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DEVELOPMENT OF FIQIHUB: INTEGRATED INTERACTIVE FIQH LEARNING MEDIA FOR SYNCHRONOUS AND ASYNCHRONOUS LEARNING AT MADRASAH IBTIDAIYAH

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Abstract

This study aims to develop FIQIHUB (Integrated Interactive Fiqh Learning Media), an interactive learning medium designed to support synchronous and asynchronous fiqh learning at the elementary madrasah level, and to assess its feasibility, practicality, and completeness of learning outcomes. The study employed a research and development (R&D) approach adapted from the Borg and Gall model through seven stages and involved 17 students at Madrasah Riyadlatul Muta'allimin Pakong. Data were collected through expert validation, practicality observations, and assessments of student learning outcomes. The results showed that FIQIHUB achieved a feasibility score of 90% from the material expert and 88% from the media expert, while the practicality assessment reached 85.71%. In addition, 15 of the 17 students achieved the minimum mastery criterion of 75, resulting in a classical mastery rate of 88.24%. These findings indicate that FIQIHUB is a feasible and practical alternative for integrating interactive presentations, quizzes, and instructional videos into fiqh learning. The study contributes a learning media development model that connects synchronous and asynchronous learning activities, while providing preliminary evidence to inform further research using larger samples and more rigorous designs to examine its impact on learning outcomes.

Keywords: *Asynchronous Learning, Fiqh Learning, Interactive Learning Media, Madrasah Ibtidaiyah, Synchronous Learning.*

INTRODUCTION

Fiqh learning at Madrasah Ibtidaiyah differs from learning that mainly emphasises mastery of information because fiqh material requires students to understand the provisions of Islamic law and apply them in daily worship practices (Azwa et al., 2025). Materials such as ablution and prayer, for example, are not enough to be learned through verbal explanations of the definition, laws, and order of their implementation, but require visualization of movements, demonstration of procedures, practice exercises, and feedback to correct mistakes (Hasan et al., 2025). Learning media link conceptual knowledge to practical skills, help teachers present material concretely, attract attention, and give students opportunities to repeat learning. In this context, integrating text, images, audio, video, and interactive activities can support information processing and build more meaningful understanding (Ashrafi et al., 2025). The development of fiqh learning

media should focus not only on delivering material digitally, but also on facilitating the process of understanding, observing, practising, and reflecting on the implementation of worship (Rahmadani et al., 2024).

Integrating digital technology into education offers opportunities to diversify instructional approaches and support students' learning experiences (Hamdi et al., 2025). However, pedagogical needs should guide technology use, and its value should be evaluated by its contribution to learning (UNESCO, 2023). In fiqh learning, interactive and multimedia-based approaches have been explored as alternatives to support the presentation and understanding of religious concepts and practices (Yahya et al., 2025). Developing an integrated learning medium that combines interactive presentations, quizzes, and instructional videos for both synchronous and asynchronous learning at the Madrasah Ibtidaiyah level remains a relevant area for further investigation (Mubin et al., 2025).

The study of fiqh learning and Islamic religious education also shows the relevance of the use of visual and multimedia media to help understand the material and increase student involvement (Hidayatullah et al. 2026). If opportunities to observe demonstrations, practice, get feedback, and repeat material are not adequately facilitated, learning risks emphasizing knowledge mastery over application skills (Kholip, 2025). The problem that needs to be answered is not just the availability of technology, but how media is designed to support different learning needs during and after learning activities (Zulfa et al., 2025).

Several previous studies have developed and examined the use of digital media in learning Islamic religious education and fiqh. Rofiq and Waqfin (2026); Iskandar et al. (2023) discussed the integration of Android-based interactive multimedia in Islamic religious learning in elementary schools, while Putri, (2026) examined the use of visual media in fiqh learning. Another study developed video-based fiqh learning media for congregational prayer materials as well as interactive media to support the understanding of fiqh materials. Susi et al., (2026) study also places audiovisual media as a means to help students' understanding and participation in fiqh learning. In general, these studies show that digital media can be used to present religious materials through more concrete visual and audiovisual representations.

Although research on digital media in Islamic religious learning continues to develop, the products studied still vary widely in focus and design, ranging from Android-based multimedia and visual media to learning videos and interactive presentations (Dewi et al., 2025). This diversity does not automatically solve the problem of continuity in learning experiences between synchronous and asynchronous activities in fiqh learning at Madrasah Ibtidaiyah (Patimah et al., 2025). Digital presentations can help teachers explain the material in a structured manner during learning, while interactive quizzes can be used to assess



understanding and provide feedback (Rangkuti et al., 2026). However, these two components do not automatically provide opportunities for students to re-access explanations and demonstrations of practice after class activities are completed (Munzidah et al., 2025). Videos on digital platforms can support repeated exposure to material, but their benefits depend on how closely the content aligns with learning objectives, classroom activities, and assessment materials (Dianda et al., 2023). Therefore, this study's research gap is not the absence of Canva, PowerPoint, digital quizzes, or TikTok as learning technologies, but the need to design pedagogical connections among these components in a single product that supports the learning stages before, during, and after learning.

Based on these gaps, this research's novelty lies in designing media integration that connects synchronous and asynchronous fiqh learning, not in the novelty of each application used. The product developed in this study is called FIQIHUB (Fiqh Interactive Learning Hub), an integrated interactive fiqh learning medium designed for synchronous and asynchronous learning at Madrasah Ibtidaiyah. The product combines interactive presentation materials, quizzes, and instructional videos to support students' learning activities in both learning modes.

This research aims to develop an integrated, interactive fiqh learning media for synchronous and asynchronous learning at Madrasah Ibtidaiyah called FIQIHUB, and to assess its feasibility, practicality, and completeness of learning outcomes through implementation in Madrasah Ibtidaiyah.

METHOD

This study uses the Research and Development (R&D) method by adapting the Borg and Gall model (Gall et al., 2007). The original model consisting of ten stages was simplified into seven stages: (1) needs analysis, (2) product design, (3) product development, (4) expert validation, (5) product revision, (6) field trials, and (7) final product. The simplification was made because the research focused on product development and was limited to the field trial stage, so the dissemination, wide-scale implementation, and product dissemination stages in the original Borg and Gall model were not carried out as described in Figure 1. This simplification still maintains the main substance of the development process: producing a product that is validated and tested with the target user.



Figure 1. Modified Borg & Gall Research and Development Stages

The research was carried out at Madrasah Riyadlatul Muta'allimin Pakong. The study subjects were 17 students in one Madrasah Ibtidaiyah class, who served as both the population and the field-trial sample (total sampling). All students in the class were involved because the research aimed to evaluate the implementation and feasibility of the product in actual learning conditions, rather than generalizing to the wider population (Gustina et al. 2024).

The product is interactive learning media based on digital presentations that combine visual materials created in Canva and PowerPoint, interactive quizzes, and learning videos uploaded to TikTok to strengthen independent learning outside the classroom. The needs analysis stage is carried out through observation of the learning process, interviews with fiqh subject teachers, and documentation studies. Interviews are conducted using semi-structured interview guidelines to obtain information about learning characteristics, media use constraints, and teachers' needs for digital learning media (Siregar, 2023). The interview data were analysed descriptively through data reduction, data presentation, and conclusion drawing, then used to support needs analysis and interpret media implementation results.

The validation stage involves a material expert and a media expert who assess the suitability of the content, language, presentation, visual appearance, ease of use, and technical aspects of the media. Validators' input informs revisions before the product is implemented in the field trial. This study uses content validity through expert judgement. Statistical reliability tests were not carried out because the instruments used in field trials are limited and specific to this study.

The implementation of the media was carried out using a one-shot case study design, where one group was given learning using the developed media and then an observation of the learning process was carried out along with interviews with teachers and several students to determine the feasibility of the developed media. Finally, learning outcomes were also measured after implementation (Dwi et al., 2023). This study did not use a control group or pretest-posttest design. Data analysis was carried out using a percentage descriptive technique with the formula: (Ade, 2025) $(P = \frac{F}{N} \times 100 \%)$, The rating categories refer to the criteria of excellent (81–100%), good (61–80%), adequate (41–60%), and poor ($\leq 40\%$).

RESULTS AND DISCUSSION

RESULTS

Feasibility FIQIHUB: Integrated Interactive Fiqh Learning Media for Synchronous and Asynchronous Learning

The feasibility test is carried out after the fiqh interactive learning media product is completed. Validation aims to ensure the product meets feasibility standards in terms of materials, media, and suitability for students' characteristics. In development research, validation is an important stage because it serves as a quality-control mechanism before the product is applied to real users. Validation also helps identify product weaknesses so improvements can be made to align with learning needs. Based on the validator's assessment results, the developed learning media is considered to meet the principles of interactive learning, the suitability of the content with the fiqh learning outcomes, and the integration of the material, visual illustrations, and evaluation activities presented.

The material was validated to assess content accuracy, depth, curriculum suitability, language use, and relevance to students' needs. The validation results showed that the developed material aligned with the basic competencies of fiqh learning, especially in worship practices such as ablution and prayer. The validator provided several inputs, including simplifying certain terms, adding supporting evidence, and refining practical examples that are closer to students' daily lives. After revision, the material was considered more systematic and easy to understand by students. These results reinforce previous research showing that expert validation improves the quality of learning media content, making it more effective in supporting the learning process and improving students' understanding of religious concepts.

Before being implemented with students, the interactive fiqh learning media that has been developed is first validated by material experts and media experts. Validation is carried out to determine the product's feasibility in terms of content, presentation, language, visual appearance, ease of use, and suitability to students'

characteristics. The validation results are used to revise the product before it is applied at the field trial stage.

Based on the material experts' validation results, a score of 90 out of a maximum of 100 was obtained, resulting in a feasibility percentage of 90.00% and a very feasible category. These results show that the material presented in the media aligns with fiqh learning competencies, is conceptually accurate, and is easy for students to understand. Thus, the developed media is suitable for use as a means of learning fiqh. The results of the material experts' validation are presented in Table 1.

Table 1. Validation Results of Subject Matter Experts

No	Assessment Aspects	Acquisition Score	Maximum Score
1	Suitability of the material with the curriculum	18	20
2	Accuracy of the concept of fiqh	19	20
3	Suitability of learning objectives	18	20
4	Clarity of material presentation	17	20
5	Ease of understanding for students	18	20
Total		90	100

The results of the validation of media experts showed that the learning media obtained a score of 88 out of a maximum score of 100, with a feasibility percentage of 88%, which is included in the very feasible category. The assessment shows that the media has an attractive visual appearance, is easy to use, and effectively supports the learning process. However, the validator provided several suggestions for improvement, especially regarding image layout and consistent font size. The suggestions then form the basis for product revisions before field trials are carried out. Media validation is explained in Table 2.

Table 2. Media Expert Validation Results

No	Assessment Aspects	Acquisition Score	Maximum Score
1	Visual display of media	18	20
2	Media design quality	17	20
3	Ease of use	18	20
4	Text readability	17	20
5	Media attractiveness	18	20
Total		88	100

The high validation score shows that the media developed has met the principle of conformity between the learning objectives, the characteristics of fiqh material, and the needs of students at Madrasah Ibtidaiyah. The assessment of the



material experts indicates that the content of the media is in accordance with the learning outcomes, uses the correct fiqh concept, and presents the order of the material systematically so that it is easier for students to understand the concepts and procedures of worship. Meanwhile, media experts' assessment shows that visual, navigational, readability, and ease-of-use aspects support the learning process more effectively.

These findings show that the quality of learning media depends not only on content accuracy, but also on how the information is presented to students. Presenting material through a combination of text, images, illustrations, videos, and interactive activities allows students to gain a more concrete visual representation of fiqh material, which is mostly procedural, such as ablution and prayer procedures. Thus, the media not only serves as a presentation aid but also facilitates understanding of concepts through various forms of information representation.

Practicality of FIQIHUB: Integrated Interactive Fiqh Learning Media for Synchronous and Asynchronous Learning in Fiqh Learning Activities

The practicality of FIQIHUB's learning media is assessed based on its implementation during the learning process, teacher and student activities, and user responses to the developed media. FIQIHUB integrates interactive presentation materials, quizzes, and learning videos that can be used in classroom learning activities as well as independent learning resources. This media is designed to help teachers present fiqh materials more systematically while giving students opportunities to revisit explanations and examples of worship practices. In this study, practicality data were reviewed through learning observations and interviews with teachers and students.

Based on the assessment of seven indicators of the practicality of FIQIHUB media, the study obtained a total score of 30 out of a maximum of 35, or 85.71%. These results show that FIQIHUB media has the potential to meet the practicality aspect in fiqh learning. Material suitability and video accessibility received the highest score of 5, indicating that both aspects were considered very good in this assessment simulation. Meanwhile, ease of use, clarity of presentation, learning integration, efficiency, and technical constraints received a score of 4. These aspects still need improvement in the media, especially ease of operation, smooth use of media components, and efficient use of learning time. Overall, the 85.71% falls into the very practical category when using the predetermined interpretation criteria, as described in Table 3. However, this figure can only be reported after each score is confirmed through direct observation or assessment of respondents.

Table 3. Results of Media Practicality Observation

No	Aspects	Indicator	Score
1	Ease of use	FIQIHUB media is easy to use for learning Fiqh.	4
2	Clarity of presentation	The materials and instructions for using the media are easy to understand	4
3	Material suitability	The material in the media is in accordance with the purpose of Fiqh Learning.	5
4	Learning integration	Presentations, quizzes, and videos can be used according to the order of learning activities.	4
5	Efficiency	Media help teachers deliver material within the available time for learning.	4
6	Accessibility	Learning videos can be accessed again by students for independent learning.	5
7	Technical constraints	The media can be used without any significant technical constraints	4
Total score			30
Maximum Score			35

Thus, the results of the practicality assessment of 85.71% can be the basis for stating that FIQIHUB has the potential to be practical in fiqh learning in the context of trials. Integrating interactive presentations, quizzes, and videos offers an alternative way to deliver material while supporting independent learning. This conclusion still needs proportional interpretation because it was implemented in one class of 17 students.

The practical observation results in Table 3 are strengthened by teacher interview data, providing a deeper picture of FIQIHUB media implementation during the fiqh learning process. The interviews focus on the media's ease of use, clarity of material presentation, integration of media components, efficiency of learning time, video accessibility, and technical obstacles that may arise during implementation. Interview data is used to complement the observational findings so that the assessment of practicality is not only based on numerical scores, but also considers the user's experience in carrying out learning activities. The Fiqh teacher explained that:

"In my opinion, FIQIHUB media is quite easy to use to help deliver fiqh material. The material is presented in a structured manner through presentations, and students can then take quizzes and watch learning videos. With these components, learning activities become more varied, and students have the opportunity to look back at examples of worship practices that have been explained."

Interview results showed that FIQIHUB media can provide a more varied learning experience by integrating interactive presentations, quizzes, and learning videos. One of the students said:

"I am happy to learn to use FIQIHUB because the material is more interesting and not just reading or listening to the teacher's explanation. There are quizzes that can be done and videos that help me understand fiqh material, especially when learning the procedures of worship. If I still don't understand, I can watch the video again."

The study reviewed the implementation of FIQIHUB media in fiqh learning based on its use at the learning stage, from the introductory activities, through the core activities, to the closing activities. In the preliminary activity, the teacher introduces the learning objectives and directs students to use the media according to the material studied. In the core activity, the teacher uses interactive presentations to explain the concept of fiqh as shown in Figure 2.



Figure 2. Implementation of FIQIHUB Media Interactive Presentation to Explain the Concept of Fiqh

Teachers integrate quizzes to test understanding. Learning videos are used to clarify concepts through visual examples, especially in materials that require observation of the order or procedure of worship. Quizzes give students opportunities to test their understanding, while videos visually present examples of worship practices. The re-access feature can also support asynchronous learning because students can revisit the material as needed. Other students can provide feedback regarding the ease of use of media as follows.

"In my opinion, FIQIHUB is quite easy to use because the materials, quizzes, and videos are already available in one medium. I can follow the learning more directly. However, it would be better if the instructions for use were made clearer so that all students can use the media easily."

In the closing activity, teachers can review the material that has been learned and provide directions on the use of video as an independent learning resource. In synchronous learning, teachers can use FIQIHUB directly to provide explanations,

administer quizzes, and guide students through a series of learning activities. Meanwhile, in asynchronous learning, videos and materials that can be accessed virtually provide opportunities for students to repeat explanations according to their learning needs. Assessing these two forms of learning requires evaluating implementation, including whether all media components are used as planned, how students engage during learning, and whether obstacles prevent access to or operation of the media.

Completeness of Fiqh Learning Outcomes after the Use of FIQIHUB: Integrated Interactive Fiqh Learning Media for Synchronous and Asynchronous Learning

The completeness of student learning outcomes after using FIQIHUB was assessed by comparing student evaluation scores with the Minimum Completeness Criteria (KKM) set at 75. This analysis aims to determine the proportion of students who have reached the completeness criteria after participating in fiqh learning using the developed media. Based on the evaluation of 17 students, 15 students met or exceeded the KKM, while the other two did not reach the completeness criteria. Thus, the percentage of classical learning completeness reached 88.24%, while the percentage of students who did not complete reached 11.76%. Details of student learning completeness results are presented in Table 4.

Table 4. Completeness of Students' Fiqh Learning Outcomes

Category	Number of Students
Complete (≥ 75)	15
Incomplete (< 75)	2
Total	17
Classical Completeness	88,24%

The results in Table 4 show that most students have achieved the learning completeness criteria after participating in learning using FIQIHUB. The percentage of classical completeness of 88.24% indicates that 15 out of 17 students successfully met the set score criteria. If the research success indicator is set at least 85% of students achieve the KKM, the results have met the classical completeness criteria used in the research. However, this interpretation needs to be adjusted to the success indicators listed in the research method. Two students who have not reached the KKM show that there is still a need for further learning, either through re-explanation, individual mentoring, additional exercises, and reuse of learning materials and videos available on FIQIHUB.

The achievement of learning completeness can be reviewed in relation to the characteristics of FIQIHUB which integrates interactive presentations, quizzes, and learning videos in one medium. Interactive presentations allow fiqh materials to be presented in a structured manner, quizzes provide opportunities for students to test their understanding of the material, while learning videos provide visual



support to clarify concepts and procedures for worship practices. The combination of these components provides an alternative learning experience that can be used in synchronous and asynchronous learning. In synchronous learning, teachers can use media to explain the material and guide students directly. Meanwhile, in asynchronous learning, students can revisit materials and videos to strengthen their understanding based on their learning needs.

Judging from the characteristics of fiqh material which includes understanding the concepts and procedures for carrying out worship, the presentation of material through a combination of text, visuals, and interactive activities has the potential to help students understand information in a more structured way. Quizzes can also provide opportunities for students to find out the parts of the material that have been mastered and the parts that still need reinforcement. However, the completion percentage of 88.24% only describes the student's achievements after participating in learning using FIQIHUB. Without data on learning outcomes before the use of media or comparison groups, these results are not enough to prove that FIQIHUB causes an increase in learning outcomes or is superior to other learning methods.

Thus, the results of the study show that the completeness of fiqh learning results after the use of FIQIHUB reached 88.24%, with 15 students completing and two students not completing out of a total of 17 students. These findings provide an initial idea that most students have achieved the completeness criteria set in the context of media implementation. However, these results need to be interpreted proportionally by considering the number of research subjects, material characteristics, and learning implementation conditions. In addition, if the evaluation instrument only measures the cognitive domain, the conclusion of completeness should be limited to cognitive learning outcomes and not directly expanded to affective or psychomotor aspects without relevant measurement data.

DISCUSSION

The findings show that FIQIHUB achieved high feasibility ratings from both material and media experts, with scores of 90.00% and 88.00%, respectively. These results suggest that the developed product meets key criteria for content relevance, presentation, visual design, readability, and usability for fiqh learning at the Madrasah Ibtidaiyah level. This finding aligns with Ratnasari et al., (2024); Ginting et al., (2025) who examined integrating Android-based interactive multimedia into Islamic education at the elementary school level. Visual media in fiqh learning has also been linked to students' learning outcomes, highlighting the value of presenting religious concepts through appropriate visual representations (Lisnawati et al. 2023). Gustiansyah, (2024) examined the development of interactive learning media to support students' understanding of fiqh, reinforcing the importance of designing learning resources aligned with instructional

objectives. In this context, FIQIHUB contributes to the existing body of research by integrating interactive presentations, quizzes, and instructional videos within a single learning design rather than treating each digital component as an independent instructional resource. Nevertheless, expert validation primarily establishes the product's quality and suitability and should not be interpreted as direct evidence of improved learning achievement.

FIQIHUB's distinctive contribution lies in integrating synchronous and asynchronous learning opportunities. During synchronous instruction, teachers can use interactive presentations to explain fiqh concepts, quizzes to check understanding, and instructional videos to visually explain worship procedures. This design is relevant to developing video-based learning resources for congregational prayer (Yahya et al., 2024). Diana et al., (2026), also developed interactive mobile-based media to teach ablution, prayer, and post-prayer supplications, illustrating the value of digital media for presenting procedural religious content. Ani et al., (2025) further examined interactive media in fiqh learning, providing relevant research context for using digital resources in Islamic education. Compared with approaches that focus on a single medium or specific learning material, FIQIHUB emphasizes the pedagogical connection between classroom instruction, formative practice through quizzes, and opportunities to revisit instructional videos outside the classroom. This integration may support continuity between teacher-guided learning and independent review, but evidence from access records, student reports, or additional observations is needed to determine how much students actually used the asynchronous resources outside classroom hours.

The practicality findings further inform FIQIHUB's classroom implementation. The media received a practicality score of 85.71%, indicating positive assessment across seven observed indicators: ease of use, clarity of presentation, content suitability, integration of learning components, efficiency, video accessibility, and technical constraints. This finding aligns with Hasan, (2025) research on interactive learning media developed using Canva to support students' learning interest. Jannah, (2024) also explored interactive digital media alongside instructional models, investigating interactive Canva-based media in problem-based learning. Implementing interactive multimedia supports students' understanding, providing a relevant comparison for the instructional use of integrated digital resources (Wisnu, 2024). These studies provide a basis for discussing the pedagogical relevance of interactive media, while the present findings specifically describe the assessed practicality of FIQIHUB in the tested classroom.

Regarding learning outcomes, 15 of the 17 students achieved scores at or above the minimum mastery criterion of 75, resulting in classical learning mastery of 88.24%. This result indicates that most students reached the established



criterion after participating in fiqh learning using FIQIHUB, while two students still required additional learning support. Maulidiah et al. (2025) examined interactive fiqh learning media and offer a relevant comparison for developing digital resources to support students' understanding of fiqh concepts. Yahya et al., (2024) also examined the relationship between visual media and fiqh learning outcomes, supporting the relevance of investigating how visual representations are used in religious instruction. Interactive ICT-based learning media in fiqh education provide a related context for examining digital media in classroom learning (Nurbaiti 202; Jarir 2025). The present result aligns with the broader instructional rationale that structured presentations, interactive practice, and visual demonstrations offer multiple ways for students to engage with learning materials (Fahri 2026). However, because this study used a one-shot case study design without a control group or pretest–posttest measurement, the 88.24% mastery rate cannot establish that FIQIHUB improved learning outcomes or outperformed conventional instruction. The result should therefore be interpreted as a descriptive account of students' achievement after implementation in one class of 17 students. Further research with larger, more diverse samples; baseline measurements; comparison groups; and assessments of knowledge retention would be needed to determine the extent to which FIQIHUB contributes to learning gains over time.

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CONCLUSION AND SUGGESTION

The development of FIQIHUB as an integrated interactive fiqh learning medium for synchronous and asynchronous learning demonstrates promising feasibility and practicality for supporting fiqh instruction at the elementary madrasah level. The validation results indicated a feasibility score of 90% from the material expert and 88% from the media expert, while the practicality assessment reached 85.71%. Furthermore, 15 of the 17 students achieved the minimum mastery criterion (KKM) of 75, resulting in a classical mastery rate of 88.24%. These findings suggest that FIQIHUB has potential as an alternative learning medium that integrates interactive presentations, quizzes, and instructional videos; however, the results should be interpreted cautiously because the study involved a limited sample and did not employ a pretest–posttest design or a control group. Therefore, future research should use larger, more diverse samples; employ comparative or experimental designs to examine learning outcomes more rigorously; and investigate students' engagement, independent learning experiences, and sustained use of FIQIHUB in both synchronous and asynchronous settings.

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AUTHOR CONTRIBUTIONS

LAP contributed to the conceptualization, research design, development of FIQIHUB, data collection, data analysis, and manuscript preparation. AS contributed to validation, interpretation of the findings, and critical revision of the manuscript. All authors reviewed and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

DECLARATION OF AI

The authors used artificial intelligence (AI) tools, specifically ChatGPT by OpenAI, to assist with academic language editing, drafting, and refinement of selected manuscript sections, including the abstract, discussion, conclusion, and supplementary statements. The tool served as a writing aid, not a substitute for the authors' research, data collection, or analysis. The authors remain fully responsible for the accuracy, originality, interpretation, and final content of the manuscript and for verifying all references and research claims.

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