令和 7 年度 修士論文

ベトナム中学生のトランス脂肪酸摂取量

Trans fatty acids intake
in Vietnamese secondary school students

十文字学園女子大学大学院

人間生活学研究科食物栄養学専攻修士課程

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SUMMARY IN ENGLISH

Background and Objective: Stroke and ischemic heart disease are the leading causes of death in Vietnamese people. Trans fatty acids (TFA) may be a potential cause of the increased risk of these diseases. The World Health Organization (WHO) recommends that TFA intake should be less than 1% of daily energy intake. The TFA intake of Vietnamese people is unknown. Therefore, this study was conducted to clarify the TFA intake of Vietnamese people.

Study 1: TFA content of foods in Vietnam

Methods: A total of 147 food samples, including 109 packaged foods, 30 ready-to-eat foods, and 8 home-cooked dishes, which are considered to have high TFA content from foods commonly consumed by Vietnamese people, were collected and analyzed by gas chromatography.

Results: In the packaged food group, 49 out of 109 items contained measurable concentrations of TFA, especially in margarine and cheese products, which were 1215 mg and 3782 mg per 100 g. In the ready-to-eat foods group, TFA was identified in 8 items, with the top three being grilled sausage (531 mg/100 g), fried corn (329 mg/100 g), and fried fish (274 mg/100 g). In home cooking, Vietnamese fried spring rolls, fried pork (shoulder), and fried shrimp were found to have TFA levels of 1135 mg, 533 mg, and 347 mg per 100 g.

Study 2: Dietary survey of TFA intake in junior high school students

Methods: A total of 200 students from three junior high schools in Hanoi, the capital of Vietnam, agreed to participate in this study. The dietary survey was conducted for three non-consecutive days using a 24-hour recall method.

Results: TFA intake was within the WHO recommended range for all participants.

Conclusion: The TFA content of foods in Vietnam was high in some foods that used margarine and vegetable oil, which are commonly considered to be high. The three-day diet of 200 junior high school students in Hanoi who participated in the study suggested that TFA intake was appropriate, at less than 1% of the total energy intake recommended by the WHO. In the future, we would like to investigate other age groups and use this information to contribute to national policy formulation.

SUMMARY IN JAPANESE

背景と目的:、脳卒中と虚血性心疾患は、ベトナム人の主死因である。トランス脂肪酸（TFA）は、これら疾患のリスクを高める可能性がある。世界保健機関（WHO）は、TFAの摂取を1日エネルギー摂取量の1%未満にするよう推奨している。ベトナム人の TFA 摂取量は不明である。そこで、本研究ではベトナム人の TFA 摂取量を明らかにすることを目的として実施した。

研究 1: ベトナムの食品 TFA 含有量

方法：ベトナム人がよく利用する食品から TFA 含量が高いとおもわれるパッケージ食品 109 品目、調理済み食品 30 品目および家庭料理 8 品目、合計 147 品目の食品サンプルを収集し、ガスクロマトグラフィーで分析した。

結果: 包装食品群では、109 品目中 49 品目から TFA が測定され、特にマーガリン（1215 mg/100 g)、チーズ製品（3782 mg/100 g）で高濃度が検出された。調理済み食品群では、8 品目から TFA が検出され、特にグリルソーセージ（531 mg/100 g)、バターコーン（マーガリン利用）(329 mg/100 g)、魚のフライ（274 mg/100 g）の 3 品目が高かった。家庭料理では、ベトナム風揚げ春巻き（1135 mg/100 g)、豚カツ（533 mg/100 g)、海老フライ （347 mg/100 g）から TFA が検出された。

研究 2：中学生における TFA 摂取に関する食事調査

方法： ベトナムの首都ハノイ市の 3 中学校から合計 200 名の生徒が本研究に同意し、参加した。食事調査は、24 時間思い出し法で非連続 3 日間実施した 。

結果： TFA 摂取量は、参加者全員が WHO 推奨量の範囲あった。

結論： ベトナムの食品 TFA 含有量は一般的に考えられるマーガリンや植物油を利用した食品で一部たかいものがあった。研究に参加したハノイ市の中学生 200 名の 3 日間の食事で、TFA 摂取量は WHO 推奨の総エネルギー摂取量の 1%未満で適切であることが示唆された。今後は他の年齢層でも調べ、国の政策立案に資する資料としたい。

INTRODUCTION

Ischaemic Heart Disease (IHD) is currently the leading cause of death globally, accounting for approximately 13% of total mortality. The number of deaths from this condition has risen sharply from 2.7 million in 2000 to 9.1 million in 2021 (1). In Vietnam, according to statistics from the World Health Organization (WHO) in 2021, stroke and ischaemic heart disease were the two leading causes of death, with rates of 186.43 and 72.16 deaths per 100.000 population, respectively (2).

One of the primary risk factors contributing to this condition is the accumulation of atherosclerotic plaques within the arteries, which results from lipid metabolism disorders, in which trans fatty acids (TFA) play a significant role (3–5). TFA are unsaturated fatty acids containing at least one double bond in the trans configuration. They are known to increase levels of low-density lipoprotein cholesterol (LDL-C, or "bad" cholesterol) and decrease levels of high-density lipoprotein cholesterol (HDL-C, or "good" cholesterol), thereby promoting atherosclerosis and increasing the risk of cardiovascular diseases (6,7). Compared to saturated fat, TFAs are associated with a considerably higher risk increment for IHD. In addition to cardiovascular implications, there is a positive association between TFA intake and the prevalence of allergic conditions and diabetes mellitus (8,9).

TFA exists in two primary forms: naturally occurring (found in the meat and dairy products of ruminant animals such as cows, sheep, and goats) and industrially produced (formed during the partial hydrogenation of vegetable oils, commonly present in margarine, shortening, fast food, fried foods, baked goods, processed foods, and street food). The industrial hardening process aims to produce stable products that remain solid at room temperature, thereby facilitating easy transportation, storage, and lower costs. The industrial process results in the formation of mainly monounsaturated TFAs, of which elaidic acid (c9-trans-18:1) is the main component (10). Both forms of TFA are considered harmful to human health (11,12).

To mitigate health risks, the WHO recommends that total TFA intake should not exceed 1% of daily energy consumption, which is equivalent to less than 2.2 grams per day in a 2000 kcal diet (11,13). A systematic review of global dietary survey data reported that TFA intake in 29 countries ranged from 0.3% to 4.2% of total energy intake. Of these, 22 countries met the WHO target, while 7 exceeded the recommendation (14). In countries like the United States, despite strong policy interventions such as mandatory TFA labeling since 2006 (15) and a ban on partially hydrogenated oils since 2018 (16), intake in 2019 still exceeded the WHO recommendation, reaching 1.7% of total energy intake (17). Meanwhile, in Japan, an Asian country with some similar dietary characteristics to Vietnam, such as the use of vegetable oil, consumption of street food and rice-based meals, studies have shown that the average TFA intake is still within the WHO recommendation, with TFA intake in Japanese people being about 0.7–0.8% of total energy intake, significantly lower than in many Western countries (18).

While global data show varying TFA consumption patterns, Vietnam is facing increasing dietary challenges due to modernization and economic integration. Fast food consumption has become more common due to affordability, convenience, and changing work–life patterns. A study by Hoang Thi Duc Ngan conducted among 371 individuals aged 15–25 years revealed that approximately 94.9% reported consuming various types of fast food and bottled beverages at different frequencies (19). Similarly, among 329 sixth-year medical students at a university in Vietnam, 75.4% reported frequent consumption of fast food, primarily during breakfast (37.1%) and lunch (35.8%). The main reasons for choosing fast food included time efficiency, low cost, favorable taste, and the opportunity to socialize with friends and family (20).

In the context of increasing challenges related to dietary habits, particularly the growing dependence on convenient fast foods, there is rising concern about potential long-term health impacts. TFA, found in many processed and fast food products, is among the widely used industrial ingredients due to its low cost and is commonly sold at street food vendors. However, data on both the TFA content in commonly consumed foods and the actual intake levels among the population remain unavailable. In addition, TFA is a modifiable risk factor; establishing baseline data is essential. This would not only contribute to assessing disease risk within the community but also provide a scientific foundation for the development of appropriate nutrition and food safety policies.

Therefore, this study was conducted with two main objectives:

1. To investigate the TFA content of foods in Vietnam.

2. Dietary survey of TFA intake in junior high school students.

STUDY 1: TRANS FATTY ACID CONTENT OF FOODS

1. Definition of trans fatty acid

Trans fatty acids (TFA) are a type of unsaturated fatty acid that contains at least one double bond in the trans configuration. Unlike the more common cis-configured unsaturated fatty acids, TFAs have a straighter molecular structure due to the trans configuration of their double bonds. This linear structure causes TFAs to resemble saturated fatty acids more closely in their three-dimensional shape and physical properties, such as higher melting points and solidification at room temperature. As a result, TFAs can impact lipid metabolism in ways similar to saturated fats and are associated with adverse health effects when consumed in excess. (6,7)

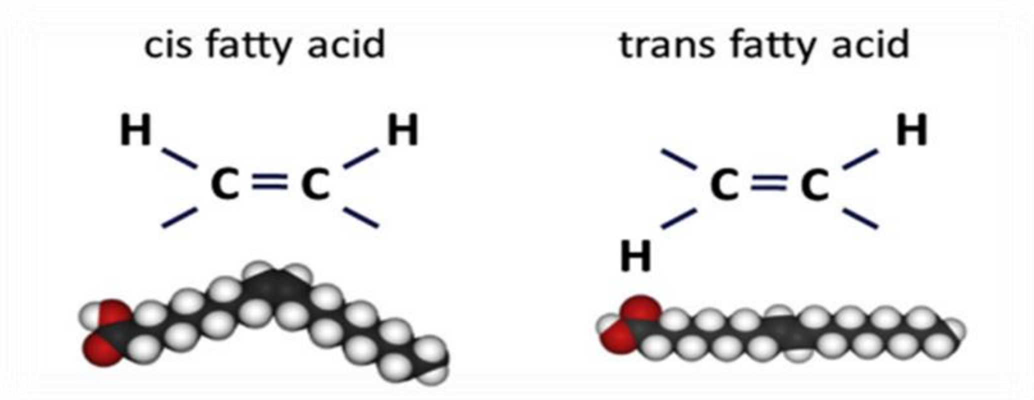


Figure 1. Structural difference between cis and trans fatty acid

2. Method

2.1. Study design

This study was a cross-sectional descriptive design to analyze the content of TFA in selected food products commonly consumed in Vietnam. The collected food samples were processed and analyzed using gas chromatography with flame ionization detection (GC-FID) (7).

2.2. Sample selection and collection

2.2.1. Sample selection criteria

Food products were selected based on their popularity and frequency of consumption in the daily diet of the Vietnamese population, especially among secondary school students. The targeted food groups included packaged foods, ready-to-eat foods, household foods, and processed products that have the potential to contain TFA.

Table 1. Sample selection criteria

Food	Selection criteria	Exclusion criteria
Packaged foods	Fully packaged and labeled. Sold for immediate consumption without preparation.	Available at other locations.
Ready-to-eat foods	Foods that are fully prepared and ready to eat	Unprocessed and purchased at other locations
Household foods	Fried and home-cooked dishes that can be eaten immediately	Boiled, steamed, and uncooked foods and foods purchased outside the home

2.2.2. Sample collection

A total of 147 food samples were collected, consisting of 109 packaged food samples, 30 ready-to-eat foods samples, and 8 homemade food samples. Details of the samples collected are presented on the sample collection table**.**

The sampling procedure was conducted by the Vietnamese standard TCVN 12386:2018 – Food – General guidance for sampling (21). Each food product or dish was collected in a minimum quantity of 100 grams. If the sample did not meet the required weight, additional portions were collected.

Criteria for sample collection locations:

- Packaged foods: Samples were collected from major supermarkets in Hanoi, such as Big C, VinMart, and AEON.
- Ready-to-eat foods: Samples were obtained from street vendors and food stalls located in densely populated areas such as school gates, parks, markets, train stations, and bus terminals in Hanoi and Hai Phong.
- Homemade foods: These included deep-fried dishes prepared using reused cooking oil at high temperatures, collected from selected households in Hanoi (22).

Table 2. Sample collection criteria

Food group	Code	Number of samples collected	Location	Minimum sample quantity
Packaged foods	BG_01	109	Major supermarkets in Hanoi	Each sample unit requires at least 100g of food
Ready-to-eat foods	HN_01 or HP_01	30	Crowded places such as: markets, school gates, food carts, etc., in Hanoi and Hai Phong*	Each serving is at least 100g
Household foods	HGD_01	8	Some households in Hanoi	Minimum food amount: 100g

** Hanoi and Hai Phong: 2 populous cities and top in Gross Regional Domestic Product growth rate* (23)**.**

2.3. Sample preparation

After collection, all food samples were transported under controlled conditions to the laboratory of the National Institute of Nutrition (NIN) for further processing. To ensure consistency in analysis, different types of samples were handled appropriately based on their physical state:

Solid and semi-solid samples (e.g., baked goods, margarine) were chopped or crushed using a stainless-steel laboratory blender until a uniform texture was achieved.

Liquid samples (e.g., edible oils) were homogenized by gentle inversion to evenly redistribute any fat content that might have separated during storage or transport.

Each homogenized sample was placed into a clean, labeled, airtight zip bag and stored at -10°C to prevent lipid oxidation and maintain the integrity of the fatty acids until analysis.

Before analysis, samples were thawed to room temperature and thoroughly mixed. An accurately weighed portion of each sample (0.5–1.0 ±0.001 g) was transferred into a clean 50 mL screw-cap centrifuge tube.

Lipid extraction and fatty acid methyl ester (FAME) preparation (24)

- *Lipid extraction & saponification:*

+ 5 mL MeOH was added to the tube containing the sample. Methanol serves as a polar solvent that dissolves lipids and facilitates subsequent chemical reactions. Next, 0.7 mL of 10N KOH was added. The mixture was vortexed for 30 seconds and incubated in a water bath at 55°C for 1.5 hours. During this step, saponification occurs, breaking down triglycerides into glycerol and free fatty acids.

- *Methylation:*
  + After the saponification reaction, the sample was cooled to room temperature. Then, 0.5 mL of 24N H_2SO_4 was carefully added to the tube to carry out the methylation of free fatty acids. The mixture was vortexed again and incubated in the water bath at 55°C for another 1.5 hours. This step converts free fatty acids into fatty acid methyl esters (FAMEs), which are volatile and suitable for gas chromatographic analysis.
- *FAME extraction:*
  + Once the methylation reaction was complete and the sample cooled, 5 mL of n-hexane was added to the tube to extract the FAMEs into the organic layer. The mixture was vortexed vigorously for 1 minute to enhance phase separation and then centrifuged at 3500 rpm for 10 minutes.
- *Purification and storage:*
  + The upper hexane layer, containing the FAMEs, was carefully collected using a Pasteur pipette and filtered through a 0.45 µm syringe filter to remove any particulates. The filtered extract was transferred into a clean, labeled GC vial, tightly sealed, and stored at a low temperature until chromatographic analysis.

All reagents and solvents used in this process were of analytical grade. Deionized or distilled water was used throughout all experimental procedures. Fatty acid standards were used to identify and quantify FAMEs in the sample chromatograms.

2.4. Analytical method

2.4.1. Instruments and equipment

The analysis was conducted using a gas chromatography system equipped with a flame ionization detector (GC-FID). Other laboratory instruments and consumables used included:

+ Analytical balance (±0.1 mg)
+ Centrifuge

- Vortex mixer
- Water bath (maintained at 55 °C)
- Adjustable micropipettes and compatible tips
- Glass pipettes, Pasteur pipettes
- GC vials, PTFE-sealed syringes, 50 mL plastic centrifuge tubes
- 100 mL beakers and measuring cylinders
- 25 mL and 50 mL volumetric flasks
- 0.45 µm syringe filters (15 mm diameter)
- Filter paper
- Quartz liners
- Helium carrier gas, hydrogen gas, and zero air
- Hydrocarbon trap, moisture trap, M1000 oxygen trap
- Waste solution bottles, solvent rinse vials
- Septa and hydrogen generator filters
- General lab supplies: gloves, face masks, etc.

2.4.2. Conditions of GC

- Column: DB-225 (30 m × 0.25 mm × 0.25 µm, Agilent Technologies)

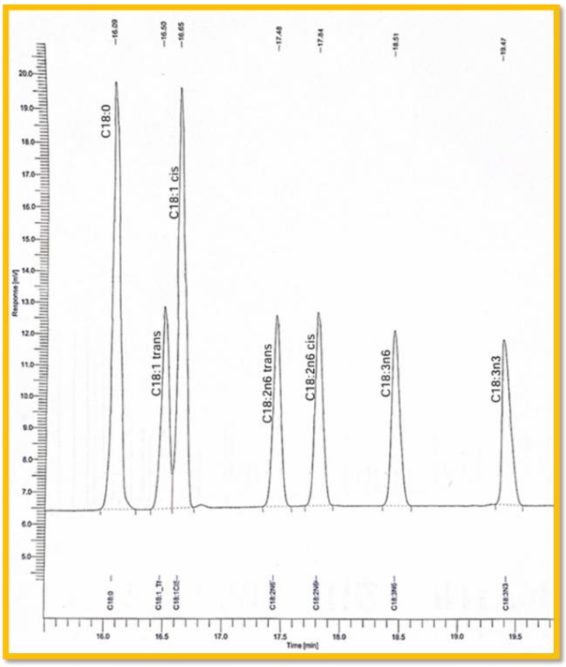
- Oven temperature program:
  - Start at 35 °C (hold for 1 min)
  - Ramp to 180 °C at 20 °C/min
  - Ramp to 220 °C at 3 °C/min, hold for 35 min

- Injector temperature: 250 °C
- Detector temperature: 260 °C
- Injection mode: Split (split ratio 10:1)
- Injection volume: 1 µL
- Carrier gas: Helium, 1 mL/min
- Hydrogen: 45 ml/min
- Air: 450 ml/min

The injector syringe was rinsed with n-hexane before and after each injection to avoid cross-contamination.

2.5. Data processing and statistical analysis

The chromatographic data obtained from the GC-FID system were processed using the instrument's proprietary software (Perkin Elmer TotalChrom™). This software was used to identify and quantify fatty acid methyl esters (FAMEs) based on their retention times and peak areas.



Component Name	Time [min]	Area [uV*sec]
C16:1n7	11.977	26176.94
C17:0	13.526	28514.59
C17:1n7	14.148	28392.02
	15.099	702.62
C18:0	16.087	62011.64
C18:1_Tn9	16.500	29569.41
C18:1cisn9	16.649	59331.75
C18:2n6t nilolelaidi	17.479	28365.70
C18:2n6c linoleic	17.841	29066.29
C18:3n6 gama-linolei	18.506	27515.04
C18:3n3	19.471	27085.54
	20.207	24159.96
C20:0	22.834	60656.31
C20:1n9	23.577	29523.04
C20:2n6	25.237	28718.35
C20:3n6	26.083	28429.26
C20:4n6	26.554	27149.55
C21:0	26.992	30412.36
C20:3n3	27.485	28470.81
EPA	28.736	2737.75
	28.990	28746.19
C22:0	31.984	61427.69
	32.176	390.37
C22:1n9	32.721	29875.97
C22:2n6	34.081	29513.33
C23:0	35.316	32057.76
	35.817	264.79
DHA	37.580	26201.67
C24:0	39.130	62177.15
C24:1n9	40.081	29831.02
		10758574.83

Figure 2. Typical GC-FID chromatogram of fatty acid methyl esters (FAMEs) identified in standard food samples

The chromatogram (left) shows separated peaks corresponding to a variety of saturated, monounsaturated, and polyunsaturated fatty acids, including trans isomers such as C18:1 trans (elaidic acid) and C18:2n6t (linolelaidic acid). Each peak is identified by its retention time, which is cross-referenced with a standard whose composition is detailed in the data sheet.

The data sheet (right) shows the retention times and signal responses (peak areas) for the different fatty acid components identified in the sample. These data are used as a basis for determining the presence and relative proportions of the different fatty acids. The chromatographic method applied effectively distinguishes between the different isomers, including the trans configuration. Once identified, the trans fatty acids are then calculated based on the data in the table.

Statistical Analysis: Further calculations, including the determination of total TFA content and comparison with regulatory limits, were performed using Microsoft Excel. The TFA concentration in each sample was expressed as a percentage of total identified fatty acids.

To determine the TFA content in each sample, the relative peak area of trans fatty acids was combined with the total lipid content extracted from the food, and the following formula was used to calculate the TFA content:

$$W_x = \left(\frac{Ax}{At} \times 100\right) \times \left(\frac{M}{100}\right) x\, n$$

Where the variables are defined as follows:

Wx:	*The TFA content (% or g/100g) in the food sample*
Ax:	*The peak area of TFA in gas chromatography*
At:	*The total peak area of all fatty acids in the sample*
M:	*Lipid mass extracted from food (g/100g)*
n:	*Fatty acid conversion factor*(25)

This calculation ensures that the TFA concentration reflects both the proportion of trans fatty acids in the total fatty acids and the actual lipid content in the food sample.

3. Results

After collecting, processing, and analyzing a total of 147 food samples categorized into three main groups: 109 packaged food samples, 30 ready-to-eat foods samples, and 8 household food samples.

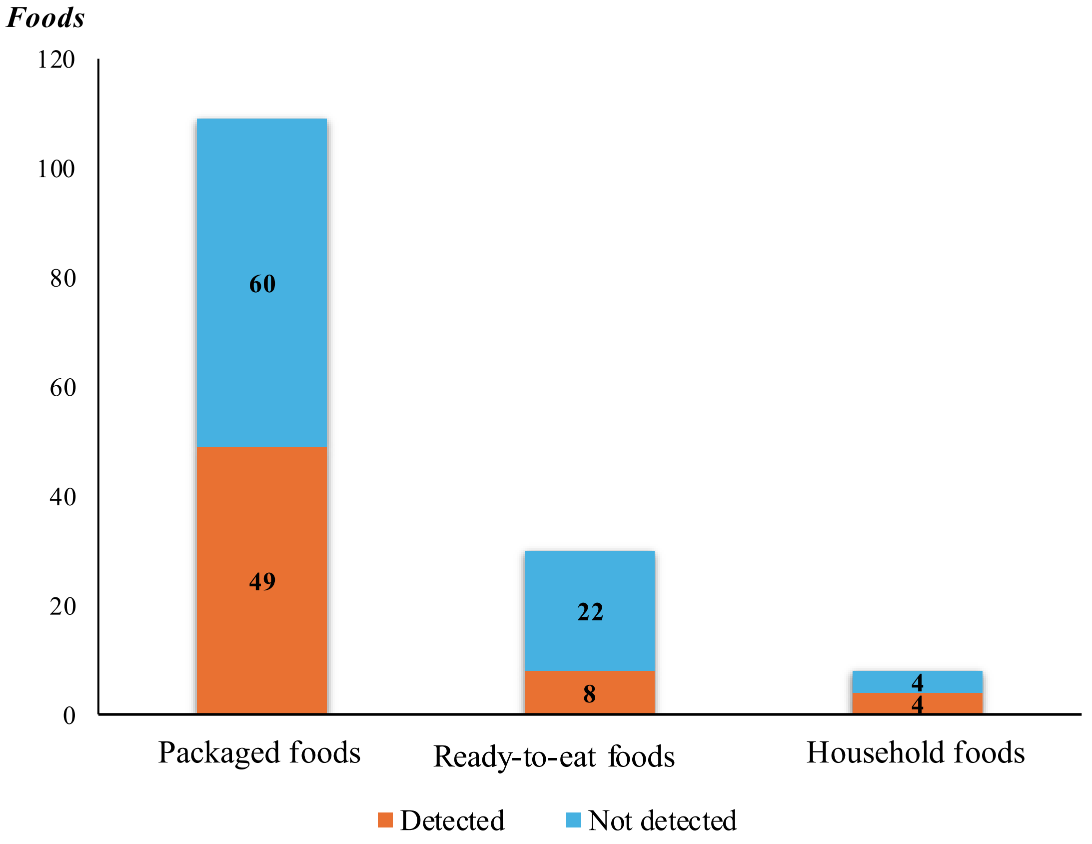


Figure 3. Detection of trans fatty acid in different food categories

The results revealed the presence of TFA in a considerable proportion of the analyzed items. Specifically, TFA was detected in 49 packaged food samples, 8 ready-to-eat foods samples, and 4 household food samples. Most food samples showed relatively low TFA content, with a few notable exceptions. The detailed TFA content for each food category is presented in the following tables:

Table 3. TFA content (mg/100g) in some packaged foods

Food Group	Food item	Number of samples	TFA (mg/100g)
Margarine	Margarine	3	1215
Cheese products	Processed cheese	2	3782
Prepackaged foods, from cereals	Cereals	8	ND
	Oatmeal	2	ND
	Instant noodle	20	11
	Instant pho	10	57
	Bread with filling	4	8
Oil and oil products	Oils	8	ND
	Canned Tuna	2	49
Snacks	Potato chips	20	978
	Rice snacks	5	35
	Sponge cake	5	18
	Cream biscuits	2	ND
	Chocopie Cake	2	14
	Crispy biscuits	2	21
	Biscuit stick	4	3
Meat products	Instant sausage	4	297
	Sausage	3	5
	Smoked ham	3	94

(ND: Not Detected)

The results of TFA analysis in various packaged food items are presented in *Table 3*. Among all samples tested, cheese products exhibited the highest TFA concentration, with processed cheese reaching 3782 mg/100g. This was followed by margarine, which also showed a notably high level at 1215 mg/100g.

In the snacks category, potato chips contained relatively high TFA content (978 mg/100g), while other items such as sponge cakes, biscuit sticks, and rice snacks showed lower levels ranging from 3 to 35 mg/100g.

Prepackaged cereal-based foods had low TFA content, with values below 57mg/100g instant pho and 11mg/100g with instant noodles. Likewise, oil products and meat products such as canned tuna, sausage, and smoked ham showed generally low levels, ranging from 49 to 94 mg/100g. Notably, instant sausage was an exception with 297 mg/100g.

Overall, dairy-based and fat-rich products (cheese, margarine) contributed the highest TFA content, while most processed cereal- and meat-based foods had relatively low TFA levels. These findings highlight significant variations in TFA content across different food groups and product types.

Table 4. TFA content (mg/100g) in some ready-to-eat foods

Food group	Food item	Number of samples	TFA (mg/100g)
Ready-to-eat foods	Grilled sausage	18	531
	Fried corn	18	329
	Fried fish	18	274
	Sweet corn fritters	18	247
	BBQ pork skewers	18	185
	Fried dumpling (no filling)	18	166
	Fried bread stick	18	165
	Fried fish balls	18	113
	Sponge cake	18	ND
	Crepe cake	18	ND
	Fried chicken cake	18	ND
	Coin cake	18	ND
	Fried sweet potato cake	18	ND
	Fried banana cake	18	ND
	Fried stuffed cake (with meat)	18	ND
	Fried stuffed cake (with beans)	18	ND
	Vietnamese fried dumplings	18	ND
	Crispy fried chicken wings	18	ND
	Cookie cream	18	ND
	Fried tofu	18	ND
	Crispy fried chicken drumsticks	18	ND
	French fries	18	ND
	Fried sweet potatoes	18	ND
	Vietnamese fried fermented pork	18	ND
	Fried cheese	18	ND
	Pizza	18	ND
	Brown sugar bubbles fresh milk	18	ND
	Roasted pork belly	18	ND
	Tempura shrimp	18	ND
	Milk tea with cream topping	18	ND

(ND: Not Detected)

As presented in *Table 4,* TFA was detected in 8 out of 30 analyzed ready-to-eat foods items, with significant variation in TFA concentrations across different types of prepared foods. Grilled sausage, fried corn, showed the highest TFA levels in this group, at 531 mg, 329 mg per 100 g, respectively. In contrast, lower TFA levels were found in items such as fried bread sticks (165 mg/100 g) and fried fish balls (113 mg/100 g).

Table 5. TFA content (mg/100g) in some home-cooked foods

Food group	Food item	Number of samples	TFA (mg/100g)
Household foods	Vietnamese Fried Spring Rolls	6	1135
	Fried Pork (Shoulder)	6	533
	Fried shrimp	6	347
	Fried Pork Belly	6	129
	Deep-Fried Chicken Leg	6	ND
	Fried Chicken Wings	6	ND
	Fried tofu	6	ND
	Fried fish	6	ND

(ND: Not Detected)

In *Table 5*, the TFA content varied among household-cooked foods. Vietnamese fried spring rolls had the highest TFA concentration (1135 mg/100g), followed by fried pork shoulder (533 mg/100g) and fried shrimp (347 mg/100g). In comparison, fried pork belly contained the lowest TFA level (129 mg/100g). These results indicate that certain commonly prepared household dishes may contribute significantly to dietary TFA intake, depending on the type of ingredients and cooking methods used.

Ready-to-eat food

Household foods

Some packaged foods

Figure 4. Images of some food samples collected locally

The results of the analysis of TFA content in several food products indicate that this compound is present at varying levels, especially in processed foods. Although the TFA content in individual food items is an important indicator, assessing the potential health risks requires not only analyzing the concentration but also considering actual consumption levels. Therefore, a nutritional survey was conducted to investigate the extent of consumption of TFA-containing foods within the community.

STUDY 2. DIETARY SURVEY ON TFA INTAKE IN JUNIOR HIGH SCHOOL STUDENTS

1. Method

1.1. Study design

A cross-sectional study was conducted among secondary school students at three schools in Hanoi. The data collection took place from October to November 2024.

1.2. Sampling method

In Thanh Xuan District, Hanoi, three secondary schools were randomly selected. Only students who agreed to participate and had obtained parental consent were included in the study.

The sample size was calculated using the following formula:

$$\boldsymbol{n} \geq \left(\frac{\boldsymbol{Z_1 - \alpha/2^{\sigma}}}{\boldsymbol{d}}\right)^2$$

$Z_1 - \alpha/2 = 1.96$, corresponding to a 95% confidence level

σ: The estimated standard deviation of TFA intake*

d: The desired margin of error

(****Based on a study by Yoshizawa et al. on the average TFA intake among Japanese female high school students, the standard deviation was reported to be 0.5 g/day***(26)**.** A desired margin of error of 0.07 g/day was chosen to ensure reasonable precision under the study conditions.)

By substituting the values into the formula, the minimum required sample size was calculated to be 196 participants. In this study, a total of 200 students who met the inclusion criteria agreed to participate, aiming to enhance the precision of the findings.

Inclusion and exclusion criteria:

- *Inclusion criteria*: Students and their families who voluntarily agreed to participate in the study (with a signed informed consent form) (*Appendix 2*).
- *Exclusion criteria*: Students with congenital conditions such as muteness, deafness, or mental disorders, as well as those undergoing medical treatment that could affect their dietary intake

1.3. Data collection

Anthropometric measurements (height and weight) were taken for all 200 participating students to assess their body composition.

Figure 5. Measuring body mass index for students

1.3.1. Dietary data collection

Data collection for the dietary survey was conducted using the multiple-pass 24-hour dietary recall method, implemented over three non-consecutive days, including two weekdays and one weekend day, to capture variations in daily dietary intake *(Appendix3).*

- ***Preparation phase:***

Before the dietary recall interviews, all participating students were instructed to write a simple food diary for each of the three recall days. The diary required students to note the names of all foods and beverages consumed, estimated portion sizes, time and location of meals, and any specific brands or preparation methods, if known. The objective of the food diary was to act as a memory aid and to help standardize the recall process across all respondents.

- ***Interview procedure:***

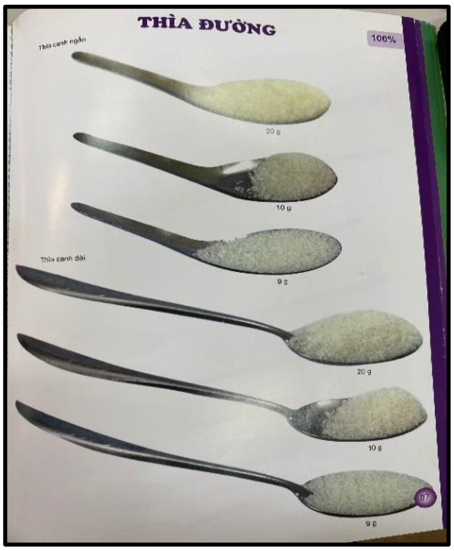
The dietary interview was conducted for 20–30 minutes for each participant and was conducted face-to-face at school, in a private setting, away from the public. Researchers were extensively trained in interviewing techniques and followed a standard protocol from the National Institute of Nutrition to estimate food intake and record food composition data in the most detailed manner.

Figure 6. Conducting 24-hour dietary recall interviews with students

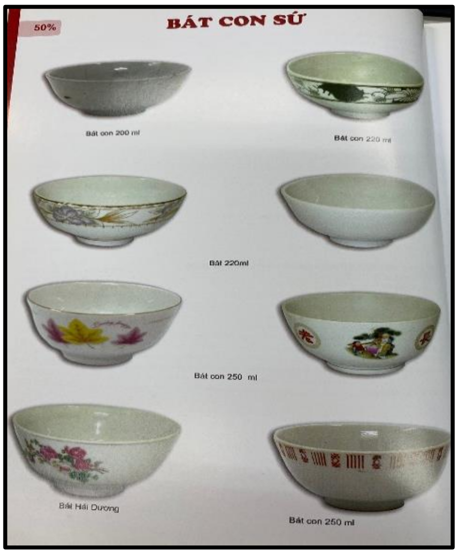
- Portion size estimation

To facilitate the recall of secondary school students' dietary intake and assist interviewers in data collection, the Institute of Nutrition's Food Picture Book served as a valuable tool. It helped respondents recall the names of foods, serving sizes, and preparation methods. In addition, it helped interviewers more accurately identify the types of foods consumed and estimate the approximate amount (in grams) of each.

Institute of nutrition's food picture book



Spice spoon



Bowl for measuring food

Serving size
of some packaged foods

Figure 7. Researchers support tools used in the 24-hour recall interviews

1.4. Data analysis

Dietary intake data collected from participants were reviewed for completeness and consistency before being entered into Microsoft Access for nutritional analysis. The daily food intake of each student was converted into corresponding nutrient values using data primarily derived from the Vietnamese Food Composition Table.

The intake of trans fatty acids (TFA) was calculated in milligrams per person per day and subsequently converted into the percentage of total daily energy intake. This value was then compared against the World Health Organization (WHO) recommendation, which states that TFA intake should not exceed 1% of total daily energy intake.

Statistical analyses were performed using *SPSS version 27*. Quantitative variables were tested for normality, and as they did not follow a normal distribution, they were presented as median and interquartile range (IQR). These values were used to describe the daily intake of TFA and other nutrients.

To compare TFA intake between male and female students, the ***Mann–Whitney U*** test was applied. A p-value of less than 0.05 was considered statistically significant.

1.5. Ethics approval and consent to participate

This study was conducted after being approved by the Ethics Committee, the Scientific Council of the National Institute of Nutrition of Vietnam ***(No. 598/QD-VDD)*** *(Appendix 1)*. Written consent was obtained from the participants, and personal information about the research subjects was kept confidential and used only for research purposes *(Appendix 2)*.

2. Results

Data from 200 participants were analyzed based on 24-hour dietary recall questionnaires.

Table 6. General information of subjects (n=200)

	Male (n=134)	Female (n=66)
Age	12 (1.0)	12(1.0)
Weight (kg)	54.7 (23.2)	50.2 (16.9)
Height (cm)	157.1 (11.7)	153.6 (8.5)

Data are expressed as median (interquartile range).
Mann–Whitney U test was used to compare differences between males and females.

Table 6 summarizes the demographic and anthropometric characteristics of the study participants by sex. The median age was 12 years (IQR: 1.0) for both males and females. Males had a higher weight and height than females (54.7 kg, IQR: 23.2 versus 50.2 kg, IQR: 16.9), (157.1 cm, IQR: 11.7 versus 153.6 cm, IQR: 8.5), respectively.

Table 7. TFA and nutrient intakes among the subjects (n=200)

	Total (n=200)	Male (n=134)	Female (n=66)	*p*-value
TFA (g)	0.3 (0.5)	0.3 (0.5)	0.3 (0.5)	>0.05
Energy (kcal)	1967 (748)	2096 (768)	1746 (632)	<0.05
% TFA consumption/ total energy	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)	>0.05
Protein (g)	70.1 (28.2)	76.0 (29.9)	63.0 (28.4)	<0.05
Animal Protein (g)	22.1 (21.0)	22.7 (21.2)	20.2 (19.4)	<0.05
Carbohydrate (g)	271.0 (119.1)	288.3 (145.2)	226.4 (108.8)	<0.05
Lipids (g)	61.3 (30.7)	64.3 (25.4)	51.5 (30.5)	<0.05
Vegetable Lipids(g)	41.2 (25.1)	44.0 (24.7)	36.9 (27.1)	<0.05

Data are expressed as median (interquartile range).
Mann–Whitney U test was used to compare differences between males and females.

Table 7 presents the median (interquartile range, IQR) values of trans fatty acid (TFA) and macronutrient intakes by sex. The overall median TFA intake was 0.3 g (IQR: 0.5), with similar values observed in both males and females [0.3 g (IQR: 0.5)]. Similarly, the median percentage of total energy intake from TFA was the same for both sexes, at 0.2% (IQR: 0.2), with no statistically significant difference observed ($p > 0.05$). On the other hand, boys had significantly higher median intakes of energy, protein, animal protein, carbohydrates, lipids, and vegetable lipids compared to girls ($p < 0.05$). These findings indicate that although males consumed higher amounts of energy and macronutrients, TFA intake patterns were similar between sexes during early adolescence.

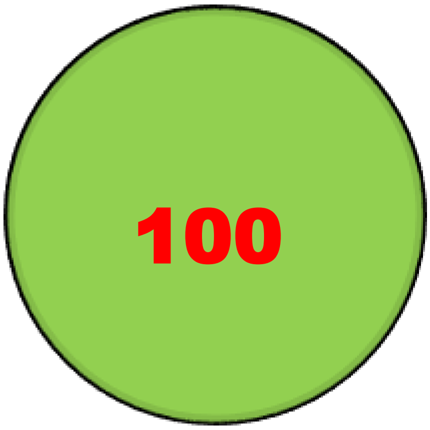


Figure 8. Prevalence of subjects consuming less than 1% of total energy intake from TFA

100% participants consumed less than 1% of total energy from trans fatty acids (TFA), as illustrated in *Figure 8*. This indicated a uniformly low TFA intake across the entire study population. The low intake may reflect the relatively limited presence of TFA in the local food environment, including home-prepared foods and ready-to-eat foods.

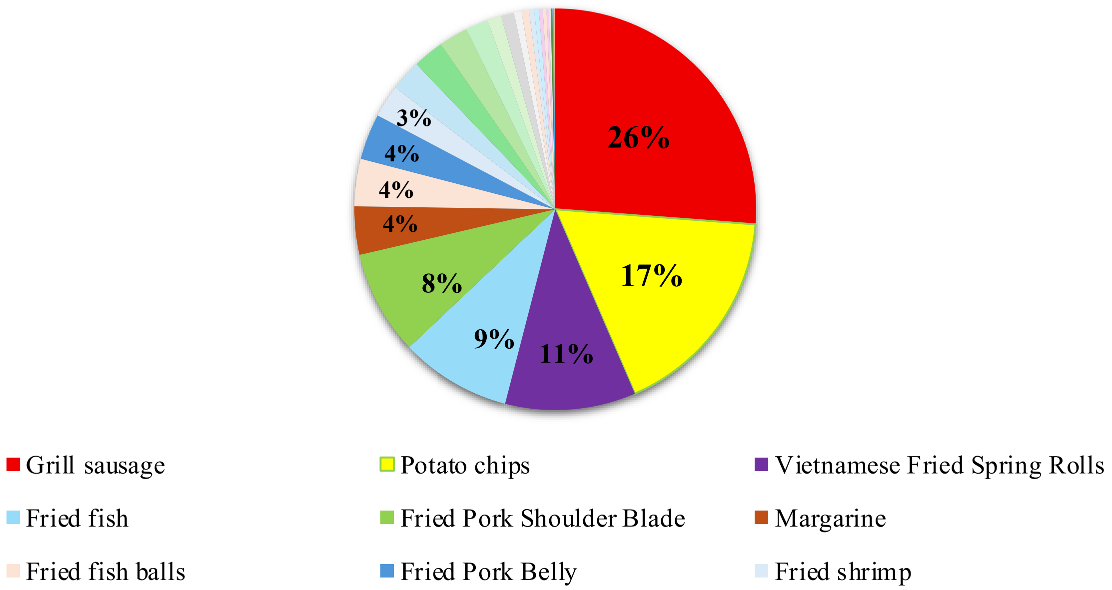


Figure 9. Percentage of TFA containing foods contributing to the TFA intake

Figure 9 shows the percentage of TFA-containing foods contributing to the TFA intake. The TFA contribution of each food was estimated by combining the average daily intake (g/day) per individual, based on data from 200 participants, with the corresponding TFA concentration (mg/100 g) of each item. Among the TFA-containing food items, grilled sausage exhibited the highest contribution to the total TFA intake, accounting for 26%. This was followed by potato chips (17%) and Vietnamese fried spring rolls (11%). The range of other items each contributed less than 10% to the overall intake. These proportions were calculated based on an estimated mean daily TFA intake of 0.3 g, derived from a limited number of food items identified as containing TFA.

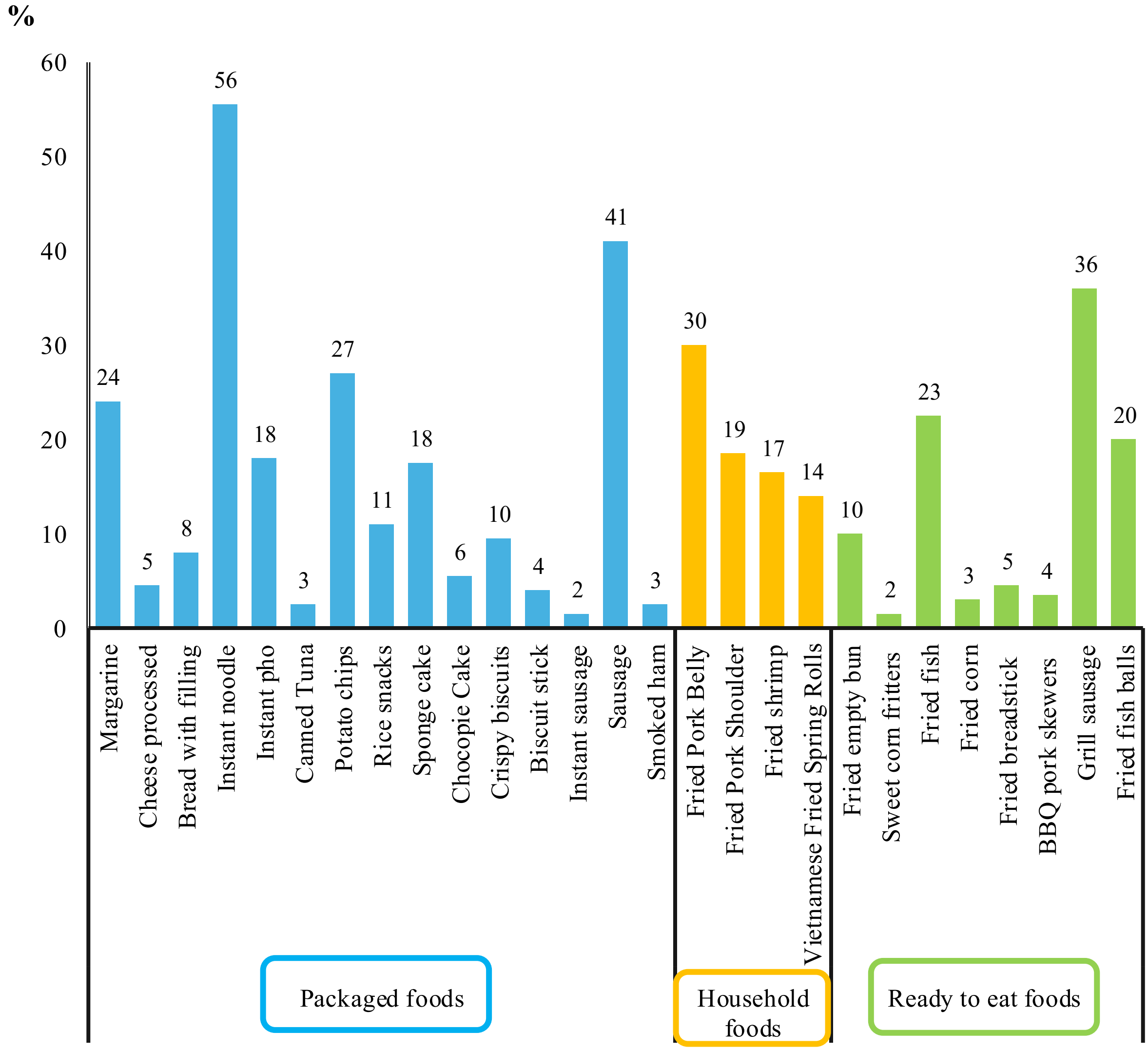


Figure 10. Percentage of students consuming TFA-containing food in a day (n=200)

Figure 10 illustrates the percentage of children consuming various food items across three categories: packaged foods, household foods, and ready-to-eat foods in a day.

Among packaged foods, instant noodles were the most frequently consumed, with 56% of children reporting intake. This was followed by sausages (41%), potato chips (27%), and margarine (24%).

Within the household food group, fried pork belly and fried pork shoulder were the most commonly consumed, reported by 30% and 19% of children, respectively.

In the ready-to-eat foods category, the highest consumption rates were observed for grilled sausages (36%), fried fish (23%), and fried fish balls (20%).

DISCUSSION

In this study, the content of TFA in food samples was determined using gas chromatography with flame ionization detection (GC-FID), following the official guidelines of the AOAC (Association of Official Analytical Chemists). The procedure was carried out based on the standardized steps of AOAC Official Method 996.06, ensuring repeatability and accuracy in the quantification of fatty acids, including trans isomers. GC-FID is considered an appropriate method for TFA analysis due to its high sensitivity, strong capability to separate isomers, and reliable performance(27,28). The simultaneous application of an internationally recognized standard method (AOAC) and the modern GC-FID technique enhances the reliability and comparability of the results, providing a solid foundation for assessing TFA content in various food groups in Vietnam, as well as for comparisons with regional and international studies.

In the present study, margarine and processed cheese exhibited relatively high average TFA contents, measured at 1215 mg/100g and 3782 mg/100g of product, respectively. These values are higher than those reported in a previous study from Malaysia and Japan (29,30), but lower than the findings from China, where the TFA content of margarine was 1.68g/100g (31). The observed variation may be due in part to the limited sample size, as only 2 to 3 samples were analyzed per food category in this study. This small number of samples constitutes a methodological limitation and may affect the representativeness of the average values reported.

In the group of Prepackaged foods from cereals (such as instant noodles, instant pho, and filled bread), the TFA content was found to be relatively low, ranging from 8 mg to 57 mg per 100 g of food. This result is generally consistent with the findings of Tuan et al., who reported that TFA levels ranged from 0.16% to 0.83% of total fatty acids in the noodle portion and from 0.23% to 0.7% in the accompanying oil sachets(32). However, a more recent study by Nguyen et al., which analyzed 30 samples of instant noodles, did not detect the presence of TFA in any of the samples(33). The discrepancies among these studies may stem from differences in sample collection methods, the types of samples analyzed, and the analytical techniques employed. Moreover, the variation in results may also reflect technological changes in food processing and the types of oils used by manufacturers over time. This is particularly relevant in the context of increasing global efforts to regulate and eliminate industrially produced TFAs from the food supply, in line with the World Health Organization (WHO)'s recommendations.

In this study, we did not detect the presence of TFA in several samples of commercial cooking oils, suggesting that manufacturers in Vietnam have taken conscious steps to eliminate TFA from direct consumer products. However, TFA was found in certain processed foods made using these oils, with levels remaining low (approximately 49 mg per 100 g of product) but still noteworthy. This finding indicates that TFA formation may occur during the processing of packaged foods, even when the original cooking oil contains no detectable TFAs. It highlights the need for TFA control measures not only at the level of raw material selection but also throughout the entire food production process, including processing, packaging, and storage stages.

In the snack food category of this study, two cream biscuit products showed no detectable levels of TFA, while the remaining products had TFA contents ranging from 3mg/100g to 978 mg/100 g of food. Among these, potato chips had the highest TFA concentration. This finding is consistent with a study conducted in Malaysia, where potato chips were also reported to contain the highest TFA levels among snack products (34).

Among the 30 ready-to-eat foods samples analyzed in this study, TFA was detected in 8 items (approximately 26%), including grilled sausage, fried corn, fried fish, sweet corn fritters, BBQ pork skewers, fried dumplings (without filling), fried breadsticks, and fried fish balls. Among these, grilled sausage showed a relatively high TFA content of 531 mg per 100 g. Although this item is typically grilled without the addition of oil or seasoning, it is important to note that it belongs to the category of low-cost ready-to-eat foods, often made from unverified ingredients, without proper packaging or labeling. The inability to trace the origin of these ingredients may explain the presence of TFA in this product.

In addition, several fried items were also found to contain TFA. Field observations revealed that cooking oil was repeatedly reused and maintained at high temperatures for extended periods throughout the day. Such conditions are known to accelerate the formation of TFA through oxidation and structural modification of fatty acids, especially during repeated deep-frying (35–38) .

This result suggests that not only industrially processed foods but also foods prepared on-site under uncontrolled conditions—like street food—can serve as significant sources of TFA in the daily diet. This highlights a public health concern, especially in the context of the growing popularity of street food consumption.

In addition to ready-to-eat foods, home-cooked foods also exhibited the presence of TFA. In this study, TFA was detected in 4 out of 8 samples of home-cooked fried foods. This is a noteworthy finding, as these foods are not industrially processed but prepared within household settings, which are generally considered to pose a lower risk for TFA presence compared to commercially processed products. The TFA content ranged from 129 to 1135 mg per 100 g of food, with the highest level observed in Vietnamese fried spring rolls, averaging 1135 mg/100 g. This level is relatively high and may contribute substantially to total daily TFA intake, especially given the popularity of this dish in many family meals and its widespread consumption across various age groups.

This finding highlights the potential risk associated with home cooking practices, which are often overlooked when assessing dietary exposure to trans fatty acids (TFAs). High-temperature frying, repeated reuse of cooking oil, and prolonged cooking times may promote the cis–trans isomerization of unsaturated fatty acids, primarily through free radical mechanisms triggered by strong oil oxidation at elevated temperatures. These mechanisms have been demonstrated in previous experimental studies. Specifically, a review article reported that higher temperatures lead to greater TFA formation in oils, particularly during deep-frying processes. The extent of TFA formation is not only influenced by temperature but also by frying duration, the type of oil used, the number of times the oil is reused, and the composition of the food being cooked(35–37). Another study involving six types of vegetable oils found that after heating at 170 °C for 12 hours, TFA levels increased to 2.57 mg/g in canola oil, 2.62 mg/g in soybean oil, and 3.39 mg/g in sunflower oil. Meanwhile, other oils such as rice bran oil, corn oil, and peanut oil also exhibited varying TFA levels depending on their original composition and oxidative stability(38).

These findings indicate that home frying practices also warrant greater nutritional attention, particularly in contexts where cooking temperatures, oil types, oil quality, and the reuse of cooking oil are not carefully managed. The data emphasizes the critical role of cooking techniques in the formation of the TFA and underscores the need to raise public awareness regarding appropriate ingredient selection and cooking methods to minimize TFA exposure in the diet.

Furthermore, the detection of TFA in several traditional homemade dishes highlights the necessity for further research into other food types and cooking practices to obtain a more comprehensive understanding of TFA formation in daily meals. These results also provide a solid scientific foundation for conducting dietary intake assessments to evaluate actual TFA consumption based on common eating habits and culinary methods in the community. Such evaluations are essential to determine whether TFA intake exceeds WHO recommendations and poses potential risks to public health.

Building upon the food items analyzed in Study 1, we further conducted a dietary assessment using the 24-hour dietary recall method over three non-consecutive days to estimate the intake of the TFA among junior high school students. The analysis revealed a median TFA intake of 0.3 g/day, with an interquartile range (IQR) of 0.5 g. This intake accounted for approximately 0.2% of total daily energy, based on an average energy intake of 1967 kcal/day. These findings provide a preliminary yet valuable estimate of TFA exposure in this age group, contributing to the broader understanding of dietary risks associated with common eating habits.

The target population in this study consisted of junior high school students, with a median age of 12 years. This age group represents early adolescence, during which energy requirements are comparable to those of adults due to rapid growth and development. Investigating TFA intake at this stage is particularly important, as dietary habits formed during adolescence may persist into adulthood and influence long-term health outcomes.

The estimated average median intake of TFA in this study was 0.3g/day, accounting for approximately 0.2% of total energy intake. This level remains within the World Health Organization (WHO) recommendation, which advises that TFA consumption should not exceed 1% of total daily energy intake. Previous studies have also reported that TFA intake in many Asian countries remains within this recommended threshold. For instance, in Japan, Yamada et al. (2010) estimated an average TFA intake of 1.7g/day, equivalent to 0.7–0.8% of total energy intake for both men and women. In contrast, data from China reported a lower intake, approximately 0.47g/day, corresponding to 0.19% of total energy.(18,39)

In several Western countries, however, reported levels of TFA intake have exceeded WHO recommendations (14,17). This difference may be partially explained by dietary habits and food consumption patterns. In many Western populations, there is a tendency to consume larger amounts of processed foods, including fast food, commercially baked goods, and packaged snacks, which are well-known sources of industrial trans fatty acids (i-TFA).

Participants in this study-junior high school students, generally maintained home-based eating habits, with most meals being prepared simply at home. According to the survey, traditional daily meals typically consisted of one or two dishes, primarily cooked by boiling, steaming, or braising, while fried foods-especially deep-fried ones—were less commonly consumed. This household cooking pattern may have contributed to the TFA intake levels observed in the study.

However, the relatively wide interquartile range (IQR = 0.5 g and 0.2%) indicates considerable variation among individuals, suggesting that some participants may have had substantially higher exposure to TFA. This could be explained by their habit of consuming snacks outside the home, particularly packaged foods and ready-to-eat foods types of food that are difficult for parents to monitor. Through this study, we observed that some students consumed a notable amount of items from these two food groups, which may help explain the wide interquartile range observed, as also illustrated in *Figure 10*.

Among the foods found to contain TFA, grilled sausage, potato chips, and Vietnamese fried spring rolls were the top three contributors to total TFA intake, each accounting for more than 10%. Grilled sausage contributed the most, at 26%, despite not being a deep-fried item. As a popular ready-to-eat foods, it is often made with inexpensive and unregulated ingredients. Its appealing flavor, low cost, and widespread availability, especially around school entrances, markets, and street vendor carts, make it a common choice among junior high school students, thereby significantly increasing their exposure to TFA. Potato chips ranked second, contributing 17%, which is not surprising given their widespread popularity across age groups due to their taste, convenience, and affordability; their prominent placement in retail settings further reflects their high consumption. Meanwhile, Vietnamese fried spring rolls, a home-prepared dish with a relatively high TFA content (1135 mg/100 g)—also made a substantial contribution (11%) to overall intake, likely due to their preparation method involving deep frying, making them a notable dietary source of TFA in this population.

In 200 participants, 56% reported consuming instant noodles, followed by sausages (41%) and fried sausages (36%). These figures suggest a strong preference among the study population for packaged and ready-to-eat foods, particularly for breakfast. The popularity of these_items may be attributed to their convenience, affordability, and taste appeal—factors that are often prioritized in the context of busy school mornings. Moreover, the frequent consumption of such ready-to-eat or quickly prepared items may reflect changing eating habits among adolescents, as well as limited parental oversight during morning meals. This pattern raises concerns about early exposure to processed foods that may contain trans fats and other unhealthy components, potentially influencing long-term dietary behaviors.

In conclusion, the TFA content of foods in Vietnam was high in some foods that used margarine and vegetable oil, which are commonly considered to be high. The three-day diet of 200 junior high school students in Hanoi who participated in the study suggested that TFA intake was appropriate, at less than 1% of the total energy intake recommended by the WHO. In the future, we would like to investigate other age groups and use this information to contribute to national policy formulation.

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APPENDIX

Appendix 1: Ethics approval

BỘ Y TẾ
VIỆN DINH DƯỠNG

Số: 598 /QĐ-VDD

CỘNG HOÀ XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

Hà Nội, ngày 15 tháng 9 năm 2024

QUYẾT ĐỊNH
Về việc thành lập Hội đồng thông qua đề cương nhiệm vụ KHCN cấp cơ sở

VIỆN TRƯỞNG VIỆN DINH DƯỠNG

Căn cứ Quyết định số 181/CP ngày 13/6/1980 của Chính phủ về việc thành lập Viện Dinh dưỡng thuộc Bộ Y tế;

Căn cứ Quyết định số 300/QĐ-BYT ngày 27/01/2015 của Bộ trưởng Bộ Y tế ban hành quy định Điều lệ tổ chức và hoạt động của Viện Dinh dưỡng;

Căn cứ Quyết định số 35/QĐ-VDD ngày 23/1/2024 của Viện trưởng Viện Dinh dưỡng dự kiến phân bổ kế hoạch và kinh phí hoạt động Phòng chống bệnh không lây nhiễm năm 2024;

Theo đề nghị của Trưởng phòng Quản lý khoa học.

QUYẾT ĐỊNH:

Điều 1. Thành lập Hội đồng, gồm Chủ tịch và các thành viên có tên trong danh sách kèm theo Quyết định này, xét duyệt thuyết minh đề cương nhiệm vụ:

"Đánh giá mức tiêu thụ thực phẩm chứa tranfat, đường đơn, đường đôi và mối liên quan tới rối loạn đường máu, lipid máu, tăng huyết áp và thừa cân béo phì ở trẻ em 12 - 13 tuổi tại Hà Nội và thành phố Hải Phòng".

Chủ trì nhiệm vụ: ThS. Lê Thị Hằng

Kinh phí: 235.000.000đ (Nguồn Phòng chống bệnh không lây nhiễm năm 2024).

Điều 2. Hội đồng có trách nhiệm giúp Viện trưởng Viện Dinh dưỡng xét duyệt thuyết minh đề cương nhiệm vụ theo đúng quy định của Bộ KH&CN và Bộ Y tế. Hội đồng tự giải thể sau khi hoàn thành nhiệm vụ;

Điều 3. Trưởng phòng Quản lý Khoa học, Tổ chức - Hành chính, KHTH, TCKT, chủ nhiệm nhiệm vụ và các thành viên trong Hội đồng chịu trách nhiệm thi hành Quyết định này./.

Nơi nhận:
- Như điều 3;
- Lưu VT, QLKH.

VIỆN TRƯỞNG

VIỆN DINH DƯỠNG

Trần Thanh Dương

Appendix 2: Informed consent form

(In Vietnamese)

BẢN THOẢ THUẬN THAM GIA NGHIÊN CỨU CHO ĐỐI TƯỢNG THAM GIA

Tôi em là: ………………………………………Lớp……………………………………….

Trường: …………………………………………………………………………………….

Em được nghe giải thích về hoạt động: Đánh giá mức tiêu thụ thực phẩm chứa transfat, đường đơn, đường đôi và mối liên quan tới rối loạn đường máu, Lipid máu, tăng huyết áp và thừa cân béo phì ở trẻ em 12 -13 tuổi tại Hà Nội và Thành phố Hải Phòng.

Gồm các nội dung chính sau đây:

- Mục đích của chương trình:

  + Tìm hiểu thực trạng thừa cân – béo phì và hội chứng chuyển hóa ở trẻ em lứa tuổi THCS.

  + Mức tiêu thụ thực phẩm chứa transfat, đường đơn, đường đôi ở học sinh.

Khi tham gia em sẽ được:

  + Cân đo nhân trắc xác định tình trạng dinh dưỡng miễn phí

  + Được nhận bồi dưỡng cho việc trả lời phỏng vấn và được bác sỹ tư vấn dinh dưỡng miễn phí.

- Nghĩa vụ của học sinh tham gia: trả lời trung thực các câu hỏi trong phiếu phỏng vấn.
- Những thông tin cá nhân sẽ được mã hóa để giữ bí mật.
- Đảm bảo bí mật riêng tư đối với người tham gia nghiên cứu: Những thông tin cá nhân sẽ được mã hóa để giữ bí mật và chỉ dùng cho mục đích nghiên cứu.
- Phương thức liên hệ với cán bộ Viện Dinh dưỡng: Khi có bất cứ thắc mắc gì, em liên lạc trực tiếp với bác sỹ Lê Thị Hằng, số ĐT: 0983599585

Em hoàn toàn tự nguyện đồng ý tham gia và tuân thủ các hướng dẫn của Cán bộ Viện dinh dưỡng.

Đại diện Nghiên cứu **Người tham gia**

Appendix 3: 24 - hour dietary recall form

Mã số				

PHIẾU PHỎNG VẤN KHẨU PHẦN ĂN TRONG 24 GIỜ QUA

Họ tên học sinh: ………………………..…………………   Lớp:……… Trường:...

Ngày tháng năm sinh: …………………………… Giới tính: Nam/ Nữ............ Số điện thoại:..

Người phỏng vấn: ....Ngày phỏng vấn:...

Cháu đã ăn/ uống những gì trong cả ngày hôm qua (từ khi ngủ dậy buổi sáng cho tới buổi tối trước khi đi ngủ):

Lưu ý: Hỏi thức uống trong ngày(trà sữa, nước ngọt,trà chanh, C2,...), đồ ăn vặt (bim bim, bánh kẹo, phô mai,chè, kem,...)

1. Ăn nhà 2. Ăn ngoài	Thời gian	Bữa ăn	Tên và thành phần thức ăn		Phần chế biến	Phần học sinh đã ăn					Quy đổi trọng lượng sống sạch	Mã thực phẩm
			Tên món ăn	Thành phần món ăn	Thải bỏ *1. Có* *2.Không*	Sống /chín	Số lượng ĐVĐL	Đơn vị đo lường (bát, thìa,...)	Trọng lượng 1 ĐVĐL (g)	Trọng lượng đã ăn (g/ hoặc kích thước 3 chiều)		

研究成果発表記録

十文字学園女子大学大学院人間生活学研究科食物栄養学専攻

学位申請者　23MA501　LAI THI CAM NHUNG

Conference: **Conference at Nam Dinh University of Nursing.**

Date: **10th September 2025.**

Place: **Nam Dinh University of Nursing, Ninh Binh.**

Title: Trans fatty acid intake in Vietnamese secondary school students aged 12-13 years old.

Authours: Lai Thi Cam Nhung, Vu Thi Thu Hien, Tran Thuy Nga, Nguyen Van Sy, Le Thi Hang, Pham Thanh Nga, Yamamoto Shigeru.

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HAND - HEART - HEAD - HONOR

Ninh Binh, August 18, 2025

ACCEPTANCE LETTER
Regarding the Registration for Scientific Presentation in the Conference at Nam Dinh University of Nursing, September 2025

Dear LAI THI CAM NHUNG,

Thank you for registering your scientific report entitled: "**Trans fatty acid intake in Vietnamese secondary school students aged 12-13 years old"**

We are pleased to inform you that your research has been accepted for presentation **in the Conference at Nam Dinh University of Nursing, September 2025**.

Your presentation is scheduled on **10th September 2025**, at the 2nd Floor Conference Hall, Nam Dinh University of Nursing.

We sincerely appreciate your valuable contribution and look forward to your participation in the conference.

Sincerely,

Rector of Nam Dinh University of Nursing
Dr. Truong Tuan Anh

TRƯỜNG ĐẠI HỌC ĐIỀU DƯỠNG NAM ĐỊNH