to come to the CNRU every morning for breakfast and to return to consume one other meal under supervision at the CNRU every day. The third meal was prepared and packed for the subjects to consume outside of the unit. Diets were designed to resemble a typical North American diet and contained 40% of energy as fat, 15% as protein, and 45% as carbohydrates. The two different diets were consumed in random order for a period of 4 weeks each, separated by a 4-week washout period. These diets were identical except for the quality of the fat. The MCT-containing diet contained a functional oil (FctO) composed of 64.7% MCT oil (Neobee 1053, Stepan Company, Northfield, IL), 12.6% OL, 6.8% each of canola and flaxseed oil, and 5.8% coconut oil as the main source of fat (75% of total fat). The control diet (OL) contained 75% of total fat as OL. The rest of the fat came from the other foods in the meals that were identical in both diets. The fatty acid composition of the FctO is provided in Table 1. The FctO also contained 3.4% of unesterified stanol/sterol mixture (Forbes Medi-Tech, Vancouver, Canada) because previous studies have shown increased plasma lipid concentrations with MCT consumption (6,18,20). Lipid level data were obtained and form the basis for a complementary manuscript currently under consideration for publication.

Table 1. Fatty acid composition of the functional oil

Fatty acid	Functional oil (%)
6:0	0.17
8:0	36.95
10:0	30.35
12:0	3.61
14:0	1.06
16:0	3.52
16:1	0.23
18:0	0.65
18:1	13.81
18:2n-6	4.62
18:3n-3	4.94
20:0	0.05

Energy intake was calculated on an individual basis using the Mifflin equation (21) and an activity factor of 1.7. This activity factor was shown to be appropriate for weight maintenance (22) and has been used by our group previously (9,10). During the 1st week of the first experimental phase, energy intake was adjusted to compensate for any change in BW that may have occurred. However, after this initial 1-week period, energy intake was kept constant throughout both experimental phases. Meals were isoenergetic and were provided in a 3-day rotating cycle menu. Subjects were instructed to consume all foods provided to them and nothing else for the duration of the trial. They were also advised to maintain a regular exercise pattern throughout the trial in accordance with habitual levels.

Methods

BW was measured every morning before breakfast using a standard scale. Body composition was assessed using magnetic resonance imaging (MRI) on days 1 and 29 of each experimental phase. The MRI protocol is described in detail elsewhere (10). Briefly, images were acquired using a Siemens 1.5 Tesla MRI scanner (Siemens, Mississauga, Canada) using a T-1 weighted, spin-echo sequence with a 210-ms repetition time and a 17-ms echo time. Subjects lay in the magnet in a prone position with their arms straight

above their head. Using the intervertebral space between the fourth and fifth lumbar vertebrae as the point of origin, transverse images with 10-mm slice thickness were obtained every 40 mm from hand to foot, resulting in a total of ~45 images for each subject. MRI data were analyzed using specially designed image analysis software (Tomovision Inc., Montreal, Canada). Details of the data analysis procedure have been published previously (10).

It is reported that the mean difference for repeat measurements of whole-body adipose tissue (AT) and lean tissue (LT) was <3% and <2%, respectively (23), and the mean difference for subcutaneous and visceral AT at the fourth and fifth lumbar vertebrae was 1.1% and 5.5%, respectively (24). Thus, MRI measures the different AT compartments with an error of estimate of 2% to 10% (25). More recently, Mitsiopoulos et al. (26) determined the reproducibility of MRI subcutaneous AT volume measurements by comparing the intra- and interobserver estimates for MRI measurements and found that these were 2.9 ± 1.2% and 1.5 ± 1.5% for intra- and interobserver variability of subcutaneous AT, respectively. Results from our group showed intraobserver differences of 2.1 ± 1.2% for total, 1.8 ± 1.1% for subcutaneous, and 8.1 ± 3.9% for visceral AT when comparing two analyses of five MRI datasets by a single observer (10).

EE was measured with a metabolic monitor (Delta Trac, Sensor Medics, Anaheim, CA) on days 2 or 3 and 27 or 28 for 19 of the subjects. After an overnight warm-up period, the metabolic monitor was calibrated daily using gas containing 96% O_2 and 4% CO_2 at ambient pressure. Expired gases were analyzed against ambient air. Subjects were required to arrive at the CNRU 1 hour before the start of the measurement period to allow for their metabolism to return to a state that approximated basal state. EE was then measured for 30 minutes before consumption of a standard breakfast. Subjects were required to consume the breakfast within a 30-minute period, after which EE measurements resumed for 5.5 h. This length of monitoring was recommended previously to capture most of the thermic effect of food (TEF) (27). EE was measured for 30 minutes of each hour after breakfast. Fat and carbohydrate oxidation rates were calculated every minute using the equations derived by Lusk (28).

Total fecal samples were collected over 3 days midway through each experimental phase for 19 of the subjects for determination of fecal fat excretion. Samples were weighed and diluted by 50% with water, aliquoted, and lyophilized. Fecal lipids were extracted from ~3 g of the combined 3-day dried samples, with each day of sampling being proportionately represented. Lipid extraction was carried out using the method of Folch et al. (29) in duplicate. The lipid fraction was then weighed and used to calculate total fecal fat excretion over 3 days.

Total daily EE was calculated using the following equation:

$$\text{Total EE} = \text{energy intake} - (\Delta \text{ total AT} + \Delta \text{ LT} + \text{energy excreted})$$

where AT represents total energy stored in AT mass, and LT represents total energy stored in LT mass. Energy stored in AT was determined by multiplying the change in AT volume by 0.92 g/cm^3 (30) and further multiplying by 7650 kcal/kg, assuming that 85% of AT is fat (31). To determine energy stored in LT, the change in LT volume was multiplied by 1.04 g/cm^3 (30) and again by 2920 kcal/kg, assuming 73% hydration of LT (32). Both values were then divided by 28 to obtain daily values. Energy excreted was determined as the product of daily fecal fat excretion multiplied by 9 kcal/g of fat.

For a subgroup of 5 subjects, for whom we did not measure EE and fecal fat excretion but who were part of the main group of 24 subjects, we tested the effects of FctO and OL on satiety and food intake. Subjects were required to rank their level of satiety by answering six questions on a validated VAS (33) immediately after (0 hours), at 2 hours, and at 4 hours after consuming a standard breakfast containing either FctO or OL. Questions included in the VAS were: 1) how hungry do you feel?; 2) how full do you feel?; 3) how strong is your desire to eat?; 4) how much do you think about food?; 5) urge to eat; and 6) preoccupations with thoughts on food. Subjects were asked to place a mark on a continuous scale from 0 to 10, where 0 meant "not at all" and 10 meant "very much." After answering the last questionnaire (4 hours), subjects were given foods, which did not contain the test fats, in excess of their expected food intake and were instructed to consume as much of these foods as they wanted until they felt satiated. The amount of food consumed at this ad libitum lunch session was measured and energy and macronutrient intakes analyzed using Food Processor Nutrition Analysis Software (version 7.81, ESHA Research, Salem, OR).

Statistical Analyses

The effect of each diet on EE and substrate oxidation was analyzed using ANOVA with a mixed model procedure. Diet, day, and hour were tested as variables in the model. Interactions between diet and day and among diet, day, and hour were also examined. Paired Student's *t* test was used to determine differences in EE between FctO and OL at each time-point. Paired Student's *t* test was used to assess differences between FctO and OL on average postprandial (PP) EE, average TEF, average PP fat oxidation, calculated total daily EE, changes in body composition, fecal fat excretion, and food intake during the satiety test. ANOVA was used to assess differences between treatments in response to questions on the VAS. Diet, hour, and diet-by-hour inter-

Table 2. Subject characteristics at screening

Characteristic	Average (SEM)
Age (*y*)	43.1 (2.3)
Weight (kg)	87.2 (1.9)
Height (m)	1.76 (0.01)
Body mass index (kg/m^2)	28.2 (0.4)
Total cholesterol (mmol/L)	5.62 (0.18)
Triglyceride (mmol/L)	1.86 (0.15)

actions were used as variables in the model. All statistical analyses were conducted using SAS statistical software (SAS/STAT version 8.0, SAS Institute, Cary, NC). A p value of 0.05 was taken as statistically significant. Data are reported as means ± SEM.

Results

Twenty-five of the 30 men enrolled in the study successfully completed the protocol. Three subjects were asked to withdraw from the study due to poor compliance, one withdrew due to medical reasons unrelated to the trial, and one withdrew for work-related reasons. Data from one subject were not analyzed due to difficulties with the acquisition of images during the last MRI scan. Subject characteristics at recruitment are shown in Table 2.

BWs at endpoint were lower than at baseline for both FctO ($p < 0.001$) and OL ($p < 0.05$) feeding periods. BWs were 87.4 ± 2.0 kg at baseline and 86.3 ± 1.9 kg at the end of the FctO feeding period and were 86.6 ± 2.0 kg and 85.9 ± 1.8 kg at baseline and at the end of the OL feeding period, respectively. Weight loss occurred gradually over the entire 28-day period for both FctO and OL feeding periods. Table 3 shows changes in BW and body composition values with FctO and OL consumption. Using MRI to assess body composition changes, there was a significant decrease ($p < 0.01$) in total body mass from 70.2 ± 1.6 kg on day 1 to 69.2 ± 1.5 kg on day 29 with FctO consumption, whereas the change from 69.5 ± 1.5 kg to 69.0 ± 1.5 kg with OL consumption was not statistically significant. Total AT masses were 24.7 ± 1.0 kg and 23.9 ± 1.1 kg on days 1 and 29, respectively, with FctO consumption ($p < 0.01$, within diet difference) and 24.3 ± 1.0 kg and 24.0 ± 1.0 kg on days 1 and 29, respectively, with OL consumption. There was a trend ($p = 0.087$) for greater loss of total subcutaneous AT with FctO compared with OL consumption. FctO consumption resulted in a significant decrease ($p < 0.01$) from 18.1 ± 0.9 kg to 17.6 ± 0.9 kg in subcutaneous AT. With OL consumption, subcutaneous AT mass varied from 17.8 ± 0.9 kg on day 1 to 17.7 ± 0.9 liters on day 29. When regional adiposity was analyzed, there was greater ($p < 0.05$) loss of upper body AT with FctO consumption compared with OL. FctO consumption resulted in a decrease ($p < 0.05$) in upper body AT from 12.5 ± 0.6 kg on day 1 to 11.8 ± 0.6 kg on day 29. Upper body AT masses were 12.1 ± 0.6 liters on days 1 and 29 during OL feeding. Abdominal and lower body AT volumes were not altered by FctO or OL consumption. There was no difference in change in muscle mass and LT mass between FctO and OL consumption. Changes in body composition with FctO consumption were not correlated with initial body mass index.

Table 3. Change in body weight and body compartment volumes with functional oil and olive oil consumption

Body compartment	Functional oil (SEM)	Olive oil (SEM)
Body weight (kg)	−1.03 (0.25)	−0.62 (0.29)
Total adipose tissue (kg)	−0.83 (0.25)*	−0.31 (0.30)
Subcutaneous adipose tissue (kg)	−0.54 (0.16)*	−0.17 (0.19)
Upper body adipose tissue (kg)	−0.67 (0.26)*†	−0.02 (0.19)
Abdominal adipose tissue (kg)	−0.17 (0.13)	−0.07 (0.08)
Lower body adipose tissue (kg)	−0.24 (0.21)	−0.27 (0.16)

* Significant within-diet change, $p < 0.05$, using paired Student's t test.

† Significantly different from change with olive oil consumption, $p < 0.05$, using paired Student's t test.

Resting metabolic rate (RMR) was not different between periods of FctO and OL consumption. Average RMR with FctO consumption was 0.82 ± 0.02 kcal/min on day 2 and 0.80 ± 0.03 kcal/min on day 28, and with OL consumption, RMR was 0.81 ± 0.02 kcal/min on day 2 and 0.83 ± 0.02 kcal/min on day 28.

Figure 1 shows basal and PP EE on days 2 and 28. There was a significant effect of diet ($p < 0.01$) and hour ($p < 0.01$) on EE. Average PP EE tended to be greater ($p = 0.055$) with FctO consumption compared with OL for both days 2 and 28. On day 2, average PP EE was 1.04 ± 0.02 kcal/min and 0.99 ± 0.03 kcal/min for FctO and OL consumption, respectively. On day 28, average PP EE was 1.01 ± 0.02 kcal/min after consumption of the breakfast containing FctO, compared with 0.98 ± 0.03 kcal/min for OL. Average TEF was calculated as the difference between average PP EE and RMR. On day 2, TEF with FctO consumption was 0.21 ± 0.02 kcal/min compared with 0.19 ± 0.01 kcal/min with OL consumption. For day 28, TEF after consumption of the breakfast containing FctO was greater

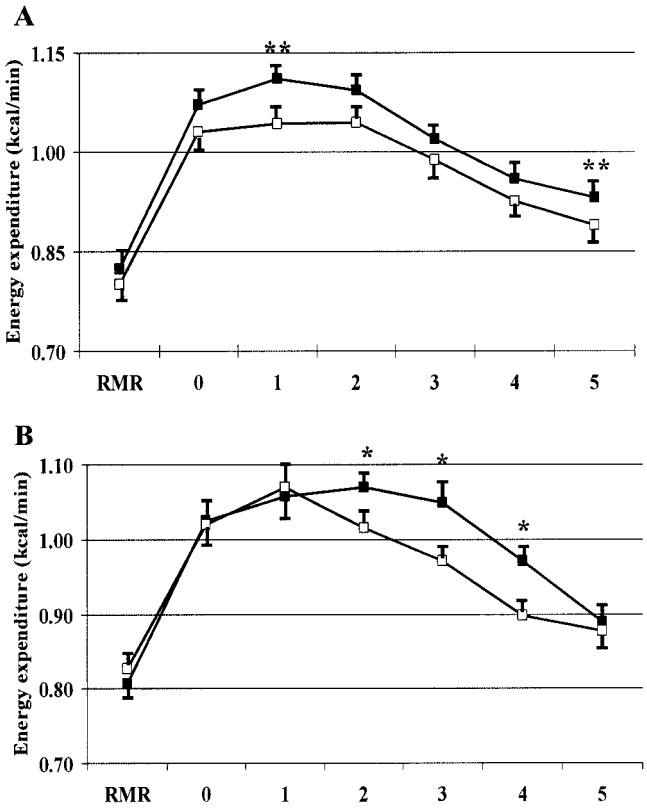

Figure 1: EE after consumption of a breakfast containing OL or FctO on day 2 (A) and 28 (B). FctO phase (closed squares), OL phase (open squares). Values are means ± SEM, $n = 19$. FctO significantly different from OL, $p < 0.05$ (*). Trend for diet difference, $p < 0.1$ (**).

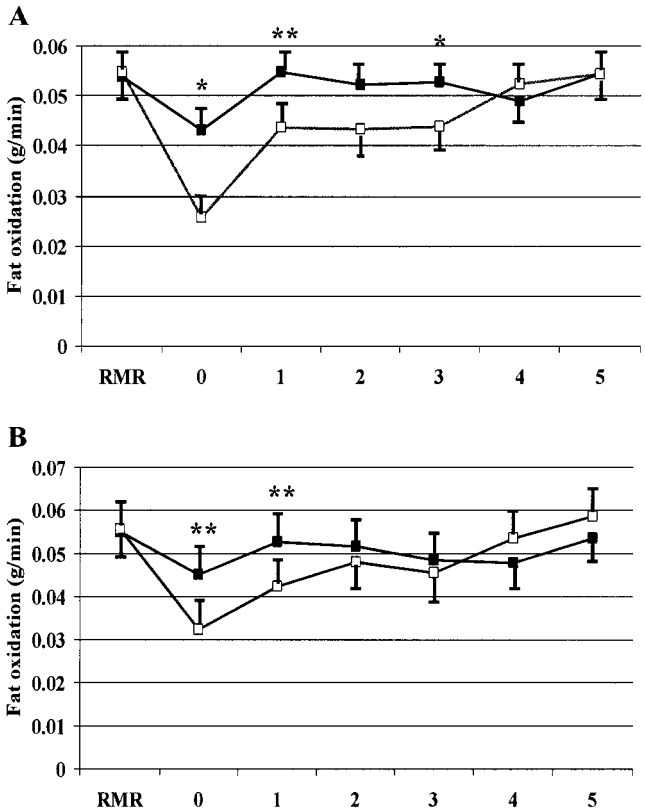

Figure 2: Fat oxidation after consumption of a breakfast containing OL or FctO on day 2 (A) and 28 (B). FctO phase (closed squares), OL phase (open squares). Values are means ± SEM, $n = 19$. FctO significantly different from OL, $p < 0.05$ (*). Trend for diet difference, $p < 0.1$ (**).

($p < 0.01$) than that observed after the breakfast containing OL. After consumption of the FctO-containing breakfast, TEF was 0.21 ± 0.01 kcal/min vs. 0.15 ± 0.02 kcal/min for the OL-containing breakfast.

Average EE over the entire measurement period, from RMR until 6.5 hours after breakfast, was greater ($p < 0.05$) with consumption of the breakfast containing FctO compared with OL on day 2, although this was no longer significant for day 28. Average EE was 1.00 ± 0.02 kcal/min with FctO consumption and 0.96 ± 0.03 kcal/min with OL consumption on day 2, and 0.98 ± 0.02 kcal/min with FctO intake and 0.95 ± 0.03 kcal/min with OL intake on day 28. Using Equation 1 to calculate total daily EE, we found that EE during FctO consumption was 3169.7 ± 125.8 kcal/d and 3050.9 ± 114.6 kcal/d during OL consumption.

Figure 2 shows basal and PP fat oxidation on days 2 and 28. There was a significant effect of diet ($p < 0.01$), hour ($p < 0.01$), and diet-by-hour interaction ($p < 0.01$) on fat oxidation. Basal fat oxidation was not different between phases of FctO and OL consumption. On day 2, basal fat oxidation was 0.054 ± 0.004 g/min and 0.055 ± 0.003 g/min with FctO and OL consumption, respectively. Similarly, on day 28, basal fat oxidation was 0.055 ± 0.003 g/min with FctO and 0.056 ± 0.004 g/min with OL consumption. Average PP fat oxidation was greater ($p = 0.052$) after consumption of the breakfast containing FctO compared with the breakfast containing OL, but this difference was not present on day 28 ($p = 0.32$). Fat oxidation after the FctO-containing breakfast was 0.052 ± 0.003 g/min vs. 0.044 ± 0.003 g/min after the OL-containing breakfast. On day 28, average fat oxidation was 0.049 ± 0.003 g/min and 0.047 ± 0.003 g/min after the FctO- and the OL-containing breakfasts, respectively.

Fecal fat excretion was similar between FctO consumption and OL. Average fecal fat recovery was 0.481 ± 0.05 g/d with FctO intake and 0.334 ± 0.04 g/d with OL intake. This represents ~99.6% and 99.7% fat absorption for periods of FctO and OL consumption, respectively.

There was no effect of diet, but a significant effect of hour, on hunger and satiety perceptions using the VAS. Also, there was no significant interaction between diet and hour on responses to the questions on the VAS. However, there was a trend ($p = 0.062$) toward lower energy intake at

the ad libitum lunch session after the breakfast containing FctO compared with the session after OL breakfast consumption. This was mostly due to lower ($p < 0.05$) fat consumption at the ad libitum lunch session after the FctO breakfast compared with the one after the OL breakfast.

Discussion

This study shows, for the first time, that when consumed as part of a strictly controlled targeted weight maintenance diet, an FctO rich in MCT leads to greater loss of AT stores compared with a diet rich in LCT. This change in total adiposity may be due to a rise in EE and fat oxidation with FctO consumption relative to a diet rich in LCT in the form of OL.

Results obtained in this trial on body composition are in contrast with those obtained previously in women, which showed no significant effect of MCT consumption compared with LCT on total adiposity (10). Differences in MCT and LCT consumption on EE between men and women may be due to hormonal differences or, more likely, to differences in intakes. Men generally consume more calories than women and, therefore, would have a greater absolute intake of MCT.

Although the magnitude of the difference observed in total AT reduction between diets contrast, our results agree with those of Tsuji et al. (14), who found greater body fat loss with MCT compared with LCT supplementation in their overweight subgroup. Reasons for discrepancies in results likely include differences in study design. Because the study by Tsuji et al. (14) was a supplementation trial, it is possible that subjects consuming the MCT supplement altered their diet or spontaneously consumed fewer calories than those supplemented with LCT. In addition, the dose of MCT given was low (10 g) to produce such an effect on body composition (14). Also, our results are similar to those of Matsuo et al. (34), who found that subjects supplemented with structured MCT gained less body fat than subjects supplemented with LCT over a 12-week period. However, in this trial, intakes were not strictly controlled and, as in the trial by Tsuji et al. (14), the dose of MCT supplied was low.

The use of MRI in this study allowed determination of small variations in tissue volumes and is a well-established method for measuring total and regional adiposity because contiguous slices are acquired (23,35). The accuracy of MRI in assessing body fat compartments has been demonstrated previously (23,24). Therefore, we are confident that the changes observed are biological and not due to methodological error.

When extrapolating average measured EE to total daily EE, the difference in EE between FctO and OL feeding periods represents ~63 kcal/d on day 2 and 43 kcal/d on day 28. This is slightly lower than observed by Scalfi et al. (7) and Dulloo et al. (8), who have reported differences in daily EE between MCT and LCT consumption of ~86 and 120 kcal/d. However, when we calculated total EE based on the difference between energy intake and energy output, we found a difference of 119 kcal/d (not significant) between FctO and OL consumption. Differences between previous results (7,8) and those obtained in the present trial may be due to differences in the quantities of MCT provided in the diet. In this trial, subjects consumed an average of 21.5 g of MCT per meal compared with 30 g for the previous trials (7,8). Furthermore, it is possible that MCTs exert more profound increments in EE when given in a single acute ingestion than during chronic ingestion. Our results and those of White et al. (9) support the idea that the initial increase in EE with MCT consumption compared with LCT is lessened when measured again after 14 days (9) and 28 days, as observed with diminished statistical power on day 28 in this trial. Nevertheless, the extent of increase in EE observed in this trial can explain the differences in BW change between FctO and OL phases. When daily EE is extrapolated over a 28-day period, the total difference in EE would lead to differences in BW change between the two diets of 0.36 to 0.51 kg, when using EE values measured on days 28 and 2, respectively.

Fat absorption was 99.6% with FctO consumption, which is similar to that observed in an animal trial comparing the digestibility of different types of fat (36). Also, earlier studies of the absorbability of fats in rats showed that coconut oil, which is rich in MCT, is 99.7% absorbed (37). With OL consumption, fat absorption was measured to be 99.7%, which is greater than the 97.4% absorption rate reported by Jones et al. (38) for oleic acid. However, OL also contains ~11.4% of fatty acids as linoleic acid (39), which was found to be 99.4% absorbed (38).

Our data on subjective satiety and ad libitum intake at lunch, although collected on only a small number of subjects, extend and support existing literature. Data obtained using VAS to assess perceived satiety showed no difference between FctO and OL phases, as was observed by VanWymelbeke et al. (16) when comparing OL, lard, MCT oil, and a fat substitute, and by Bendixen et al. (11) when comparing the effects of modified fats containing medium chain fatty acids with rapeseed oil. The use of the VAS to assess satiety sensations has been shown to be reproducible under controlled conditions and with the use of subject designs (40).

Bendixen et al. (11) also found no difference in ad libitum food intake with consumption of modified fats compared with the rapeseed oil. This is in contrast with what was observed in this trial and that of others (15,16). We found a strong trend toward lower energy intake of 221 kcal at the lunch after the breakfast containing FctO compared with the breakfast containing OL. VanWymelbeke et al. (16) found differences in energy intakes between MCT and OL diets of 43 kcal, whereas in a subsequent study, the same group (17) found that subjects consumed 129 kcal less at a meal after

MCT consumption compared with LCT. Similarly, Stubbs and Harbron (15) found differences in daily energy intakes of 258 kcal between a diet containing large amounts of MCTs compared with that containing the least amount of MCT, when food intakes were precisely recorded.

In conclusion, we have shown that consumption of a diet rich in MCT for 28 days improves adiposity, particularly upper body adiposity in overweight men. This may be due to enhanced EE and fat oxidation compared with OL consumption and to greater fecal fat excretion. In addition, there was a strong trend toward lower spontaneous energy intake at the free lunch session after a standard breakfast rich in MCT, compared with one rich in OL. Therefore, it is possible that, under free-living conditions, subjects would consume less energy and fat when their diet contained MCT and, thus, would obtain this added benefit to increased EE, resulting in better weight maintenance and possibly weight loss. Therefore, future studies should be conducted on a free-living population, replacing the major source of added fat in the diet with MCTs for a period of 6 months and comparing with a control group consuming an oil rich in LCTs. This design would allow all aspects of MCT consumption, increased EE, and satiety to exert their effect and possibly produce beneficial changes in body composition. Results from the present trial suggest that MCTs may be considered as a potential tool in the prevention of weight gain and obesity.

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