RESEARCH ARTICLE

Low Fruit and Vegetable Consumption in Areas of High Cholangiocarcinoma Risk in Thailand

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Abstract

Objective: This study aimed to determine the proportion of fruit and vegetable (FV) consumption in regions of Thailand with the highest risk for cholangiocarcinoma (CCA). **Methods:** A multi-stage sampling method was employed to recruit participants. One sub-district per district was selected using random sampling. Simple random sampling was used to select individuals based on age range and sex, resulting in a final sample size of 744 participants. Data were collected using a structured questionnaire. FV consumption was assessed through a 24-hour recall interview, recording the types and quantities consumed in three meals. Consumption proportions were calculated by comparing the amounts of each FV consumed. Household consumption units were converted to grams. Descriptive statistics, including number, percentage, mean, and standard deviation, were calculated. The total amount of FV consumed across all meals was compared to the recommended daily intake of ≥400 grams. The prevalence rate of FV consumption was also calculated. **Results:** The prevalence rate of FV consumption in Ubon Ratchathani, Thailand, was 11.30 per 100,000 people. The highest frequency of FV consumption was 1-3 days/week, reported by 66.93% of participants. Most respondents (61.43%) exhibited excellent knowledge regarding FV consumption. Similarly, the mean score for attitude regarding the health benefits of FV consumption was 3.10±0.18. **Conclusion:** This study highlights insufficient FV consumption, associated with the high incidence of CCA, in the studied region. To mitigate the risk of CCA, relevant organizations should implement campaigns to raise awareness about the importance of FV consumption through social media communication and other channels.

Keywords: Cholangiocarcinoma- fruit- vegetable- high-risk areas

Introduction

According to global cancer statistics from the GLOBOCAN database, liver cancer was reported as the fifth-highest incidence and second-highest death rate among all cancers worldwide [1]. Cholangiocarcinoma (CCA) is the second most common type of liver cancer. The International Agency for Research on Cancer (IARC) has classified *Opisthorchis viverrini* (OV) as a biological risk factor for CCA. In Thailand, Ubon Ratchathani Province has the highest prevalence of OV and CCA in the country, based on the following empirical data: 1) a survey of OV prevalence revealed a rate of 28.7% [2] ; 2) an assessment of CCA risk areas found a prevalence 1.61 times higher than the national average the data from an assessment of risk areas for CCA, which was found to be 1.61 times [3] ; and 3) the National Cancer Institute's cancer registry data showed an age-standardized incidence rate (ASR) of 57.1 and 29.3 in men and women,

respectively [4]. CCA poses a significant threat to patient physical and mental health, as well as quality of life [5]. It also impacts families, the economy, and society, having a substantial effect on national stability. Literature reviews indicate that a key approach to preventing CCA is raising awareness of its risk [6]. Proper nutrition, particularly fruit and vegetable consumption, offers protection against CCA [7]. A meta-analysis of studies focusing on Northeast Thailand, the region with the highest worldwide incidence rate of CCA, found that consuming fruits and vegetables can help prevent this disease [8]. Furthermore, the national strategy "Strong Thailand" (2017-2021) emphasizes food consumption and proper nutrition for all ages. Individuals of all ages should consume fruits and vegetables according to their bodily needs or the recommended daily intake of 400-600 grams per day. This will promote a strong body and reduce the risk of disease [9].

In 2019, a survey report on fruit and vegetable consumption in Thailand revealed that only 37.5% of Thai

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people, or approximately 4 out of 10, consumed enough fruits and vegetables according to the recommended daily intake of 400-600 grams/day. This was significantly lower for school-age children, with only 2-3 out of 10 meeting the recommended intake. The survey also found that adults, single individuals, those with secondary education or lower, private sector employees, and people with incomes not exceeding 10,000 Baht per month consumed fewer fruits and vegetables compared to other groups. Notably, individuals in Northeast Thailand consumed the least amount of fruits and vegetables [10], a finding inversely related to the region's highest incidence rate of CCA [4]. Extrapolating fruit and vegetable consumption to the incidence of CCA in high-risk areas, studies have shown that consuming vegetables, fruits, or a combination of both can help prevent CCA [8]. The low consumption of fruits and vegetables in these areas, particularly in Northeast Thailand, suggests that insufficient intake may be a contributing factor to the development of CCA. Therefore, this research aimed to study the proportion of fruit and vegetable consumption among individuals residing in Ubon Ratchathani Province, the highest risk area for CCA in Thailand and explore the knowledge and attitudes regarding the health benefits of fruit and vegetable consumption in this population. The study results will contribute to driving policy initiatives that encourage individuals to consume fruits and vegetables according to the recommended daily intake to effectively prevent CCA and other diseases.

Materials and Methods

Study Design

This cross-sectional analytic study explored the proportion of fruit and vegetable consumption among individuals residing in Ubon Ratchathani Province, Thailand, a region with the highest risk for CCA. The study was conducted from April to October 2022. The study area is depicted in Figure 1.

Study Participants

The study population comprised 778,633 individuals aged 40 years and over living in high-risk CCA areas within Ubon Ratchathani Province [11]. The sample size was calculated using the finite population formula [12], with N = 778,633, p = the prevalence of fruit and vegetable consumption in Northeast Thailand (41.70%) [13], d = 0.05, and α = 0.01.

$$n = \frac{Np(1-p)z^2_{1-\frac{\alpha}{2}}}{d^2(N-1) + p(1-p)z^2_{1-\frac{\alpha}{2}}}$$

This resulted in a required sample size of 645 individuals. To account for potential incomplete responses, an additional 10% of the sample size was added, yielding a total sample of 709. The sample was selected using a multi-stage sampling method:

1. National Level: The Northeast region of Thailand was selected.

2. Regional Level: Ubon Ratchathani Province was chosen.

3. Provincial Level: Twenty-five districts within the province were selected.

4. District Level: One sub-district was randomly selected from each district to serve as a representative.

Inclusion Criteria

• Individuals residing in Ubon Ratchathani Province for more than one year.

• Individuals able to read and write Thai.

• Individuals who voluntarily agreed to participate in the research project.

Exclusion Criteria

• Individuals who refused to participate in the research during the study process.

• Individuals with a severe illness that prevented them from participating in the research project.

Research Tools and quality validation

The data collection tool was a structured questionnaire consisting of three parts:

Part 1: Bio-social Information

This section collected data on the following variables: age, gender, education level, occupation, average family income, comorbidity, weight, and height.

Part 2: Prevalence and Behavior of Fruit and Vegetable Consumption

This part explored four aspects, namely

1. Amount of Daily Fruit and Vegetable Consumption: Respondents completed a fill-in-the-blank form to record their daily consumption.

2. Frequency of Fruit and Vegetable Consumption: Respondents used a 4-point rating scale to indicate their consumption frequency: not eating, 1-3 days/week, 4-6 days/week, and every day.

3. Access to Sources for Purchasing Fruits and Vegetables: Respondents answered closed-ended questions with three options: yes, no, and do not know.

4. Access to Information about Fruits and Vegetables from Media: Respondents answered multiple-choice questions, allowing them to select more than one answer.

Part 3: Knowledge and Attitude Regarding the Health Benefits of Fruit and Vegetable Consumption

This section focused on two aspects:

1. Knowledge about the Health Benefits of Fruit and Vegetable Consumption: Respondents answered closed-ended questions with three options: correct, incorrect, and do not know.

2. Attitude Regarding the Health Benefits of Fruit and Vegetable Consumption: Respondents used a 4-point rating scale: strongly disagree, disagree, agree, and strongly agree.

Quality Validation of Research Tools

• Content Validity: Five experts assessed the content validity of the research tool. The Index of Item Objective Congruence (IOC) value was greater than 0.50, indicating acceptable content validity.

• Reliability: The reliability of the research tool was tested with a sample of 30 individuals from Mueang District, Sisaket Province. The knowledge questionnaire

exhibited a reliability coefficient of 0.74 using the Kuder-Richardson 20 (KR-20) method. The attitude and behavior questionnaire demonstrated a reliability coefficient of 0.80 using Cronbach's Alpha formula.

Data Collection

Data collection involved the following steps:

1. Permission Request: A letter requesting permission to collect data in the 25 districts was submitted to the director of the Ubon Ratchathani Provincial Public Health Office.

2. Cooperation Request: Letters seeking cooperation were submitted to officers of District Health Offices in all 25 districts, providing self-introductions, explaining the research objectives, and outlining the data collection process.

3. Data Collection: Researchers and research assistants conducted data collection in each district. Before data collection began, a meeting was held to explain the procedures and details to the research assistants.

4. Data Verification: The obtained data was checked for completeness and coded for analysis.

Outcome Measures
Data Collection of Fruit and Vegetable Consumption

• Instruments: The data collection instruments included a fruit and vegetable consumption questionnaire, picture books or food models, and household weighing and measuring equipment, such as eating spoons, ladles, and measuring cups. Measurement conversions were as follows: 60 grams = 1/4 measuring cup, 80 grams = 1/3 measuring cup, 120 grams = 1/2 measuring cup, and 240 grams = 1 measuring cup.

• Data Collection: Participants provided consumption information through a 24-hour recall interview. They answered the questionnaire about the types and quantity of fruit and vegetable consumption over the previous day (breakfast, lunch, and dinner). The types and quantities of fruit and vegetable consumption were recorded using various household measuring devices. Data was then converted to grams.

Measurement of Average Fruit and Vegetable Consumption (<400 grams/day and ≥400 grams/day)

The respondents completed a 24-hour recall interview, detailing the types and quantities of fruits and vegetables consumed during three meals (breakfast, lunch, and dinner). Consumption was measured using household units, including measuring cups, spoons, and ladles. The consumption proportions of each fruit and vegetable type were calculated by comparing the amounts consumed. Household consumption units were then converted to gram measurements. The total amount of fruits and vegetables consumed per day was analyzed. To assess adherence to the recommended daily intake, the quantities consumed in all three meals were summed, with consumption considered adequate if it reached 400 grams or more. After obtaining daily fruit and vegetable consumption data for each individual, the average consumption per district and for the entire province was calculated. Prevalence was determined by dividing the

number of respondents who met the recommended fruit and vegetable consumption standards by the province's population and multiplying by 100,000. This resulted in a prevalence rate per 100,000 individuals.

Access to Sources of Information about Fruits and Vegetables

Access to fruit and vegetable markets was assessed by asking respondents whether they knew any places in their community or nearby locations that sold fruits and vegetables, where to purchase them when needed, and if they had access to direct sales sources (with precise location information) or online channels.

Access to sources of fruits and vegetables referred to access to information sources and distribution points for fruits and vegetables, where buyers and sellers could directly trade. This included facilities such as warehouses, weighing and measuring equipment, grading products with standards, and marketing information services for fruit and vegetable markets.

Access to information on the health benefits of fruits and vegetables means access to information about fruits and vegetables from various media channels, including print media, online media, advertising media, training/seminars promoting healthy consumption choices, and the advantages of consuming fruits and vegetables.

Statistical Analysis

General data, prevalence, knowledge, attitude towards the health benefits of fruit and vegetable consumption, and fruit and vegetable consumption among individuals residing in the highest risk area for CCA were analyzed using descriptive statistics, including number, percentage, mean, and standard deviation. The prevalence rate was calculated by dividing the number of individuals consuming fruits and vegetables by the total population of Ubon Ratchathani Province and multiplying by 100,000.

Results

General Information of the Sample in the Highest Risk Area for CCA

The majority of the study population was aged 40-49 years (39.38%), with an average age of 53.72 ± 9.99 years. Participants reported no chronic diseases. Most had completed primary school (80.38%) and worked in agriculture (78.76%), with an average family income of less than 10,000 baht per month (68.95%) (Table 1).

Prevalence of Fruit and Vegetable Consumption Among Individuals in the Highest Risk Area for CCA

Out of 744 respondents, 88 individuals (11.83%) consumed fruits and vegetables according to the recommended daily intake (more than 400 grams daily). The prevalence rate of fruit and vegetable consumption in Ubon Ratchathani, Thailand, was 11.30 per 100,000 people. The average vegetable consumption was 155.87 ± 81.69 grams/day (minimum: 0 grams/day, maximum: 1,550 grams/day). The average fruit consumption was 96.39 ± 49.38 grams/day (minimum: 0 grams/day, maximum: 400 grams/day). The combined average fruit

Table 1. The General Information of Samples in The Highest Risk Area for CCA.

	Number (N=744)	Percentage
Gender		
Male	365	49.10
Female	379	50.90
Age		
40 - 49 years	293	39.38
50 - 59 years	219	29.44
60 - 69 years	133	17.87
70 years and over	99	13.31
Education level		
Primary education	598	80.38
Lower secondary education	137	18.41
Upper secondary education /Vocational Certificate	4	0.54
Diploma/High Vocational Certificate	4	0.54
Bachelor's degree	1	0.13
Occupation		
Agriculturist	586	78.76
Seller/personal business	28	3.76
General worker	114	15.33
Government officer/State enterprise officer	2	0.27
Unemployed	14	1.88
Average monthly family income		
<10,000 Baht	513	68.95
10,000 - 15,000 Baht	75	10.08
15,001 - 20,000 Baht	123	16.53
>20,000 Baht	33	4.44

Figure 1. Determination of the Study Area

Figure 2. Prevalence of Fruit Consumption in Ubon Ratchathani, the Highest Risk Area for CCA in Thailand.

and vegetable consumption was 251.97 ± 99.87 grams/day (minimum: 0 grams/day, maximum: 1,650 grams/day). The highest frequency of fruit and vegetable consumption was 1-3 days/week (66.93%). Regarding access to sources for purchasing fruits and vegetables, respondents primarily preferred fresh markets (96.37%). Most accessed information about fruits and vegetables through online channels (websites/social media) (90.86%) (Table 2).

The overall prevalence of fruit and vegetable consumption in Ubon Ratchathani Province is presented in maps classified by district (Figures 2-4). The overall prevalence of fruit consumption ≥400 grams/day in the province was 0.95%. Mueang District had the highest prevalence (23.66%) (Figure 2). The prevalence of vegetable consumption ≥400 grams/day in the entire province was 0.27%. Nam Khun District had the highest prevalence (7.65%), followed by Det Udom District (1.45%) (Figure 3). Notably, the combined prevalence of fruit and vegetable consumption ≥400 grams/day in the province was 11.83%. Nam Yuen District had the highest prevalence (100%), followed by Thung Si Udom District (91.67%). Several districts exhibited high rates of combined fruit and vegetable consumption ≥400 grams/day (Figure 4).
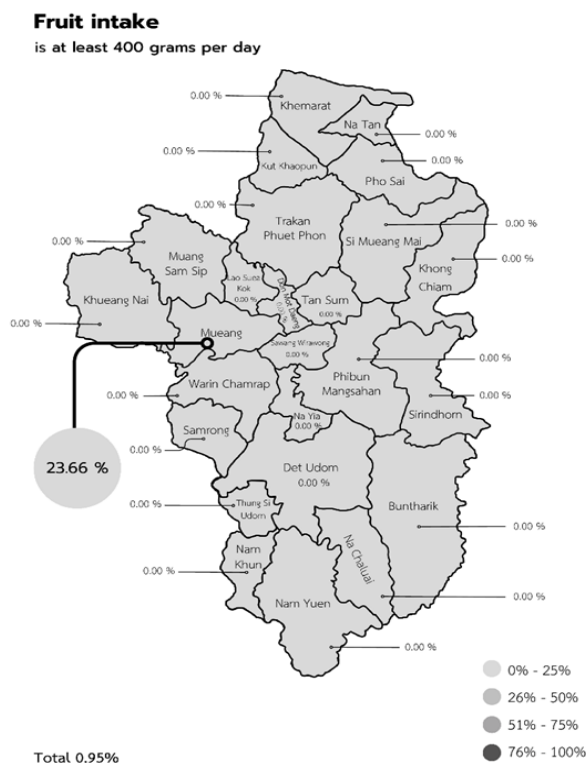
Knowledge and Attitude Regarding the Health Benefits of Fruit and Vegetable Consumption Among Individuals in the Highest Risk Area for CCA

The overall knowledge scores on fruit and vegetable consumption were high, with 594 individuals (79.84%)

Table 2. The Prevalence of Fruit and Vegetable Consumption among People in The Highest Risk Area for CCA.

|	Number (N=744)	Percentage
Total amount of fruit and vegetable consumption		
<400 grams/day (below the standard)	656	88.17
≥400 grams/day (meeting the standard)	88	11.83
Frequency of fruit and vegetable consumption		
1-3 days/week	498	66.93
4-6 days/week	163	21.91
Every day/week	83	11.16
Sources for purchasing fruits and vegetables		
Fresh market	717	96.37
Convenience store	51	6.85
Food truck	72	9.68
Online	46	6.18
Sources of information about fruits and vegetables		
Online channels (website/social media)	676	90.86
Family and friends	364	48.92
Television	169	22.72
Library/reading books	133	17.88
Public health officials	115	15.46
Knowledge posters, campaign signs in various locations	76	10.22
Radio	64	8.60
Conference/seminar/lecture	49	6.59
Newspapers	6	0.81

Prevalence rate = 13.30 per 100,000 people
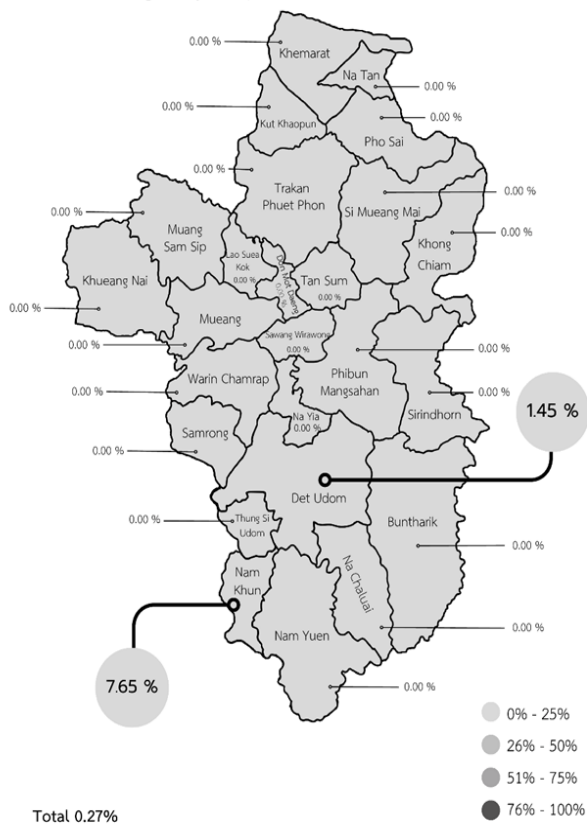
Figure 3. Prevalence of Vegetable Consumption in Ubon Ratchathani, the Highest Risk Area for CCA in Thailand.
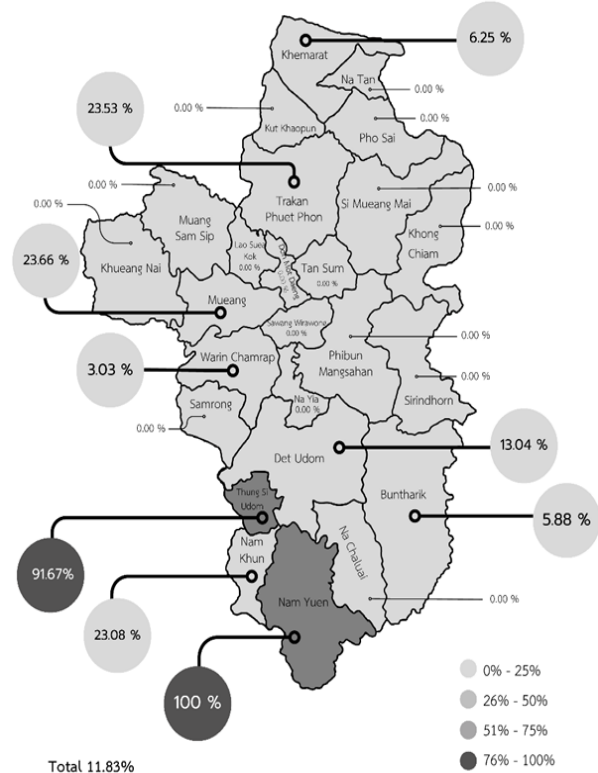

Figure 4. Prevalence of Fruit and Vegetable Consumption in Ubon Ratchathani, the Highest Risk Area for CCA in Thailand.

Table 3. Knowledge Score Levels Regarding Fruit and Vegetable Consumption among People in The Highest Risk Area for CCA.

Level	Criteria (Scores)	Number (N=744)	Percentage
Not pass	<8	150	20.16
A good level	9-11	137	18.41
An excellent level	12-15	457	61.43

achieving high scores. The majority of respondents, 457 individuals (61.43%), scored 12-15 points on the knowledge questionnaire (Table 3). Three items were answered correctly by all participants (100%): Item 9: You should consume a variety of fruits and vegetables. Item 11: Fruit and vegetable consumption can help control weight. Item 12: Fruit and vegetable consumption helps the digestive system work usually. The item with the lowest percentage of correct answers (46.51%) was Item

5: You should buy fruits and vegetables with beautiful leaves and shapes without pores (Table 4).

The mean score for attitude towards the health benefits of fruit and vegetable consumption was 3.10 ± 0.18. When examining individual items, Item 3, "You will buy fruits and vegetables from the source that is thought to be the safest from chemicals," had the highest mean score of 3.96 ± 0.20. The lowest mean score was for Item 6, "You do not like to consume fruits and vegetables because you do not like the taste" (Table 5).

Discussion

This study revealed that only 11.83% of individuals consumed fruits and vegetables according to the recommended daily intake of more than 400 grams. The low consumption observed may be attributed to a lack of knowledge about the appropriate daily intake of fruits and vegetables. While individuals may consume

Table 4. The Knowledge about Fruit and Vegetable Consumption among People in The Highest Risk Area for CCA

	Knowledge about fruit and vegetable consumption	Number of people answering correctly	Percentage
1	You should consume only cooked vegetables.	431	57.93
2	You should consume six scoops of vegetables and 2-3 servings of fruits per day.	601	80.78
3	Consuming fruits and vegetables in the right proportion can prevent cholangiocarcinoma.	476	63.98
4	Fruits and vegetables contain antioxidants.	682	91.67
5	You should buy fruits and vegetables with beautiful leaves and shapes without pores.	436	46.51
6	Soaking fruits and vegetables in the water left over from washing uncooked rice for 10 minutes and rinsing them with clean water helps reduce the amount of toxic residue.	570	76.61
7	Washing vegetables thoroughly by separating them into each leaf and soaking them in water for 15 minutes helps reduce the pesticide residues.	532	71.51
8	Vegetables containing beta-carotene help fight free radicals that destroy cells in the body.	508	68.28
9	You should consume a variety of fruits and vegetables.	744	100.00
10	Ready-made fruit and vegetable juices are high in vitamins.	576	77.42
11	Fruit and vegetable consumption can help control weight.	744	100.00
12	Fruit and vegetable consumption helps the digestive system work usually.	744	100.00
13	The nutritional value of vegetables can be preserved by quickly cooking them with heat.	508	68.28
14	The nutritional value of fruits can be preserved by washing and eating them immediately.	484	65.05
15	Green leafy vegetables contain a lot of calcium.	426	57.26
	Mean	558.13	75.02

Table 5. The Mean Scores of Attitude Health Benefit of Fruit and Vegetable Consumption among People in The Highest Risk Area for CCA.

|	Attitude health benefit of fruit and vegetable consumption	Mean	S.D.
1	You think consuming fruits and vegetables will make you healthy and not get sick often.	3.05	0.22
2	Fruit and vegetable consumption can reduce the risk of cancer.	3.60	0.50
3	You will buy fruits and vegetables from a source considered the safest from chemicals.	3.96	0.20
4	You think you consume more than 400 grams of fruits and vegetables daily.	3.75	0.57
5	You agree with growing vegetables for household consumption.	3.46	0.50
6	You do not like to consume fruits and vegetables because you do not like the taste.	1.64	0.73
7	You think that accessing sources of selling fruits and vegetables is difficult.	2.68	0.62
8	You think that local fruits and vegetables have no nutritional benefits.	2.98	0.13
9	You think promoting fruit and vegetable consumption since childhood is unnecessary.	3.26	0.44
10	You think that expensive fruits are usually safe from chemicals.	2.60	0.54
	Total average	3.10	0.18
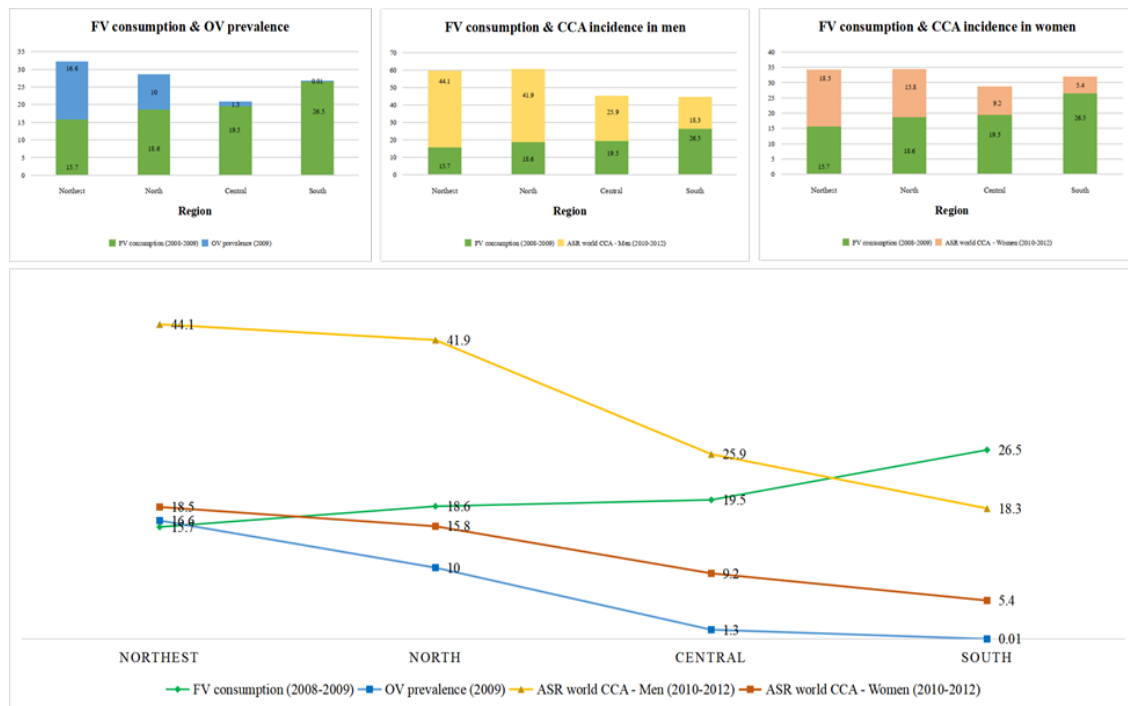
Figure 5. Comparison of Fruit and Vegetable Consumption with OV Prevalence and CCA Incidence in Thailand.

fruits and vegetables daily, they may not be aware of the recommended quantities. This finding aligns with the Thai National Health Examination Survey 4 and 5, which reported a decline in the prevalence of ideal fruit and vegetable consumption from 29.1% in 2009 to 24.8% in 2014 [10]. Modern lifestyles, often characterized by time constraints, particularly among working-age individuals, may also contribute to lower fruit and vegetable consumption.

Another contributing factor may be a focus on convenience, speed, and modernity in food purchasing, which can overshadow considerations of nutritional value or safety from toxins. A study by Zasimova, [14] highlighted the influence of fast food consumption on dietary choices among working-age individuals, potentially influenced by external factors such as work, part-time employment, and multiple jobs. Regarding access to sources for purchasing fruits and vegetables, respondents primarily relied on community markets and local fresh markets, consistent with the widespread distribution of grocery stores and convenience shops in the region [15].

Furthermore, a comparison of fruit and vegetable consumption data with OV prevalence and CCA incidence reveals a concerning trend (Figure 5). The northeastern region of Thailand has the highest prevalence of OV [2] and incidence of CCA in both men and women [16], followed by the northern, central, and southern regions. Conversely, fruit and vegetable consumption in the northeast was found to be lower compared to the northern, central, and southern regions [17]. This inverse relationship is further emphasized by a nested case-control study within a cohort study in Khon Kaen, Thailand, which found that fruit and vegetable consumption was a protective factor against CCA [18].

The majority of study participants demonstrated a good level of knowledge regarding fruit and vegetable consumption, with an average knowledge score of 79.84%. Furthermore, most participants (61.43%) scored between 12 and 15 points on the knowledge questionnaire. Participants primarily obtained information about fruit and vegetable consumption from various sources, particularly online channels such as websites and social media (90.86%). In today's digital age, individuals across all age groups readily access multiple sources of knowledge about health, diet, and diseases through online channels [19] and social marketing campaigns [20].

The average score for attitude towards the health benefits of fruit and vegetable consumption was 3.10 ± 0.18, indicating a generally positive attitude. This positive attitude may be linked to the participants' good level of knowledge and their positive attitudes towards the health benefits of fruit and vegetable consumption. Tailoring nutrition education programs to match the target group's interests and using engaging content can lead to more positive changes in knowledge and attitudes. For example, the Cosmetic Content-Based Nutrition Education Program has proven successful in encouraging students to increase their fruit and vegetable consumption [21]. Factors influencing knowledge and attitude towards the health benefits of fruit and vegetable consumption include age, household income, and gender. Working-age women, who often serve as homemakers responsible for preparing family meals, are particularly important to consider [22]. However, empowering communities to proactively address this issue is crucial for sustainable CCA prevention. This could involve developing model communities that prioritize self-reliance in producing fruit and vegetable juice products for CCA prevention [23] or building community capacity to encourage high-risk

groups to consume fruits and vegetables [24].

In conclusion, this research confirms the hypothesis that low fruit and vegetable consumption is prevalent in areas with the highest risk for CCA. Individuals in Ubon Ratchathani Province, which has the highest incidence of CCA in Thailand, exhibited a low intake of fruits and vegetables. This finding likely stems from attitudes towards the health benefits of fruits and vegetables, which directly influence behavioral intentions and impact consumption habits. To address this issue, relevant organizations should collaborate to cultivate positive attitudes towards fruit and vegetable consumption. Proactive campaigns should be implemented to raise awareness about the importance of these foods, utilizing easily accessible and convenient communication channels such as social media. Such efforts can help prevent and reduce the risk of CCA while promoting positive health outcomes in the short and long term.

Author Contribution Statement

NS1, MR, and NS2 conceived and designed the research. NS1 collected the data. NS1, NS2, and SW conducted the analyses. NS1 reviewed drafts of the paper. All authors contributed to writing and revising the manuscript and approved the final version.

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