# MINISTRY OF EDUCATION MINISTRY OF HEALTH

#  AND TRAINING

**NATIONAL INSTITUTE OF NUTRITION**

**------------------**

**DOAN THI ANH TUYET**

**THE EFFECTIVENESS OF USING MEDIUM CHAIN TRIGLYCERIDES ON NUTRITIONAL STATUS, BLOOD LIPID INDEX AND FASTING BLOOD GLUCOSE OF OVERWEIGHT/OBESE WOMEN 20-45 YEARS OLD IN BAC GIANG PROVINCE (2019-2020)**

**Specialization: Nutrition**

**Code: 9720401**

**SUMMARY OF DOCTORAL DISSERTATION**

**HANOI – 2024**

**THIS WORK WAS COMPLETED**

 at the National Institute of Nutrition

# Academic Advisor:

# Ass.Prof. PhD. Le Danh Tuyen

# Ass.PhD. Nguyen Song Tu

# Reviewer 1:

# Reviewer 2:

# Reviewer 3:

The thesis will be defended at the Department-level doctoral thesis grading committee at the National Institute of Nutrition

At the:

**The thesis can be found at:**

- Vietnam National Library

- Library of the National Institute of Nutrition

**LIST OF DISCLOSED RESEARCH RELATED**

**TO THE THESIS THEME**

**1. Doan Thi Anh Tuyet,** Nguyen Song Tu, Le Danh Tuyen, Tran Khanh Van (2023). Blood pressure status, anthropometric characteristics, body composition and associated factors of overweight/obese women 20-45 years old in Bac Giang, 2019. Vietnam Preventative Journal Volum 532, issue 2 – 2023, pages 291 – 295.

**2. Doan Thi Anh Tuyet,** Nguyen Song Tu, Tran Khanh Van, Le Danh Tuyen (2023). Effectivenese of using medium-chain triglycerides oil on body weight, body mass index on overweight/obese women 20-45 years old in 2020. Vietnam Preventative Journal Volum 33, issue 4 – 2023, pages 70 – 77.

3. **Doan Thi Anh Tuyet,** Nguyen Song Tu, Le Danh Tuyen (2024). The effects of medium-chain triglycerides on body weight and body fat composition in overweight and obese adults. *Journal of Nutrition and Food*, Volum 20, Issue 6, pages 10–17.

**INTRODUCTION**

According to WHO, in 2022, more than 890 million adults over 18 years old were obese, leading to more deaths compared to underweight. In Vietnam, the rate of obesity in women has increased 4 - 5 times over more than 20 years, especially in urban areas.

Many studies have conducted on management of obesity through diet by changing in eating habits, or finding substances that promoted weight loss and increased metabolism, which might significantly improve obese status and biochemical disorders. Women aged 20-45, belong to the childbearing age group, are likely to be overweight and obese due to an unbalacened diet, limited physical acitvity, and little time to take care their health. Several clinical trials, researched medium chain triglycerides (MCTs) on overweight and obese individuals, gave possitive results on losing weight without negatively affecting body metabolism. This is explained by increased energy expenditure and higher fat oxidation compared to long chain triglycerides (LCTs). However, these trials lack sufficient data for a comprehensive evaluation and have not been conducted on Vietnamese populations. Therefore, we conducted research: ***"The effectiveness of using medium chain triglycerides on nutritional status, blood lipid index and fasting blood glucose of overweight/obese women 20-45 years old in Bac Giang province (2019-2020)”*** aims to:

**Objectives:**

1. Describe the nutritional status and blood biochemical characteristics of overweight/obese women aged 20-45 in Bac Giang province.
2. Evaluate the effectiveness of using MCT oil after 4 months on changes in weight, body mass index, body fat percentage, waist circumference, and hip circumference in overweight/obese women aged 20-45 in Bac Giang province.
3. Evaluation the effectiveness of using MCT oil after 4 months on changes in total cholesterol, high density lipoprotein (HDL) cholesterol, low density lipoprotein (LDL) cholesterol, triglycerides, and fasting blood glucose in overweight/obese women aged 20-45 in Bac Giang province.

**New contributions of the thesis:**

- Providing scientific evidence on the effectiveness of MCT oil in improving nutritional status, particularly body fat composition and some blood biochemical indices in overweight and obese women aged 20 - 45 in Vietnam.

- Additionally, providing a supportive method in the treatment and management of overweight and obesity in Vietnam by altering the fat composition in the diet without significantly affecting the blood lipid levels of overweight and obese women.

- This is the first research project in Vietnam to describe the nutritional status and blood biochemical indices of overweight and obese women aged 20 - 45 in the community and to evaluate the effectiveness of MCT oil usage in overweight and obese adults.

**Structure of the thesis:**

The thesis consits of 162 pages: Introduction and Objectives of study: 3 pages. Literature review: 42 pages ; Subjects and Methods of study: 31 pages ; Research results 37 pages; Discussions: 46 pages. Conclusion: 2 pages and recommendations: 1 page. The thesis has 11 figures, 46 tables, 194 references, of which 168 are in English.

CHAPTER I. LITERATURE REVIEW

1.1. Overweight and obesity in adults

Overweight and obesity are increasing to alarming levels worldwide. Women aged 20 - 45 have physiological characteristics of stability in body function and structure to be ready for reproductive functions and achieve optimal working capacity. At the same time, they also face many health issues that need attention, such as chronic energy deficiency, micronutrient deficiencies, and overweight and obesity. While chronic energy deficiency and micronutrient deficiencies tend to decrease due to the priority policies and support of international organizations and the policies of each country, overweight and obesity tend to increase, causing a triple burden on the population.

1.2. Medium chain triglycerides and clinical trials on human beings

Medium chain triglycerides are esters of a glycerol molecule with three medium chain fatty acids containing six to twelve carbon atoms. MCT oil is a liquid form of MCT, produced from MCT-rich foods to dietary supplements. The structural composition of MCT oil typically focuses on medium chain fatty acids with pharmacological and clinical effects, mainly the fatty acids C8: caprylic acid and C10: capric acid. The fatty acids C6: caproic acid and C12: lauric acid are present in very low and negligible proportions in MCT oil products. This form of MCT was also used in this study. Most MCT oils or MCT powder products are hydrolyzed, extracted, and synthesized from foods such as palm oil, coconut oil, whole milk, and butter.

MCTs are absorbed into the human body differently from regular fats such as LCTs. They are absorbed through the portal vein instead of the lymphatic system. Since MCTs do not require Carnitine to be transported to the mitochondria, they are quickly beta-oxidized and converted into energy. In contrast, long chain fatty acids have a slower pathway, being re-esterified in the cells of the small intestine and transported by chylomicrons through the lymphatic and vascular systems before being oxidized for energy or stored. Therefore, the rapid metabolism of MCTs reduces the chance of being absorbed by body fat tissues.

Studies have shown that MCTs cause an increase in energy expenditure and enhance the oxidation of fats, specifically the C8:0 and C10:0 chains, compared to LCTs. Another benefit of MCTs is an increased feeling of fullness, leading to reduced food intake. This effect results from the rapid oxidation of MCTs through the formation of ketones. Therefore, a diet supplemented with MCTs can partially replace LCTs, potentially leading to a negative energy balance and possible long-term weight loss.

1.3. Clinical trials on the role of MCT in overweight and obesity

Currently, the safety level for the use of MCTs in the diet has been established at up to 1g/kg, with clinical trials and MCT doses in clinical nutrition being quite commonly applied. Clinical studies on the role of MCTs in weight loss and body fat accumulation, as well as in reducing blood biochemical components such as blood lipids and blood glucose, have recorded improvements.

1.4. Remaining issues and required research

According to tendency in level up overweight and obesity rates in women aged 20-45, the control is quite poor in this group due to unbalanced diets, lack of exercise and less concern for personal health because they often spend more time to take care of their offsprings and family. Recommendations for strategies to manage overweight and obesity through changing dietary patterns and supplementing substances that contribute to controlling body weight without much impacting on blood biochemical indicators are encouraged to maximize model of treatment, control and prevention of this group in the community.

Evaluation of nutritional status and blood biochemical index through the use of MCT oil supplemented in the current diet of overweight and obese women aged 20-45 is the first study in Vietnam, which can provide additionally scientific evidence on assessing intervention effectiveness.

**CHAPTER 2- RESEARCH SUBJECTS AND METHODS**

2.1. Subjects, location and time of research

- Subjects*:*

*+ For screening study: Women aged 20-45 with risk of overweight/ obesity or BMI* ≥ 23 kg/m2.

*+ For intervention study: Selected women from screening study with BMI* ≥ 25 kg/m2 and BMI < 40 kg/m2.

- *Location:* the study was conducted in Bac Giang city, Viet Yen and Lang Giang districts in Bac Giang Province, Vietnam.

**- *Research duration***: The intervention period was 4 months, from July 2019 to March 2020.

2.2. Research design

- Phase 1: Screening to recruit subjects.

- Phase 2: Population-based intervention study (randomized controlled, double-blind and assessed before - after intervention).

2.3. Sample size

***Sample size for community intervention study:***

2s2 (Z­­­­1-α/2 + Z1-β/2 )2

($\overline{X}$1 - $\overline{X}$2)2

Sample size formula: n =

With: n: required sample size; α: Type 1 error, estimated for 5%. (Z­­­­1-a/2 =1.96); β: Type 2 error, estimated for 10%, (Z­­­­1-β/2 = 1.28); $\overline{X}$1 - $\overline{X}$2: Difference in mean value; s: Standard deviation of the mean value

The sample size for anthropometric analysis was 64 women/group; body composition was 25 women/group; blood lipid index was 56 women/group; blood fasting glucose was 64 women/group. Together, combining the above indicators, the minimum sample size required was 64 women/group to participate in the intervention trial. Estimated 20% of women dropout. So the sample size for one research group was rounded for 80 women, the sample size for two groups was 161 women. As a result, the study intervened on 161 subjects, of which 80 women were in the control group and 81 women were in the intervention group.

***Sample size for 24 hour recall:*** All samples in the beginning survey

***Selecting subjects and grouping for the study:***

*Sampling for phase 1:* convenience sampling

- Province selection: intentionally selecting Bac Giang province.

- District selection: intentionally selecting Bac Giang city, Viet Yen and Lang Giang districts.

- Subject selection: Listing all women aged 20-45 at risk of overweight and obesity in the wards/communes of the 3 cities/districts, then compiling them into a sampling frame and conducting screening surveys at health stations. The results were used to create a list of subjects eligible to participate in the intervention study.

*Sampling for phase 2:* simple random sampling from the list compiled in phase 1 to divide into two random groups.

Group 1: intervention group using MCT oil (20ml/day for 4 months # 120 days) combined with 1 cup of low-sugar yogurt (100g/day) and group 2: control group using soybean oil (20ml/day) combined with 1 cup of low-sugar yogurt (100g/day). The two oils were packaged similarly to avoid bias in the community deployment. Participants, researchers, and local supervising collaborators did not know which group was using the intervention product or the control product.

2.4. Research Indicators and Variables

***General Information:*** This includes variables such as the women’s age, ethnicity, occupation, education level, number of children, numver of family members, menstrual condition, medical and medication history.

*Nutritional Status Assessment:* in accordance with the guidelines of WHO about overweight and obesity; abdominal obesity had waist circumference (WC) above 80 cm; the waist-to-hip ratio (WHR) above the health risk threshold was above 0.8 for women. The risk of developing metabolic illness with WC was above 88 cm for women and WHR was above 0.85.

*Hematological Index:* Threshold assessment of elevated blood lipid indices according to NCEP ATP III; hyperglycemia (HG) according to WHO, IDF 2012; metabolic syndrome according to IDF (WC ≥ 80 cm and at least two in four factors following: triglycerides ≥ 1.7 mmol/L; HDL-C < 1.29 mmol/L; HATT ≥ 130 mmHg or HATTr ≥ 85 mmHg; PFG ≥ 5.60 mmol/L).

*Body Composition Index, Fat Mass percentage, Fat Mass, Visceral fat rating:* this group was measured by Tanita SC 330 scale. The company's rating threshold based on age groups 20-39 and 40-59 were used to assess.

*Dietary Evaluation*: This was conducted through a 24-hour dietary recall method, where participants were asked to record their food intake from the previous day. The nutritional value of these diets was then determined using the Vietnam Food Composition Table, as published by the Institute of Nutrition under the Ministry of Health in 2016.

2.5. Implement research

***Research product*:**

- Intervention oil: Medium chain triglyceride oil containing 100% pure MCT produced from natural palm oil. Each 14g of MCT oil contains 8.4g of Caprylic Acid C8 and 5.6g of Capric Acid C10, which are medium chain fatty acids.

- Control oil: Soy oil containing 100% pure refined soy oil. Each 14g of soy oil contains 0.035g of MCT oil and mainly contains long-chain fatty acids.

***Intervention implementation:***

**-** Women in the intervention group received MCT oil (one 400ml bottle every 20 days along with 20 cups of 100g low-sugar yogurt for daily use, totaling 6 bottles used over 4 months). Women in the control group received control oil (with the same volume and usage as the intervention group), to be used just before the main meal (lunch).

- Research products were distributed in batches to health stations of the wards and communes. Materials were managed by ward officials, and distributed to subjects every 20 days (tracked via logbooks). Additionally, group managers and supervisors collected used bottles after each distribution and destroyed them according to the bottle destruction form.

- Throughout the intervention period, the usage of the product and disease monitoring were recorded daily by the subjects at home in pre-designed tracking forms. Health workers checked and supervised weekly the recording of product usage and disease monitoring. Subjects' meals were required to be maintained normally in both groups, ensuring hygiene (required to wash hands before eating and using the research product).



Hình 2.1. Research diagram

2.6. Data Analysis

The analysis of data was carried out using STATA software, version 14.0.

***Statistical Tests Employed***: Various statistical tests were applied in the analysis, including the Kolmogorov-Smirnov test for distribution assessment, Chi-Squared test (χ²-test) or Fisher's exact test for categorical data, t-test for comparing means, and the Mann-Whitney U Test and Wilcoxon test for non-parametric data.

***Intervention Effectiveness Evaluation:*** ARR Index (Absolute Risk Reduction); NNT Index (Number Needed to Treat); Risk Ratio (RR); Adjusted Results - calculated as RR\* (95% Confidence Interval) for qualitative variables and as mean (± SEM, Standard Error of the Mean) for quantitative variables.

2.7. Research Ethics

The study was approved by the Ethical Review Board in Biomedical Research of the Institute of Nutrition No. 152/VDD-QLKH on March 19, 2019.

CHAPTER 3. RESEARCH RESULTS

**3.1. Anthropometric status and some related factors of the child**

**Table 3.1. Characteristics of study subjects (n = 161)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Age group** | **Total (%)** | **< 40 yrs** | **≥ 40 yrs** | **pc** |
| **Ethnics**OthersKinh | 4 (2.5)157 (97.5) | 3 (3.6)80 (96.4) | 1 (1.3)77 (98.7) | 0.621\* |
| **Occupations**Workers,officals, tradersFarmers,housekeepers,freelancers | 131 (81.4)30 (18.6) | 72 (86.8)11 (13.2) | 59 (75.6)19 (24.4) | 0.071 |
| **Education**< High school≥ High school | 80 (49.7)81 (50.3) | 47 (56.6)36 (43.4) | 33 (42.3)45 (57.7) | 0.069 |
| **Residence**RuralUrban | 63 (39.1)98 (60.9) | 39 (47.0)44 (53.0) | 24 (30.8)54 (69.2) | **0.035** |
| **Child number**≤ 2> 2 | 137 (85.1)24 (14.9) | 68 (81.9)15 (18.1) | 69 (88.5)9 (11.5) | 0.245 |
| **Household income**Poverty, near povertyNormality | 5 (3.1)156 (96.9) | 2 (2.4)81 (97.6) | 3 (3.8)75 (96.2) | 0.674\* |
| **Family member**1-4> 4 | 93 (57.8)68 (42.2) | 38 (45.8)45 (54.2) | 55 (70.5)23 (29.5) | **0.001** |

*c)* χ2 *test, \* Fisher test, data were presented by frequency (%),< 40 yrs: 20 years old to under 40 years old, ≥ 40 yrs: 40 years old to 45 years old*

The average age of the study subjects was 37.2 ± 6.0 years. There were statistical differences in residence and the number of family members among the age groups (p < 0.05).

**Table 3.2. Anthropometric characteristics of the study subjects by age group, education level, and exercise (n=161)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **n** | **W (kg)\*** | **H (cm)** | **BMI (kg/m2)\*** | **WC (cm)** | **HC (cm)\*** |
| mean±sd(t-test) | median(M) | mean±sd (t-test) | mean±sd (t-test) | median (M) | mean±sd (t-test) | mean±sd (t-test) | median (M) |
| **Total** | **161** | 64.4 ± 8.3  | 153.2±5.1  | 27.4 ± 2.6 | 91.2 ± 7.3 | 99.2 ± 6.0  |
| **Age group** |
| < 40yrs≥ 40yrs | 8378 | 64.6±7.564.3±9.2 | 64.262.5 | 153.2±4.8153.1±5.3 | 27.5±2.427.3±2.9 | 26.826.4 | 91.0±6.891.4±7.7 | 99.6±5.898.7±6.3 | 99.297.2 |
| p |  | 0.825 | 0.397 | 0.906 | 0.779 | 0.323 | 0.727 | 0.337 | **0.039** |
| **Education** |
| <highsc≥highsc | 8081 | 62.9±7.166.0±9.2 | 62.065.7 | 152.5±4.9153.8±5.2 | 27.0±2.327.8±2.8 | 26.227.3 | 89.0±6.493.4±7.4 | 98.6±5.499.7±6.6 | 97.498.4 |
| p |  | **0.019** | **0.016** | 0.117 | **0.046** | **0.023** | **0.0001** | 0.255 | 0.222 |
| **Exercise** |
| YesNo | 7982 | 63.6±8.365.2±8.4 | 62.663.1 | 153.0±4.9153.3±5.2 | 27.1±2.727.7±2.5 | 26.227.5 | 90.9±7.491.5±7.2 | 98.4±6.599.9±5.5 | 97.299.4 |
| p |  | 0.222 | 0.133 | 0.726 | 0.163 | **0.012** | 0.567 | 0.102 | **0.013** |

*\*Non-normal distribution; M Mann - Whitney U test; W weight; H height; BMI body mass index; WC waist circumference; HC hip circumference; highsc high school; < 40 yrs: 20 years old to under 40 years old, ≥ 40 yrs: 40 years old to 45 years old*

Differences were statistically significant in hip circumference by age group (p < 0.05); between weight (p < 0.05), BMI (p < 0.05), and waist circumference (p < 0.001) in the education level group < high school vs. ≥ high school; and in BMI (p < 0.05) and hip circumference (p < 0.05) in the group with exercise and without.

**Table 3.3. Characteristics of blood biochemical indices of the study subjects by age group, education level, and exercise (n=161)**

|  | **n** | **Chol (mmol/L)** | **TG** **(mmol/L)\*** | **LDL (mmol/L)** | **HDL (mmol/L)** | **FBG (mmol/L)** |
| --- | --- | --- | --- | --- | --- | --- |
| mean±sd (t-test) | mean±sd (t-test) | median(M) | mean±sd (t-test) | mean±sd (t-test) | mean±sd (t-test) |
| Total | 161 | 4.3 ± 0.89 | 1.61 ± 1.17 | 2.46 ± 0.57 | 1.08 ± 0.22 | 5.24 ± 0.74 |

|  |
| --- |
| **Age group** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| < 40 yrs≥ 40 yrs | 8378 | 4.15±0.764.43±1.00 | 1.48±1.021.75±1.31 | 1.251.44 | 2.41±0.532.51±0.61 | 1.08±0.191.09±0.25 | 5.18±0.675.30±0.81 |
| p |  | 0.0502 | 0.150 | 0.403 | 0.279 | 0.773 | 0.291 |

|  |
| --- |
| **Education** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| <highsc≥highsc | 8081 | 4.27±0.804.30±0.97 | 1.39±0.721.82±1.46 | 1.241.36 | 2.49±0.572.42±0.57 | 1.09±0.191.08±0.25 | 5.20±0.655.28±0.82 |
| p |  | 0.863 | **0.021** | 0.250 | 0.404 | 0.939 | 0.460 |

|  |
| --- |
| **Exercise** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| YesNo | 7982 | 4.33±1.024.24±0.75 | 1.58±1.041.64±1.29 | 1.381.25 | 2.47±0.612.44±0.53 | 1.09±0.211.08±0.23 | 5.16±0.655.32±0.81 |
| p |  | 0.558 | 0.733 | 0.795 | 0.683 | 0.608 | 0.172 |

*\*Non-normal distribution; M Mann - Whitney U test; Chol total cholesterol; TG triglycerides; FBG fasting blood glucose; highsc high school; < 40 yrs: 20 years old to under 40 years old, ≥ 40 yrs: 40 years old to 45 years old*

The difference was significant in blood triglycerides concentration between the education level group < high school vs. ≥ high school (p < 0.05).

**Table 3.4. Rates of hyperglycemia, elevated blood lipid indices, and metabolic syndrome by age group in overweight and obese women aged 20 - 45 (n=161)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Age group****Rates** | **Total (%)** | **< 40 yrs** | **≥ 40 yrs** | **pc** |
| Hyperglycemia | 39 (24.2) | 15 (18.1) | 24 (30.8) | 0.060 |
| High total cholesterol  | 22 (13.7)  | 8 (9.6) | 14 (18.0) | 0.125 |
| High triglycerides | 55 (34.2)  | 25 (30.1) | 30 (38.5) | 0.265 |
| Low HDL cholesterol | 70 (43.5)  | 33 (39.8) | 37 (47.4) | 0.326 |
| High LDL cholesterol | 65 (40.4)  | 31 (37.4) | 34 (43.6) | 0.420 |
| Metabolic syndrome | 73 (45.3)  | 33 (39.8) | 40 (51.3) | 0.142 |

*c)* χ2 *test, \* Fisher test, < 40 yrs: 20 years old to under 40 years old, ≥ 40 yrs: 40 years old to 45 years old*

 No differences were observed between age groups in the rates of hyperglycemia, dyslipidemia, and metabolic syndrome (p > 0.05).

**3.2.** **Evaluate the effectiveness of intervention on body weight and rate of overweight/obesity**

**Table 3.5. Change in women's body weight after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention (I)****(n = 71)** | **Control** **(C)****(n = 70)** | **C-I** | **pa** |
| **Weight (kg)** **after 2 and 4 months intervention** |
| T0 | 63.7 ± 5.4 | 64.3 ± 6.7 | 0.62 | 0.548 |
| T2 | 62.2 ± 5.5 | 63.8 ± 6.8 | 1.61 | 0.142 |
| T4 | 62.5 ± 5.4 | 64.1 ± 7.0 | 1.68 | 0.138 |
| T2 - T0 | -1.4 ± 1.7 | -0.5 ± 1.4 | 0.90 | **< 0.001** |
| T2 - T0\* | -1.5 ± 0.2 | -0.5 ± 0.2 | 1.0 | **0.000\*** |
| T4 - T0 | -1.2 ± 2.0 | -0.2 ± 2.0 | 0.97 | **0.004** |
| T4 - T0\* | -1.3 ± 0.2 | -0.1 ± 0.2 | 1.2 | **0.000**\* |
| pb1 | **< 0.001** | **0.003** |  |  |
| pb2 | **< 0.001** | 0.369 |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 2 and 4 months, the effect of intervention on women's body weight was clearly seen (p < 0.001).

**Table 3.6. Change in women's BMI after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| **BMI (kg/m2) after 2 and 4 months intervention**  |
| T0 | 26.9 ± 2.0 | 27.4 ± 1.9 | 0.48 | 0.146 |
| T2 | 26.2 ± 2.2 | 27.2 ± 2.0 | 1.00 | **0.008** |
| T4 | 26.3 ± 2.2 | 27.2 ± 2.2 | 0.93 | **0.016** |
| T2 - T0 | -0.7 ± 0.8 | -0.3 ± 0.7 | 0.48 | **< 0.001** |
| T2 - T0\* | -0.7 ± 0.1 | -0.2 ± 0.1 | 0.5 | **0.000\*** |
| T4 - T0 | -0.6 ± 0.9 | -0.2 ± 1.0 | 0.41 | **0.007** |
| T4 - T0\* | -0.7 ± 0.1 | -0.2 ± 0.1 | 0.5 | **0.001\*** |
| pb1 | **< 0.001** | **0.003** |  |  |
| pb2 | **< 0.001** | 0.064 |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 2 and 4 months, the effect of intervention on women's BMI was clearly seen (p < 0.01).

**Table 3.7. Effective treatment support on overweight and obesity status**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **p** |
| **After 2 months intervention** |
| Overweight/obesity | 47 (66.2%) | 60 (85.7%) | **0.007** |
| No overweight/obesity | 24 (33.8%) | 10 (14.3%) |
| ARR% (95%CI)  | 19.5 (5.8; 33.2) |
| NNT | 5.1 (3.0; 17.2) |
| RR (95%CI) | 0.77 (0.64; 0.94) | **0.007** |
| RR (95%CI)\* | 0.76 (0.62; 0.92) | **0.004** |
| **After 4 months intervention** |
| Overweight/obesity | 49 (69.0%) | 60 (85.7%) | **0.018** |
| No overweight/obesity | 22 (31.0%) | 10 (14.3%) |
| ARR% (95%CI)  | 16.7 (3.2; 30.2) |
| NNT | 6.0 (3.3; 31.5) |
| RR (95%CI) | 0.81 (0.67; 0.97) | **0.018** |
| RR (95%CI)\* | 0.81 (0.68; 0.97) | **0.024** |

*RR (95%CI)\* Derived from comprehensive multivariate regression analysis*

The effectiveness of treatment support was 19.5% and 16.7% after 2 and 4 months, respectively. Results after 2 months and 4 months showed a clear impact of treatment on the overweight and obesity status in women (p < 0.05).

**Table 3.8. Change in women's fat mass after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| **Fat mass (kg) after 2 and 4 months intervention**  |
| T0 | 23.7 ± 3.8 | 24.6 ± 4.1 | 0.87 | 0.192 |
| T2 | 22.9 ± 3.8 | 24.4 ± 4.1 | 1.53 | **0.023** |
| T4 | 23.2 ± 3.8 | 24.8 ± 4.3 | 1.59 | **0.021** |
| T2 - T0 | -0.8 ± 1.2 | -0.2 ± 1.0 | 0.66 | **0.001** |
| T2 - T0\* | -0.9 ± 0.1 | -0.1 ± 0.1 | 0.8 | **0.000\*** |
| T4 - T0 | -0.5 ± 1.4 | 0.2 ± 1.4 | 0.7 | **0.004** |
| T4 - T0\* | -0.6 ± 0.2 | 0.3 ± 0.2 | 0.9 | **0.000\*** |
| pb1 | **< 0.001** | 0.162 |  |  |
| pb2 | **0.002** | 0.326 |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 12 months, the effect of the intervention on the fat mass was clearly seen (p < 0.001).

**Table 3.9. Change in women's visceral fat rating after intervention**

| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| --- | --- | --- | --- | --- |
| **Visceral fat rating** **after 2 and 4 months intervention**  |
| T0 | 7.2 ± 1.1 | 7.6 ± 1.1 | 0.36 | 0.056 |
| T2 | 6.9 ± 1.1 | 7.5 ± 1.1 | 0.58 | **0.002** |
| T4 | 6.9 ± 1.2 | 7.6 ± 1.2 | 0.70 | **0.001** |
| T2 - T0 | -0.3 ± 0.6 | -0.1 ± 0.5 | 0.22 | **0.019** |
| T2 - T0\* | -0.3 ± 0.1 | -0.1 ± 0.1 | 0.2 | **0.008\*** |
| T4 - T0 | -0.3 ± 0.6 | 0.03 ± 0.6 | 0.34 | **0.001** |
| T4 - T0\* | -0.3 ± 0.1 | 0.04 ± 0.1 | 0.4 | **0.000\*** |
| pb1 | **< 0.001** | 0.109 |  |  |
| pb2 | **< 0.001** | 0.673 |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 2 and 4 months, the effect of intervention on women's visceral fat rating was clearly seen (p < 0.01).

**Table 3.10. Effective treatment support for abdominal obesity status**

| **Index** | **Intervention****(n = 44)** | **Control****(n = 48)** | **p** |
| --- | --- | --- | --- |
| **After 2 months intervention** |
| Abdominal obesity | 29 (65.9%) | 41 (85.4%) | **0.028** |
| No abdominal obesity | 15 (34.1%) | 7 (14.6%) |
| ARR% (95%CI)  | 19.5 (2.3; 36.7) |
| NNT | 5.1 (2.7; 43.3) |
| RR (95%CI) | 0.77 (0.61; 0.98) | **0.028** |
| RR (95%CI)\* | 0.75 (0.58; 0.97) | **0.030** |
| **After 4 months intervention** |
| Abdominal obesity | 17 (38.6%) | 24 (50.0%) | 0.273 |
| No abdominal obesity | 27 (61.4%) | 24 (50.0%) |
| ARR% (95%CI)  | 11.4 (-8.8; 31.5) |
| RR (95%CI) | 0.77 (0.48; 1.23) | 0.273 |
| RR (95%CI)\* | 1.05 (0.66; 1.65) | 0.840 |

*RR (95%CI)\* Derived from comprehensive multivariate regression analysis*

After 2 months, the impact of treatment support on abdominal obesity status in women was seen (p < 0.05) .

**Table 3.11.** **Change in women's hip circumference after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| **Hip circumference (cm) after 2 and 4 months intervention** |
| T0 | 98.9 ± 4.7 | 98.8 ± 4.5 | -0.09 | 0.904 |
| T2 | 98.3 ± 4.8 | 99.1 ± 5.0 | 0.84 | 0.309 |
| T4 | 98.1± 4.8 | 98.1 ± 4.9 | 0.01 | 0.991 |
| T2 - T0 | -0.7 ± 1.9 | 0.3 ± 2.2 | 0.93 | **0.008** |
| T2 - T0\* | -0.7 ± 0.2 | 0.3 ± 0.3 | 1.0 | **0.003\*** |
| T4 - T0 | -0.8 ± 2.5 | -0.7 ± 2.6 | 0.10 | 0.810 |
| T4 - T0\* | -0.9 ± 0.3 | -0.6 ± 0.3 | 0.33 | 0.444\* |
| pb1 | **0.005** | 0.303 |  |  |
| pb2 | **0.008** | **0.030** |  |  |

*Value p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 2 months, the intervention's impact on women's hip circumference was observed (p < 0.01).

**3.3.** **Evaluation of the intervention's effectiveness on total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, and blood fasting glucose**

**Table 3.12. Change in the total cholesterol level of women after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention**  | **Control** | **C-I** | **pa** |
| **(n = 71)**  | **(n = 70)**  |
| **Total cholesterol (mmol/L) after 2 and 4 months intervention** |
| T0 | 4.23 ± 0.81 | 4.40 ± 0.98 | 0.17 | 0.258 |
| T2 | 4.19 ± 0.69 | 4.60 ± 0.96b1 | 0.41 | **0.005** |
| T4 | 4.48 ± 0.78b2 | 4.89 ± 0.99b3 | 0.41 | **0.007** |
| T2 - T0 | -0.03 ± 0.64 | 0.20 ± 0.73 | 0.23 | **0.046** |
| T2 - T0\* | -0.01 ± 0.06 | 0.18 ± 0.07 | 0.19 | **0.040\*** |
| T4 - T0 | 0.25 ± 0.69 | 0.49 ± 0.88 | 0.24 |  0.078 |
| T4 - T0\* | 0.25 ± 0.07 | 0.50 ± 0.09 | 0.25 | **0.028\*** |

*p\* Derived from comprehensive multivariate regression analysis, pb1) < 0.05, b2) < 0.01, b3) < 0.001*

After 2 and 4 months, the effect of intervention on total cholesterol concentration in women was seen (p < 0.05).

**Table 3.13. Change in the triglycerides level of women after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| **Triglycerides (mmol/L) after 2 and 4 months intervention** |
| T0 | 1.49 ± 1.13 | 1.66 ± 1.10 | 0.17 | 0.359 |
| T2 | 1.39 ± 0.77 | 1.61 ± 1.00 | 0.22 | 0.144 |
| T4 | 1.37 ± 0.76 | 1.61 ± 1.00 | 0.24 | 0.111 |
| T2 - T0 | -0.10 ± 0.92 | -0.05 ± 0.85 | 0.05 | 0.744 |
| T2 - T0\* | -0.17 ± 0.07 | 0.02 ± 0.09 | 0.20 | 0.068\* |
| T4 - T0 | -0.12 ± 0.92 | -0.05 ± 0.85 | 0.07 | 0.649 |
| T4 - T0\* | -0.20 ± 0.07 | 0.03 ± 0.08 | 0.23 | **0.030\*** |
| pb1 | 0.362 | 0.618 |  |  |
| pb2 | 0.276 | 0.612 |  |  |

*p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 4 months, the impact of the intervention on blood triglycerides in women was observed (p < 0.05).

**Table 3.14. Change in the LDL-C level of women after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| **LDL-C (mmol/L) after 2 and 4 months intervention** |
| T0 | 2.40 ± 0.54 | 2.55 ± 0.58 | 0.15 | 0.111 |
| T2 | 2.51 ± 0.58 | 2.76 ± 0.78 | 0.25 | **0.033** |
| T4 | 2.49 ± 0.61 | 2.77 ± 0.79 | 0.28 | **0.020** |
| T2 - T0 | 0.10 ± 0.49 | 0.20 ± 0.64 | 0.10 | 0.305 |
| T2 - T0\* | 0.12 ± 0.05 | 0.19 ± 0.07 | 0.07 | 0.446\* |
| T4 - T0 | 0.08 ± 0.51 | 0.21 ± 0.64 | 0.13 | 0.194 |
| T4 - T0\* | 0.10 ± 0.05 | 0.19 ± 0.07 | 0.09 | 0.318\* |
| pb1 | 0.082 | **0.010** |  |  |
| pb2 | 0.163 | **0.007** |  |  |

*p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 4 months, no impact of the intervention on blood LDL-C in women was observed (p > 0.05).

**Table 3.15. Change in the HDL-C level of women after intervention**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **Intervention****(n = 71)** | **Control****(n = 70)** | **C-I** | **pa** |
| **HDL-C (mmol/L) sau 2 và 4 tháng can thiệp** |
| T0 | 1.07 ± 0.19 | 1.09 ± 0.25 | 0.02 | 0.601 |
| T2 | 1.06 ± 0.21 | 1.11 ± 0.26 | 0.05 | 0.237 |
| T4 | 1.06 ± 0.21 | 1.09 ± 0.21 | 0.04 | 0.307 |
| T2 - T0 | -0.01 ± 0.13 | 0.02 ± 0.19 | 0.03 | 0.308 |
| T2 -T0\* | -0.01 ± 0.02 | 0.01 ± 0.02 | 0.02 | 0.411\* |
| T4 - T0 | -0.01 ± 0.13 | 0.00 ± 0.19 | 0.02 | 0.548 |
| T4 - T0\* | -0.01 ± 0.02 | 0.00 ± 0.02 | 0.02 | 0.523\* |
| pb1 | 0.513 | 0.434 |  |  |
| pb2 | 0.420 | 0.853 |  |  |

*p\* Derived from comprehensive multivariate regression analysis, pa) independent t-test, pb) paired t-test b1) comparison of T2 with T0 b2) comparison of T4 with T0*

After 4 months, no impact of the intervention on blood HDL-C in women was observed (p > 0.05).

**Table 3.16. Impact of treatment on hyperglycemia in women after the intervention**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Intervention****(n = 14)** | **Control****(n = 12)** | **p** |
| **After 2 months intervention** |
| Hyperglycemia | 9 (64.3%) | 7 (58.3%) | 0.756c |
| No hyperglycemia | 5 (35.7%) | 5 (41.7%) |
| ARR% (95%CI) | - 5.9 (-43.5; 32.6) |  |
| RR (95%CI) | 1.10 (0.59; 2.04) | 0.756 |
| RR (95%CI)\* | 1.03 (0.48; 2.18) | 0.942 |
| **After 4 months intervention** |
| Hyperglycemia | 11 (78.6%) | 11 (91.7%) | 0.356 |
| No hyperglycemia | 3 (21.4%) | 1 (8.3%) |
| ARR% (95%CI) | 13.1 (-13.5; 40.0) |  |
| RR (95%CI) | 0.86 (0.62; 1.18) | 0.356 |
| RR (95%CI)\* | 0.96 (0.47; 1.93) | 0.790 |

*RR (95%CI)\* Derived from comprehensive multivariate regression analysis*

After 2 months and 4 months, no impact of the treatment on hyperglycemia in women was observed (p > 0.05).

CHAPTER 4. DISCUSSION

**4.1.** **Nutritional status and biochemical characteristics of overweight and obese women aged 20-45**

The study showed that the rates of metabolic syndrome, HDL-C, LDL-C, triglycerides disorder, hyperglycemia, and total cholesterol disorder were 45.3%, 43.5%, 40.4%, 34.2%, 24.2%, and 13.7%, respectively. There were statistically significant differences between age groups regarding residence, family size, and average hip circumference. Specifically, overweight and obese women aged 40 and above who lived in urban areas, had families with 4 or fewer members, had a lower average hip circumference, compared to those under 40 years old. Weight, BMI, and average waist circumference were significantly higher in the group with higher education compared to the group with lower education. Additionally, the group that did not exercise had higher BMI and hip circumference compared to the group that exercises. Therefore, the study results indicated that socioeconomic conditions and lifestyle (exercise) affected the anthropometric indices in overweight and obese women aged 20-45, and the prevalence of metabolic disorders was quite high in these subjects.

**4.2.** **Evaluating the effectiveness of intervention on body weight, overweight and obesity rate, body fat composition, waist circumference, and hip circumference**

***Effectiveness of intervention on body weight, overweight and obesity rate:***

The average weight, BMI, and obesity treatment support rate in the intervention group were more effective than in the control group. Weight loss caused by MCT may be secondary to the oxidation of medium-chain fatty acids in the liver, leading to increased energy expenditure. This energy expenditure is higher compared to meals containing LCT within 6 hours after eating or over 24 hours, and this increased energy expenditure effect is dose-dependent. The high thermogenic potential of MCT remains clear after 6 days on a liquid diet rich in MCT. Moreover, MCT also has a high satiety value, which helps prevent excessive food consumption. These could be the reasons why the weight loss and BMI reduction in the intervention group were significantly greater than in the control group.

***Effect on body fat composition:***

This study shows that after 2 months and 4 months, the intervention group had a better reduction in body fat mass and visceral fat index compared to the control group. The results were quite consistent with other studies evaluating the effectiveness of using MCT on fat mass, but the overall amount of fat mass reduction was generally less than in other studies, possibly due to stricter dietary control in those studies. However, the effectiveness of reducing the visceral fat index in the intervention group was better than in the control group, and the reduction continued over time from 2 months to 4 months. This can be explained by the fact that medium-chain fatty acids are less likely to be stored in adipose tissue, do not generate metabolic byproducts, and may be less likely to activate macrophages. The reduced fat accumulation in adipose tissue along with increased oxidation of medium-chain fats after using MCT compared to LCT contributes to the mechanism of reducing body fat components in obese individuals.

***Effect on waist and hip circumference:***

The results show that the intervention was effective in treating abdominal obesity and reducing average hip circumference after just 2 months. The results are also consistent with some studies by Xue (2009) and Mumme (2015), which showed that waist and hip circumference decreased in the intervention group compared to the control group. This highlights the importance of monitoring body measurements in overweight and obese women to control health risks in this group.

**4.3.** **Evaluating the effectiveness of intervention on total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, and fasting blood glucose**

The results show that the use of MCT oil was more effective in reducing total cholesterol levels after 2 and 4 months and triglycerides levels after 4 months compared to the control group. However, the study did not show the effectiveness of MCT oil on LDL-C, HDL-C, and fasting blood glucose levels compared to the control group. This study partially aligns with the findings of Mckenzie K when analyzing 7 RCT studies on the effects of MCT oil on blood lipids, which showed no impact on blood lipid indices except for a slight increase in triglycerides. This difference may be explained by the relatively larger sample size of this study compared to the combined studies used in Mckenzie K's analysis, and the study controlled for confounding factors through generalized linear models, demonstrating the effectiveness of MCT oil compared to the control oil after 4 months of intervention. This is also consistent with the mechanism of MCT's lower fat accumulation in adipose cells as triglycerides and the rapid metabolism of most MCTs in the liver after absorption.

Additionally, the study may open up a deeper research direction at the molecular level regarding the effectiveness of intervention with medium-chain fatty acids on the biosynthesis of fatty acids in the liver and triglycerides levels in the blood.

**4.4. Some limitations**

The study did not show an effect on waist and hip circumferences after 4 months of intervention, nor did it show an effect on triglyceride levels, LDL-C, HDL-C, and fasting blood glucose levels after 2 and 4 months of intervention. The research was limited to women aged 20-45 and did not extend to men or subjects over 45 years old, so the applicability of this intervention method was only confined to women aged 20-45.

In the generalized linear regression analysis, variables were included to account for confounding factors to determine the true effect value. However, it is challenging to control all confounding variables in the study.

CONCLUSION

**1. Nutritional status and blood biochemical characteristics of 161 overweight and obese women aged 20-45**

* Average weight: 64.4 ± 8.3 kg
* Average height: 153.2 ± 5.1 cm
* Average BMI: 27.4 ± 2.6 kg/m²
* Average waist circumference: 91.2 ± 7.3 cm
* Average hip circumference: 99.2 ± 6.0 cm
* Average blood cholesterol level: 4.3 ± 0.89 mmol/L
* Average triglyceride level: 1.61 ± 1.17 mmol/L
* Average LDL-C level: 2.46 ± 0.57 mmol/L
* Average HDL-C level: 1.08 ± 0.22 mmol/L
* Average fasting blood glucose level: 5.24 ± 0.74 mmol/L

The rates of metabolic syndrome (MetS) and other biochemical abnormalities are:

* MetS: 45.3%
* Low HDL-C: 43.5%
* High LDL-C: 40.4%
* High triglycerides: 34.2%
* Hyperglycemia: 24.2%
* High total cholesterol: 13.7%

**2. Evaluation of the effectiveness of MCT oil on weight, body mass index, body fat composition, waist and hip circumference**

Using MCT oil has been shown to improve weight, BMI, body fat percentage, body fat mass, visceral fat index, and hip circumference compared to the control group in overweight and obese women aged 20-45 in Bac Giang. Specifically:

**After 2 months of intervention:**

* Weight difference: -1.0 kg (95% CI: -1.5, -0.6; p < 0.001)
* BMI difference: -0.5 kg/m² (95% CI: -0.7, -0.3; p < 0.001)
* Body fat mass difference: -0.8 kg (95% CI: -1.1, -0.4; p < 0.001)
* Visceral fat index difference: -0.2 (95% CI: -0.40, -0.06; p < 0.01)
* Hip circumference difference: -1.0 cm (95% CI: -1.7, -0.4; p < 0.01)

**After 4 months of intervention:**

* Weight difference: -1.2 kg (95% CI: -1.8, -0.7; p < 0.001)
* BMI difference: -0.5 kg/m² (95% CI: -0.7, -0.2; p < 0.01)
* Body fat mass difference: -0.9 kg (95% CI: -1.3, -0.4; p < 0.001)
* Visceral fat index difference: -0.4 (95% CI: -0.55, -0.18; p < 0.001)

The intervention effectively reduced the rates of overweight and obesity after 2 and 4 months, and decreased the rate of abdominal obesity after 2 months.

 **2.3. Evaluation of the effectiveness of MCT oil on changes in total cholesterol, triglycerides, LDL cholesterol, HDL cholesterol, and blood glucose levels**

Using MCT oil has been observed to improve the average levels of total cholesterol and triglycerides in the blood of overweight and obese women aged 20-45. The differences between the intervention group and the control group were as follows:

* After 2 months of intervention, the difference in average total cholesterol was -0.19 mmol/L (95% CI: -0.38, -0.01; p < 0.05).
* After 4 months of intervention, the difference in average total cholesterol was -0.25 mmol/L (95% CI: -0.48, -0.03; p < 0.05).
* The difference in average triglycerides was -0.23 mmol/L (95% CI: -0.43, -0.02; p < 0.05).

RECOMMENDATIONS

Women aged 20-45 who are overweight or obese can use 20 ml of MCT oil daily, either directly or mixed with yogurt, for at least 2 months and up to 4 months. This can serve as a dietary supplement to aid in weight loss, reduce BMI, decrease body fat mass, and lower visceral fat index. Additionally, it may contribute to improving overweight and obesity conditions as well as blood lipid levels (total cholesterol and triglycerides).