DOI: https://doi.org/10.31351/vol35iss1pp229-242

Knowledge of Medical Cannabis use, Cannabis in Food, and Health Literacy among Late-Adolescent Students in a Thai Province

Prasittichai Poonphol[1], Charuwan Thanawiroon[2], Chaisit Soontara[3], Supaphit Thammakittiphan[4], Soraya Kulbunya[4] Chanathip Dalas[4] Janjaree Kunnamas[4], Tawanchai Phohom[5], Narongchai Chaksupa[6], Jeerisuda Khumsikiew[1] and Teeraporn Sadira Supapaan[*,1]

[1]Division of Pharmacy Practice, Faculty of Pharmaceutical Sciences, Ubon Ratchathani University, Ubon Ratchathani, Thailand.
[2]Division of Pharmaceutical Chemistry and Technology, Faculty of Pharmaceutical Sciences, Ubon Ratchathani University, Thailand.
[3]Department of Pharmacy, Sunpasitthiprasong Hospital, Ubon Ratchathani, Thailand.
[4]Faculty of Pharmaceutical Sciences, Ubon Ratchathani University, Ubon Ratchathani, Thailand.
[5]Department of Industrial Engineering, Faculty of Engineering, Ubon Ratchathani University, Ubon Ratchathani, Thailand.
[6]Division of Biopharmacy, Faculty of Pharmaceutical Sciences, Ubon Ratchathani University, Ubon Ratchathani, Thailand.
***Corresponding author**

Received 3/3/2025, Accepted 15/7/2025, Published 29/3/2026

Abstract

Cannabis is the most widely used illicit drug globally, with an increasing use for both medical and non-medical purposes. Despite evolving policies and regulations, knowledge gaps persist among the youth, particularly regarding cannabis use, its integration into food products, and associated health risks. Many adolescents rely on unverified sources such as social media and peer networks for cannabis-related information, thereby increasing the risk of misinformation and unsafe consumption. This cross-sectional descriptive study assessed knowledge levels with respect to medical cannabis use, cannabis in food, and health literacy among late adolescent students in educational institutions. Additionally, it examined the factors influencing knowledge, experience, and willingness to try cannabis while exploring opinions on medical cannabis use and cannabis in food. Data were collected from 252 students aged 15 - 18 years, using self-administered questionnaires. Descriptive statistics were used to analyze participant characteristics, while the chi-square test was applied to assess relationships between demographic factors, knowledge, and health literacy. The findings revealed that 49.2% of the participants had low cannabis-related knowledge, whereas 62.3% demonstrated moderate health literacy. Gender and field of study significantly influenced knowledge and health literacy. Most of the participants acknowledged the benefits and risks of cannabis use. These results highlight the need for targeted educational interventions to enhance cannabis-related knowledge and health literacy among late adolescents, considering their unique contexts and experiences.
Keywords: Cannabis, Knowledge, Health Literacy, Adolescence, Students.

Introduction

The global cannabis landscape is undergoing a profound and accelerated transformation. Historically classified as a worldwide illicit substance, cannabis is now navigating a complex transition towards legalization for medical and non-medical purposes in a growing number of jurisdictions[1, 2]. This paradigm shift is occurring within a context of rising substance use globally. The United Nations Office on Drugs and Crime (UNODC) reported that in 2020 alone, an estimated 284 million people aged 15-64 had used drugs, marking a 26% increase over the preceding decade[3].

As these liberalizing policies proliferate, they have precipitated urgent public health concerns, particularly surrounding the heightened risk of access and unintentional exposure among vulnerable populations, most notably adolescents[4, 5].

This international trend is also evident in Thailand, where the legalization of medical cannabis in 2019—followed by broad decriminalization in 2022, catalyzed a rapid expansion of retail outlets and a measurable rise in adolescent and young-adult use[6]. Public-health commentators argue that the country has

"embarked on a nationwide experiment without adequate safeguards," warning that weak product regulation, youth-directed marketing, and the absence of potency limits together constitute a "policy vacuum" and a "crisis in the making" [7].These concerns are not merely theoretical: surveys of Bangkok vocational students already list cannabis as the most commonly used illicit substance[8], and adolescent poison-control calls for cannabis intoxication have quadrupled since 2021[7].

Underlying these behaviors are profound knowledge deficits. A foundational cross-sectional survey of Bangkok adolescents showed only moderate overall knowledge (mean 7.9 ± 2.3 on a 13-item scale), with fewer than half able to name a single government-approved medical indication[9]. Critically, over 70% of respondents cited the internet or social media as their primary information source, underscoring how youth must navigate a digital ecosystem lacking reliable oversight at the very moment cannabis products, many of increasingly high potency, have become widely accessible[7, 9].

Emerging public-health priorities include: (i) surveillance of escalating THC potency and related psychiatric harms; (ii) research on cannabis-impaired driving among Thailand's youngest licensed drivers; and (iii) development of evidence-based, youth-focused prevention programs that address misinformation, label literacy, and delayed-onset risks of edibles[7].

Adolescence is a critical neurodevelopmental window, rendering this demographic uniquely vulnerable to the deleterious effects of cannabis[10]. Exposure to its primary psychoactive compound, Δ9-tetrahydrocannabinol (Δ9-THC), can interfere with crucial brain maturation processes, particularly those governing executive functions such as decision-making, emotional regulation, and impulse control. Short-term consequences include impairments to memory, attention, and judgment, which can compromise academic performance and elevate accident risk[11]. The long-term risks are even more severe, with established links to persistent cognitive deficits, a substantially higher likelihood of developing substance use disorders, and an increased incidence of mental health conditions, including anxiety, depression, and psychosis[10, 12-15]. These risks are progressively amplified by the ever-increasing potency of cannabis products, with mean Δ9-THC concentrations in global markets soaring from below 10% in the mid-2000s to frequently exceeding 20-30% in recent years[16, 17].

In this high-risk environment, health literacy emerges as a crucial mediating factor. Formally defined as the capacity to access, understand, appraise, and apply health information to inform health-related decisions[18, 19], health literacy is fundamental for navigating the complexities of cannabis. For an adolescent, this involves a specific skill set: the ability to locate credible information, comprehend pharmacological terms, critically evaluate peer and social media claims, and translate that understanding into safer behaviors[20]. Conversely, low health literacy creates a vulnerability to misinformation and risky use patterns[21-24]. However, few empirical studies have examined how health literacy specifically mediates cannabis-related perceptions and risk appraisals among youth, especially within the unique cultural and regulatory context of Southeast Asia.

This gap is critical because, despite ongoing public health campaigns, significant and often dangerous knowledge deficits persist among youth worldwide. A systematic review of 133 studies revealed that while accurate knowledge of harms is protective, overall knowledge levels have paradoxically declined in jurisdictions following legalization[25]. Quantitative surveys paint a concerning picture globally: only 41% of Indian college students could identify long-term cognitive risks[26], while U.S. undergraduates who felt most confident in their cannabis knowledge were often the least knowledgeable and paradoxically more inclined to use[27]. This confusion is compounded by the failure of traditional educational models. Qualitative research with Canadian youth shows a clear preference for interactive, harm-reduction-oriented education over simplistic "just-say-no" messages, with many criticizing school-based programs for failing to provide practical, real-world guidance[28].

The challenge is further complicated by the proliferation of cannabis-infused edibles. Among adolescents with a history of cannabis use, a staggering 72% report having tried edibles[29]. These products pose unique risks due to their delayed pharmacokinetic profile, which often leads to dosing misinterpretation and unintentional overconsumption[30]. Research consistently shows that young consumers struggle to interpret THC percentages and serving sizes on labels[31-33]. This knowledge vacuum is actively exploited in the digital sphere, where pro-use narratives on platforms like TikTok and Instagram often glamorize consumption while omitting critical risk information, thereby normalizing unsafe behaviors[34, 35]. In Thailand, these risks are disproportionately concentrated, with vocational students exhibiting nearly double the rate of lifetime

cannabis use compared to their peers in general education[8, 36].

This confluence of factors—heightened neurobiological vulnerability, expanding access to high-potency products, pervasive misinformation, and documented inadequacies in traditional education, underscores an urgent need for research. Understanding the specific knowledge gaps and health literacy levels among different youth populations is an indispensable prerequisite for designing effective, evidence-based public health and educational strategies that are interactive, non-judgmental, and empower youth with practical harm-reduction skills. Therefore, this study aims to assess and compare the knowledge, awareness, and health literacy regarding medical cannabis and cannabis-infused food products among late-adolescent students in general and vocational education streams in Thailand.

Materials and Methods

Study population

This cross-sectional survey targeted late adolescents (15 – 18 years) enrolled in two distinct secondary-level pathways within one north-eastern Thai province:

1. General upper-secondary schools (Mathayom 4–6) – academic programs geared toward university entrance, emphasizing mathematics, science, languages and social studies in a classroom setting.
2. Vocational colleges (Por Wor Chor/ Por Wor Sor) – competency-based curricula in trades such as engineering, business or hospitality, with up to 50 % of contact hours spent in workshops or industry internships[37].

These contrasting curricular emphases create different peer environments and risk exposures, making direct comparison of cannabis-related knowledge, awareness and health literacy particularly informative[37]. All students registered during the 2024 academic year formed the sampling frame. The sample size was calculated using Cochran's formula, applying a 5% margin of error and 95% confidence level, yielding a final sample size of 385 participants[38].

Research procedures

This cross-sectional descriptive study used a self-administered[39], web-based questionnaire[40]. After obtaining permission from school directors, QR codes linking to a Google Forms survey were posted in classrooms and common areas. Students scanned the code and completed the questionnaire privately on their own devices at a time of their choosing—a mode shown to reduce social-desirability bias and improve disclosure in sensitive health topics[40, 41]. Only 252 eligible students completed the survey, falling short of the target; this reduced sample size is therefore a study limitation.

Research Instruments

The research instrument was a questionnaire divided into three sections:

Section 1: General Information

This section included eight closed-ended questions on gender, age, institution, and monthly income, etc.

Section 2: Knowledge about Medical Cannabis and Cannabis in Food

This section consisted of 15 closed-ended questions across four domains: medical cannabis indications, adverse effects, legal aspects, and cannabis use in food. The scores ranged from 0-15, categorized as follows:

< 60% (0 - 8 points): Low knowledge
60-80% (9 - 12 points): Moderate knowledge
> 80% (13 - 15 points): High knowledge

These score categories were adopted based on Bloom's cut-off points [42].

Section 3: Health Literacy in Cannabis Use

This section included 5 Likert scale questions across five domains: access to health information and services, understanding information, evaluation information, communication and social support, and self-health management. Adapted from the Thai Health Literacy Scale[43], responses were rated from 1 (least) to 5 (most), with a total score of 75 and categorized as follows:

< 60% (1- 44 points): Low health literacy
60-80% (45 - 60 points): Moderate health literacy
> 80% (61 - 75 points): High health literacy

The score categories were derived from Bloom's cut-off criteria[42].

Both Sections 2 and 3 were designed and validated by the authors. However, the questions in Section 3 were adapted from the Thai Health Literacy Scale, which primarily focuses on general health literacy concepts such as access to health information, ability to communicate with healthcare providers, and decision-making in everyday health contexts. To enhance relevance, Section 3 was modified to specifically address health literacy in the context of medical cannabis use and cannabis-infused food, including participants' ability to access, understand, evaluate, and apply information related to cannabis in making informed health decisions.

Instrument validation

The questionnaire was validated by three experts (items with an IOC score of > 0.5 were accepted). Content validity was established by a panel of three subject-matter experts, consistent with published recommendations[44-46]. To test reliability, a pilot study was conducted with 30 participants. Section 2 (Knowledge about Medical Cannabis and Cannabis in Food) showed a KR-20 coefficient of

0.702—KR-20 being the reliability index for dichotomously scored items (1 = correct, 0 = incorrect)—while Section 3 (Health Literacy in Cannabis Use) demonstrated strong internal consistency with a Cronbach's α of 0.920.

Data analysis

Descriptive statistics, including frequencies, means, percentages, and standard deviations were used to analyze general participant data, knowledge of medical cannabis, cannabis use in food, and health literacy levels. Inferential statistics, specifically the Chi-Square Test, were used to examine the relationships between the participants' characteristics, knowledge, and health literacy. A confidence level of 95% was set for all analyses.

Results and Discussion

General information

The sample size was calculated with Cochran's formula—using a 5 % margin of error and a 95 % confidence level—which indicated that 385 participants were required. However, because cannabis is a culturally sensitive topic in Thailand and participation was strictly voluntary, only 252 students consented and completed the survey. This shortfall, driven by privacy concerns and stigma, is acknowledged as a study limitation.

The study included 252 participants, predominantly females (68.3%), most of whom were aged > 17 years (35.7%). Most participants were enrolled in general education (79.0%), 84.5% relied on parental support, and 15.5% were self-funded. Monthly income varied, with 34.5% earning less than 3,000 THB. With respect to substance use (e.g. cigarettes/e-cigarettes and alcoholic beverages), 39.3% had prior substance use experience, whereas 59.9% reported never using substances (Table 1). Among the participants (13.5%) had used cannabis, for medical purposes (4.4%), through cannabis-infused foods or drinks (12.3%), or for recreation (2.4%). Most (86.5%) had never used cannabis, (7.9%) were willing to try it, and (78.6%) were unwilling. The main reasons for not attempting cannabis were health risks (27.4%), legal restrictions (1.6%), and parental disapproval (12.3%).

Table 1. General Characteristics of the Sample (n= 252)

Characteristic	Number (n)	Percentage (%)
1. Gender		
Male	76	30.2
Female	172	68.3
Prefer not to say	4	1.6
2. Age (14 – 18 years)		
Less than 15 years	6	2.4
15 years	48	19.0
16 years	66	26.2
17 years	42	16.7
More than 17 years	90	35.7
3. Field of Study		
General education	199	79.0
Vocational education	53	21.0
4. Source of Income		
Parents	213	84.5
Self	39	15.5
5. Monthly Income		
Less than 3,000 THB	87	34.5
3,000-5,999 THB	65	25.8
6,000-10,000 THB	34	13.5
10,000-15,000 THB	32	12.7
More than 15,000 THB	34	13.5
6. Experience with Other Substances (N=250, missing data = 2)		

Continued table 1.

- Ever Used	99	39.3
-Cigarettes/E-cigarettes	5	2.0
-Alcoholic beverages	60	23.8
-Both cigarettes/ e-cigarettes and alcoholic beverages	34	13.5
- Never Used	151	59.9
7. Experience with Cannabis		
- Ever used cannabis	34	13.5
-Used medical cannabis	11	4.4
-Consumed cannabis-infused food/drink	31	12.3
-Used cannabis for recreation	6	2.4
- Never used cannabis	218	86.5
-Want to try	20	7.9
-Do not want to try	198	78.6
8. The reasons for not wanting to try cannabis		
-Health risks	69	27.4
-Legal restrictions	4	1.6
-Parental disapproval	31	12.3

Knowledge of Medical Cannabis and Cannabis in Food

Thus, nearly half of the participants (49.2%) had low knowledge of medical cannabis and cannabis-infused food, 31.0% had moderate knowledge, and 19.8% exhibited a high level of understanding (Table 2). Participants showed moderate knowledge regarding the adverse effects of cannabis (63.1%), but knowledge was lower in key areas, such as indications (58.8%), legal regulations (54.8%), and cannabis use in food (45.8%). The overall knowledge score was 54.5%, which is classified as low (Table 3). Misconceptions were common and more than half of the participants provided incorrect answers to several key questions (Table 4). A substantial proportion (67.9%) did not recognize cannabis as a treatment for chemotherapy-induced nausea and vomiting, while 61.1% misunderstood the legal classification of cannabis extracts containing THC levels ≤ 0.2%. Additionally, 54.8% were unaware of the existing age restrictions on possession and use.

Table 2. Overall knowledge of Medical Cannabis and Cannabis in Food (n=252)

Knowledge Level	Number (n)	Percentage (%)
Low (0-8 points, <60%)	124	49.2
Moderate (9-12 points, 60-80%)	78	31.0
High (13-15 points, >80%)	50	19.8
Total	**252**	**100**

Table 3. Knowledge of medical cannabis and cannabis in food by category

Knowledge category	Mean ($\bar{x}$)	SD	Percentage (%)	Knowledge level
1. Indications and guidelines for medical cannabis use (4 items, 4 points)	2.35	0.49	58.8	Low
2. Adverse effects of medical cannabis use (3 items, 3 points)	1.89	0.48	63.1	Moderate
3. Cannabis-related laws (3 items, 3 points)	1.64	0.50	54.8	Low
4. Use of Cannabis in food or cannabis-infused food products (5 items, 5 points)	2.29	0.50	45.8	Low
Total (15 items, 15 points)	**8.18**	**0.34**		

Table 4. Knowledge of medical cannabis and cannabis in food by specific questions

	Questions	Correct	%	Incorrect	%
	Indications and guidelines for medical cannabis use				
1.	Cannabis can alleviate nausea and vomiting from chemotherapy	81	32.1	171	67.9
2.	Cannabis can treat all diseases	139	55.2	113	44.8
3.	Use of cannabis is prohibited for pregnant or breastfeeding women	199	79.0	53	21.0
4.	Schizophrenia patients should consult a doctor before using cannabis	174	69.0	78	31.0
	Adverse effects of medical cannabis use				
5.	Cannabis can cause dizziness	151	59.9	101	40.1
6.	Cannabis can cause hallucinations	165	65.5	87	34.5
7.	Cannabis can cause rapid heartbeat	161	63.9	91	36.1
	Cannabis-related laws				
8.	Cannabis use is prohibited in public places	202	80.2	50	19.8
9.	Cannabis extract with THC ≤ 0.2% by weight is not a category 5 narcotic	98	38.9	154	61.1
10.	Individuals over 15 years old can possess, use, maintain, transport, and sell cannabis	114	45.2	138	54.8
	Use of Cannabis in Food or Cannabis-Infused Food Products				
11.	The use of cannabis flowers in food preparation for commercial sale is prohibited.	132	52.4	120	47.6
12.	The combination of cannabis with alcohol for commercial sale is prohibited.	142	56.3	110	43.7
13.	The combination of cannabis with caffeine for commercial sale is prohibited.	134	53.2	118	46.8
14.	Tetrahydrocannabinol (THC) is an addictive substance.	103	40.9	149	59.1
15.	Cannabidiol (CBD) is a non-addictive compound.	66	26.2	186	73.8

Health literacy in cannabis use

Assessment of health literacy levels with respect to cannabis use among the participants revealed that the majority demonstrated a moderate level of health literacy (62.3%), 21.8% exhibited low health literacy, and 15.9% had high health literacy (Table 5). When examining health literacy across different categories, the participants showed moderate literacy in all key areas, including access to health information and services (67.1%), understanding health information and services (68.6%), evaluating health information and services (65.9%), communication and social support (62.9%), and self-management (65.2%). The overall health literacy score was 66.0%, which was within the moderate range (Table 6).

Further analysis of health using specific questions indicated that most participants demonstrated moderate understanding of cannabis-related health information. However, the ability to effectively communicate health information about cannabis to others was notably lower than that in the other domains (Table 7).

Table 5. Overall health literacy regarding cannabis use

Health Literacy Level	Number (n)	Percentage (%)
Low (0-44 points, <60%)	55	21.8
Moderate (45-60 points, 60-80%)	157	62.3
High (61-75 points, >80%)	40	15.9
Total	**252**	**100**

Table 6. Health literacy regarding cannabis use by category

Health Literacy Category	Mean ($\bar{x}$)	SD	Percentage (%)	Literacy Level
Access to health information and services (4 items, 20 points)	13.42	0.98	67.1	Moderate
Understanding health information and services (3 items, 15 points)	10.29	0.95	68.6	Moderate
Evaluating health information and services (2 items, 10 points)	6.59	0.95	65.9	Moderate
Communication and social support (3 items, 15 points)	9.43	1.00	62.9	Moderate
Self-management (3 items, 15 points)	9.78	0.95	65.2	Moderate
Total (15 items, 75 points)	**49.52**	**2.44**	**66.0**	**Moderate**

Table 7. Health literacy regarding cannabis use

Question	Mean ($\bar{x}$)	SD	Literacy Level
Access to health information and services			
I always seek out health information to maintain good health	3.48	0.91	Moderate
I can see a healthcare provider whenever I need	3.21	1.01	Moderate
I can find accurate cannabis information from various sources	3.37	0.98	Moderate
I can find health information about cannabis by myself	3.37	0.93	Moderate
Understanding health information and services			
I understand the explanations provided by health service providers	3.49	0.88	Moderate
I can follow the recommendations in cannabis use manuals and documents	3.39	1.01	Moderate
I can understand cannabis information from various media	3.41	0.95	Moderate
Evaluating health information and services			
I compare cannabis information from multiple sources to verify accuracy before sharing it with others	3.34	0.92	Moderate
I consult healthcare professionals about health practices regarding cannabis use before following them	3.25	0.98	Moderate
Communication and social support			
I have relatives or friends who can help me with health matters	3.13	1.04	Moderate
I can ask healthcare professionals questions I want to know	3.32	0.99	Moderate
I can convey health information about cannabis to others	2.98	0.93	Low
Self-management			
I set goals to exercise, take care of my health, and achieve my aims	3.28	0.93	Moderate
I regularly observe any abnormalities in my body and mind to improve my health	3.47	0.91	Moderate
I have health knowledge about cannabis use to take care of my health	3.04	0.95	Moderate

Relationship between participants' characteristics and their knowledge and health literacy

The relationships between the participants' characteristics and their knowledge of medical cannabis, cannabis-infused food, and health literacy were analyzed (Table 8). The findings showed a statistically significant association between gender and knowledge of cannabis, as well as between the field of study and health literacy ($p \leq 0.05$). Other demographic factors did not exhibit significant relationships with knowledge or health literacy levels.

Table 8. Relationship between participants' characteristics and their knowledge of health literacy

Factor	Knowledge of Medical Cannabis and Cannabis in Food				Health Literacy in Cannabis Use			
	Number (%) of respondents		Statistics		Number (%) of respondents		Statistics	
	Low (%)	Moderate-High (%)	χ^2 value	p-value	Low (%)	Moderate -High (%)	χ^2 value	p-value
Gender								
Male	47 (61.8)	29 (38.2)	6.57	0.010*	17 (22.4)	59 (77.6)	0.02	0.880
Female	76 (44.2)	96 (55.8)			37 (21.5)	135 (78.5)		
Field of Study								
General Education	94 (47.2)	105 (52.8)	1.47	0.225	34 (17.1)	165 (82.9)	12.46	0.000*
Vocational Education	30 (56.6)	23 (43.4)			21 (39.6)	32 (60.4)		
Cannabis Use Experience								
Yes	12 (35.3)	22 (64.7)	3.04	0.081	8 (23.5)	26 (76.5)	0.07	0.796
No	112 (51.4)	106 (48.6)			47 (21.6)	171 (78.4)		

*Statistically significant)$p \leq 0.05$)

Results from the open-ended questionnaire

Six respondents provided feedback using an open-ended questionnaire. Their responses were categorized into key themes, summarizing their perspectives on supportive measures, attitudes towards cannabis, experiences with cannabis and other substances, the perceived effects of cannabis use, and opinions on cannabis laws.

Regarding supportive measures, one respondent emphasized the importance of incorporating drug education and training in schools to enhance students' knowledge and critical thinking skills related to drugs and legal frameworks. In terms of attitudes towards cannabis, two respondents expressed negative perceptions, citing concerns over its potential to cause hallucinations and addiction. Three respondents held mixed views, recognizing both its medicinal benefits and the risks associated with misuse.

With respect to their experience with cannabis use, none of the respondents reported using cannabis recreationally, although all acknowledged knowing who did so. The primary reasons for abstaining included concerns about addiction, legal repercussions, and a lack of peer influence. One respondent mentioned using cannabis for cooking within a family setting, stating that it enhanced flavor and promoted relaxation. None of the participants reported the use of cannabis for medical purposes. Regarding experiences with other substances, two respondents noted that substances such as alcohol, cigarettes, e-cigarettes, kratom, and methamphetamine were easily accessible. Three respondents highlighted the widespread use of e-cigarettes by their peers, whereas one reported knowledge of kratom use.

The effects of cannabis use have been described in both physical and social contexts. The reported physical effects include hallucinations, confusion, drowsiness, trembling, and eye twitching. Social effects include school absenteeism, social isolation, paranoia, and avoidance of close contact with others to conceal the smell of the cannabis.

When discussing cannabis laws, two respondents believed that legalization contributed to increased cannabis use. Three participants suggested that stricter regulations are necessary to control consumption, whereas one respondent argued that stricter laws would not necessarily deter individuals from using cannabis.

Discussion

This study provided critical insights into the determinants of cannabis use and abstinence in adolescents. The findings highlighted significant

associations between demographic characteristics, knowledge levels, health literacy, and substance use behavior.

Knowledge of medical cannabis and cannabis in food

The results indicated that nearly half (49.2%) of the participants had low knowledge about medical cannabis and its incorporation into food, with only 19.8% demonstrating a high level of knowledge. These findings align with those of previous studies that reported limited cannabis-related literacy among adolescents, particularly regarding medicinal properties and legal frameworks[28, 31]. Most participants exhibited moderate awareness of the adverse effects of cannabis (63.1%); however, misconceptions persisted regarding its medical indications and regulatory aspects. For example, 67.9% of the participants failed to recognize cannabis as a treatment for chemotherapy-induced nausea and vomiting, highlighting a significant gap in understanding its therapeutic use, which has been well documented in clinical research[47-49]

Moreover, 61.1% misunderstood the legal classification of cannabis extracts containing ≤ 0.2% THC, and 55.2% incorrectly believed that cannabis could be used to treat all diseases. These misconceptions align with prior research suggesting that adolescents often rely on unverified sources, such as social media and peer discussions, for cannabis-related information, increasing their susceptibility to misinformation [35, 50, 51]. Due to the increasing accessibility of cannabis-infused products, particularly in jurisdictions with relaxed policies, it is imperative to improve public awareness of cannabis regulatory status and medical applications to mitigate misperception[52].

Lack of knowledge regarding cannabis-infused food was particularly concerning, with only 45.8% of the participants demonstrating awareness of its risks. Unlike smoked cannabis, edible products have a delayed onset of effects owing to their metabolic conversion into the more potent psychoactive metabolite 11-hydroxy-THC, which prolongs and intensifies psychoactivity[14, 53, 54]. This delay often leads to unintentional overconsumption, a trend reflected in the increasing incidence of cannabis-related emergency room visits following legalization[5, 54, 55]. Given that cannabis-infused foods are often marketed in appealing forms, such as candies, chocolates, and baked goods, adolescents are particularly vulnerable to misuse because of their lack of understanding of dosing and delayed psychoactive effects[54, 56, 57].

Health literacy in cannabis use

The study found that 62.3% of the participants exhibited moderate health literacy regarding cannabis use, whereas 21.8% had low literacy levels. Although most students reported moderate proficiency in accessing and understanding cannabis-related information, their ability to critically evaluate and communicate this information was significantly lower. This finding suggests that while the youth had access to cannabis-related information, they often struggled to differentiate credible sources and accurately interpret scientific data. This highlights the need for targeted educational programs to improve cannabis health literacy in adolescents[20, 28, 58].

One concerning finding was the limited ability of students to convey cannabis-related health information to others, which was classified as low. This reflects the broader issues observed in adolescent health literacy in which the ability to critically assess and communicate substance-related information remains underdeveloped[21, 24, 30, 59]. As misinformation continues to spread through digital platforms, it is crucial to equip adolescents with the skills necessary to engage in informed discussions about cannabis use and its health implications[24, 28, 59, 60].

Moreover, while students demonstrated moderate self-management skills (65.2%), their capacity to actively seek professional guidance regarding cannabis use was relatively low. This finding is consistent with previous studies indicating that adolescents often perceive medical professionals as inaccessible or unapproachable when discussing substance use[22, 24, 25]. Enhancing health literacy programs that promote open, non-judgmental communication between youth and healthcare providers could improve students' willingness to seek accurate information and make informed decisions[22, 24, 28, 61].

Demographic Influences on Cannabis Knowledge and Health Literacy

Sex and field of study significantly influenced participants' knowledge and health literacy. Male students exhibited lower cannabis knowledge than female students, which is consistent with research indicating that males are more likely to engage in risk-taking behaviors and may have different information-seeking patterns regarding substance use[25, 62]. Similarly, students enrolled in vocational education programs displayed lower health literacy levels than those enrolled in general education programs. Differences in curriculum focus may contribute to variations in educational outcomes, highlighting the need to expand health education opportunities through vocational programs[63-65]. Ensuring equitable access to health education across different educational pathways is essential for fostering comprehensive knowledge and awareness among students[65-68].

Perceptions and attitudes towards cannabis

The open-ended responses provided additional insights into the students' attitudes towards cannabis use. While some participants recognized its medicinal benefits, others expressed concerns regarding its potential to cause addiction, hallucinations, and social isolation. These responses align with existing literature, indicating that adolescent cannabis use is often associated with cognitive impairment, emotional disturbances, and academic decline[69].

Furthermore, participants highlighted the ease of access to other substances, such as alcohol, cigarettes, and kratom, suggesting that cannabis use should be examined within the broader context of polysubstance use trends among adolescents. This finding supports the need for integrated prevention strategies that address multiple risk factors rather than focusing solely on cannabis use[70, 71].

Implications for policy and education

These findings highlight the critical gaps in cannabis knowledge and health literacy among late adolescent students, underscoring the need for more effective education and policy interventions. Current school-based programs tend to emphasize deterrence rather than harm reduction, limiting their effectiveness in equipping students with practical knowledge of responsible cannabis use[28, 72]. Incorporating evidence-based, interactive learning approaches that address both risk and harm reduction strategies could enhance cannabis literacy and promote informed decision-making.

In addition, expanding access to reliable cannabis-related health information through school health services, peer education programs, and digital literacy training may help adolescents better navigate online misinformation[31, 58]. Policies aimed at regulating the marketing and packaging of cannabis-infused food products should also be reinforced to prevent unintentional consumption by the uninformed youth[56, 73]. Given the evolving cannabis regulations in Thailand, future research should examine the long-term trends in adolescent cannabis use and the effectiveness of educational interventions. Strengthening health literacy, implementing harm-reduction strategies, and reinforcing regulatory measures are essential for mitigating potential risks and fostering responsible attitudes towards cannabis use among adolescents.

Conclusion

The findings of this study revealed that most participants had low knowledge of medical cannabis and cannabis-infused food products, with only a small proportion demonstrating high knowledge levels. Additionally, while most students exhibited moderate health literacy regarding cannabis use, significant gaps remained in their ability to critically assess information and communicate cannabis-related knowledge effectively. Demographic factors such as sex and field of study significantly influenced knowledge levels and health literacy. Male students and those in vocational education displayed lower knowledge and health literacy than their counterparts in general education. Furthermore, misconceptions regarding the legal status, indications, and risks of cannabis use were prevalent, emphasizing the need for structured educational interventions to address these gaps. The study also identified age as a key determinant of cannabis use behavior, with younger participants being less likely to report prior cannabis use. Health risks, legal concerns, and social consequences were the primary limitations to abstaining from cannabis use. These findings highlight the importance of integrating targeted, evidence-based cannabis education programs into school curricula to improve awareness and promote informed decision-making.

Acknowledgment

The authors would like to express their sincere gratitude to all the participants who generously took part in this study. We are deeply appreciative of their time, cooperation, and invaluable contributions.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This work was supported by the grant from the Faculty of Pharmaceutical Sciences, Ubon Ratchathani University

Ethics Statements

The study received approval from the Research Ethics Committee of Ubon Ratchathani University (Approval No. UBU – REC – 173/2565).

Author Contribution

The authors confirm contribution to the paper as follows: study conception and design: Charuwan Thanawiroon, Prasittichai Poonphol, Teeraporn Sadira Supapaan, Chaisit Soontara; data collection: Supaphit Thammakittiphan, Soraya Kulbunya, Chanathip Dalas, Janjaree Kunnamas, Teeraporn Sadira Supapaan; analysis and interpretation of results: Charuwan Thanawiroon, Tawanchai Phohom, Teeraporn Sadira Supapaan, Prasittichai Poonphol, Chaisit Soontara, Jeerisuda Khumsikiew, Narongchai Chaksupa; draft manuscript preparation: Prasittichai Poonphol, Charuwan Thanawiroon, Teeraporn Sadira Supapaan, Narongchai Chaksupa, Jeerisuda Khumsikiew. All

authors reviewed the results and approved the final version of the manuscript.

References

1. Hurst T. World Drug Report. *The Encyclopedia of Women and Crime*. Hoboken, NJ: John Wiley & Sons, Inc., 2019, pp.1-2.
2. Barata PC, Ferreira F, Oliveira C. Non-medical cannabis use: international policies and outcomes overview. An outline for Portugal. *Trends Psychiatry Psychother*, 2022; 44: e20210239. 2021/12/14. DOI: 10.47626/2237-6089-2021-0239.
3. United Nations Office on Drugs and Crime (UNODC). UNODC World Drug Report 2022 highlights trends on cannabis post-legalization, environmental impacts of illicit drugs, and drug use among women and youth, https://www.unodc.org/unodc/press/releases/2022/June/unodc-world-drug-report-2022-highlights-trends-on-cannabis-post-legalization environmental-impacts-of-illicit-drugs--and-drug-use-among-women-and-youth .html, 2022, accessed 15 Feb 2025.
4. Pacula RL, Smart R. Medical marijuana and marijuana legalization. *Annu Rev Clin Psychol*, 2017; 13: 397-419. 2017/05/10. DOI: 10.1146 /annurev - clinpsy - 032816-045128.
5. Hall W, Lynskey M. Assessing the public health impacts of legalizing recreational cannabis use: the US experience. *World Psychiatry*, 2020; 19: 179-186. 2020/05/13. DOI: 10.1002/wps.20735.
6. Ladegard K, Bhatia D. Impact of cannabis legalization on adolescent cannabis use. *Child Adolesc Psychiatr Clin N Am*, 2023; 32: 1-12. 2022/11/22. DOI: 10.1016/j.chc.2022.07.001.
7. Yimsaard P, Lancaster KE, Sohn AH. Potential impact of Thailand's cannabis policy on the health of young adults: current status and future landscape. *Lancet Reg Health Southeast Asia*, 2023; 10. DOI: 10.1016/j.lansea.2023.100145.
8. Kongjareon Y, Samoh N, Peerawaranun P, Guadamuz TE. Pride-based violence, intoxicated sex and poly-drug use: a vocational school-based study of heterosexual and LGBT students in Bangkok. *BMC Psychiatry*, 2022; 22: 148. 2022/02/26. DOI: 10.1186/s12888-022-03777-7.
9. Meebankreng K, Suancharoen P, Jootar T, Chuaichip S, Mungkalarungsi S. Knowledge, attitude, and cannabis use behavior among adolescents aged 15-22 in Bangkok. *UBRU J Public Health Research*, 2024; 13: 87-94.
10. Scheyer AF, Laviolette SR, Pelissier AL, Manzoni OJJ. Cannabis in adolescence: Lasting cognitive alterations and underlying mechanisms. *Cannabis Cannabinoid Res*, 2023; 8: 12-23. 2022/10/28. DOI: 10. 1089 / can .2022.0183.
11. Volkow ND, Baler RD, Compton WM, Weiss SR. Adverse health effects of marijuana use. *N Engl J Med*, 2014; 370: 2219-2227. 2014/06/05. DOI: 10.1056/NEJMra1402309.
12. Jacobus J, Tapert SF. Effects of cannabis on the adolescent brain. *Curr Pharm Des*, 2014; 20: 2186-2193. 2013/07/09. DOI: 10.2174/13816128113199990426.
13. Hernandez Mejia M, Wade NE, Baca R, Diaz VG, Jacobus J. The influence of cannabis and nicotine co-use on neuromaturation: A systematic review of adolescent and young adult studies. *Biol Psychiatry*, 2021; 89: 162-171. 2020/12/19. DOI: 10. 1016 /j. biopsych .2020 .09.021.
14. Schlienz NJ, Spindle TR, Cone EJ, Herrmann ES, Bigelow GE, Mitchell JM, et al. Pharmacodynamic dose effects of oral cannabis ingestion in healthy adults who infrequently use cannabis. *Drug Alcohol Depend*, 2020; 211: 107969. 2020/04/17. DOI: 10.1016/j.drugalcdep.2020.107969.
15. Godin SL, Shehata S. Adolescent cannabis use and later development of schizophrenia: An updated systematic review of longitudinal studies. *J Clin Psychol*, 2022; 78: 1331-1340. 2022/01/13. DOI: 10.1002/jclp.23312.
16. European Monitoring Centre for Drugs and Drug Addiction (EMCDDA). European Drug Report 2024: Trends and Developments, https://www.euda.europa.eu/publications/european-drug-report/2024_en, 2024, accessed 29 June 2025.
17. Freeman TP, Groshkova T, Cunningham A, Sedefov R, Griffiths P, Lynskey MT. Increasing potency and price of cannabis in Europe, 2006-16. *Addiction*, 2019; 114: 1015-1023. 2019/01/01. DOI: 10.1111/add.14525.
18. Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. *Health Promot Int*, 2000; 15: 259-267. DOI: 10.1093/heapro/15.3.259.
19. Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health*, 2012; 12: 80. 2012/01/27. DOI: 10.1186/1471-2458-12-80.
20. Kinnunen JM, Paakkari L, Rimpelä AH, Kulmala M, Richter M, Kuipers MAG, et al. The role of health literacy in the association between academic performance and substance use. *Eur J Public Health*, 2022; 32: 182-187. 2022/01/06. DOI: 10.1093/eurpub/ckab213.

21. Kim Y, Vera L, Huang J, Emery S. Marijuana content on digital media and marijuana use among young people in the United States. *Cannabis*, 2022; 5: 74-84. 2022/11/05. DOI: 10.26828/cannabis/2022.02.007.

22. Fleary SA, Joseph P. Adolescents' health literacy and decision-making: A qualitative study. *Am J Health Behav*, 2020; 44: 392-408. 2020/06/20. DOI: 10.5993/ajhb.44.4.3.

23. Fleary SA, Joseph P, Pappagianopoulos JE. Adolescent health literacy and health behaviors: A systematic review. *J Adolesc*, 2018; 62: 116-127. 2017/11/28. DOI: 10.1016/j.adolescence.2017.11.010.

24. Fleary SA, Rastogi S, Fenton T, Ali Z. Health literacy and adolescents' substance use behaviors and correlates: a scoping review. *Health Promot Int*, 2024; 39 2024/06/29 23:42. DOI: 10.1093/heapro/daae074.

25. Harrison ME, Kanbur N, Canton K, Desai TS, Lim-Reinders S, Groulx C, et al. Adolescents' cannabis knowledge and risk perception: A systematic review. *J Adolesc Health*, 2024; 74: 402-440. DOI: 10.1016/j.jadohealth.2023.09.014.

26. Kannan K, Nattala P, Mahadevan J, Meena KS. Knowledge, attitude, and expectancies related to cannabis use: A cross-sectional community study among college students from Bangalore, Karnataka. *Indian J Psychol Med*, 2024; 46: 221-227. 2024/05/03. DOI: 10.1177/02537176231210681.

27. Park SY, Constantino N, Yun GW, Moser L, Cortes-Arriola D. U.S. college students' marijuana information sources, confidence in knowledge, and objective knowledge. *J Health Commun*, 2020; 25: 859-869. 2020/11/06. DOI: 10.1080/10810730.2020.1840677.

28. Bishop LD, Drakes DH, Donnan JR, Rowe EC, Najafizada M. Exploring youths' cannabis health literacy post legalization: A qualitative study. *J Adolesc Res*, 2025; 40: 130-160. 2024/12/16. DOI: 10.1177/07435584221118380.

29. Friese B, Slater MD, Annechino R, Battle RS. Teen use of marijuana edibles: A focus group study of an emerging issue. *J Prim Prev*, 2016; 37: 303-309. 2016/04/09. DOI: 10.1007/s10935-016-0432-9.

30. Reboussin BA, Wagoner KG, Sutfin EL, Suerken C, Ross JC, Egan KL, et al. Trends in marijuana edible consumption and perceptions of harm in a cohort of young adults. *Drug Alcohol Depend*, 2019; 205: 107660. 2019/11/11. DOI: 10.1016/ j. drugalcdep .2019.107660.

31. Goodman S, Hammond D. THC labeling on cannabis products: an experimental study of approaches for labeling THC servings on cannabis edibles. *J Cannabis Res*, 2022; 4: 17. DOI: 10.1186/s42238-022-00124-1.

32. Cooper M, Shi Y. Packaging of cannabis edibles, health warning recall, and perceptions among young adults. *JAMA Netw Open*, 2025; 8: e253117. 2025/04/03. DOI: 10.1001/jamanetworkopen.2025.3117.

33. Spindle TR, Bonn-Miller MO, Vandrey R. Changing landscape of cannabis: novel products, formulations, and methods of administration. *Curr Opin Psychol*, 2019; 30: 98-102. 2019/05/10. DOI: 10.1016/j.copsyc.2019.04.002.

34. Moreno MA, Jenkins M, Binger K, Kelly L, Trangenstein PJ, Whitehill JM, et al. A content analysis of cannabis company adherence to marketing requirements in four states. *J Stud Alcohol Drugs*, 2022; 83: 27-36. 2022/01/19. DOI: 10.15288/jsad.2022.83.27.

35. Torrejón-Guirado MC, Baena-Jiménez M, Lima-Serrano M, de Vries H, Mercken L. The influence of peer's social networks on adolescent's cannabis use: a systematic review of longitudinal studies. *Front Psychiatry*, 2023; 14: 1306439. 2024/01/08. DOI: 10.3389/fpsyt.2023.1306439.

36. Assanangkornchai S, Pattanasattayawong U, Samangsri N, Mukthong A. Substance use among high-school students in Southern Thailand: trends over 3 years (2002-2004). *Drug Alcohol Depend*, 2007; 86: 167-174. 2006/07/14. DOI: 10.1016/j.drugalcdep.2006.06.001.

37. Ministry of Education of Thailand. *Upper secondary and vocational education Ccurriculum structure B.E. 2566* Bangkok: Office of the Basic Education Commission / Office of Vocational Education Commission. [In Thai], 2023.

38. Lwanga SK, Lemeshow S, Organization WH. Sample size determination in health studies: a practical manual/SK Lwanga and S. Lemeshow. *Sample size determination in health studies: a practical manual/SK Lwanga and S Lemeshow*. 1991.

39. Marcano Belisario JS, Jamsek J, Huckvale K, O'Donoghue J, Morrison CP, Car J. Comparison of self-administered survey questionnaire responses collected using mobile apps versus other methods. *Cochrane Database Syst Rev*, 2015; 2015: Mr000042. 2015/07/28. DOI: 10.1002/14651858.MR000042.pub2.

40. Wright KB. Researching internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey

services. *J Comput-Mediat Commun*, 2005; 10. DOI: https://doi.org/10.1111/j.1083-6101.2005.tb00259.x.

41. Dillman D, Smyth J, Christian L. *Internet, phone, mail, and mixed-mode surveys: The tailored design method (4th ed)*. New Jersey: John Wiley & Sons, Inc., 2014.

42. Bloom BS, Engelhart MD, Furst EJ, Hill WH, Krathwohl DR. *Taxonomy of educational objectives*. Longmans, Green New York, 1964.

43. Intarakamhang U, Khammungkul J, Boocha P. General health literacy scale for Thais and comparison between age groups. *Heliyon*, 2022; 8: e09462. 2022/05/28. DOI: 10.1016/j.heliyon.2022.e09462.

44. Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? Critique and recommendations. *Res Nurs Health*, 2006; 29: 489-497. 2006/09/16. DOI: 10.1002/nur.20147.

45. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Res Nurs Health*, 2007; 30: 459-467. 2007/07/27. DOI: 10.1002/nur.20199.

46. Grant JS, Davis LL. Selection and use of content experts for instrument development. *Res Nurs Health*, 1997; 20: 269-274. 1997/06/01. DOI: 10.1002/(sici)1098-240x(199706)20:3<269::aid-nur9>3.0.co;2-g.

47. Bathula PP, Maciver MB. Cannabinoids in treating chemotherapy-induced nausea and vomiting, cancer-associated pain, and tumor growth. *Int J Mol Sci*, 2023; 25 2024/01/11. DOI: 10.3390/ijms25010074.

48. Kamkaen N, Treesak C. Medicinal cannabis for cancer. *J Chulabhorn Royal Acad*, 2019; 1: 16-29.

49. Ward SJ, Lichtman AH, Piomelli D, Parker LA. Cannabinoids and cancer chemotherapy-associated adverse effects. *J Natl Cancer Inst Monogr*, 2021; 2021: 78-85. 2021/12/02. DOI: 10.1093/jncimonographs/lgab007.

50. West M, Rice S, Vella-Brodrick D. Mid-adolescents' social media use: Supporting and suppressing autonomy. *J Adolesc Res*, 2023; 40: 448-482. DOI: 10.1177/07435584231168402.

51. González-Cano-Caballero M, Torrejón-Guirado M-C, Cano-Caballero MD, Mac Fadden I, Barrera-Villalba M-D-C, Lima-Serrano M. Adolescents and youths' opinions about the factors associated with cannabis use: a qualitative study based on the I-Change model. *BMC Nursing*, 2023; 22: 114. DOI: 10.1186/s12912-023-01283-z.

52. Fordjour E, Manful CF, Khalsamehta TSK, Armah A, Cheema M, Thomas R. Cannabis-infused foods: Phytonutrients, health, and safe product innovations. *Compr Rev Food Sci Food Saf*, 2024; 23: e70021. 2024/09/13. DOI: 10.1111/1541-4337.70021.

53. Chayasirisobhon S. Mechanisms of action and pharmacokinetics of cannabis. *Perm J*, 2020; 25: 1-3. 2021/02/27. DOI: 10.7812/tpp/19.200.

54. Barrus DG, Capogrossi KL, Cates SC, Gourdet CK, Peiper NC, Novak SP, et al. Tasty THC: Promises and challenges of cannabis edibles. *Methods Rep RTI Press*, 2016; 2016 2017/01/28. DOI: 10.3768/rtipress.2016.op.0035.1611.

55. Matheson J, Le Foll B. Cannabis legalization and acute harm from high potency cannabis products: A narrative review and recommendations for public health. *Frontiers in Psychiatry*, 2020; 11. Review. DOI: 10.3389/fpsyt.2020.591979.

56. Tan ASL, Weinreich E, Padon A, Sanchez M, Snyder KM, Vasilyeva A, et al. Presence of content appealing to youth on cannabis-infused edibles packaging. *Subst Use Misuse*, 2022; 57: 1215-1219. 2022/05/03. DOI: 10.1080/10826084.2022.2069268.

57. Borodovsky JT, Lee DC, Crosier BS, Gabrielli JL, Sargent JD, Budney AJ. U.S. cannabis legalization and use of vaping and edible products among youth. *Drug Alcohol Depend*, 2017; 177: 299-306. 2017/07/01. DOI: 10.1016/j.drugalcdep.2017.02.017.

58. Khamluang P. Enhancing health literacy on cannabis: Preventing issues and health impact on the population. *Journal of Nursing and Health Research*, 2023; 24: 153-167.

59. Sikaow O, Trakulsithichoke S. Health literacy and health behaviors of student age 10-18 year. *Nursing J of The Ministry of Public Health*, 2024; 34: 72-85.

60. George T, Vaccarino F. Substance abuse in Canada: The effects of Cannabis use during adolescence, https://www.ccsa.ca/sites/default/files/2019-04/CCSA-Effects-of-Cannabis-Use-during-Adolescence-Report-2015-en.pdf, 2015, accessed 17 Feb 2025.

61. Rolova G, Gavurova B, Petruzelka B. Exploring health literacy in individuals with alcohol addiction: A mixed methods clinical study. *Int J Environ Res Public Health*, 2020; 17: 6728.

62. Ritchwood TD, Ford H, DeCoster J, Sutton M, Lochman JE. Risky sexual behavior and substance use among adolescents: A meta-analysis. *Child Youth Serv Rev*, 2015; 52: 74-88. 2015/04/01. DOI: 10.1016/j.childyouth.2015.03.005.

63. Loyalka P, Huang X, Zhang L, Wei J, Yi H, Song Y, et al. The impact of vocational schooling on

human capital development in developing countries: Evidence from China. *World Bank Econ Rev*, 2016; 30: 143-170.

64. Phiphithkul P, Samawattana R, Wattanaburanont A. Development of health education program based on constructionism concept and health belief model for enhancing health literacy on health quotient of vocational education students. *J Royal Thai Army Nurses*, 2024; 25: 151-159.

65. Klinker CD, Aaby A, Ringgaard LW, Hjort AV, Hawkins M, Maindal HT. Health literacy is associated with health behaviors in students from vocational education and training schools: A Danish population-based survey. *Int J Environ Res Public Health*, 2020; 17 2020/01/24. DOI: 10.3390/ijerph17020671.

66. Pulimeno M, Piscitelli P, Colazzo S, Colao A, Miani A. School as ideal setting to promote health and wellbeing among young people. *Health Promot Perspect*, 2020; 10: 316-324. 2020/12/15. DOI: 10.34172/hpp.2020.50.

67. CICC Research CGI. Establishing equitable and efficient systems for education and healthcare. *Building an olive-shaped society : Economic growth, income distribution and public policies in China*. Singapore: Springer Nature Singapore, 2024, pp.107-139.

68. Svendsen MT, Bak CK, Sørensen K, Pelikan J, Riddersholm SJ, Skals RK, et al. Associations of health literacy with socioeconomic position, health risk behavior, and health status: a large national population-based survey among Danish adults. *BMC Public Health*, 2020; 20: 565. 2020/04/30. DOI: 10.1186/s12889-020-08498-8.

69. Karlsgodt KH. Cannabis use in adolescence: Vulnerability to cognitive and psychological effects. *Biol Psychiatry Glob Open Sci*, 2023; 3: 167-168. 2023/05/01. DOI: 10.1016/j.bpsgos.2022.09.004.

70. Connor JP, Stjepanović D, Le Foll B, Hoch E, Budney AJ, Hall WD. Cannabis use and cannabis use disorder. *Nat Rev Dis Primers*, 2021; 7: 16. 2021/02/26. DOI: 10.1038/s41572-021-00247-4.

71. Khairinisa MA, Alfaqeeh M, Rafif SN, Muljono FO, Colin MN. Cannabis and other substance misuse: Implications and regulations. *Toxics*, 2023; 11: 756.

72. Substance Abuse and Mental Health Services Administration (SAMHSA). *Preventing marijuana use among youth. SAMHSA Publication No. PEP21-06-01-001*. Rockville, MD: National Mental Health and Substance Use Policy Laboratory. Substance Abuse and Mental Health Services Administration, 2021.

73. Meeprom S, Sathatip P, Leruksa C, Manosuthi N, Fakfare P. Cannabis-infused food: Uncovering effective conditions for achieving well-being perception and choice behavior among young adult consumers. *Food Quality and Preference*, 2023; 109: 104915. DOI: https://doi.org/10.1016/j.foodqual.2023.104915.