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RESEARCH ARTICLE

Enacting One Health in medical practice: A qualitative exploration of doctors' professional roles, identity, and cross-sector collaboration in Indonesia

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ABSTRACT

Background and Aim: The One Health approach promotes collaboration among human, animal, and environmental health sectors to address complex global health challenges. Despite increasing international and national commitment to One Health implementation, evidence describing how medical doctors enact this approach in routine professional practice remains limited. This study explored how One Health is enacted in the professional activities of medical doctors in Indonesia, with particular attention to professional roles, identity, and cross-sector collaboration.

Materials and Methods: This Exploratory-Descriptive Qualitative study employed semistructured online interviews with One Health practitioners from medical, veterinary, and public health backgrounds in Indonesia. Participants were purposively selected based on their involvement in cross-sector health activities related to zoonotic diseases, antimicrobial resistance, and emerging infectious diseases. Interviews were audio-recorded, transcribed verbatim, and analyzed thematically using an inductive approach. Concepts from Situated Learning Theory and boundary crossing were used as interpretive lenses during analysis.

Results: Thirteen participants were interviewed, comprising medical doctors, veterinarians, and public health professionals. Six interrelated themes were identified. One Health implementation was described as fragmented, reactive, and highly dependent on local commitment and informal networks. Doctors' readiness to enact One Health was constrained by limited exposure during medical education, insufficient training on interprofessional collaboration, and systemic workplace limitations such as weak reporting systems and inadequate laboratory capacity. Clinician identity functioned both as a facilitator and barrier to cross-sector engagement. While clinical responsibilities positioned doctors as important initiators of collaboration, the immediacy of patient care and strong orientation toward independent clinical decision-making often limited sustained interaction with other sectors. Doctors' roles extended beyond clinical care to include educator and collaborator functions, particularly in disease surveillance, advocacy, health promotion, and community engagement. Participants emphasized that apart from clinical competencies, effective One Health practice requires competencies in systems thinking, communication, collaboration, leadership, public health, and sociocultural understanding. Suggested educational strategies included systematic integration of One Health into existing curricula, interprofessional learning, and providing authentic collaborative learning experiences in diverse practice settings.

Conclusion: Medical doctors can enact One Health through clinical, educational, and collaborative roles. However, implementation remains limited and context-dependent due to systemic, educational, and professional identity-related constraints. Strengthening practice-oriented medical education and institutional support may facilitate more sustained and meaningful One Health engagement in professional practice.

Keywords: boundary crossing, cross-sector collaboration, Indonesia, medical education, medical doctors, One Health, professional identity, qualitative research.

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INTRODUCTION

Grounded in recognition of the interdependence of human, animal, and environmental health, the One Health approach emphasizes integrating expertise, resources, and efforts across sectors to achieve and sustain health for all [1]. The approach has been actively promoted by international organizations to strengthen global capacity to address complex health challenges, including epidemics and pandemics, as well as antimicrobial resistance (AMR) [2].

Despite widespread acceptance, reviews indicate that operationalizing and implementing One Health remain challenging, with gaps persisting at multiple levels [3–5]. At the macro-level, governance and leadership influence operationalization through political commitment, supportive policies, and legal frameworks. However, challenges in coordination mechanisms and difficulties in securing sustainable funding are frequently reported, particularly in developing countries [3, 4].

At the meso level, institutional structures that facilitate intersectoral collaboration are critical for implementing the One Health approach. Implementation can be constrained by siloed organizational cultures, competing sectoral priorities, and limited human resource capacities. In addition, operational protocols that guide cross-sector collaboration play an important role in enabling One Health activities [3–5]. At the local level, community awareness, trust, and participation further influence how the approach is implemented in practice [3–5].

Although One Health operationalization is challenging globally, the dynamics differ by region, and Southeast Asia has specific characteristics. The region is often described as a global hotspot for emerging infectious diseases [6]. It has experienced major outbreaks such as avian influenza, which shaped One Health adoption. The approach has been promoted in this region, including by the Association of Southeast Asian Nations. All Southeast Asian countries have a national mechanism for One Health coordination and have mainstreamed One Health in their strategies to address priority concerns, particularly infectious diseases and AMR [7]. Regional networks and collaborative platforms, including the Southeast Asia One Health University Network, further support knowledge sharing and capacity building. However, cross-country coordination in the region remains challenging. Limited data sharing infrastructure, insufficient capacity, lack of buy-in, and bureaucratic constraints are national-level barriers reported in the literature. In addition, One Health initiatives in Southeast Asia often depend on international donors and development programs, which can influence sustainability [7]. Despite these policy and institutional developments, questions remain regarding how One Health is implemented in practice across sectors.

A critical gap exists in the current literature on One Health. Most studies have focused on policy, governance, legislation, financing, and organizational capacity building [8]. In contrast, comparatively limited attention has been given to how One Health is enacted in the everyday professional activities of frontline health workers, particularly medical doctors. When medical doctors are discussed in the literature, their contributions are predominantly framed in clinical terms, focusing on the diagnosis and management of zoonotic diseases [9, 10]. Such framing risks narrowing One Health to a technical or disease-specific issue, rather than recognizing it as a collaborative practice embedded in broader professional work.

The literature has also suggested that medical doctors remain relatively under-engaged in One Health initiatives compared with animal health professionals [10–14]. Examining how medical doctors engage with other sectors in addressing health problems requires a perspective that considers how professional practices are learned, negotiated, and enacted in real-world settings. Medicine can be understood as a community of practice, in which competence and professional identity are developed through participation in everyday clinical work and interaction with other members of the professional community [15, 16]. Within this community, the primary domain of the medical profession is promoting health and preventing and treating diseases in humans [15]. Enacting the One Health approach may require doctors to communicate, coordinate, and collaborate with professionals from other sectors, activities that can be understood as forms of boundary crossing [17]. Situated Learning Theory [16] and the boundary crossing concept [17], therefore, provide a useful lens for examining how medical doctors enact One Health in their professional activities.

Many studies examining medical doctors' engagement with One Health primarily focus on perceptions, knowledge, or attitudes, typically using cross-sectional surveys. For example, surveys have examined general practitioners' knowledge in the Netherlands [14], compared doctors' and veterinarians' experiences and confidence in managing zoonoses in Australia [10], assessed knowledge and perceptions of One Health among professionals in Türkiye [13], and evaluated One Health knowledge, attitudes, and practices among multiple

professional groups in Bhutan [12]. While these studies provide useful insights into awareness and perceptions, qualitative evidence on how medical doctors enact One Health in their routine professional practice is scarce. This lack of practice-based understanding has been identified as a barrier to effective coordination and collaboration between medical doctors and other sectors, including veterinary and public health professionals [9].

In addition, a growing body of literature has examined the integration of One Health into health professional education, particularly through interprofessional education initiatives and curriculum development [18–21]. However, these studies primarily focus on student learning and training environments rather than the professional activities of practicing medical doctors. Empirical research examining how medical doctors enact One Health in their day-to-day professional activities, including how they negotiate collaboration with other sectors in routine practice, remains limited.

Understanding how the One Health approach is enacted in professional practice requires insight into the specific health systems context in which this practice unfolds. Indonesia, a middle-income country located in Southeast Asia, provides a particularly relevant context for examining the enactment of One Health in professional practice. The country faces a high burden of zoonotic threats [6] and has formally adopted a national One Health policy framework [22, 23]. This framework promotes cross-sector coordination through joint risk assessment, an integrated zoonotic surveillance system such as the zoonotic and emerging infectious diseases information system (SIZE), and formal coordination mechanisms at national and subnational levels. However, Indonesia's decentralized governance structure means that implementation of national policies often varies across subnational levels. The literature reported that decentralization has negatively impacted delivery of healthcare services, health workforce, and financing [24]. Furthermore, it can create challenges for coordination and response in collaboration across sectors [22]. These contextual variations may shape how cross-sector collaborations occur in practice.

Although previous studies have provided important evidence on One Health policies, governance mechanisms, educational integration, and professional awareness [8–14, 18–21], they do not sufficiently explain how One Health is enacted as part of routine professional medical practice. In particular, limited evidence is available on how doctors translate One Health concepts into everyday professional activities; how they negotiate boundaries with veterinary, public health, and other sectors; and how their professional identity influences engagement with cross-sector collaboration [9, 15–17]. This gap is important because implementation cannot be understood only through policy commitments or curriculum-level initiatives; it also depends on how frontline professionals interpret, learn, and enact collaborative roles in real-world settings [3–5, 8, 17].

This gap is especially relevant in Indonesia, where formal One Health policy structures and national coordination mechanisms exist [22, 23], but decentralized governance may produce variation in local implementation, resource availability, reporting systems, and intersectoral coordination [22, 24]. Therefore, examining doctors' professional practice in this context can provide empirical insight into the relationship between national One Health policy, health system structure, professional identity, and everyday practice. Such understanding is needed to inform practice-oriented medical education, strengthen doctors' readiness for interprofessional collaboration, and support more sustainable One Health implementation in decentralized middle-income settings [18–21, 24].

Understanding how medical doctors navigate these conditions may provide insights into the enactment of One Health in decentralized middle-income settings. Therefore, this study aims to explore how the One Health approach is enacted in the professional practice of medical doctors in Indonesia, thereby providing one of the first empirical accounts of enacted roles and activities in a decentralized, middle-income setting. Specifically, this study examines how doctors understand and perform their professional roles; how professional identity shapes boundary crossing with other sectors; and how educational and workplace systems influence their capacity to engage in One Health practice. The findings are expected to provide an empirical basis for developing practice-oriented strategies in medical education and professional practice to support more structured, sustained, and contextually responsive One Health enactment.

MATERIAL AND METHODS

Ethical approval

Ethical approval for this study was obtained from the Medical and Health Research Ethics Committee, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Indonesia, under Approval No. KE/FK/0381/EC/2025. The study was conducted in accordance with ethical principles for research involving human participants, including confidentiality, voluntary participation, and informed consent procedures. Before

participation, all participants received written information explaining the study objectives, interview procedures, confidentiality measures, potential risks and benefits, and their right to withdraw from the study at any stage without consequences. Participants were also provided opportunities to ask questions and clarify study-related information before signing the informed consent form.

Verbal informed consent, including permission for audio and video recording, was obtained and recorded before each interview session. Written informed consent forms were subsequently collected from all participants after the interviews. To maintain confidentiality and privacy, all identifying information was removed during transcription, and participants were assigned unique codes. Interview recordings, transcripts, and analytic documents were stored in password-protected computers and encrypted cloud storage accessible only to the research team.

Study period and location

This study was conducted in Indonesia from May 2025 to February 2026 during the post-coronavirus disease 2019 period. Indonesia was selected as the study setting because the country faces a high burden of zoonotic and emerging infectious disease threats and has formally adopted a national One Health policy framework [22, 23]. To address health threats across the human-animal-environment interface, the Indonesian government has demonstrated a high-level commitment to cross-sectoral collaboration. The Coordinating Minister for Human Development and Cultural Affairs plays a central role in establishing and implementing multisectoral coordination mechanisms.

The Coordinating Minister for Human Development and Cultural Affairs Regulation No. 7 of 2022, concerning Guidelines for the Prevention and Control of Zoonoses and Emerging Infectious Diseases, serves as the legal foundation for formal coordination mechanisms among the public health, animal health, and environmental sectors at national and subnational levels [23]. In relation to AMR, Indonesia has also established its National Action Plan for Antimicrobial Resistance 2020–2024 based on the One Health approach, which is overseen by the multisectoral steering committee chaired by the Coordinating Minister for Human Development and Cultural Affairs. Despite the presence of these formal structures, operationalization gaps, particularly at subnational levels, remain a challenge [22].

Study design

The reporting of this study follows the Consolidated Criteria for Reporting Qualitative Research checklist for qualitative research [25]. This study is situated within an Exploratory-Descriptive Qualitative design, as described by Hunter *et al.* [26]. Exploratory-Descriptive Qualitative is suitable for investigating under-researched phenomena, such as the enactment of the One Health approach in medical doctors' professional activities. This design enables the generation of rich descriptions while allowing the identification of emerging patterns and the drawing of tentative conclusions. The design integrates Sandelowski's qualitative descriptive tradition, which prioritizes staying close to participants' accounts, and Stebbins' exploratory research principles, which emphasize flexibility and openness to discovery [26]. Consistent with Exploratory-Descriptive Qualitative, semistructured interviews were used to capture detailed accounts of professional experiences while allowing unanticipated practices to surface. Thematic analysis was employed to inductively identify patterns across accounts, supporting the exploratory aim of this study. Stebbins' principle of flexibility and open-minded data sourcing is reflected in the recruitment of participants from varied professional contexts to ensure diverse perspectives. In addition, Sandelowski's emphasis on allowing phenomena to appear as naturally as possible [27] aligns with the development of the interview guide and the analytic approach, which stayed close to participants' descriptions.

This study was underpinned by a pragmatist paradigm, which emphasizes the practical consequences of knowledge and inquiry directed toward real-world problems [28, 29]. Pragmatism was selected because the study sought to understand how the One Health approach is enacted in everyday medical practice, rather than to generate abstract theory or to test predefined hypotheses about professional practice. A pragmatic stance, therefore, supported focusing on what doctors actually do in practice, and how One Health activities operate within their working environments. This paradigm informed methodological decisions, including selecting participants with direct experience in One Health activities, using semistructured interviews to elicit experience-based accounts, and employing inductive thematic analysis to generate findings that can inform education and professional development.

Population and sampling

The study population consisted of One Health practitioners in Indonesia. For this study, One Health

practitioners were defined as individuals whose educational background, professional expertise, interests, and experiences involve multiprofessional or multisectoral collaboration to address health problems at the intersection of human, animal, and environmental health. Participants were selected using purposive criterion sampling to capture maximum variation in professional background, roles, and experiences in One Health collaboration across sectors.

Eligible individuals were those who: (1) had an educational background in human health (medicine or public health), animal health, or environmental sciences or (2) held positions with responsibilities related to preventing, managing, or controlling zoonotic diseases or AMR; and (3) had been involved in One Health cross-sector collaborations in academic settings, clinical or public health practice, or policymaking. Sampling aimed to include participants from diverse disciplinary perspectives, professional roles, and geographical distributions.

Potential participants were identified through the Indonesia One Health University Network database, which also provided access to their contact information. In addition, a snowball approach was used to identify practitioners outside the academic sector to further enhance variation in professional background and working contexts. Individuals recommended through this process were screened against the predefined inclusion criteria before recruitment. Potential participants were approached individually through WhatsApp text messages. Upon first contact, they received written information about the study and an informed consent form.

During recruitment, participants' characteristics were monitored to ensure representation of diverse professional backgrounds (e.g., medical, public health, and animal health), roles (e.g., practitioners, academics, and policy actors), and geographic locations where possible. A total of 18 individuals were contacted; 15 responded, and 13 agreed to participate. Two individuals declined participation because of time constraints. A summary of participant recruitment is presented in Table 1.

Table 1: Summary of participant recruitment.

Recruitment stage	Number
Individual approached	18
Responded to invitation	15
Participated in interviews	13
Declined participation because of time constraints	2

Data collection

Data were collected through online semistructured interviews using Zoom (Zoom Video Communications, Inc., San Jose, CA, USA). All interviews were recorded in audio and video formats. Only the interviewer and participant were present during interviews. An interview guide was developed and refined through two pilot interviews conducted by the first author. Insights obtained were discussed within the research team and were used to improve clarity.

The guide consisted of open-ended questions about participants' experiences, roles, and professional activities of medical doctors in managing health problems using a One Health approach. Examples included: (1) "Can you describe your experiences in managing health problems that involved a One Health approach?"; (2) "Based on your experiences, what were the roles of the medical profession in the One Health context?"; and (3) "Within these roles, what specific activities does a doctor do?" Probing prompts were used to elicit detailed and context-rich descriptions. The interview guide is provided as Supplementary File 1.

The main interview questions remained consistent throughout the study. However, as is common in semistructured qualitative interviewing, additional probing questions were introduced iteratively during and in subsequent interviews to explore issues raised by participants and to better understand emerging perspectives [30]. For example, when early participants raised concerns about limited recognition of veterinarians' roles in addressing zoonotic diseases, subsequent interviews with medical doctors included probes exploring whether and how they considered consulting veterinarians in such cases.

All interviews were conducted in Bahasa Indonesia by the first author at times and places convenient to the participants. Before each interview, participants were re-briefed on the study through a short video and invited to ask questions. Participants were also informed about the handling and storage of recordings and transcripts. Verbal informed consent, including consent for audio and video recording, was obtained and recorded before the interview. Participants subsequently returned written consent forms after the interview. During interviews, the interviewer took field notes to capture key points and emerging ideas that could be explored further with subsequent participants.

Each participant took part in one primary interview conducted between May and October 2025. To enhance credibility, member-checking was conducted separately in January and February 2026 through follow-up online interviews conducted using Zoom.

A total of 13 interviews were conducted. Interviews lasted from 30 to 88 min, with an average duration of 56 min. Video and audio recordings were stored in password-protected personal computers and encrypted cloud storage accessible only to the research team. All recordings were transcribed verbatim by a trained research assistant. To maintain confidentiality, identifying information was removed during transcription, and participants were assigned unique codes. Version control was maintained by saving date-stamped copies of each transcript and coding file, allowing the researchers to track changes and ensure data integrity throughout the analysis process. Transcripts were not returned to participants.

Qualitative data analysis

Interview transcripts were imported into ATLAS.ti software (version 25.0.2.33323; ATLAS.ti Scientific Software Development GmbH, Berlin, Germany) and analyzed thematically. Thematic analysis is a method of examining qualitative data by searching across datasets to identify, analyze, and report recurring patterns. It involves researchers describing and interpreting data through coding, comparing, combining, and mapping codes. The resulting themes represent recurring patterns of meaning in the data that address the research questions [31, 32].

Initial coding was conducted inductively, with themes generated directly from participants' accounts without applying predefined theoretical categories [31, 32]. As analysis progressed, the sensitizing concept [33] from Situated Learning Theory [16], the concept of boundary crossing [17], and the One Health core competency literature [34, 35] were introduced during iterative team discussions to critically examine, reorganize, and refine emerging themes. These theoretical perspectives were not used as deductive coding frameworks but as interpretive lenses to deepen understanding and situate findings within relevant conceptual discussions. This iterative engagement between data and theory is consistent with the pragmatic paradigm and supports the development of themes that were both empirically grounded and practically meaningful in relation to the study's exploratory aims.

The first and second authors independently analyzed two transcripts and compared their initial codes. Differences in coding were discussed within the research team until consensus was reached, and an initial coding framework was agreed upon. The first author applied and refined this framework while continuing to analyze the remaining transcripts. Participants' professional backgrounds were known during analysis, as this contextual information was relevant for interpreting perspectives across professional roles. Divergent perspectives that did not align with emerging interpretations were actively examined during coding and team discussions. Where relevant, these contrasting perspectives were incorporated into the interpretation to avoid an overly uniform representation of findings.

Codes were then grouped into categories, and the research team discussed and reviewed initial candidate themes during team meetings. These initial themes were refined by identifying the essence of each, its underlying assumptions, the conditions that shape it, and how each addressed the research question. Through this iterative process, both descriptive and interpretive themes were developed. The researchers then defined the scope and content of the final themes. Data analysis was conducted simultaneously with data collection.

Data saturation

Data saturation was monitored throughout data collection and preliminary analysis. Interviews were conducted until no new conceptual categories emerged regarding medical doctors' professional activities in the context of One Health. Saturation was reached after 11 interviews, and two additional interviews were conducted for confirmation.

Positionality

All authors are medical doctors working in academia. The first author, a female Doctor of Philosophy student in medical education, conducted all interviews, whereas the second and third authors hold a Doctor of Philosophy degree in the same field. The interviewer had prior involvement in workshops and events organized by the Indonesia One Health University Network, and several participants had previously interacted with her in these professional settings. In terms of professional hierarchy, the interviewer was generally junior or at a similar professional level to most participants.

Trustworthiness

The trustworthiness of this study was ensured through strategies addressing credibility, transferability, dependability, and confirmability [36]. In addition, reflexive practices were employed to monitor and critically reflect on the potential influence of researchers' positionality on study conduct and data analysis.

Credibility

Credibility was strengthened through prolonged engagement, participant and investigator triangulation, peer debriefing, and member-checking. The first author's engagement with Indonesia's One Health community enabled understanding and appreciation of the context and facilitated trust with study participants. The inclusion of participants from diverse professional backgrounds allowed the analysis to incorporate multiple perspectives on One Health practice.

Furthermore, researcher triangulation during the early stages of coding supported credibility. Involvement of the entire research team in analytic discussions, including a team member not directly involved in the coding process, through peer debriefing enabled critical examination of emerging interpretations. Member-checking was conducted by sharing synthesized themes and illustrative quotations with all participants and inviting them to provide feedback on their accuracy and completeness. Seven participants provided feedback and generally affirmed that the findings resonated with their experiences. Participants also provided clarifications, particularly regarding identity-related ambivalence, additional information on implementation contexts, and suggestions regarding required competencies. These feedbacks contributed to refinement and deeper contextualization of interpretations.

Transferability

Transferability was facilitated through thick descriptions of the study context and participants. The setting descriptions included key characteristics of Indonesia that may shape the enactment of One Health practices. These characteristics comprised decentralization of health governance, multisectoral zoonotic disease coordination mechanisms, and uneven implementation across regions. By providing these contextual details, readers can assess the applicability of findings to their own settings.

Dependability

Dependability was supported by maintaining a transparent and systematic audit trail. Raw audio and video recordings, verbatim transcripts, and analytic documents were securely stored. Coding processes, including code development and refinement, were documented. Analytic memos were used to record the shift from descriptive to more interpretive themes. These records provide a traceable account of how interpretation evolved over time.

Confirmability

Confirmability was addressed by grounding interpretations in participants' accounts and by providing illustrative quotations to demonstrate the link between data and analytic claims. In addition, the study's philosophical stance, research design, and analytic procedures were explicitly justified to ensure coherence between paradigm, methodology, and interpretation.

Reflexivity

Given the first author's insider position within the Indonesia One Health community, reflexivity was intentionally integrated into both data collection and analysis. To mitigate the risk of insider and social desirability bias during data collection, participants were informed that participation was voluntary, that there were no right or wrong answers, and that responses would remain confidential and would not affect professional relationships. The interviewer adopted a conversational approach to minimize hierarchical dynamics.

Furthermore, interviews employed clarifying probes to avoid assumptions of shared understanding and to encourage diverse perspectives. Reflexive notes were maintained to document assumptions and evolving interpretations. These reflections informed ongoing critical examination of how prior relationships might shape questioning, interpretation, and theme development. Team discussions during analysis also served as a mechanism for challenging assumptions and reducing the influence of individual bias.

RESULTS

Participant characteristics

Thirteen One Health practitioners were interviewed. Participants represented diverse backgrounds in terms of gender, professional training, and occupation. Seven participants were female. Their professional training included medicine (7/13), veterinary medicine (4/13), and public health (2/13). In terms of occupational roles,

participants worked as academics, medical practitioners, public health practitioners, and policy actors. Participants ranged in age from 30–39 years to over 70 years, with the largest age group being 40–49 years. The majority of participants (10/13) reported more than 10 years of experience in One Health collaboration. Over half held a Doctor of Philosophy degree (7/13), and most were academics (8/13). Most participants (9/13) resided on the island of Java. Participants had been involved in One Health collaborations addressing issues such as zoonotic disease prevention and control, AMR, and emerging infectious diseases, including the coronavirus disease 2019 pandemic, across national, subnational, organizational, and community levels. These collaborations occurred in various contexts, including healthcare services, interinstitutional coordination, research, teaching, and policymaking. Further details of participants' characteristics are provided in Table 2.

Table 2: Participant characteristics.

Characteristics	N = 13	%
Age (years)		
30–39	1	7.7
40–49	6	46.2
50–59	3	23.1
60–69	2	15.4
≥70	1	7.7
Sex		
Male	6	46.2
Female	7	53.8
Professional background		
Medical doctor	7	53.8
Veterinarian	4	30.8
Public health	2	15.4
Current occupation		
Academic in veterinary/public health	3	23.1
Academic in medicine and medical practitioner	5	38.5
Medical practitioner	2	15.4
Public health practitioner	1	7.7
Policy actors	2	15.4
Highest level of education		
Doctor of Philosophy	7	53.8
Master's degree	4	30.8
Medical degree with specialist training	1	7.7
Medical degree	1	7.7
One Health-related experiences		
5–9 years	3	23.1
≥10 years	10	76.9
Geographic location		
Java	9	69.2
Outer islands	4	30.8

Overview of themes and conceptual framework

Six themes were identified from this study: (1) Fragmented One Health implementation context shaped how medical doctors enact One Health, (2) Medical doctors' professional capacity to engage in One Health as shaped and constrained by educational and workplace systems, (3) Clinician identity as both a driver and a constraint on boundary crossing in One Health, (4) Medical doctors' roles in One Health, (5) Profiles and competency domains supporting doctors' One Health practice, and (6) Strategies to develop One Health competencies through medical education. Categories and codes for each theme are provided in Table 3.

To synthesize how different levels of influence shape medical doctors' enactment of One Health in practice, Figure 1 illustrates the interrelated contextual conditions identified in the data. Fragmented implementation at national and subnational levels (macro), structural limitations within educational and healthcare systems (meso), and tensions within clinicians' professional identity at the individual level (micro), as depicted by opposing arrows, collectively influence how One Health activities are understood and enacted. Rather than operating independently, these factors interact dynamically to shape both opportunities for and hesitation toward sustained enactment of One Health in practice.

Figure 1 illustrates interrelated contextual factors influencing the enactment of One Health in medical doctors' professional practice. The outer circle (macro-level) represents fragmented implementation of One

Health policies at the national and subnational levels. The middle circle (meso level) reflects structural conditions within educational and healthcare systems that shape doctors' readiness and capacity to enact One Health. The inner circle with opposing arrows (micro level) depicts tensions within clinicians' professional identity when engaging in cross-sector collaboration. The dynamic interactions among these levels collectively shape both opportunities for and hesitation toward sustained enactment of One Health in practice.

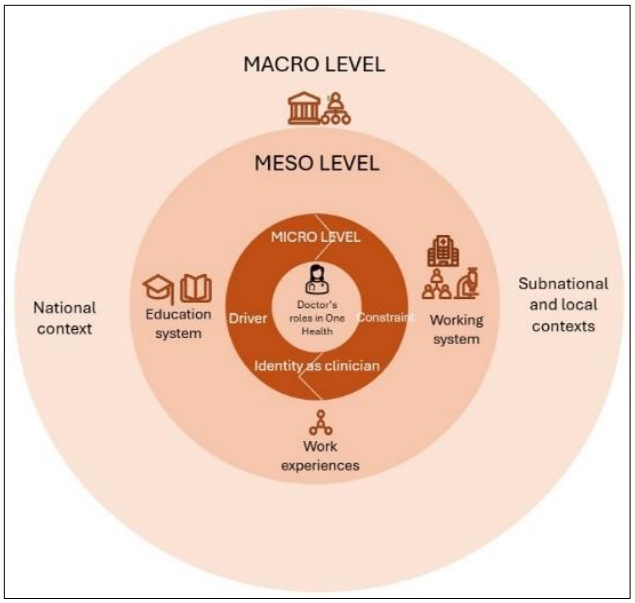

Figure 1: Factors shaping enactment of One Health in medical doctors' professional practice.

While Figure 1 summarizes the contextual conditions shaping enactment, the findings also reveal how One Health practice is enacted through interrelated layers of professional competence. To further synthesize Themes 4–6, the identified forms of professional enactment were integrated with Harden's Three-Circle Model [37]. Figure 2 presents an empirically grounded adaptation of this model to illustrate how One Health enactment extends beyond discrete professional tasks and roles to encompass practice approaches and professional dispositions. In this framework, the inner circle represents professional tasks and roles, whereas the middle and outer circles capture broader approaches to practice and professional dispositions that shape how these tasks are enacted. Competency domains identified in the data are positioned alongside and linked to the respective circles, demonstrating how these competencies support enactment across the three competence levels. An arrow connecting the competency domains to the three circles highlights the strategies participants suggested for developing these competencies. This integrated framework links competencies, educational strategies, and professional enactment, offering a practice-oriented perspective for understanding how One Health is enacted in professional practice.

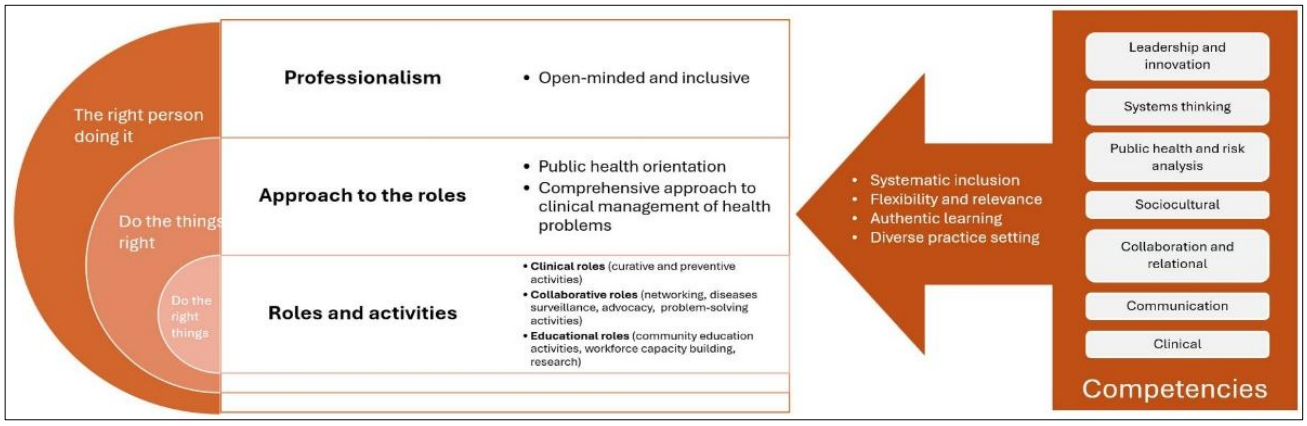

Figure 2: An integrated framework for the professional enactment of One Health in medical practice, adapted from Harden's Three-Circle Model. The framework illustrates how One Health enactment in medical practice extends beyond discrete professional tasks and roles (inner circle) to include broader approaches to practice (middle circle) and professional dispositions (outer circle). Competency domains identified from the data aligned with these levels, while the connecting arrow indicates strategies suggested by participants for developing these competencies.

Table 3: Themes, categories, and codes.

Theme	Category	Codes
Theme 1. Fragmented One Health implementation context shaped medical doctors' engagement in One Health	Scope and arena of One Health implementation	1. Implementation levels 2. Implementation contexts 3. Collaboration partners 4. Objective of collaboration
	Implementation fell short of expectations	1. No tangible actions with real impact 2. One Health remains at the level of discourse and discussion
	Dependence on informal cross-sector networks	1. Reliance on personal communication channel 2. Keeping contact numbers saved on personal phones
	One Health collaboration is not yet systematic	1. Reactive collaboration triggered by crises 2. Collaboration needs to be action-focused 3. Collaboration framed as part of university Tri Dharma duties 4. Collaboration driven by personal initiative 5. Engagement is influenced by economic interest 6. Invitations to collaborate are not always met with enthusiasm
	Enablers of implementation	1. Allocation of resources 2. Support from the central government strengthens cross-sector collaboration at the local level 3. Institutionalization of One Health-aware communities 4. National policies and regulations on zoonotic control 5. Local government commitment through formal legitimacy 6. Mapping of One Health resources 7. SIZE as integration platform
	Structural and governance challenges	1. Limited access to cross-sector communication linkages in the field 2. Low government capacity for rapid response 3. Funding constraints 4. Ambiguity regarding the authority responsible for the environment sector 5. Weak interagency coordination in Indonesia
Theme 2. Medical doctors' professional capacity to engage in One Health as shaped and constrained by educational and workplace systems	Weaknesses in the education system	1. One Health competencies are not taught in medical schools 2. Narrow focus of the higher education system 3. Narrow focus of the medical education system 4. Zoonoses receive limited attention in medical schools
	Limited capacity and readiness of doctors	1. Limited capability to diagnose zoonotic diseases 2. Doctors have limited advocacy skills 3. Doctors are unaware of mandatory reporting requirements 4. Limited One Health knowledge and skills
	Collaboration skills are acquired informally through practice	1. Collaboration is learned on the job 2. Collaboration helps to mobilize communities 3. Collaboration helps to solve problems
	System-level unpreparedness to support doctors' One Health roles	1. Doctors performing their roles while being underequipped 2. Absence of an integrated information system 3. Turnover of One Health personnel 4. Reporting systems are not yet functioning 5. Limited laboratory diagnostic capacity 6. The integrated information system is not yet operational
	Cross-professional cultural and relational challenges	1. Critiques about doctors' professional ego 2. Silo culture 3. Differing perceptions between physicians and veterinarians regarding the integration of human and animal laboratories
Theme 3. Clinician identity as both a driver and a constraint on boundary crossing in One Health	Clinician identity as a driver	1. Clinical activities as an entry point for collaboration 2. The knowledge possessed by doctors exerts an influence 3. Motivation: Public health problems cannot be solved alone 4. Motivation: The community lacks awareness about zoonoses 5. Motivation: Community well-being 6. Motivation: There is a practical need

Theme	Category	Codes
	Clinician identity as a barrier	1. Perceptions about role of clinicians 2. Clinical decision-making as an independent area of clinical practice 3. Evaluating the value of information from other sectors 4. The immediacy of clinical decision-making 5. Narrow clinical orientation
Theme 4. Medical doctors' roles in One Health	Clinical role	1. Curative activity: Rational use of antimicrobials 2. Curative activity: Detecting AMR in humans 3. Curative activity: Eliciting zoonotic risk factors during history taking 4. Curative activity: Diagnosing and managing zoonotic diseases 5. Curative activity: Referring zoonotic cases 6. Curative activity: Wound management for potential rabies exposure 7. Preventive activity: Provision of patient health education 8. Preventive activity: Early disease detection 9. Preventive activity: Administering rabies vaccine as post-exposure prophylaxis in humans 10. Preventive activity: Development of infection prevention and control protocol 11. Preventive activity: Implementation of infection prevention and control measures during medical procedures
	Educational role	1. General community education activities 2. Educating the communities: Education on infectious diseases and zoonosis 3. Educating the communities: Education on infection prevention and control practices 4. Educational activities 5. Research and publication activities 6. Health workforce capacity building
	Collaborative role	1. Networking/collaboration activity: Initiating cross-sectoral collaboration 2. Networking/collaboration activity: Cross-sectoral coordination 3. Networking/collaboration activity: Networking 4. Advocacy activity: Advocating for health issues to receive adequate attention 5. Advocacy activity: Advocating for other sectors to be involved in addressing the issue 6. Advocacy activity: Conducting advocacy 7. Advocacy activity: Providing input to the government on addressing health problems 8. Problem-solving activity: Intersectoral discussions 9. Problem-solving activity: Conducting negotiation 10. Problem-solving activity: Involving local authorities and community members in solving health problems 11. Problem-solving activity: Seeking solutions to problems 12. Problem-solving activity: Developing innovations 13. Disease surveillance activities: Conducting epidemiological investigations 14. Disease surveillance activities: Reporting cases of potentially outbreak-prone diseases 15. Disease surveillance activities: Reporting AMR cases
Theme 5. Profiles and competency domains supporting doctors' One Health practice	Profile of One Health medical doctors	1. Public health oriented 2. Comprehensive clinician 3. Open-minded and inclusive
	Clinical competencies	1. Competencies in diagnosing and managing zoonotic diseases 2. Understanding of mechanisms of AMR dissemination 3. Competencies in wound management for potential rabies exposure 4. Competencies in infectious diseases
	Competencies in public health and risk analysis	1. Health risk and priority assessment 2. Epidemiological understanding 3. Health data analysis and interpretation 4. Recognizing notifiable disease

Theme	Category	Codes
	Competencies in systems thinking	1. Awareness of interrelated determinants of health 2. System mapping and analysis 3. Ability to identify cross-sector solutions
	Competencies in leadership and innovation	1. Leadership competencies 2. Competencies in problem-solving and innovation
	Collaborative and relational competencies	1. Networking competencies 2. Collaboration competencies 3. Values and ethics in collaboration
	Sociocultural competencies	1. Considering cultural aspects in problem-solving 2. Understanding cultural influences on health 3. Understanding risky behavior for zoonotic transmission
	Communication competencies	1. Disease reporting 2. Communicating health issues across sectors 3. Providing health education
Theme 6. Strategies to develop One Health competencies through medical education	Convincing stakeholders in medical education institutions	1. One Health is globally recognized 2. Improving stakeholders' understanding 3. Demonstrating the magnitude of the problems requiring cross-sector collaboration 4. Demonstrating benefits of One Health competencies to meet future demands
	Forms of One Health integration in the curriculum	1. Integration of clinical competencies 2. A course for nearly graduating doctors 3. A course on emerging or re-emerging infectious diseases 4. A specific course on the One Health concept 5. Inserting One Health in other courses 6. Elective or local content course
	Authentic learning environments for One Health	1. Port health office 2. District/provincial health office 3. Animal health facilities 4. Livestock farming community 5. Policymakers 6. Primary health centers 7. Abattoir
	Learning methods	1. Case simulation 2. Case study 3. Field visit 4. Interdisciplinary guest lectures 5. Engagement in real-world collaborative practices 6. Interprofessional learning 7. Learning through research activities

Fragmented One Health implementation context shaped medical doctors' enactment of One Health

This theme highlights fragmentation in the implementation context, leading to doctors' reactive and limited enactment of One Health. According to participants, One Health was observed at multiple levels in Indonesia, including national, subnational, organizational, and community settings.

Scope and implementation context of One Health: Across all levels, the most commonly identified implementation contexts related to zoonotic diseases and the coronavirus disease 2019 pandemic. At the national-level, Indonesia has established policies and regulations that provide a framework for One Health implementation in the management of zoonotic diseases, as well as a national action plan on AMR. However, participants noted that One Health implementation in practice has yet to be fully translated into effective action.

Some participants described that One Health engagement was often confined to discussion-oriented forums rather than being translated into concrete and impactful action. As one participant noted, "One Health seemed to exist only as discussion when we met" (P1, academic and medical practitioner). Another highlighted that "in planning, it is indeed framed as One Health, but during implementation there is no connection and no interaction" (P5, academic and medical practitioner).

Challenges in coordination and implementation: Despite the presence of coordination mechanisms intended to support One Health implementation, some participants perceived an absence of a clear coordinating structure at the subnational level, as illustrated by one participant who noted, "At the central level there is a coordinating ministry, but at the local level there is no equivalent structure" (P7, public health practitioner). Other participants pointed to the establishment of the Coordination Team at national and subnational levels to prevent and control zoonotic and emerging infectious diseases, which are formalized through decrees issued by local government leaders. However, some participants described that even when such structures exist, their implementation is

often uneven, with limited monitoring and difficulties sustaining routine cross-sector collaboration beyond specific events such as zoonotic outbreaks.

As a result, implementation at the local level is highly dependent on local governments' commitment and formal legitimacy. Participants described that in practice, cross-sector engagement was more likely when collaboration was supported by a formal mandate from local leaders. In the absence of such mandates, invitations for cross-sector collaboration do not always result in substantive engagement, as illustrated by the following account:

"When the invitation came from the Health Office, those who attended were not decision-makers. However, when the invitation came from the district head and was supported by a formal decree, the senior leaders attended." (P6, medical practitioner)

Reliance on informal collaboration networks: Findings in this theme indicate that One Health collaboration has not yet been implemented systematically. The collaborative experiences described by participants were generally reactive and triggered by crises.

Limitations in structural support, such as communication linkages between sectors at the field level and weak interagency coordination in Indonesia, complicate collaborative efforts. When interaction with other sectors is required, frontline practitioners often rely on informal networks. This implementation context suggests that, despite the presence of national-level policies and regulatory frameworks, cross-sectoral collaboration has not yet become routine at the field level.

Medical doctors' professional capacity to engage in One Health as shaped and constrained by educational and workplace systems

In contrast to the previous theme, which depicts the macro-level context of One Health implementation, this theme focuses on doctors' professional capacity and how this capacity is shaped and constrained by educational and workplace systems.

Educational limitations and preparedness gaps: Higher education in Indonesia in general, and medical education in particular, was described by participants as having a narrow focus on core disciplinary fields, with limited exposure of students to cross-disciplinary interaction. As a result, medical graduates are insufficiently prepared for collaborative practice.

"Because of the way education is structured, collaboration at the community level is shaped by individual perspectives. (…) From the very beginning, they are trained in a highly specialized way." (P3, academic, veterinary, and public health background)

In addition, the absence of explicit One Health competencies and the limited attention to zoonotic diseases in the curriculum further constrained doctors' capacity and readiness to engage in One Health collaboration. Participants reported gaps in doctors' ability to diagnose priority zoonotic diseases, limited awareness of mandatory reporting requirements, and limited advocacy capacity. As one participant noted, "Doctors in health facilities often do not recognize the signs and symptoms of anthrax, resulting in delayed case detection" (P7, public health practitioner).

Informal acquisition of collaborative competencies: Participants reported that learning about the value and importance of collaboration occurred primarily through doctors' experiences after entering practice rather than during formal medical education. As one participant explained:

"I used to think that as doctors we were expected to be 'five-star doctors' and capable of doing everything. However, once we started working in the community, we realized that we needed support from other professions and sectors." (P13, medical practitioner)

Another participant described how collaboration with people beyond the health sector broadened perspectives, shifting from a focus "only on patients and health" to considering "other dimensions" (P11, academic and medical practitioner). These experiences contributed to greater appreciation of preventive approaches compared with earlier practice.

Workplace and interprofessional challenges: Limitations within the education system also contribute to the persistence of siloed professional cultures and readiness for interprofessional interaction. Each discipline, including medicine, is accustomed to working independently, which may limit understanding and appreciation of other professions' roles in addressing health problems. Poorly communicated perspective differences may give rise to conflict and lead to criticism of the medical profession, which was perceived as egocentric. As one participant stated, "because the doctors tend to be very individualistic and feel that the knowledge belongs to them" (P4, academic with veterinary background).

In addition to doctors' individual readiness, findings also indicate that unpreparedness within workplace systems further constrains doctors' roles in One Health. Several barriers were identified, including limited laboratory capacity for diagnostic confirmation, SIZE that has not yet been fully operational, frequent reassignment of One Health-related human resources, and disease reporting pathways that, according to some participants, do not function optimally in some districts.

Overall, this theme highlights that neither the medical education system nor the health sector workplace system has yet adequately supported doctors' enactment of One Health.

Clinician identity as both a driver and a constraint on boundary crossing in One Health

This theme illustrates how clinicians' professional identity both enables and constrains boundary crossing in One Health.

Clinician identity as a facilitator of collaboration: Participants agreed that doctors' clinical role in diagnosing and managing human diseases may position them as key actors in recognizing zoonotic threats and initiating cross-sector responses. The clinical role can serve as an entry point for engaging with other sectors when doctors encounter health problems extending beyond the human health domain, as illustrated below:

"We traced the patient's history to identify any related event... and it was found that they had slaughtered an animal. Following this, we contacted the Health Office, the Agriculture Office, and the Animal Health Office. In this way, the collaboration actually began." (P10, academic and medical practitioner)

Clinicians' responsibilities for protecting human health at both individual and community levels were reported to motivate participants' engagement with other sectors when addressing health problems involving animals and environmental dimensions. Practical considerations, such as access to laboratory testing, awareness of community knowledge gaps about disease and prevention, and recognition that effective control often requires contributions from multiple actors, further reinforced this motivation. As another participant explained when describing her decision to inform the animal health sector when encountering dog bite cases:

"These alone [wound management and post-exposure prophylaxis] would not address the problem, because further issues could arise if the animals themselves were not managed." (P13, medical practitioner)

Apart from doctors' perception of their roles and responsibilities as clinicians, doctors' clinical knowledge and involvement in community settings were suggested to provide credibility and professional authority with local actors, which could facilitate collaboration with other sectors:

"Usually, when a doctor explains something based on their professional knowledge, it makes more sense and is generally listened to by the village authorities. This is because the doctor is directly involved with the community." (P13, medical practitioner)

Clinician identity as a barrier to collaboration: However, participants also noted that their role in diagnosis and management of patients often demands timely decision-making. When information from other sectors is not perceived as directly relevant or not readily available, doctors reported proceeding independently with patient management based on information available at the time. One participant noted that clinical training emphasizes the need to make timely diagnostic and treatment decisions, reinforcing a sense of independent clinical decision-making. As a result, participants described evaluating cross-sector interaction largely in terms of whether information from other sectors could inform clinical decision-making:

"They had [academics from veterinary medicine] mappings of animals that might—well, not exactly vectors, but animals that could potentially be associated with the coronavirus disease 2019 virus. That was roughly the kind of information we received at the time. But in terms of practical use for us, there was nothing yet." (P1, academic and medical practitioner)

During member-checking interviews, participants from medical backgrounds emphasized that this constraint did not reflect professional superiority or dismissal of other expertise but rather the immediacy of clinical decision-making and limited access to cross-sector information.

Participants also described situations in which the same professional identity constrained collaboration. When immediate patient care takes priority, clinicians reported directing their attention primarily toward clinical responsibilities, leaving limited opportunities to engage with other sectors. As one participant noted during a member-checking interview:

"However, in reality we may miss opportunities to trace things back, especially when the patient arrives in a critical condition. In such situations, the doctor's focus shifts to the individual patient rather than to the community." (P12, academic and medical practitioner – member-checking interview)

Together, these accounts illustrate how clinicians' professional identity simultaneously enables and

constrains boundary crossing in One Health. Its influence depends on how clinical roles and responsibilities intersect with time pressures, patient care priorities, access to cross-sector information, and perceived usefulness of that information for clinical decision-making.

Medical doctors' roles in One Health

This theme highlights that, in the context of One Health, doctors perform both clinical and strategic roles in supporting public health, particularly in disease prevention. Three primary roles were identified: clinician, educator, and collaborator.

Clinical roles: As clinicians, doctors are responsible for diagnosing and managing patients, especially in cases of zoonotic infections. Other focuses of doctors' clinical activities in One Health are AMR stewardship and infection prevention and control within clinical settings.

Educational roles: Recognizing that community health issues cannot be addressed solely through individual patient care, doctors also act as educators. In this role, they contribute to disease prevention and health promotion by providing education to communities, other health professionals, and students through teaching and research activities, as illustrated below:

"After completing patient diagnoses, my task at the end of the day is to provide outreach and information to the community and to health workers in the endemic areas." (P10, academic and medical practitioner)

Collaborative and surveillance roles: As collaborators, doctors provided input and advocated to policymakers and relevant sectors to collectively address health problems. This requires actively building collaborative networks. One participant described experiences advocating and collaborating with law enforcement institutions, which contributed to development of an innovative program during the coronavirus disease 2019 pandemic:

"A colleague from the Faculty of Law, who had connections with the police, helped advocate to the regional police chief, who then invited us to discuss how the police could support community health initiatives." (P1, academic and medical practitioner)

In addition, as collaborators, doctors contributed to disease surveillance through case reporting. Reporting cases, particularly infectious diseases with outbreak potential, can prompt coordination among relevant authorities for follow-up actions.

Profiles and competency domains supporting doctors' One Health practice

This theme describes the profile of doctors as One Health practitioners and the competencies that support their practice.

Comprehensive clinical and public health orientation: One Health doctors are comprehensive clinicians who engage not only in curative care but also in promotive, preventive, and rehabilitative efforts, as noted by one participant, "Previously, we may have focused primarily on curative processes. But with One Health, we have begun to address promotive and preventive aspects" (P12, academic and medical practitioner). This profile is underpinned by clinical and technical competencies, including the ability to diagnose and manage priority zoonotic diseases, as well as knowledge of infectious disease prevention.

In addition, as One Health practitioners, doctors also demonstrated a public health orientation in their practice, focusing not only on individual patients but also on assessing risks and implementing preventive measures at the community level. This profile is supported by public health competencies, including knowledge of disease epidemiology and the ability to conduct risk analysis. A public health-oriented profile also requires doctors to understand the purposes, processes, and implications of disease reporting within the health system for community prevention and control efforts, enabling them to function as one link in the collaborative process.

Open-minded and collaborative professional identity: The third profile is characterized by doctors having an open and inclusive mindset. This profile is supported by systems thinking competencies and relational and collaborative skills. Systems thinking helps doctors recognize interconnections between sectors beyond health that influence health outcomes, thereby fostering openness to collaboration. One participant stated: "In action, it is necessary to be inclusive. By inclusivity, I mean recognizing and acknowledging other disciplines and evidence outside one's own field" (P3, academic with veterinary and public health background).

Leadership and innovation competencies: In addition to competencies supporting the three profiles described above, participants also highlighted the importance of leadership and innovation competencies for doctors practicing One Health. These competencies are situational and may be required when gaps exist within workplace systems. For example, one participant described a scenario in which a doctor assumes a leadership role to guide the surveillance team at puskesmas in the absence of an epidemiologist: "In this situation, the doctor takes on a

leadership role" (P7, public health practitioner).

This theme highlights the profiles and competencies that enable doctors to practice One Health. In addition to competencies supporting these profiles, doctors are also expected to adapt to system conditions, including through leadership and innovation.

Strategies to develop One Health competencies through medical education

This theme describes strategies participants suggested for developing doctors' competencies in applying the One Health approach.

Curriculum integration and stakeholder engagement: The first strategy is to systematically integrate this concept into medical curricula to ensure continuity in competency development throughout the educational process. Efforts are needed to engage medical schools' policymakers in recognizing the importance of One Health. This can be achieved by illustrating the scope and impact of health problems arising from human-animal-environment interactions, highlighting potential benefits of the One Health approach, and demonstrating how it can help prepare doctors to collaborate.

Second, although participants suggested various flexible approaches to integrate One Health, including dedicated courses, embedded learning within relevant courses, and interprofessional learning, most participants suggested that One Health competencies should be taught within relevant courses such as those on zoonotic diseases or emerging infectious diseases to demonstrate the relevance of One Health. One participant explained:

"If taught as a standalone topic, students may ask, 'What is One Health?', but within the context of zoonoses, it becomes clear that it involves not only humans, but also animals, and the environment." (P6, medical practitioner)

Another clinician also emphasized the importance of linking One Health competencies to the clinical context of disease management, enabling doctors to manage cases independently and refer patients whose conditions require advanced care.

Authentic and interprofessional learning approaches: Participants suggested various learning methods to teach One Health, including case studies, simulations, field visits, and interprofessional learning in real practice settings. These suggestions highlight the perceived importance of authentic learning in developing One Health competencies. Participants also emphasized benefits of interacting with other professions in real contexts, for example, during placements in community health centers, because "it may help develop their understanding of interprofessional collaboration" (P13, medical practitioner).

Learning environments for One Health competency development: When asked to suggest appropriate work settings for One Health learning, participants identified a range of settings suitable for developing One Health competencies. Suggested learning environments included human health institutions and work settings outside the human health sector. This diversity of learning environments indicates that developing One Health competencies requires exposure to other sectors, enabling students to understand how these sectors influence human health.

DISCUSSION

Principal findings and contribution to One Health practice

This study extends prior work by shifting beyond knowledge/attitudes assessment or policy-oriented analysis to examine routine, enacted professional activities. The findings offer novel insights into how systemic fragmentation and clinician identity-related ambivalence enable and constrain boundary crossing in One Health contexts. The inclusion of multisectoral participants enables triangulation of perspectives and captures both insider and outsider views, revealing subtle dynamics in the enactment of One Health that monoprofessional studies may overlook. To our knowledge, this study is among the first to empirically examine how medical doctors enact One Health roles in everyday professional practice within a decentralized, middle-income health system.

Policy commitment and limited routine implementation

Despite increasing policy attention to One Health in Indonesia and Southeast Asia, our findings suggest that its enactment in routine professional medical practice remains limited. Recent initiatives at both national and regional levels reflect growing recognition of the importance of cross-sector collaboration. For example, the Association of Southeast Asian Nations One Health network was launched in 2024 to strengthen cross-sector collaboration and exchange of information among member countries [38]. In Indonesia, several initiatives have aimed to strengthen zoonotic surveillance systems, including the further development of SIZE [39] and expansion

of community-based surveillance program [40].

Despite these initiatives, our findings indicate that the enactment of One Health in medical doctors' day-to-day professional practices tends to occur reactively rather than as part of routine collaboration. This highlights a gap between policy commitment and routine professional practice. This pattern is consistent with broader observations that health promotion and disease prevention practices in Indonesia have not adequately addressed upstream determinants that require cross-sectoral collaboration [41]. Prior study has identified limited coordination, unclear institutional roles, and the absence of shared outcome indicators as key barriers to consistent and aligned prevention efforts across sectors [41].

Decentralized governance and institutional fragmentation

These challenges may reflect broader characteristics of the Indonesian health system. A recent analysis of community-based surveillance in Indonesia also highlights the gap between formal One Health commitments and operational practice [42]. Although the country has established coordination mechanisms and cross-sectoral surveillance initiatives, institutional silos, uneven subnational capacity, and limited cross-sector data sharing continue to challenge implementation.

These implementation challenges are further shaped by Indonesia's decentralized governance structure, which contributes to variations in how One Health initiatives are operationalized across regions, a pattern reflected in the experiences described by participants in this study. Evidence from global health systems research suggests that decentralization influences multiple components of the health system with varying effects [43]. In Indonesia, decentralization has been associated with substantial disparities in performance and health outcomes across regions [24]. These studies highlight the critical role of leadership and governance at the subnational levels in shaping other health systems components [24, 43].

Similar patterns of One Health implementation have been reported in other low- and middle-income countries with decentralized health systems [44, 45]. For example, research in Tanzania [44] and Ghana [45] found that cross-sector collaboration often occurs primarily during outbreaks, while routine coordination remains limited. The Tanzanian study also found substantial knowledge gaps regarding One Health coordination mechanisms between actors at national and subnational levels. These findings suggest that translating One Health policies into routine practice in many decentralized health systems remains constrained by institutional fragmentation and uneven local capacity.

Formal coordination mechanisms and operational gaps

In the Indonesian context, formal mandates such as Governor or District Head Decrees establishing Regional Coordination Teams (Tim Koordinasi Daerah, TIKORDA) [23] constitute a key foundation for cross-sectoral collaboration. These mandates provide legal authority, coordination mechanisms, and a basis for budget allocation for One Health collaboration in zoonosis prevention and control activities. However, the extent to which this coordination structure functions effectively at the local level remains unclear. Our findings suggest that even in regions where such structures exist, sustaining routine collaboration beyond outbreak-related events remains challenging.

Although national and subnational coordination mechanisms for zoonoses and emerging infectious diseases are available in Indonesia, the roles of medical doctors within these structures are not always clearly defined at the operational level. In the absence of operational mechanisms that facilitate routine direct cross-sectoral engagement, doctors' contributions remain largely confined to the clinical domain through the Health Office structure. This positioning aligns with the clinical authority of medical practitioners in the management of communicable diseases as stipulated in Indonesian health regulations governing communicable disease control and medical practice [46].

In Indonesia's health surveillance landscape, the Early Warning Alert and Response System serves as an early warning mechanism for priority outbreak-prone diseases [47]. Doctors contribute to this surveillance system by generating clinical data during patient care, which are subsequently reported by surveillance officers at healthcare facilities. Within the broader One Health landscape, SIZE functions as an interoperable cross-sector platform that connects the Early Warning Alert and Response System with information systems from the animal health and wildlife sectors, enabling alerts, case linkage, and coordinated rapid responses across sectors [23]. By integrating surveillance data from the three sectors, SIZE provides a mechanism for cross-sector participation in detecting and responding to zoonotic and emerging infectious disease threats. However, publicly available documentation suggests that the system has faced technical and operational challenges, and a revised version began pilot

implementation in 2025 [39]. In addition, direct access to SIZE is currently limited to designated government users rather than automatically granted to all doctors. Therefore, despite its potential to strengthen doctors' engagement in zoonotic and emerging infectious disease responses, realizing this potential would require the formal inclusion of doctors within the system's operational arrangements.

Additionally, while it facilitates cross-sector data sharing and alerts, it does not necessarily create routine channels for direct two-way communication between frontline professionals across sectors. As a result, cross-sector interaction in practice often relies on personal networks rather than institutionalized mechanisms. Taken together, these regulatory and infrastructural conditions may limit the scope and continuity of doctors' enactment of One Health, particularly related to zoonoses and emerging infectious diseases. This contributes to episodic, rather than routinely embedded, collaboration in professional work. Therefore, developing operational communication platforms or professional networks that enable frontline professionals across different sectors to exchange information and coordinate responses more directly is necessary to strengthen One Health implementation.

Educational preparedness and workplace capacity

While structural conditions shape the institutional environment for collaboration, our findings also highlight the importance of professional level factors, particularly how doctors interpret their roles and responsibilities within One Health contexts. Another finding of this study indicates that doctors' readiness and capacity to contribute to One Health are closely linked to educational systems, professional experiences, and work environments. At a global level, limited integration of One Health into medical curricula has been associated with low familiarity among medical students and doctors, reflecting insufficient exposure during training [13, 48]. Limited space within medical curricula has been reported as a common barrier to integrating One Health [18], making it difficult to compete for priority with other topics when its relevance to the specific role of the medical profession is not yet clearly defined.

Although topics relevant to One Health, such as zoonoses, vector-borne diseases, and AMR, are often included in medical curricula, their inclusion alone does not necessarily translate into coherent One Health learning. Weak integration across these topics and the absence of explicit conceptual framing have been associated with limited student awareness and understanding of One Health concepts [49]. Studies from different countries have reported that doctors perceive their training as insufficient in preparing them to address zoonotic diseases and report low confidence in diagnosing and managing these conditions [10, 14]. They also appear to engage less frequently in cross-professional referrals compared with veterinarians [10].

Professional identity and boundary crossing

Medical education contributes not only to the development of knowledge and skills but also to the formation of doctors' professional identity through the gradual internalization of professional values, norms, and dispositions. From a community of practice perspective, the medical profession may be viewed as a macro-community of practice centered on disease prevention and treatment, alongside a commitment to the public good [50]. This professional identity helps explain why doctors in this study express a motivation to collaborate when confronted with health problems that exceed individual or sectoral capacities [15].

In One Health contexts, clinical challenges, such as limitations in diagnosing zoonoses in humans and the recognition that interventions in animal populations may interrupt transmission, constitute what Akkerman and Bakker [17] describe as a "shared problem space" for collaboration. This space provides a context for doctors to interact with other professionals, within which professional identity affords doctors legitimacy to engage in interprofessional exchanges. Therefore, professional identity appears to support One Health collaboration when cross-sector engagement addresses shared problems that intersect with doctors' clinical and public health responsibilities.

However, this study also indicates that doctors' professional identity as clinicians may function as a constraint on collaboration. From a boundary crossing perspective, One Health collaboration can be understood as a boundary activity that introduces discontinuities in practice, role ambiguity, and tensions arising from sociocultural differences across communities of practice. In this study, participants emphasized distinctions in role scope at the boundary, for example: "human cases are consulted to me, animal cases to Balitvet (veterinary center)," a process described as identification [17]. While this process is important for clarifying roles and responsibilities, it may also reinforce uniprofessional identities that limit interprofessional collaboration.

Beyond role differentiation at professional boundaries, clinicians' core responsibilities may further shape

how collaboration is prioritized in practice. Identity as a clinician may constrain cross-sector collaboration by prioritizing responsibility for patient care and timely clinical decision-making. Medical training and professional norms emphasize doctors' accountability for diagnosing and managing patients, often reinforcing expectations of independent clinical judgment. Within this identity framework, cross-sector engagement may be considered primarily when it directly contributes to clinical decision-making. This interpretation is consistent with previous research showing that doctors who primarily enact a "medical expert" identity tend to rely on professional autonomy and are less engaged in collaborations across organizational boundaries, whereas those identifying as team members demonstrate more extensive collaborative practices [51].

In addition, time pressure and high workload may further reinforce these professional priorities, directing clinicians' attention toward immediate patient care and leaving little opportunity for cross-sector collaboration. Similar contextual constraints have also been reported to limit professionals' engagement in One Health collaboration more broadly [52]. To address this, making explicit how veterinarians' and other professionals' expertise can complement clinical work may help to clarify the relevance of cross-sector engagement for clinical practice. This may enable doctors to recognize whether, when, and which expertise across professional boundaries can contribute to patient care, thereby fostering greater enactment of the One Health approach in clinical settings [9].

These findings suggest that clinical identity can be viewed as a socially embedded feature that shapes how doctors interpret their roles, legitimacy, and the boundaries of engagement in cross-sectoral interactions. On the one hand, clinical identity affords legitimacy and provides moral motivation for collaboration. On the other hand, it may also reinforce professional boundaries that limit openness to cross-sectoral knowledge and roles extending beyond the clinical domain. These dynamics have important implications for medical education. They suggest that developing One Health competencies involves not only adding curricular content but also facilitating the formation of professional identity within an interprofessional team.

Expanded roles of medical doctors in One Health practice

Findings on One Health roles and activities in this study emerged from descriptions of professional activities that doctors currently perform, as well as those expected as potential contributions within One Health contexts. Participants viewed clinical responsibilities as doctors' primary contribution to One Health practice. As clinicians, doctors are expected to adopt a comprehensive approach to patient health problems. This includes not only the diagnosis and management of zoonotic diseases and the identification of AMR, but also their prevention through infection prevention measures and rational antibiotic use. These clinical responsibilities are consistent with previous One Health studies that focus on the role of medical doctors [9, 10, 53].

However, our findings suggest that the enactment of the One Health approach extends doctors' roles beyond the clinical setting. In addition to clinical responsibilities, doctors may contribute as educators and collaborators in addressing health challenges involving interactions among humans, animals, and the environment. These roles require competencies that extend beyond the clinical domain, including public health knowledge, systems thinking, and the ability to collaborate across professional boundaries. An open and inclusive mindset also emerged as an important professional disposition that fosters receptiveness to the knowledge, roles, and contributions of other professions in addressing health problems. The importance of such dispositions in supporting cross-sector collaboration has also been emphasized in previous studies [9].

Competency framework and implications for medical education

These empirical findings were synthesized into an integrated framework to organize roles, approaches, and professional dispositions related to the professional enactment of One Health. The framework also illustrates the competencies required for these roles and strategies to develop them. It was adapted from Harden's Three-Circle Model [37]. However, as this model was originally developed to guide outcome-based education rather than cross-sector collaborative practice, it may not fully capture the broader institutional and governance dynamics that influence One Health implementation. Future work may benefit from integrating an educational framework with system-oriented perspectives that account for policy and organizational contexts that shape inter-professional collaboration.

Overall, the findings indicate that enactment of One Health in medical practice requires competency profiles that extend beyond biomedical expertise. Developing these competencies cannot be achieved solely by adding curricular content. Instead, curricula need to provide opportunities for students to engage in authentic learning experiences, participate in interprofessional interactions, and reflect on these experiences in ways that support

the formation of a collaborative professional identity.

CONCLUSION

This study showed that medical doctors can enact One Health through clinical, educational, and collaborative roles, but their engagement remains limited, reactive, and highly dependent on local commitment, informal networks, and workplace conditions. The findings indicate that fragmented implementation, uneven subnational coordination, limited operational support, and insufficient integration of One Health into medical education constrain doctors' readiness and capacity to participate in sustained cross-sector collaboration. Clinician identity functioned as both a facilitator and a barrier: It provided legitimacy and motivation for doctors to initiate collaboration when human health problems intersected with animal and environmental factors, but it also reinforced clinical boundaries when immediate patient care and independent decision-making took priority.

The results also highlight that doctors' One Health practice extends beyond diagnosis and treatment of zoonotic diseases. Doctors may contribute to AMR stewardship, infection prevention and control, disease surveillance, health education, advocacy, community engagement, and intersectoral problem-solving. These expanded roles require competencies in clinical care, public health, risk analysis, systems thinking, communication, collaboration, leadership, innovation, and sociocultural understanding. Therefore, One Health competency development should not rely only on adding theoretical content to medical curricula. Instead, medical education should include contextualized, case-based, field-based, and interprofessional learning experiences that allow students to interact with veterinary, public health, environmental, and policy sectors in authentic practice settings.

Practically, the findings suggest that strengthening doctors' engagement in One Health requires clearer operational pathways for cross-sector communication, better integration of doctors into surveillance and reporting systems, institutionalized professional networks, improved laboratory and information system support, and stronger subnational coordination mechanisms. Medical schools, health offices, and One Health networks should collaborate to develop practice-oriented training and workplace strategies that help doctors recognize when and how cross-sector expertise can contribute to patient care and public health action.

This study is limited by its focus on Indonesia and by the absence of participants from environmental health and wildlife sectors. The findings were also based on retrospective accounts, which may be affected by recall bias. Future studies should include broader sectoral representation, compare different regional implementation contexts, and examine how proposed One Health competencies and educational strategies can be integrated, assessed, and sustained in medical curricula and professional practice. Longitudinal and implementation-focused studies are also needed to evaluate whether structured interprofessional training and operational communication platforms improve doctors' routine engagement in One Health.

In conclusion, medical doctors occupy a strategic position in translating One Health from policy discourse into everyday professional practice. However, meaningful enactment requires more than individual awareness; it depends on educational reform, institutional support, clarified professional roles, and routine mechanisms for cross-sector collaboration. Strengthening these areas may enable doctors to contribute more consistently to integrated responses to zoonotic diseases, AMR, emerging infectious diseases, and other health challenges at the human-animal-environment interface.

DATA AVAILABILITY

The qualitative datasets generated during the current study are not publicly available due to confidentiality considerations and the risk of participant identification. Relevant excerpts are presented in the article to support the findings.

AUTHORS' CONTRIBUTIONS

DPS: Conceptualization, methodology, investigation, formal analysis, data curation, writing – original draft. YPS: Conceptualization, methodology, investigation, supervision, writing – review and editing. GRR: Conceptualization, methodology, supervision, writing – review and editing. All authors have read and approved the final version of the manuscript.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

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