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# Biology and Health Education Curriculum on Liver Fluke Disease and Cholangiocarcinoma Prevention among Primary School Students in Endemic Areas to Support Sustainable Development Goals (SDGs): Bibliometric and Mixed-Methods Needs Analysis

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## ABSTRACT

Liver fluke disease and cholangiocarcinoma remain major health problems in endemic areas of northeastern Thailand. This study examined essential needs for developing a biology and health education curriculum to prevent these diseases among primary school students and to support SDGs-oriented health literacy. A bibliometric and mixed-methods needs analysis was conducted with 455 participants, including school administrators, teachers, and students. Quantitative data were analyzed using descriptive statistics and priority needs analysis, while qualitative data were analyzed through content analysis. The findings showed high needs for developmentally appropriate curriculum, creative media, technology-supported learning, flexible implementation, and systematic assessment. The study provides evidence for school-based curriculum development to strengthen disease prevention awareness and community health.



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## 1. INTRODUCTION

Liver fluke disease and cholangiocarcinoma remain serious public health problems in Thailand, especially in endemic areas of the northeastern region. Cholangiocarcinoma is strongly associated with liver fluke infection and has been reported as a major cause of mortality in high-risk communities. Epidemiological evidence shows that cholangiocarcinoma remains concentrated in northeastern Thailand, indicating the need for long-term prevention strategies that address community behavior, food practices, and health awareness [1]. The prevention of liver fluke disease and cholangiocarcinoma requires more than clinical treatment because the disease is closely related to behavioral, biological, and environmental risk factors. The consumption of raw or undercooked freshwater fish is a major risk factor for liver fluke infection, and repeated infection can contribute to chronic inflammation and later cancer development. Therefore, prevention must include public education, risk communication, food safety awareness, and health behavior change in endemic communities [2].

Schools can serve as strategic settings for early disease prevention because students can learn health-related knowledge before risky behaviors become established. Biology and health education are therefore important because they can introduce students to parasites, disease transmission, hygiene, safe food consumption, and prevention responsibility through developmentally appropriate learning. When students understand disease causes and prevention practices, they may also transfer this knowledge to family and community contexts. Thus, school-based curriculum development can support both individual health literacy and broader public health prevention.

Biology education is particularly relevant to liver fluke disease and cholangiocarcinoma prevention because students need to understand living organisms, parasitic transmission, the human body, disease mechanisms, and the relationship between behavior and health. However, biological concepts can be difficult for young learners when they are taught only through verbal explanation. Biology learning can be strengthened through technological pedagogical content knowledge, inquiry-based activities, dynamic visualization tools, and video-supported learning that help students understand scientific concepts more concretely [3-6].

Health education is also important because disease prevention depends on daily behavior, food safety, sanitation, and family-level responsibility. Integrated nutrition and science education has been reported to support student health and academic performance, while community-based health promotion initiatives for early childhood development show that health education can contribute to Sustainable Development Goals (SDGs). Therefore, a school-based curriculum on liver fluke disease and cholangiocarcinoma prevention can connect biology education, health education, and SDGs-oriented community prevention [7-9].

School-based prevention education can improve students' knowledge and awareness of liver fluke disease and cholangiocarcinoma. Supplementary curriculum and teacher training have been reported to support prevention-related learning and behavioral awareness among primary school students in northeastern Thailand. Educational intervention can be an important component of disease prevention in endemic areas [10, 11]. However, existing prevention curricula have mainly focused on older primary students, while younger students in grades one to four require different curriculum design. Students at this level need concrete

examples, visual media, simple language, games, stories, and activity-based learning to understand biological and health concepts. Therefore, a specific biology and health education curriculum is needed for lower primary students. Disease prevention can begin earlier and match their developmental characteristics.

Needs analysis is an important first step before curriculum development because it identifies gaps between current educational conditions and expected outcomes. In the context of liver fluke disease and cholangiocarcinoma prevention, needs analysis can help determine priority content, learning activities, instructional media, school implementation formats, and assessment strategies. Stakeholder perspectives from administrators, teachers, and students are especially important because curriculum development must be both educationally meaningful and practically implementable.

This study also positions curriculum development within the SDGs. A school-based biology and health education curriculum can support SDG 3 by promoting health and disease prevention, SDG 4 by strengthening quality education, and SDG 17 by encouraging collaboration among schools, universities, health researchers, and communities. Bibliometric-informed educational research can help position curriculum development within broader scientific and sustainability trends, especially when education is linked to SDGs-oriented learning and community development [12-14].

This study aims to examine essential needs for developing a biology and health education curriculum on liver fluke disease and cholangiocarcinoma prevention among primary school students in endemic areas. The study used a bibliometric and mixed-methods needs analysis by combining publication trend mapping, quantitative needs assessment, and qualitative focus group discussion. The novelty of this study lies in connecting biology education, health prevention, curriculum needs analysis, endemic disease context, and SDGs-oriented school-based intervention. The study is guided by the following research questions:

(i) What are the current conditions and expected needs for liver fluke disease and cholangiocarcinoma prevention education among primary school students?
(ii) What priority curriculum needs are identified by school administrators, teachers, and students?
(iii) What learning content, media, assessment, and implementation strategies are recommended for curriculum development?
(iv) How can bibliometric and mixed-methods findings support the development of an SDGs-oriented biology and health education curriculum?

Liver fluke disease and cholangiocarcinoma remain serious health problems in endemic areas and that school-based prevention education can support disease awareness (**Table 1**). Curriculum-based interventions can improve prevention-related learning among students. However, there remains limited evidence on essential curriculum-development needs for students in grades one to four. The major research gap is the lack of systematic needs analysis that integrates student perspectives, educator perspectives, school implementation needs, biology and health education content, creative media, and SDGs-oriented curriculum planning. Gap by using a bibliometric and mixed-methods needs analysis to generate evidence for developing a developmentally appropriate prevention curriculum.

**Table 1.** Synthesis of literature and research gap.

| THEME | MAIN IDEA FROM LITERATURE | RELEVANCE TO THIS STUDY | IDENTIFIED GAP |
|---|---|---|---|
| Disease burden | Liver fluke disease and cholangiocarcinoma remain serious health problems in endemic areas. | The study focuses on curriculum needs in high-risk school contexts. | More school-based prevention strategies are needed for younger students. |
| Biology education | Students need to understand parasites, transmission, host interaction, and disease mechanisms. | The curriculum will include biological concepts related to liver fluke infection. | Biology content must be simplified and visualized for grades one to four. |
| Health education | Prevention requires safe food behavior, hygiene, sanitation, and health responsibility. | The curriculum aims to build prevention awareness and healthy behavior. | More developmentally appropriate health-learning activities are needed. |
| School-based curriculum | Curriculum and teacher training can improve prevention awareness and health behavior. | The study supports curriculum planning for endemic primary schools. | Existing prevention curricula focus more on older students. |
| Creative media and technology | Media can make disease concepts concrete and engaging for children. | The study identifies needs for creative and technology-supported media. | Practical media design for liver fluke prevention remains underdeveloped. |
| Needs analysis | Curriculum design should be based on current conditions and expected needs. | The study analyzes needs from administrators, teachers, and students. | Limited needs analysis integrates student and educator perspectives in endemic areas. |
| SDGs | Disease prevention and health education support SDG 3, SDG 4, and SDG 17. | The study links curriculum development with health, education, and partnership goals. | SDGs are rarely integrated explicitly into school-based liver fluke prevention curriculum planning. |
| Bibliometric positioning | Bibliometric analysis identifies research trends and academic gaps. | The study maps the topic within health education, biology education, curriculum, and SDGs research. | Few studies combine bibliometric analysis and mixed-methods needs analysis for this topic. |

## 2. LITERATURE REVIEW

### 2.1. Liver Fluke Disease and Cholangiocarcinoma in Endemic Areas

Liver fluke disease and cholangiocarcinoma represent major health challenges in northeastern Thailand. The disease burden is closely related to local food practices, especially the consumption of raw or undercooked freshwater fish. Spatio-temporal evidence indicates that cholangiocarcinoma remains concentrated in high-prevalence areas and continues to require systematic prevention efforts [1]. Risk factors for cholangiocarcinoma in Thailand include liver fluke infection, repeated exposure to infection, and food-related behaviors that increase parasite transmission. Prevention must address knowledge, attitudes, and daily practices, not only medical screening or treatment. Public awareness of liver fluke infection and cholangiocarcinoma is therefore essential for reducing long-term disease risk in endemic communities [2].

### 2.2. Biology Education for Disease Prevention

Biology education is essential for disease prevention because students need to understand organisms, parasite life cycles, transmission pathways, host interactions, and the relationship between biological processes and human health. In the context of liver fluke disease, biology education can help students understand what liver flukes are, how infection occurs, why unsafe food consumption increases risk, and how preventive behavior can break the transmission cycle. These concepts are important for building scientific understanding and health-related decision-making. Effective biology learning requires appropriate pedagogy and learning media. Teachers need technological and pedagogical content knowledge to transform complex biological concepts into meaningful learning experiences. Inquiry-based learning, visualization tools, and video-supported learning can help students understand abstract biological processes more clearly, increase motivation, and improve engagement [3-6].

### 2.3. Health Education and School-Based Prevention

Health education helps students connect biological knowledge with daily health practices. In liver fluke disease and cholangiocarcinoma prevention, students need to learn safe food consumption, hygiene, sanitation, disease symptoms, treatment awareness, and family responsibility. These topics should be presented in ways that are suitable for children's developmental levels and connected to their lived experiences. School-based health education can also create wider community impact because students may share health messages with parents and family members. Integrated nutrition and science education has been shown to support both health and academic outcomes, while community-based health promotion projects for early childhood development indicate that health education can contribute to SDGs. Therefore, curriculum development should connect student learning with family and community prevention practices [7-9].

### 2.4. Curriculum Development for Younger Primary Students

Curriculum development for students in grades one to four requires careful attention to age, cognitive development, language level, and learning behavior. Younger primary students learn more effectively through concrete experiences, pictures, storytelling, games, demonstration, and hands-on activities. Therefore, a liver fluke disease and cholangiocarcinoma prevention curriculum for this group should use simple concepts, attractive media, interactive tasks, and learning activities that relate to students' daily lives. A developmentally appropriate curriculum should not overload young learners with complex biomedical content. Instead, it should gradually build understanding from familiar topics such as food, fish, hygiene, family meals, and personal health. From these contexts, students can learn more specific prevention concepts, including disease transmission, safe cooking, sanitation, and family responsibility. Curriculum development should also consider learner characteristics, pedagogical adaptation, curriculum standards, and SDGs-oriented educational goals. Thus, the designed curriculum is both developmentally appropriate and practically implementable [15-18]. This structure can help children develop prevention awareness in a way that is meaningful and practical.

### 2.5. School-Based Curriculum for Liver Fluke Disease and Cholangiocarcinoma Prevention

School-based curriculum development is a promising strategy for improving prevention awareness among young learners. Teacher training and curriculum implementation can

support student learning about liver fluke disease and cholangiocarcinoma prevention. These interventions can help students understand disease transmission, prevention strategies, and safer food consumption practices [10]. Interdisciplinary brain-based learning strategies can support liver fluke disease education among young students. Disease prevention curriculum should not be limited to direct instruction but should integrate activities, media, health concepts, and contextual learning. Such an approach is important for younger primary students because they learn more effectively through concrete, interactive, and meaningful activities [11].

### 2.6. Creative Media and Technology-Supported Health Learning

Creative media and technology-supported instruction are important for biology and health education because disease-related concepts can be abstract for young learners. Visual materials, games, videos, illustrated stories, models, and interactive activities can help students understand parasites, transmission pathways, symptoms, and prevention practices. These media can also make learning more engaging and memorable. The use of creative media is particularly important in liver fluke disease and cholangiocarcinoma prevention because young students may not easily understand invisible biological processes or long-term cancer risk. Instructional media can bridge this gap by transforming complex health concepts into concrete learning experiences. Therefore, curriculum development should include media resources that help teachers deliver biology and health content effectively [4-6].

### 2.7. Curriculum Needs Analysis

Curriculum studies have increasingly emphasized the importance of aligning curriculum design with teacher competence, learning media, assessment instruments, curriculum differentiation, twenty-first-century skills, and SDGs-oriented educational transformation [19-24]. These studies show that curriculum development is not only a matter of selecting learning content but also involves instructional feasibility, teacher readiness, learning resources, assessment design, and contextual relevance. Therefore, curriculum needs analysis is necessary to identify the gap between current educational conditions and expected learning outcomes. It helps curriculum developers determine what students need to learn, what teachers need to implement instruction, and what schools need to support curriculum adoption. In disease prevention education, needs analysis is essential because curriculum content must be scientifically accurate, developmentally appropriate, and feasible for school implementation. In this study, needs analysis focuses on both educator and student perspectives. Administrators and teachers provide information about school policy, curriculum integration, time allocation, learning media, and assessment needs. Students provide information about perceived learning needs, preferred instructional formats, and knowledge gaps. Combining these perspectives can produce a curriculum design that is relevant to learners and realistic for schools.

## 3. METHODS

### 3.1. Bibliometric Procedure

Bibliometric analysis was conducted using the Scopus database to position this study within the research trend related to health education in endemic contexts. The search used the query TITLE-ABS-KEY (health AND education AND endemic). The search covered publications from 1946 to 2025 and identified 4,310 documents. The analysis focused on annual publication trends to examine the development of research related to health

education, endemic disease contexts, and school-based prevention. The bibliometric data were interpreted descriptively by reviewing the number of documents published each year. The annual trend was used to determine whether research on health education in endemic contexts has increased over time. The results of this bibliometric analysis were then connected to the present mixed-methods needs analysis to support the development of a biology and health education curriculum for liver fluke disease and cholangiocarcinoma prevention among primary school students in endemic areas.

### 3.2. Research Design

This study employed a bibliometric and mixed-methods needs analysis to examine essential needs for developing a biology and health education curriculum on liver fluke disease and cholangiocarcinoma prevention among primary school students in endemic areas. The bibliometric component was used to position the topic within the broader research trend related to liver fluke disease, cholangiocarcinoma, health education, biology education, curriculum development, and SDGs. The mixed-methods component was used to collect quantitative and qualitative evidence from key stakeholders. The mixed-methods component followed an exploratory approach by combining questionnaire-based needs assessment and focus group discussion. Quantitative data were used to identify current conditions, expected conditions, and priority curriculum-development needs. Qualitative data were used to explain stakeholder perspectives, curriculum implementation constraints, learning media needs, and recommended instructional strategies. The integration of both data types provided a comprehensive basis for developing a school-based disease prevention curriculum.

### 3.3. Research Site, Population, and Sample

The study was conducted in Kut Rang District, Maha Sarakham Province, Thailand. The research site was selected because it is located in a region where liver fluke disease and cholangiocarcinoma remain important public health concerns. The quantitative population consisted of three stakeholder groups: primary school students in grades one to four, school administrators, and primary school teachers. The student population consisted of 1,074 students. The educator population consisted of 26 school administrators and 229 primary school teachers. The quantitative sample included 285 primary school students and 170 educators. The educator sample consisted of school administrators and primary school teachers. This sample structure allowed the study to capture both student learning needs and school-level curriculum implementation needs.

### 3.4. Qualitative Informants

Qualitative informants were selected using purposive sampling from five schools in the target district. Each school contributed one school administrator and four primary school teachers. Therefore, the total number of qualitative informants was 25. The school administrators provided information about school policy, curriculum implementation, scheduling, institutional support, and feasibility of curriculum adoption. The teachers provided information about classroom practice, student readiness, instructional media, learning activities, assessment needs, and implementation barriers. This combination allowed the study to include both administrative and classroom-level perspectives.

### 3.5. Research Instruments

The quantitative instrument was a structured questionnaire designed to assess current conditions, expected conditions, and essential needs for curriculum development. The questionnaire covered disease knowledge, prevention practices, curriculum content, instructional activities, creative media, assessment procedures, curriculum integration, and school implementation strategies. Separate questionnaire forms were used for educators and students to ensure that the questions were appropriate for each participant group.

The qualitative instrument was a focus group discussion guideline. The guideline included questions about the necessity of curriculum development, appropriate content, possible curriculum formats, school constraints, instructional media, technology needs, assessment, and expected outcomes. The focus group guideline was designed to obtain deeper explanations of the quantitative needs assessment results.

### 3.6. Data Collection Procedure

Quantitative data were collected from 285 primary school students and 170 educators using structured questionnaires. For younger students with limited reading ability, classroom teachers read the questionnaire items aloud to ensure that students understood the questions. This procedure helped make the data collection process accessible and appropriate for students in grades one to four.

Qualitative data were collected through focus group discussions with school administrators and teachers from five schools. Participants discussed current disease prevention education, curriculum needs, implementation formats, school constraints, learning media, technology support, assessment, and expected outcomes. The focus group discussions provided contextual information that complemented the questionnaire results.

### 3.7. Data Analysis

Quantitative data were analyzed using descriptive statistics and priority needs analysis. Mean and standard deviation were calculated to describe current conditions and expected conditions. The modified priority needs index (PNImodified) was calculated to identify and rank curriculum-development priorities. The PNImodified values were interpreted by comparing high-priority and lower-priority needs across educator and student groups. This analysis helped determine which curriculum components, instructional strategies, media resources, assessment procedures, and implementation formats were most urgently needed.

Qualitative data were analyzed using content analysis. The focus group discussion data were examined to identify recurring themes, stakeholder expectations, implementation barriers, and curriculum recommendations. The qualitative findings were then integrated with the quantitative findings to provide a comprehensive understanding of essential needs for curriculum development.

### 3.8. Trustworthiness and Triangulation

Triangulation was used to strengthen the credibility of the findings. Data triangulation was applied by collecting information from multiple participant groups, including students, school administrators, and teachers. Method triangulation was applied by combining quantitative questionnaires with qualitative focus group discussions. Investigator triangulation was applied through collaborative interpretation by the research team. The triangulation process helped reduce reliance on a single source of evidence and strengthened the interpretation of

curriculum-development needs. It also allowed the researchers to compare numerical priority needs with stakeholder explanations. This process supported a more credible understanding of essential needs for developing a biology and health education curriculum in endemic school contexts.

## 4. RESULTS AND DISCUSSION

### 4.1. Needs Analysis from School Administrators and Teachers

The needs analysis from school administrators and teachers is presented in **Table 2**. The overall current status mean score was 3.12 with a standard deviation of 1.06, while the overall expectation mean score was 4.35 with a standard deviation of 0.80. The overall PNImodified value was 0.3942, indicating a substantial gap between current educational conditions and expected curriculum-development needs. School administrators and teachers perceived a clear need for developing a biology and health education curriculum on liver fluke disease and cholangiocarcinoma prevention for primary school students in endemic areas.

The highest priority needs among school administrators and teachers were mainly related to curriculum integration and implementation pathways. The item with the highest PNImodified value was the incorporation of disease prevention content within supplementary curricular offerings and elective subject areas, with a PNImodified value of 0.5523. Educators expected the curriculum to be flexible enough to be implemented beyond compulsory classroom instruction. The second priority was curriculum integration into core subject areas, including science, health education, and social studies, with a PNImodified value of 0.5376. The third priority was incorporating disease prevention education into student development initiatives, including clubs, organizations, and extracurricular activities, with a PNImodified value of 0.5245.

Educators did not view liver fluke disease and cholangiocarcinoma prevention as a topic that should be limited to one subject. Instead, they perceived the curriculum as a cross-curricular and school-wide health education initiative. This is important because disease prevention in endemic communities requires repeated exposure, practical learning, and reinforcement across different educational settings. The curriculum should therefore be designed as a flexible module that can be used in science, health education, social studies, supplementary courses, clubs, extracurricular activities, or school-wide health promotion programs.

The lower-priority needs among school administrators and teachers were related to students' general hygiene and health-value behaviors. The lowest PNImodified value was found for students' explicit demonstration of appropriate health values and hygienic practices, followed by students' good hygiene practices and sanitation behaviors. These lower values do not mean that hygiene and health values are unimportant. Rather, educators perceived these general behaviors as relatively more established compared with the need for curriculum structure, instructional content, learning media, and disease-specific prevention education. Therefore, the proposed curriculum should focus more strongly on liver fluke-specific biological knowledge, disease transmission, prevention practices, creative learning media, and curriculum implementation systems.

**Table 2.** Research findings on current status, expectations, and priority needs index for curriculum development on liver fluke disease and cholangiocarcinoma prevention among school administrators and teachers.

| NO | ITEM | CURRENT STATUS | | EXPECTATION | | PNImodified | RANK |
|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | | |
| 1 | History, biology, and life cycle of liver fluke parasites | 3.15 | 1.07 | 4.18 | 0.88 | 0.3270 | 20 |
| 2 | Intermediate host species of liver fluke parasites | 2.98 | 1.10 | 4.21 | 0.90 | 0.4128 | 12 |
| 3 | Epidemiology of liver fluke parasitic infection and cholangiocarcinoma | 3.24 | 1.10 | 4.25 | 0.90 | 0.3117 | 23 |
| 4 | Disease control strategies for liver fluke parasitic infection and cholangiocarcinoma | 3.35 | 1.00 | 4.33 | 0.80 | 0.2925 | 25 |
| 5 | Clinical characteristics and symptomatic manifestations of liver fluke parasitic infection and cholangiocarcinoma | 3.11 | 1.03 | 4.23 | 0.85 | 0.3601 | 18 |
| 6 | Causal relationship between liver fluke parasitic infection and cholangiocarcinoma | 3.09 | 1.04 | 4.24 | 0.80 | 0.3722 | 16 |
| 7 | Diagnostic procedures for liver fluke parasitic infection and cholangiocarcinoma | 3.05 | 1.10 | 4.31 | 0.77 | 0.4131 | 13 |
| 8 | Prevention strategies for liver fluke parasitic infection and cholangiocarcinoma | 3.36 | 1.08 | 4.42 | 0.75 | 0.3155 | 21 |
| 9 | Treatment approaches for liver fluke parasitic infection and cholangiocarcinoma | 3.19 | 1.11 | 4.37 | 0.82 | 0.3702 | 17 |
| 10 | Positive attitudes toward liver fluke parasitic infection and cholangiocarcinoma prevention | 3.19 | 1.07 | 4.33 | 0.80 | 0.3574 | 19 |
| 11 | Recognition of health value and self-care importance | 3.34 | 1.14 | 4.39 | 0.81 | 0.3144 | 22 |
| 12 | Awareness of disease impact and health consequences | 3.14 | 1.09 | 4.33 | 0.79 | 0.3789 | 15 |
| 13 | Personal and family responsibility for disease prevention | 3.13 | 1.02 | 4.34 | 0.77 | 0.3866 | 14 |
| 14 | Student demonstration of disease prevention practices | 3.45 | 1.01 | 4.44 | 0.69 | 0.2870 | 26 |
| 15 | Students' capacity to influence peers and family members toward adoption of prevention behaviors | 3.39 | 0.94 | 4.44 | 0.72 | 0.3097 | 24 |
| 16 | Students demonstrate good hygiene practices and sanitation behaviors | 3.63 | 0.93 | 4.51 | 0.70 | 0.2424 | 27 |
| 17 | Students explicitly demonstrate appropriate health values and hygienic practices | 3.69 | 1.00 | 4.51 | 0.70 | 0.2222 | 28 |
| 18 | Supplementary curriculum for primary education grades 1–4 | 3.01 | 1.11 | 4.38 | 0.79 | 0.4551 | 10 |

**Table 2. (continue)** Research findings on current status, expectations, and priority needs index for curriculum development on liver fluke disease and cholangiocarcinoma prevention among school administrators and teachers.

| NO | ITEM | CURRENT STATUS | | EXPECTATION | | PNImodified | RANK |
|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | | |
| 19 | Comprehensive learning plans for disease prevention education | 2.92 | 1.13 | 4.37 | 0.81 | 0.4966 | 6 |
| 20 | Schools incorporate substantive learning content addressing liver fluke disease and cholangiocarcinoma within the primary education curriculum framework | 2.90 | 1.06 | 4.33 | 0.85 | 0.4931 | 7 |
| 21 | Schools provide systematic instruction delivering evidence-based knowledge and prevention guidance | 3.02 | 1.04 | 4.39 | 0.82 | 0.4536 | 11 |
| 22 | Schools organize learning activities using student experiences and creative media resources | 2.95 | 1.07 | 4.37 | 0.82 | 0.4814 | 8 |
| 23 | Schools develop and implement diverse creative media resources for disease prevention | 3.00 | 1.10 | 4.38 | 0.81 | 0.4600 | 9 |
| 24 | Schools implement systematic assessment procedures to measure student achievement in disease prevention | 2.86 | 1.08 | 4.33 | 0.80 | 0.5140 | 4 |
| 25 | Schools implement curriculum integration strategies embedding disease prevention content within core subjects | 2.79 | 1.084 | 4.29 | 0.878 | 0.5376 | 2 |
| 26 | Schools incorporate disease prevention content within supplementary curricular offerings and elective subject areas | 2.77 | 1.088 | 4.30 | 0.854 | 0.5523 | 1 |
| 27 | Schools incorporate disease prevention education within student development initiatives, clubs, organizations, and extracurricular activities | 2.86 | 1.104 | 4.36 | 0.792 | 0.5245 | 3 |
| 28 | Schools implement disease prevention curriculum within school-wide programs, health campaigns, and community engagement activities | 2.93 | 1.100 | 4.39 | 0.769 | 0.4983 | 5 |
| | **Summary** | **3.12** | **1.06** | **4.35** | **0.80** | **0.3942** | |

The findings from administrators and teachers are consistent with the public health context of northeastern Thailand. Liver fluke disease and cholangiocarcinoma remain serious concerns in endemic areas, and school-based education can become an upstream prevention strategy. When schools integrate prevention education into formal and informal learning activities, students can develop early awareness of disease risk and prevention behavior. This is relevant because cholangiocarcinoma prevention requires long-term behavioral change, public awareness, and community-level participation [1, 2].

### 4.2. Needs Analysis from Primary School Students

The needs analysis from primary school students in grades one to four is presented in **Table 3**. The overall current status mean score was 2.60 with a standard deviation of 1.33, while the overall expectation mean score was 4.35 with a standard deviation of 0.98. The overall PNImodified value was 0.6731, which was higher than the PNImodified value reported by school administrators and teachers. Students perceived a stronger gap between their current learning experiences and expected learning needs.

The highest priority need among students was the use of interesting equipment and technology to support instruction on liver fluke disease and cholangiocarcinoma, with a PNImodified value of 1.0140. Students expected learning to be more engaging, visual, interactive, and media-supported. Since students in grades one to four are young learners, they may find disease-related biological concepts difficult to understand through lecture-based explanation alone. Therefore, the curriculum should use pictures, videos, games, models, storytelling, visual media, and other concrete learning materials.

The second highest priority need was students' knowledge of clinical symptoms and manifestations of liver fluke disease and cholangiocarcinoma, with a PNImodified value of 1.0000. Students wanted to understand how the disease appears and why it is dangerous. The third priority was school provision of curricular subject matter addressing liver fluke disease and cholangiocarcinoma, with a PNImodified value of 0.9818. Together, students need both formal curriculum content and child-friendly explanations of disease symptoms, risk factors, and prevention strategies.

Other high-priority student needs included assessment on liver fluke disease and cholangiocarcinoma, treatment approaches, morphology of liver fluke parasites, prevention practices, classroom instruction, and extracurricular learning activities. Students did not only need general health messages. They also needed specific biology and health education content, including what liver flukes are, how infection happens, how the disease affects the body, how treatment is approached, and how students can prevent infection. This supports the need for a curriculum that integrates biology education and health education rather than treating prevention as a simple behavioral reminder.

The lower-priority needs among students were related to broader health behaviors, including the consumption of properly cooked food, sanitation practices, maintaining physical health, and healthy habits such as exercise, eating food from all five food groups, drinking clean water, and obtaining adequate rest. Students may already be familiar with general health messages or perceive them as common everyday practices. However, liver fluke-specific knowledge, symptoms, disease mechanisms, curriculum content, assessment, and media-supported learning remained stronger unmet needs.

The student findings are important for curriculum design. The proposed curriculum should use developmentally appropriate language and visual learning experiences. It should not overload young students with complex biomedical information. Instead, it should gradually introduce biological concepts through familiar contexts, such as fish, food, family meals, hygiene, and health protection. Technology-supported media and dynamic visualization can help make biological processes more concrete and engaging for young learners [5, 6].

**Table 3.** Research findings on current status, expectations, and priority needs index for curriculum development on liver fluke disease and cholangiocarcinoma prevention among primary school students in grades one to four.

| NO | ITEM | CURRENT STATUS | | EXPECTATION | | PNImodified | RANK |
|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | | |
| 1 | Students acquire knowledge of the morphological characteristics of liver fluke parasites | 2.22 | 1.44 | 4.20 | 1.13 | 0.8919 | 6 |
| 2 | Students possess knowledge concerning transmission mechanisms of liver fluke parasites | 2.24 | 1.33 | 4.21 | 1.09 | 0.8795 | 9 |
| 3 | Students possess knowledge concerning pathological development of liver fluke parasitic infection | 2.29 | 1.40 | 4.26 | 1.12 | 0.8603 | 11 |
| 4 | Students possess knowledge concerning clinical symptoms and manifestations | 2.13 | 1.31 | 4.26 | 1.02 | 1.0000 | 2 |
| 5 | Students understand therapeutic guidelines and treatment approaches | 2.28 | 1.40 | 4.37 | 0.95 | 0.9167 | 5 |
| 6 | Students demonstrate disease prevention practices | 2.28 | 1.31 | 4.31 | 0.97 | 0.8904 | 7 |
| 7 | Students recognize the importance of preventing disease through consistent consumption of properly cooked food | 3.01 | 1.34 | 4.36 | 0.92 | 0.4485 | 13 |
| 8 | Students recognize the benefits of practicing health-promoting behaviors through the ten essential hygiene habits | 3.06 | 1.29 | 4.39 | 0.90 | 0.4346 | 14 |
| 9 | Students assume responsibility toward themselves and family members in disease prevention | 2.98 | 1.28 | 4.33 | 0.98 | 0.4530 | 12 |
| 10 | Students demonstrate disease control and prevention through properly cooked food and sanitation practices | 3.37 | 1.36 | 4.40 | 0.91 | 0.3056 | 18 |
| 11 | Students demonstrate capacity to protect themselves and family members by avoiding raw or undercooked food | 3.10 | 1.30 | 4.40 | 0.90 | 0.4194 | 15 |
| 12 | Students consistently maintain physical health and strength | 3.37 | 1.23 | 4.51 | 0.88 | 0.3383 | 17 |
| 13 | Students demonstrate positive health habits through exercise, balanced food consumption, clean water, and adequate rest | 3.27 | 1.21 | 4.47 | 0.88 | 0.3670 | 16 |
| 14 | Teachers provide instruction on liver fluke disease and cholangiocarcinoma in classroom settings | 2.34 | 1.43 | 4.41 | 0.96 | 0.8846 | 8 |
| 15 | Teachers organize extracurricular activities on liver fluke disease and cholangiocarcinoma | 2.30 | 1.35 | 4.32 | 0.99 | 0.8783 | 10 |

**Table 3 (continue).** Research findings on current status, expectations, and priority needs index for curriculum development on liver fluke disease and cholangiocarcinoma prevention among primary school students in grades one to four.

| NO | ITEM | CURRENT STATUS | | EXPECTATION | | PNImodified | RANK |
|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | | |
| 16 | Teachers employ interesting equipment and technology to supplement instruction | 2.15 | 1.30 | 4.33 | 0.99 | 1.0140 | 1 |
| 17 | Teachers administer assessments concerning liver fluke disease and cholangiocarcinoma | 2.19 | 1.32 | 4.33 | 0.97 | 0.9772 | 4 |
| 18 | Schools provide curricular subject matter addressing liver fluke disease and cholangiocarcinoma | 2.20 | 1.35 | 4.36 | 1.00 | 0.9818 | 3 |
| | **Summary** | **2.60** | **1.33** | **4.35** | **0.98** | **0.6731** | |

### 4.3. Comparison of Educator and Student Needs

The comparison between educator and student needs is summarized in **Table 4**. Both groups agreed that curriculum development is necessary, but their priorities differed. School administrators and teachers emphasized curriculum integration, lesson plans, assessment procedures, media resources, and flexible implementation pathways. Students emphasized engaging equipment, technology-supported learning, disease symptoms, curriculum content, treatment knowledge, liver fluke morphology, and assessment.

The higher overall PNImodified value among students indicates that students perceived stronger unmet learning needs than educators. This may be because students directly experience the lack of engaging disease-prevention learning in the classroom. They expected learning activities that are more visual, interactive, and understandable. In contrast, administrators and teachers focused more on curriculum feasibility, time allocation, subject integration, and teaching resources. These differences are complementary rather than contradictory.

The curriculum should balance institutional feasibility and learner engagement. For schools, the curriculum should be modular and flexible. It should be implementable through core subjects, supplementary subjects, clubs, extracurricular activities, or school-wide health programs. For students, the curriculum should be engaging, visual, age-appropriate, and supported by creative media and technology. A curriculum that addresses only educator needs may be administratively feasible but less engaging for students. Conversely, a curriculum that addresses only student needs may be attractive but difficult for schools to implement. Therefore, curriculum development should combine both perspectives.

General hygiene and broad health behaviors were lower-priority areas for both groups, while disease-specific content and curriculum implementation were higher priorities. The proposed curriculum should not spend excessive time repeating general hygiene messages. Instead, it should focus on specific biology and health knowledge related to liver fluke disease and cholangiocarcinoma, including parasite morphology, transmission, symptoms, prevention practices, safe food behavior, and family-level health responsibility.

**Table 4.** Comparison of priority needs between school administrators and teachers and primary school students.

| ASPECT | SCHOOL ADMINISTRATORS AND TEACHERS | PRIMARY SCHOOL STUDENTS | CURRICULUM IMPLICATION |
|---|---|---|---|
| Overall PNImodified | 0.3942 | 0.6731 | Students showed stronger perceived unmet learning needs than educators. |
| Main priority orientation | Curriculum integration, implementation pathways, learning plans, assessment, and school-wide programs. | Interesting equipment, technology-supported learning, disease symptoms, curricular content, treatment knowledge, and assessment. | Curriculum should balance school feasibility and student engagement. |
| Highest priority item | Disease prevention content in supplementary or elective subjects. | Interesting equipment and technology to support instruction. | Curriculum should be flexible for schools and media-rich for students. |
| Curriculum format | Core subjects, supplementary subjects, clubs, extracurricular activities, and school-wide health programs. | Classroom learning, extracurricular activities, media-supported instruction, and assessment. | The curriculum should be modular and adaptable across learning contexts. |
| Learning content emphasis | Disease prevention content, learning plans, assessment, and creative media. | Symptoms, treatment, parasite morphology, prevention practices, and formal curriculum content. | Content should integrate biology education and health education. |
| Lower-priority pattern | General hygiene and sanitation behaviors were lower priorities. | Broad health habits and general sanitation practices were lower priorities. | Curriculum should focus more on disease-specific biology and prevention knowledge. |

### 4.4. Qualitative Findings from Focus Group Discussions

The qualitative findings were obtained through focus group discussions with school administrators and primary school teachers. These findings confirmed the quantitative results and provided deeper insight into the necessity of curriculum development, implementation formats, school constraints, instructional media needs, and expected outcomes. The participants emphasized that liver fluke disease and cholangiocarcinoma are serious community health problems and that school-based prevention education is necessary for long-term disease prevention. The following statements illustrate the perspectives of school administrators and teachers.

(i) School Administrator 1: “The problem of liver fluke parasitic infection and cholangiocarcinoma causes morbidity and mortality among people in our community. If we have a curriculum for students, it would represent long-term disease prevention.”

(ii) Teacher 1: “I desire that there be teaching and learning instruction concerning liver fluke parasitic infection and cholangiocarcinoma so that our student children possess knowledge and understanding of this disease and are able to prevent it.”

(iii) School Administrator 2: "I strongly agree with having a curriculum for students for the purpose of preventing liver fluke parasitic infection and cholangiocarcinoma."
(iv) Teacher 2: "I desire that there be a subject course that teaches students about this disease. It could be an additional subject or integrated into foundational subjects."
(v) School Administrator 3: "In our school there are quite numerous activities and scheduled instruction is extensive. If a curriculum is introduced, we must find a time period to conduct these activities."
(vi) Teacher 3: "During club activity periods, there is one time interval that could potentially be used to teach concerning liver fluke parasitic infection and cholangiocarcinoma."
(vii) School Administrator 4: "This matter is essential. Having a curriculum is necessary. I desire that there be instructional plans and learning media that teachers can utilize with flexibility."
(viii) Teacher 4: "If children have the opportunity to learn concerning liver fluke parasitic infection and cholangiocarcinoma, it would be very beneficial indeed. I desire that children and people in families have prevention of this disease."
(ix) School Administrator 5: "I desire that the curriculum can be utilized in various activities of the school. It could perhaps be taught in foundational subjects, additional subjects, or free periods."
(x) Teacher 5: "I desire that there be media, equipment, and technology to accompany teaching that make it interesting, so that students find enjoyment and acquire knowledge concerning liver fluke parasitic infection and cholangiocarcinoma."

The quotations show that administrators and teachers consistently viewed curriculum development as necessary. Administrators emphasized disease burden, long-term prevention, curriculum feasibility, and flexible use across school activities. Teachers emphasized student knowledge, classroom instruction, instructional media, enjoyable learning, and family-level disease prevention. These findings strengthen the quantitative evidence that both curriculum structure and instructional media are essential for successful implementation.

### 4.5. Thematic Analysis of Qualitative Findings

The thematic analysis of focus group discussion data is presented in **Table 5**. Five main themes emerged from the qualitative data: curriculum necessity, flexible implementation, school constraints, instructional media needs, and expected family or community impact. The themes are in the following:

(i) The first theme was the necessity of curriculum development. Participants emphasized that liver fluke disease and cholangiocarcinoma affect community morbidity and mortality. Therefore, they viewed school-based curriculum as a long-term prevention strategy. This theme supports the quantitative findings showing high expected needs among school administrators, teachers, and students.
(ii) The second theme was flexible curriculum implementation. Participants suggested that the curriculum could be implemented as an additional subject, integrated into foundational subjects, organized during club activity periods, or used in free periods and school-wide activities. This finding is consistent with the educator needs analysis, where supplementary curriculum, core subject integration, extracurricular activities, and school-wide programs were identified as high-priority needs.

(iii) The third theme was school constraints. Administrators noted that schools already have many scheduled activities and extensive instruction. This indicates that curriculum development must consider school workload and time availability. The curriculum should therefore be concise, modular, and adaptable. It should not require schools to restructure their entire timetable.

(iv) The fourth theme was the need for instructional media, equipment, and technology. Teachers emphasized that learning media can make disease prevention education more interesting and enjoyable. This theme aligns strongly with the student needs analysis, where the highest priority need was technology-supported instruction. The curriculum should therefore include creative media, visual materials, activity sheets, games, videos, or other interactive resources that help students understand biological and health concepts.

(v) The fifth theme was expected family and community impact. Teachers expected students to learn prevention knowledge and share it with families. This is important because liver fluke disease risk is often related to household food practices and community habits. Therefore, curriculum development should include messages and activities that help students connect school learning with home and community prevention.

**Table 5.** Thematic analysis of focus group discussions with school administrators and teachers.

| THEME | EVIDENCE FROM PARTICIPANTS | INTERPRETATION | CURRICULUM IMPLICATION |
|---|---|---|---|
| Necessity of curriculum development | Administrators and teachers stated that liver fluke disease and cholangiocarcinoma affect morbidity and mortality in the community. | Stakeholders viewed the disease as a direct local public health problem. | A prevention curriculum is needed as a long-term school-based health strategy. |
| Flexible curriculum implementation | Participants suggested using additional subjects, foundational subjects, club periods, free periods, and school-wide activities. | Schools need adaptable implementation formats because time and schedules vary. | Curriculum should be modular and usable across multiple school contexts. |
| School constraints | Administrators noted that schools already have many scheduled activities and heavy instructional loads. | Implementation must consider school workload and available time. | Curriculum should be concise, flexible, and easy for teachers to implement. |
| Instructional media, equipment, and technology | Teachers requested media, equipment, and technology to make learning interesting and enjoyable. | Young students need concrete and engaging learning resources. | Curriculum should include visual media, games, videos, illustrated materials, and interactive activities. |
| Family and community impact | Teachers expected students to help families understand and prevent the disease. | Student learning can extend to family and community prevention awareness. | Curriculum should include take-home messages and community-oriented learning activities. |

### 4.6. Bibliometric Analysis

The bibliometric analysis was conducted using the Scopus database with the search query TITLE-ABS-KEY (health AND education AND endemic). The search covered publications from 1946 to 2025 and identified 4,310 document results. The annual publication trend is presented in **Figure 1**. Research related to health education in endemic contexts was limited during the earlier publication period, with relatively small annual outputs for several decades. The number of publications began to increase more clearly after the 2000s and continued to rise in the most recent years. Annual publication output increased notably from 141 documents in 2017 to 185 documents in 2018, 200 documents in 2019, 204 documents in 2020, 275 documents in 2021, 247 documents in 2022, 237 documents in 2023, 280 documents in 2024, and 343 documents in 2025. This trend indicates growing scholarly attention to health education in endemic contexts. The increase is relevant to the present study because liver fluke disease and cholangiocarcinoma prevention requires educational strategies that respond to local disease burden, school contexts, and community health needs. The bibliometric findings strengthen the justification for developing a biology and health education curriculum for younger primary students in endemic areas. Health education in endemic contexts is becoming an increasingly important research direction. However, the present study contributes a more specific classroom-level perspective by identifying the essential needs of school administrators, teachers, and students for curriculum development. Therefore, the bibliometric evidence and mixed-methods needs analysis complement each other: the bibliometric results provide broader academic positioning, while the needs analysis provides local empirical evidence for curriculum design.

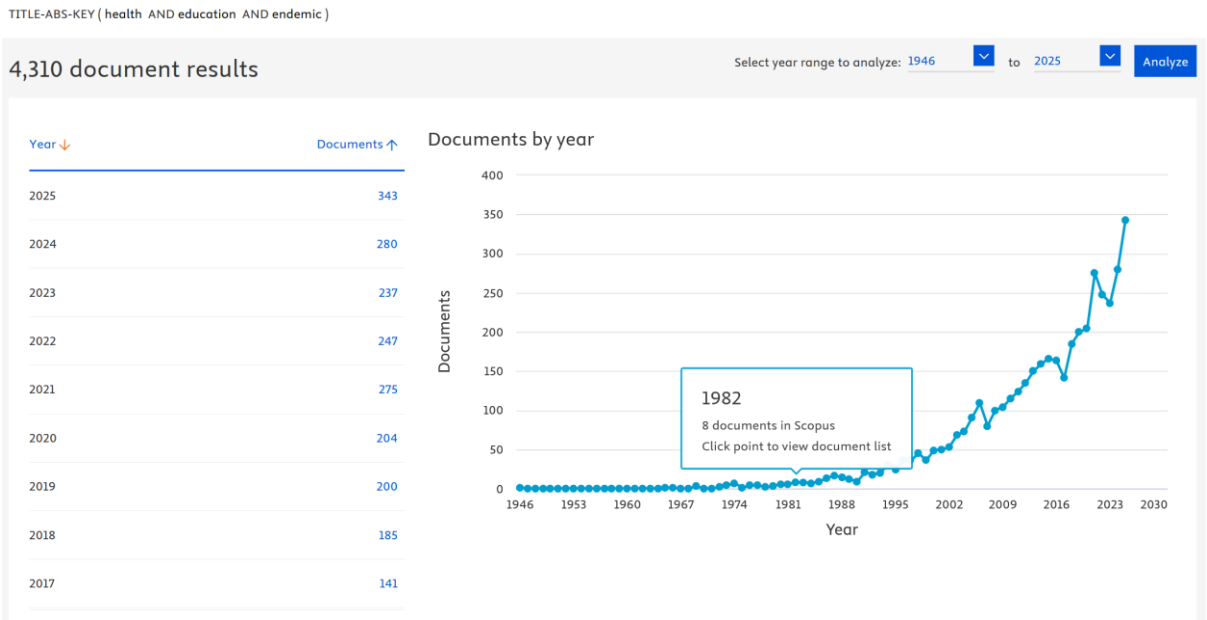


**Figure 1.** Bibliometric trend of publications related to health education in endemic contexts based on the Scopus search query TITLE-ABS-KEY (health AND education AND endemic) from 1946 to 2025. Data were obtained in June 2026.

### 4.7. SDGs Relevance

Previous studies have connected educational, health, curriculum, and sustainability-oriented interventions with SDGs, supporting the relevance of SDGs-based curriculum development in this study [8, 9, 12, 13, 15, 25]. The SDGs relevance of the proposed curriculum is summarized in Table 6. The strongest contribution is related to SDG 3 because the curriculum aims to improve health awareness and disease prevention in endemic areas. By teaching students about liver fluke disease, cholangiocarcinoma, safe food consumption, hygiene, and family prevention responsibility, the curriculum can contribute to long-term health promotion.

The curriculum also supports SDG 4 because it promotes quality education through developmentally appropriate biology and health learning. Students in grades one to four need learning experiences that are concrete, interactive, and meaningful. A curriculum supported by creative media, technology, and activity-based learning can improve students' understanding of disease prevention while also strengthening scientific literacy and health literacy.

In addition, the curriculum supports SDG 17 because effective disease prevention education requires collaboration among schools, teachers, universities, health researchers, public health agencies, and communities. Liver fluke disease and cholangiocarcinoma are not only individual health problems but also community-level public health challenges. Therefore, curriculum development should involve educational and health stakeholders to ensure that the learning content is accurate, practical, and responsive to local disease conditions.

The proposed curriculum can function as both a school-based learning intervention and a public health prevention strategy. By integrating biology education, health education, creative media, flexible implementation, and stakeholder needs, the curriculum can help younger students develop early prevention literacy and contribute to broader community health awareness in endemic areas.

**Table 6.** Relevance of the proposed biology and health education curriculum to selected SDGs.

| SDG | RELEVANCE TO THIS STUDY | CONTRIBUTION OF THE PROPOSED CURRICULUM |
|---|---|---|
| SDG 3: Good health and well-being | Liver fluke disease and cholangiocarcinoma are serious public health problems in endemic areas. | Promotes early disease prevention, safe food behavior, hygiene awareness, and health literacy among primary school students. |
| SDG 4: Quality education | Younger students need developmentally appropriate biology and health education. | Provides structured, age-appropriate, media-supported, and school-based learning for disease prevention. |
| SDG 10: Reduced inequalities | Students in endemic areas may have higher exposure to disease risk and limited access to prevention education. | Supports equitable access to disease prevention knowledge for children in high-risk communities. |
| SDG 11: Sustainable cities and communities | Disease prevention requires community awareness and healthier local food practices. | Encourages students to connect school learning with household and community prevention behaviors. |
| SDG 17: Partnerships for the goals | Effective curriculum development requires collaboration among schools, universities, health experts, and communities. | Strengthens partnership-based curriculum development and implementation for public health education. |

### 4.8. Discussion

The biology and health education curriculum on liver fluke disease and cholangiocarcinoma prevention is strongly needed for primary school students in endemic areas. School administrators and teachers reported an overall PNImodified value of 0.3942, while students reported a higher value of 0.6731. Both groups perceived important curriculum-development gaps, but students showed stronger unmet needs for concrete, engaging, and accessible disease-prevention learning. Educators prioritized curriculum integration into supplementary subjects, elective subjects, core subjects, student development activities, extracurricular activities, and school-wide programs. The curriculum should be modular and flexible rather than a rigid stand-alone subject.

The student findings emphasize the importance of media-rich and technology-supported learning. The highest student priority was the use of interesting equipment and technology to support instruction. This is important because students in grades one to four may struggle to understand abstract biological concepts such as parasites, infection, transmission, symptoms, and cancer risk through verbal explanation alone. Visual media, videos, models, games, storytelling, and hands-on activities can help transform complex health concepts into concrete learning experiences. This interpretation is consistent with studies showing that visualization tools and video-supported learning can strengthen students' motivation, engagement, and understanding of biology concepts [5, 6].

The qualitative findings support the quantitative results. Administrators viewed liver fluke disease and cholangiocarcinoma as serious community health problems and considered curriculum development a long-term prevention strategy. Teachers emphasized the need for instructional plans, media, enjoyable activities, and knowledge that students can share with their families. Prevention education should connect classroom learning with household and community practices because disease risk is closely related to local food behavior, family habits, and community health awareness.

The study also shows the importance of integrating biology education and health education. Biology education is needed to help students understand liver flukes, transmission pathways, infection processes, symptoms, and the relationship between liver fluke infection and cholangiocarcinoma risk. Health education is needed to connect this knowledge with prevention behavior, including safe food consumption, hygiene, sanitation, and family responsibility. If the curriculum focuses only on biology, students may understand the disease but not apply prevention behavior. If it focuses only on health messages, students may follow advice without understanding the biological reasons. Therefore, the curriculum should integrate scientific understanding and practical health behavior.

The curriculum should also be responsive to local context because place-based education can connect learning with students' social, cultural, and community environments, making health education more meaningful for learners in endemic areas [26]. In this study, endemicity is not only a geographical condition but also an educational context. Students live in communities where disease risk may be connected to food practices, household routines, and local health awareness. Therefore, prevention education should be designed to connect school learning with real-life community conditions.

School-based liver fluke disease and cholangiocarcinoma prevention education can support student learning and prevention awareness in northeastern Thailand [10, 11]. However, this study extends previous work by focusing on younger primary students in grades

one to four and by identifying needs before curriculum development. This is important because lower primary students need simpler language, visual media, activity-based learning, and developmentally appropriate assessment.

The bibliometric results strengthen the academic positioning of this study by showing increasing attention to health education in endemic contexts. Combined with the mixed-methods needs analysis, this evidence supports the development of a curriculum that is scientifically relevant, pedagogically appropriate, and responsive to local disease-prevention needs.

The findings also support SDGs-oriented education because the proposed curriculum connects disease prevention, quality education, equitable access to health learning, community awareness, and cross-sector collaboration. These connections are consistent with studies linking education, health promotion, curriculum development, and sustainability-oriented interventions with SDGs [8, 9, 12, 13, 15, 25].

Curriculum development should integrate educator needs, student needs, local disease context, biology content, health behavior, creative media, assessment, and flexible implementation. The key discussion implications are summarized in **Table 7**.

**Table 7.** Summary of discussion implications.

| FINDING | INTERPRETATION | CURRICULUM IMPLICATION |
|---|---|---|
| Educators reported high needs for curriculum development. | Schools need structured but flexible prevention education. | Develop modular curriculum for core subjects, supplementary subjects, clubs, and school-wide programs. |
| Students reported very high needs, especially for technology-supported learning. | Younger learners need concrete, visual, and engaging materials. | Use videos, pictures, games, models, storytelling, and hands-on activities. |
| Qualitative findings confirmed disease prevention as a community concern. | Prevention learning should connect school, family, and community. | Include take-home messages and family-oriented activities. |
| Biology and health education are both needed. | Scientific understanding must be linked with prevention behavior. | Integrate parasite biology, disease transmission, safe food behavior, hygiene, and family responsibility. |
| Bibliometric results showed increasing research on health education in endemic contexts. | The topic is academically relevant and growing. | Position the curriculum as part of health education research in endemic areas. |
| The curriculum relates to SDGs. | Disease prevention education supports health, quality education, equity, community awareness, and partnership. | Connect curriculum goals with SDG 3, SDG 4, SDG 10, SDG 11, and SDG 17. |

### 4.9. Limitations, Future Work, and Suggestions

This study has several limitations that should be considered when interpreting the findings:

(i) The study was conducted in one district in northeastern Thailand, namely Kut Rang District, Maha Sarakham, Thailand. Although this district is relevant because it is located in an endemic region, the findings may not represent all endemic areas. Different communities may have different school resources, food practices, health awareness, teacher readiness, and curriculum implementation conditions. Therefore, the findings should be interpreted as context-specific evidence for curriculum development.

(ii) This study focused on needs analysis rather than curriculum implementation. School administrators, teachers, and students need a biology and health education curriculum for liver fluke disease and cholangiocarcinoma prevention, but the study did not yet test whether the proposed curriculum can improve students' knowledge, prevention awareness, food behavior, or family communication. Therefore, future research should proceed to curriculum design, pilot implementation, and effectiveness evaluation.

(iii) The quantitative data were based on self-reported perceptions of current conditions and expected needs. This approach is appropriate for identifying curriculum-development priorities, but responses may be influenced by participant interpretation, social desirability, and limited prior knowledge. This issue is especially relevant for students in grades one to four because younger students may have different levels of reading ability and conceptual understanding. Future studies should combine questionnaires with classroom observation, child-friendly interviews, performance tasks, or visual response tools.

(iv) The qualitative data were obtained from school administrators and teachers, but did not include parents, public health officers, community leaders, curriculum experts, or medical specialists. Since liver fluke disease and cholangiocarcinoma prevention is closely related to household food practices and community health behavior, future curriculum development should involve broader stakeholders. This would help ensure that the curriculum is scientifically accurate, pedagogically appropriate, and relevant to local health practices.

(v) The bibliometric analysis used the Scopus search query TITLE-ABS-KEY (health AND education AND endemic). Although useful for positioning the study, this query did not specifically cover all studies on liver fluke disease, cholangiocarcinoma, primary education, curriculum development, and SDGs. Future bibliometric studies should use multiple search strings, keyword mapping, thematic analysis, and collaboration network analysis.

Future work should develop a biology and health education curriculum for primary school students in grades one to four based on the priority needs identified in this study. The curriculum should include age-appropriate learning objectives, disease-specific biology content, safe food behavior, hygiene, family responsibility, creative media, technology-supported learning, assessment tools, and teacher guidance. It should also be modular. Thus, schools can use it in core subjects, supplementary subjects, club activities, extracurricular programs, or school-wide health campaigns.

After curriculum development, future research should conduct pilot testing to evaluate feasibility, usability, and learning effectiveness. The pilot study should examine whether

teachers can implement the curriculum within real school schedules, whether students understand the materials, whether the media are engaging, and whether the assessment tools are appropriate for younger learners. Stronger research designs, including pretest-posttest studies, quasi-experimental studies, mixed-methods implementation research, and longitudinal multiple-case studies, are recommended to examine learning retention and behavioral change across different school contexts [27].

Based on the findings, several practical suggestions can be proposed. Policymakers should support school-based disease prevention curriculum in endemic areas as part of long-term public health education. Curriculum developers should design child-friendly materials using simple language, pictures, stories, games, videos, and hands-on activities. Teachers should be provided with lesson plans, media resources, assessment tools, and flexible implementation guidance. Schools should be allowed to adapt the curriculum according to their schedules and resources. Public health agencies, universities, schools, and families should collaborate to ensure that disease prevention messages are scientifically valid and connected to community life. The limitations, future research directions, and practical suggestions derived from the findings are summarized in **Table 8**.

**Table 8.** Summary of limitations, future work, and practical suggestions.

| ASPECT | MAIN POINT | IMPLICATION |
|---|---|---|
| Research site | The study was conducted in one endemic district. | Future studies should involve more districts and school contexts. |
| Research phase | The study examined needs, not curriculum effectiveness. | Future work should develop, implement, and evaluate the curriculum. |
| Data source | Student and educator data were based mainly on questionnaires and focus groups. | Future studies should add observation, interviews, performance tasks, and visual tools. |
| Stakeholders | Parents, public health officers, and community leaders were not included. | Broader stakeholder involvement is needed in curriculum development. |
| Bibliometric scope | The bibliometric search used one broad Scopus query. | Future bibliometric analysis should use multiple queries and thematic mapping. |
| Curriculum design | Students need concrete, visual, and media-supported learning. | The curriculum should include pictures, games, videos, models, and activity-based learning. |
| Implementation | Schools need flexible curriculum formats. | The curriculum should be modular and usable across subjects, clubs, and school programs. |
| Evaluation | Effectiveness and retention have not yet been tested. | Future research should use pilot studies, quasi-experiments, and longitudinal designs. |

## 5. CONCLUSION

This study identified essential needs for developing a biology and health education curriculum on liver fluke disease and cholangiocarcinoma prevention among primary school students in endemic areas. The findings showed substantial curriculum-development needs among school administrators and teachers and very high needs among students. Educators emphasized flexible curriculum integration, lesson plans, assessment, creative media, and school-wide implementation, while students prioritized technology-supported learning, disease symptoms, formal content, and assessment. Qualitative findings confirmed that the

curriculum is necessary for long-term prevention, family awareness, and community health. The study supports SDGs-oriented curriculum development for early disease prevention literacy.

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## 7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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