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Original Article

KOMPAK: Translation, cross-cultural adaptation, and validation of an instrument for assessing interprofessional collaboration between pharmacists and physicians in Indonesia

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Abstract

Interprofessional collaboration is crucial for addressing the complexity of health problems, requiring contributions from various professions to enhance healthcare quality, improve patient satisfaction, and achieve better clinical outcomes. The aim of this study was to develop and validate the physicians and pharmacists collaborative practice instrument, known as KOMPAK (*Kolaborasi Medis Persepsi Apoteker dan Dokter*/Medical Collaboration: Perceptions of Pharmacists and Physicians) for use in Indonesia. A cross-sectional study was conducted across the western, central, and eastern rigors of Indonesia, targeting physicians and pharmacists. The study included translation (forward and backward), cross-cultural adaptation (with 30 participants), and validation using confirmatory factor analysis (CFA) among 315 physicians and 315 pharmacists. The present study found no significant changes emerged during the translation and adaptation phases. In the validation phase, the CFA results for the physician instrument indicated a Comparative Fit Index (CFI) of 0.94 (>0.92), Tucker-Lewis Index (TLI) of 0.93 (>0.92), Root Mean Squared Error of Approximation (RMSEA) of 0.055 (<0.07), Standardized Root Mean Residual (SRMR) of 0.07 (<0.08), and Cronbach's Alpha reliability of 0.88. The pharmacist instrument yielded similar results with a CFI of 0.94 (>0.92), TLI of 0.93 (>0.92), RMSEA of 0.06 (<0.07), SRMR of 0.05 (<0.08), and Cronbach's Alpha reliability of 0.83. The final instrument consists of 24 items. In conclusion, the KOMPAK instrument demonstrated validity and reliability, supporting its use for measuring interprofessional collaboration between physicians and pharmacists in Indonesia.

Keywords: Interprofessional collaboration, KOMPAK, Nusantara, pharmacists and physicians, psychometrics

Introduction

Healthcare paradigm is experiencing a significant transformation, shifting focus from medical-centered to patient-centered care [1]. Consequently, interprofessional collaboration has become

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critical in addressing this evolving landscape [1]. The complexity of health issues and the need for effective management now require the involvement of multiple healthcare professions rather than depending on a single medical discipline [2]. Interprofessional collaboration entails the integration of diverse educational backgrounds within a team, working collectively to enhance the quality of healthcare, improve patient satisfaction, and achieve superior outcomes in overall care quality [3-5].

World Health Organization (WHO) introduced the "Framework for Action on Interprofessional Education and Collaborative Practice," emphasizing the importance of fostering team-based collaboration across various healthcare disciplines to enhance healthcare delivery [5]. According to the WHO, interprofessional collaboration refers to the coordinated efforts of different healthcare professions working together to deliver services to patients, with the objective of providing high-quality care across the continuum of care [5]. The fundamental concepts of this collaboration include shared responsibility, collective decision-making, interprofessional communication, accountability, and continuous education [5].

Insufficient cooperation among healthcare professionals is a significant factor contributing to the high incidence of prescription errors in Indonesia. A study in Yogyakarta, Indonesia, identified 226 medication errors, with 99.12% due to prescribing issues, 3.02% to pharmaceutical errors (overdosing, underdosing, incomplete drug information), and 3.66% to dispensing errors [6]. A 2014 study in Bali, Indonesia, reported 1,563 medication errors across 770 prescriptions, with administration errors (59%) being the most common–of all errors, 2.4% were classified as serious, and 10.3% as significant [7]. Australian National Prescription Service also reports that approximately 6% of hospital cases are due to drug-related adverse effects and errors in the treatment process, which are often linked to a lack of collaboration among healthcare professionals [8]. Additionally, WHO data shows that 42.7 million adverse events occur globally each year due to medical errors and poor patient management [8].

A study in Poland demonstrated that pharmacists are ready to engage in patient care and contribute to positive therapeutic outcomes through collaboration with physicians and nurses [9]. This collaboration in Poland also highlighted the ability of pharmacists to play a role in holistic and integrated healthcare [9]. Costa and Hajj noted that collaboration can start with simple actions, such as pharmacists addressing prescription errors with physicians to prevent adverse effects [10,11]. However, another study indicated that despite the rise of interprofessional collaboration, some healthcare professionals still preferred working independently [12].

Physicians are often perceived as the most competent practitioners, with their dominant role in clinical leadership rooted in the hierarchical healthcare system, resulting in other healthcare professionals feeling marginalized or hesitant to provide input [13,14]. Such dynamics are particularly pronounced in countries with strong social hierarchies, such as Indonesia [15]. To address these challenges, a reliable and validated instrument is needed to assess interprofessional collaboration. The two previous studies took place in Canada [15] and Kuwait [16], with the Kuwaiti study adapting the Canadian researchers' instrument, which we also used for our research. The original instrument came from Canada [15], where two professional groups—doctors and pharmacists—were examined. The researchers in Canada [15] did not mention the reliability scores. In Kuwait, participants who were physicians and pharmacists, with a balanced number of 230 and 217, discovered more detailed psychometric test results [16]. The results of the study in Kuwait included internal consistency for three items in the attitude domain, which was 0.81, and seven items in the perception domain, which was 0.90 [16]. In addition, the study in Kuwait identified that participants aged <40 years with <10 years of service were more open to collaboration [15].

The aim of this study was to translate, adapt, and validate a Canadian-developed instrument [15] for interprofessional collaboration, specifically adapting it to the local cultural contexts across Indonesia's western, central, and eastern regions. We named the validated Indonesian version KOMPAK (*Kolaborasi Medis Persepsi Apoteker dan Dokter* or Medical Collaboration: Perceptions of Pharmacists and Physicians). The term "KOMPAK" was purposefully chosen as an acronym because it resonates with its meaning in the *Kamus Besar Bahasa Indonesia* (KBBI, the Official Indonesian Dictionary), which signifies harmony, unity, and collaborative spirit [15].

Methods

Study design and study setting

This study employed a multi-phase quantitative cross-sectional research design to translate, adapt, and validate the 'KOMPAK' instrument for measuring interprofessional collaboration between doctors and pharmacists in the Indonesian healthcare context. The research methodology systematically progressed through three key phases: translation, cultural adaptation (pilot testing), and validation. Researchers translated the original Canadian instrument from English to Indonesian in the initial translation phase, using forward and backward translation techniques to ensure linguistic and conceptual accuracy. The cultural adaptation phase involved comprehensive semantic assessments and cognitive interviews with healthcare professionals, refining the instrument's language and contextual relevance. The cultural adaptation (pilot testing) phase critically examined the instrument's applicability, involving 518 pharmacists (407 completed) and 462 physicians (33 completed). This stage focused on improving face validity and identifying potential interpretation challenges. In the last validation phase, thorough psychometric analyses were used, and participants were carefully chosen from across Indonesia's western, central, and eastern regions to ensure that the results were representative of the whole country and could be used elsewhere.

The study maintained strict methodological and ethical standards throughout the six-month research process (from July to December 2023), ultimately developing a robust, culturally sensitive instrument for measuring interprofessional collaboration in Indonesian healthcare. Subsequent manuscript sections will elaborate on detailed methodological procedures [15].

Participants criteria

The study participants included male and female physicians and pharmacists, with carefully defined inclusion and exclusion criteria to ensure research quality and participant relevance. Inclusion criteria comprised (a) licensed physicians and pharmacists practicing in Indonesia, (b) a minimum work experience of six months—a critical period for establishing clinical competence [17], (c) active healthcare professionals currently working in clinical settings, and (d) voluntary willingness to participate in the research. Exclusion criteria were equally comprehensive, including (a) healthcare professionals with less than six months of work experience, (b) participants with incomplete or inconsistent data, (c) those who did not provide informed consent, (d) professionals currently on extended medical leave or sabbatical, and (e) individuals with significant communication barriers that could compromise data integrity.

All participants received a comprehensive explanation of the study's purpose and potential benefits. Participation was voluntary, with multiple communication channels (WhatsApp, telephone, email) available for questions and clarifications. Participants actively ticked an acknowledgment box on the initial page of the online form after carefully reading the study's purpose to obtain informed consent. To maintain data quality and research integrity, we systematically excluded from the final analysis any participants who did not meet the inclusion criteria or had incomplete data—such as interruptions during the online form completion or network disruptions resulting in partial submissions [17].

Sample size and sampling method

Physicians and pharmacists willing to participate were recruited for the study. During the adaptation stage, a minimum of 10 physicians, 10 pharmacists, and 10 academics were required. In the validation stage, the target was to enroll at least 100 physicians and 100 pharmacists as participants, as recommended previously [17,18]. A psychometric study requires a minimum sample size of 5–10 times the number of validated items [19]. In this study, the number of items on the pharmacist and physician instruments was 33 items and 25 items, respectively. Therefore, the minimum number of participants for pharmacists was 165 (5×33 items) and for physicians 125 (5×25 items). To ensure a good sociodemographic distribution of participants, all incoming data were carefully reviewed, and necessary adjustments were made to ensure a better distribution. For instance, if the incoming data included participants with a dominant work period exceeding 10 years, the investigators tried to identify and include the participants with work expectations ranging from six months to five years. For physician participants, we

collaborated with senior doctors to distribute online instruments, adhering to the principle of volunteerism throughout the entire process.

Study instrument

The instrument used in the present study was adapted from one developed by Kelly *et al.* [15] initially utilized in Canada [15], with permission to use the instrument from the corresponding author. The instrument was divided into two sections: one for physicians and another for pharmacists. Each section comprises two main components: demographic data and instrument content. The instrument assesses five key aspects, including attitudes and experiences related to collaborative practice, preferred methods of communication, perceptions of the pharmacist's professional role, areas where increased collaboration is needed, and barriers encountered in collaborative practice [15].

The instrument comprised separate questionnaires for physicians and pharmacists, consisting of 25 and 33 questions, respectively. The first section included questions about demographic characteristics, such as name initials, sex, age, highest education level, current profession, work experience, and work location. The second section assessed attitudes and experiences, featuring four questions; the first three utilized a five-point Likert scale from Strongly disagree (1) to Strongly agree (5), while the fourth employed a point scale from never (1) to always (5). The third section focused on preferred communication methods, including five items rated on a five-point Likert scale.

The fourth section, which pertained to the professional role in healthcare, asked both physicians and pharmacists to rank eight role statements in terms of importance for collaboration. The fifth section identified areas for future collaboration with seven items, while the sixth section explored barriers to collaborative practice with nine questions. Detailed questions for each section are presented in **Underlying data**.

Study procedures

Translation phase

The translation process comprised two essential stages: forward translation and backward translation. In the first stage, two sworn Indonesian translators translated the original instrument text from English to Indonesian, resulting in version 1 (V1). This version was then compared with the original instrument and discussed with the research team, yielding a final version labeled version 2 (V2).

The second stage involved backward translation, where V2 was translated back into English by two native English speakers fluent in Indonesian. The results from these two translations were then compared with the original instrument and with V2. The outcome of this development resulted in version 3 (V3). The goal of the backward translation phase was to refine and finalize the Indonesian versions. This approach ensured the accuracy of the previous translations through comparison with the original versions. The final outcome of this process was a customized instrument for Indonesia, designated as version 3 (V3) [17]. After translation into Bahasa Indonesia, the questionnaire's meaning was verified for clarity and consistency. The translation process revealed no significant issues, with no changes made to items and no concerns identified during back-translation into English.

Adaptation phase

The adaption procedure was conducted in Kota Ternate to symbolize Eastern Indonesia, Kota Makassar for Central Indonesia, and Semarang for Western Indonesia. In Semarang, the adaption process was conducted online for the completion of surveys and discussions between investigators and participants. The V3 instrument was subsequently adapted through testing with 30 participants, including 10 physicians, 10 pharmacists, and 10 academics. Participants volunteered to provide feedback regarding the instrument. Notably, the 10 academics involved in this stage held at least a master's degree and had prior experience conducting instrument validation studies to provide insights on each item of the instrument. The adapted instrument was designated as V4 and was intended for use in the subsequent validation stage [17].

Several factors were considered to ensure the success of this phase. First, the concepts measured by the instrument were clarified to avoid misunderstandings, and differences in comprehension between the source and target cultures were identified. During instrument completion, some participants expressed uncertainty, prompting requests for clarification. For example, regarding the preferred communication method, some participants inquired about contacting via WhatsApp, leading to the addition of an example for clarity. Furthermore, in the fourth section addressing the professional role of pharmacists, the questions were modified to align with those in the physician instrument based on feedback from academics, facilitating easier interpretation. The instrument was revised according to the feedback and issues observed during this adaptation process.

Validation phase

The validation process was conducted throughout Indonesian provinces, including Aceh, Central Java, East Java, South Sulawesi, Central Sulawesi, and North Maluku, together representing the three time zones in Indonesia. The final form of the instrument was intended for use with participants during the validation stage. The purposive sampling method was used during this validation phase by recruiting samples by inviting potential participants who matched to predefined research inclusion and exclusion criteria. Before participating, the aims, objectives, and research procedures were explained to the target participants. In this validation phase, the instrument was distributed either in paper format or through an online link (Google Form, Google LLC, California, United States) via sharing or barcoding. Upon completion of data collection, the data were analyzed, results interpreted, and conclusions drawn. The processes of translation, adaptation, and validation are illustrated in detail in **Figure 1**.

Statistical analysis

JASP version 0.18.1.0, developed by the JASP Team at the University of Amsterdam (Amsterdam, Netherlands), was used for statistical analysis. Confirmatory factor analysis (CFA) was employed to assess the validity of the instrument. CFA facilitates the identification and simplification of items into a single correlated factor. CFA evaluates whether indicators grouped based on previous latent items (constructs) are consistent within the construct, serving as a statistical confirmation that the proposed factor structure aligns with the observed data. The validity of the questionnaire was confirmed through the evaluation of the Kaiser-Meyer-Olkin Measure of sampling adequacy (KMO MSA) and Bartlett's test of sphericity parameters. KMO MSA >0.5 and *p*-values from Bartlett's test of sphericity <0.05 were used to indicate interdependence among items, thus permitting the conduct of CFA. A rigorous approach to validating measurement reliability and construct validity was implemented. Our analytical strategy established a conservative factor loading threshold of ≥0.35, ensuring that only substantively meaningful items were retained for further analysis [21]. By employing the Heterotrait-Monotrait (HTMT) ratio method with a discriminant validity criterion of <0.85, we systematically examined the distinctiveness and theoretical independence of our research constructs [22]. This methodological rigor ensured that the items met statistical standards and accurately represented the nuanced theoretical dimensions critical to understanding the underlying research framework.

Validity was measured through two metrics: convergent validity and discriminant validity. Convergent validity was assessed by the degree of correlation among items within a domain, quantified by the loading factor. For adequate convergent validity, the loading factor value should exceed 0.35, as previously recommended [20]. Discriminant validity refers to the extent to which the measured items are distinct and uncorrelated; the correlation between items should not surpass 0.7, as higher correlation values suggest significant covariance.

To align the CFA model with the observed data, statistical measures such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) were employed. We employed multiple fit indices to systematically evaluate the model's goodness of fit using CFA techniques. The CFI and TLI were calculated through comparative model assessments, comparing the proposed measurement model to a null model. [21,22][23,24]

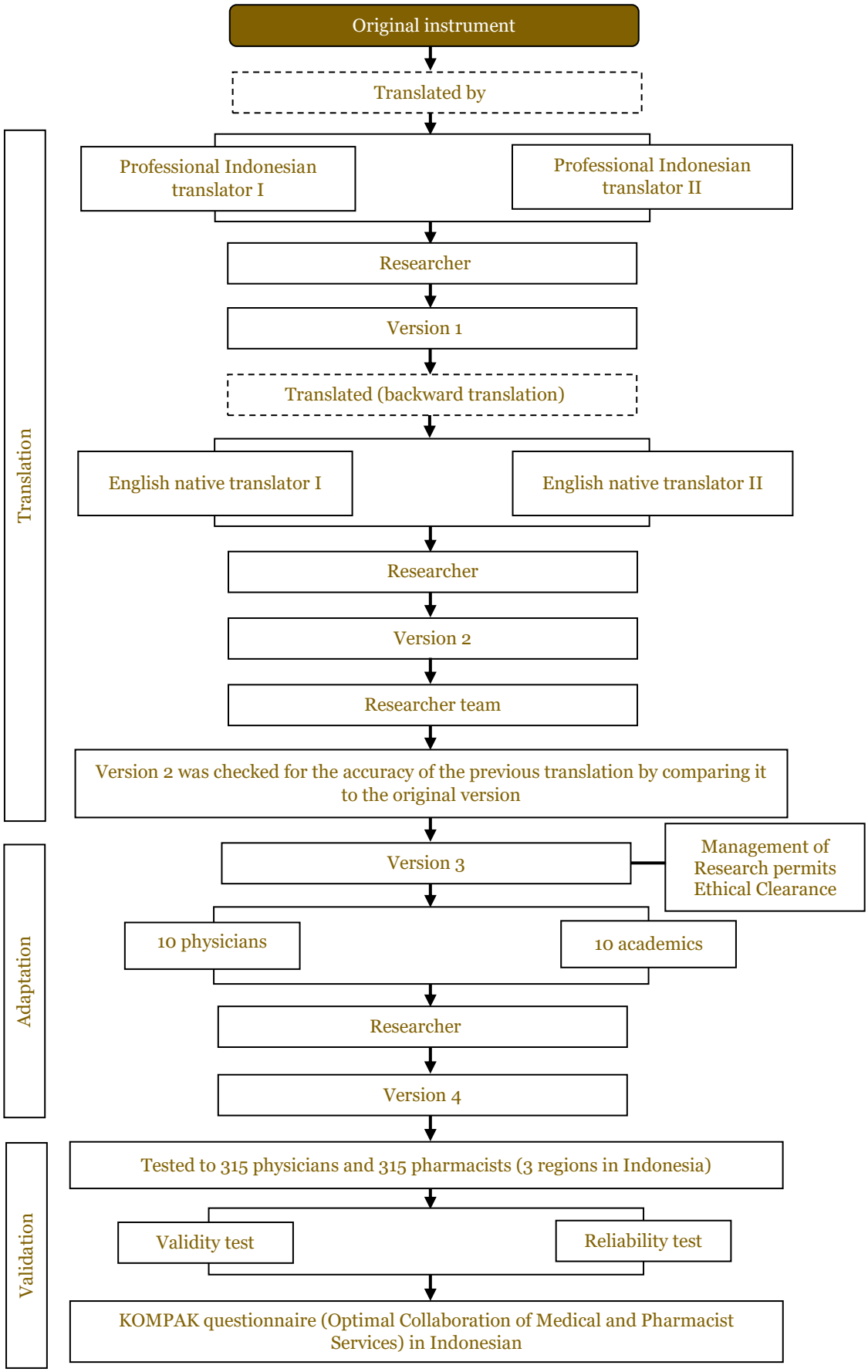

Figure 1. Flow of the present study.

The RMSEA was computed to quantify discrepancy per degree of freedom. We used the standardized root mean square residual (SRMR) to measure the standard difference between observed and predicted covariance matrices. This strict methodological approach allowed objective evaluation of the measurement model's structural integrity and predictive accuracy, which confirmed that our research model was aligned with the real world [21,22]. The reliability of the questionnaire was evaluated using Cronbach's alpha, with a minimum acceptable value of 0.6 set, as previously recommended [23,24].

Results

Characteristics of the participants

A total of 630 participants were involved in the study, comprising 315 physicians and 315 pharmacists, distributed across three regions: Western Indonesia (110 physicians and 110 pharmacists), Central Indonesia (105 physicians and 105 pharmacists), and Eastern Indonesia (100 physicians and 100 pharmacists). All participants completed the instrument; therefore, there were no dropouts. Characteristics of the participants are presented in **Table 1**. The majority of participants were female (70.8%), with most being pharmacists (77.8%). The predominant age group was 31–40 years (43.9%). The most recent educational background for most participants was as a medical professional (35.5%) or pharmacist (42.6%). The majority had working experience ranging from 1 to 5 years (38%), with most employed in hospitals (54.3%) (**Table 1**).

Table 1. Characteristics of the participants (n=630)

Variables	Total, n (%)	Physician, n (%)	Pharmacist, n (%)
Sex			
Male	184 (29.2)	114 (36.2)	70 (22.2)
Female	446 (70.8)	201 (63.8)	245 (77.8)
Age (years), mean±SD	33.9±7.5		
20–30 years	243 (38.5)	106 (33.7)	137 (43.5)
31–40 years	277 (43.9)	150 (47.6)	127 (40.3)
41–50 years	89 (14.1)	43 (13.7)	46 (14.6)
51–60 years	20 (3.1)	16 (5.1)	4 (1.3)
>60 years	1 (0.1)	0 (0.0)	1 (0.3)
Highest education level			
General practitioner	224 (35.5)	224 (71.1)	0 (0.0)
Dentist	6 (1.0)	6(1.9)	0 (0.0)
Pharmacist	269(42.6)	0 (0.0)	269 (85.4)
Master's degree	59 (9.3)	19(6.0)	40 (12.7)
Doctoral degree	15 (2.3)	9(2.9)	6 (1.9)
Specialist	57(9.0)	57(18.1)	0 (0.0)
Current profession			
General practitioner	265 (42.0)	265 (84.1)	0 (0.0)
Dentist	8 (1.3)	8 (2.5)	0 (0.0)
Specialist physicians	42(6.7)	42 (13.3)	0 (0.0)
Pharmacist	315 (50.0)	0 (0.0)	315 (100.0)
Working experience (years)			
<1 year	94 (15.0)	33 (10.5)	61 (19.4)
1–5 years	240 (38.0)	135 (42.9)	105 (33.3)
6–10 years	132 (21.0)	72 (22.9)	60 (19.0)
>10 years	164 (26.0)	75 (23.8)	89 (28.3)
Workplace			
Hospital	342 (54.3)	189 (60.0)	153 (48.6)
Private clinic	33 (5.2)	19 (6.0)	14 (4.4)
Community health center	170 (27.0)	92 (29.2)	78 (24.8)
Self-employed	44 (7.0)	4 (1.3)	40 (12.7)
Universities or health facility staff	28 (4.4)	10 (3.2)	18 (5.7)
Others	13 (2.1)	1 (3.0)	12 (3.8)

Factor analysis of the instrument

KMO MSA indicates the extent to which the data can be analyzed using factor methods, with a KMO value criterion of greater than 0.50. The total KMO value for the physician instrument was 0.84, and for the pharmacist instrument, it was 0.85; both values exceeded the threshold of 0.50, indicating an adequate sample size and strong significance, as confirmed by Bartlett's test of

sphericity (p<0.001) [25]. Thus, the requirements for factor analysis testing were met, allowing for further analysis (**Table 2**).

Table 2. Kaiser-Meyer-Olkin Measure of sampling adequacy (KMO MSA) and Bartlett's test values of instruments for physicians and pharmacists

Domain	Physician				Pharmacist			
	Indicator	KMO MSA	Total KMO AMS	Bartlett's test of sphericity	Indicator	KMO MSA	Total KMO MSA	Bartlett's test of sphericity
Attitude	DR2.A	0.68	0.85	*p*<0.001	APT2.A	0.74	0.85	*p*<0.001
	DR2.B	0.72			APT2.B	0.83		
	DR2.C	0.88			APT.C	0.81		
Communication	DR3.A	0.87			APT3.A	0.63		
	DR3.B	0.80			APT3.B	0.71		
	DR3.C	0.80			APT3.C	0.77		
	DR3.D	0.80			APT3.D	0.66		
	DR3.E	0.78			APT3.E	0.71		
Collaboration area	DR5.A	0.87			APT5.A	0.93		
	DR5.B	0.93			APT5.B	0.91		
	DR5.C	0.86			APT5.C	0.90		
	DR5.D	0.88			APT5.D	0.90		
	DR5.E	0.90			APT5.E	0.93		
	DR5.F	0.91			APT5.F	0.92		
	DR5.G	0.86			APT5.G	0.92		
Barriers	DR6.A	0.85			APT6.A	0.76		
	DR6.B	0.86			APT6.B	0.80		
	DR6.C	0.91			APT6.C	0.82		
	DR6.D	0.89			APT6.D	0.83		
	DR6.E	0.80			APT6.E	0.75		
	DR6.F	0.83			APT6.F	0.76		
	DR6.G	0.90			APT6.G	0.93		
	DR6.H	0.79			APT6.H	0.82		
	DR6.I	0.78			APT6.I	0.82		

Furthermore, the results of the model fit test presented in **Table 3** for the physician instrument demonstrate that the goodness of fit statistics meets the expected standards. All indicators of goodness of fit were satisfactory, including a CFI value of 0.94, a TLI of 0.93, a RMSEA of 0.05, and a SRMR of 0.07. Meanwhile, in the pharmacist instrument, the CFI value is 0.94, the TLI is 0.93, the RMSEA is 0.06, and the SRMR is 0.05. These results indicate that the goodness of fit criteria for the model demonstrates a good fit for the data.

Table 3. Goodness of fit statistical criteria for physicians and pharmacists

Criteria	Physician		Pharmacist	
	Reference	*p*-value	Reference	*p*-value
Comparative Fit Index (CFI)	>0.92	0.94	>0.92	0.94
Tucker-Lewis index (TLI)	>0.92	0.93	>0.92	0.93
Root Mean Square Error of Approximation (RMSEA)	<0.07	0.05	<0.07	0.06
Standardized root mean square residual (SRMR)	<0.08	0.07	<0.08	0.05

The results indicated that in the trust domain, which consisted of four question items, one question—"I ____ collaborated with pharmacists before"—had a factor loading value below 0.35. Consequently, this item was removed from the questionnaire. Following this removal, a review of the factor loading values for each indicator on the remaining two instruments confirmed that the factor loading values of the items met the predetermined validity criteria. The results of the convergent validity tests, presented in **Table 4** for the physician and the pharmacist instruments,

demonstrated positive outcomes. This was based on the factor loading values across the four domains measured in the study: attitudes, communication, collaboration areas, and barriers.

Factor loading measures how well each question or indicator represents the construct measured by a specific factor. For the physician instrument, factor loading values across four domains ranged from 0.36 to 0.93, while the pharmacist instrument showed values from 0.36 to 0.89. These results indicate that each indicator effectively reflects or correlates with the respective factor (**Table 4**). Higher factor loading values suggest a stronger contribution of the indicator to the measured construct, confirming the instruments' ability to assess attitudes, communication, collaboration areas, and barriers.

Table 4. Factor loading value for physicians and pharmacists

Domain	Physician		Pharmacist	
	Indicator	Factor loading ≥0.35	Indicator	Factor loading ≥0.35
Attitude	DR2.A	0.83	APT2.A	0.85
	DR2.B	0.93	APT2.B	0.73
	DR2.C	0.51	APT2.C	0.78
Communication	DR3.A	0.53	APT3.A	0.71
	DR3.B	0.36	APT3.B	0.36
	DR3.C	0.65	APT3.C	0.47
	DR3.D	0.70	APT3.D	0.36
	DR3.E	0.36	APT3.E	0.61
Collaboration area	DR5.A	0.57	APT5.A	0.72
	DR5.B	0.72	APT5.B	0.86
	DR5.C	0.68	APT5.C	0.83
	DR5.D	0.71	APT5.D	0.89
	DR5.E	0.77	APT5.E	0.88
	DR5.F	0.75	APT5.F	0.89
	DR5.G	0.49	APT5.G	0.86
Barriers	DR6.A	0.45	APT6.A	0.49
	DR6.B	0.54	APT6.B	0.65
	DR6.C	0.62	APT6.C	0.71
	DR6.D	0.73	APT6.D	0.62
	DR6.E	0.79	APT6.E	0.69
	DR6.F	0.73	APT6.F	0.69
	DR6.G	0.74	APT6.G	0.64
	DR6.H	0.65	APT6.H	0.58
	DR6.I	0.57	APT6.I	0.56

Convergent validity tests further demonstrated that the indicators were consistent and relevant, supporting the questionnaire's reliability and validity in measuring the intended items. Factor loading between subdomains met the expected standard (**Table 5**). Another discriminant validation test parameter used is the covariance factor value. The value of the covariance factor in the table meets the predetermined standard (<0.85).

In the pharmacist instrument analysis (**Figure 2A**), modification indices between subdomains APT6E and APT6F, APT6H and APT6I, and APT6A and APT6B were seen to improve the quality of goodness of fit. In the analysis of the physician instrument data (**Figure 2B**), there are modification indices between subdomains DR6E and DR6E, DR6H and DR6I, DR6A and DR6B, DR3B and DR3E, DR6B and DR6C, DR5C and DR5D, and DR6D and DR6G.

Table 5. Covariance factor values between domains for physicians and pharmacists

Correlation between perception domains			Physician covariance factor ≤0.85	Pharmacist covariance factor ≤0.85
Attitude	↔	Communication	0.30	-0.015
Attitude	↔	Collaboration Area	0.37	0.388
Attitude	↔	Barriers	0.11	0.057
Communication	↔	Collaboration Area	0.58	0.115
Communication	↔	Barriers	0.32	0.156
Collaboration area	↔	Barriers	0.39	0.198

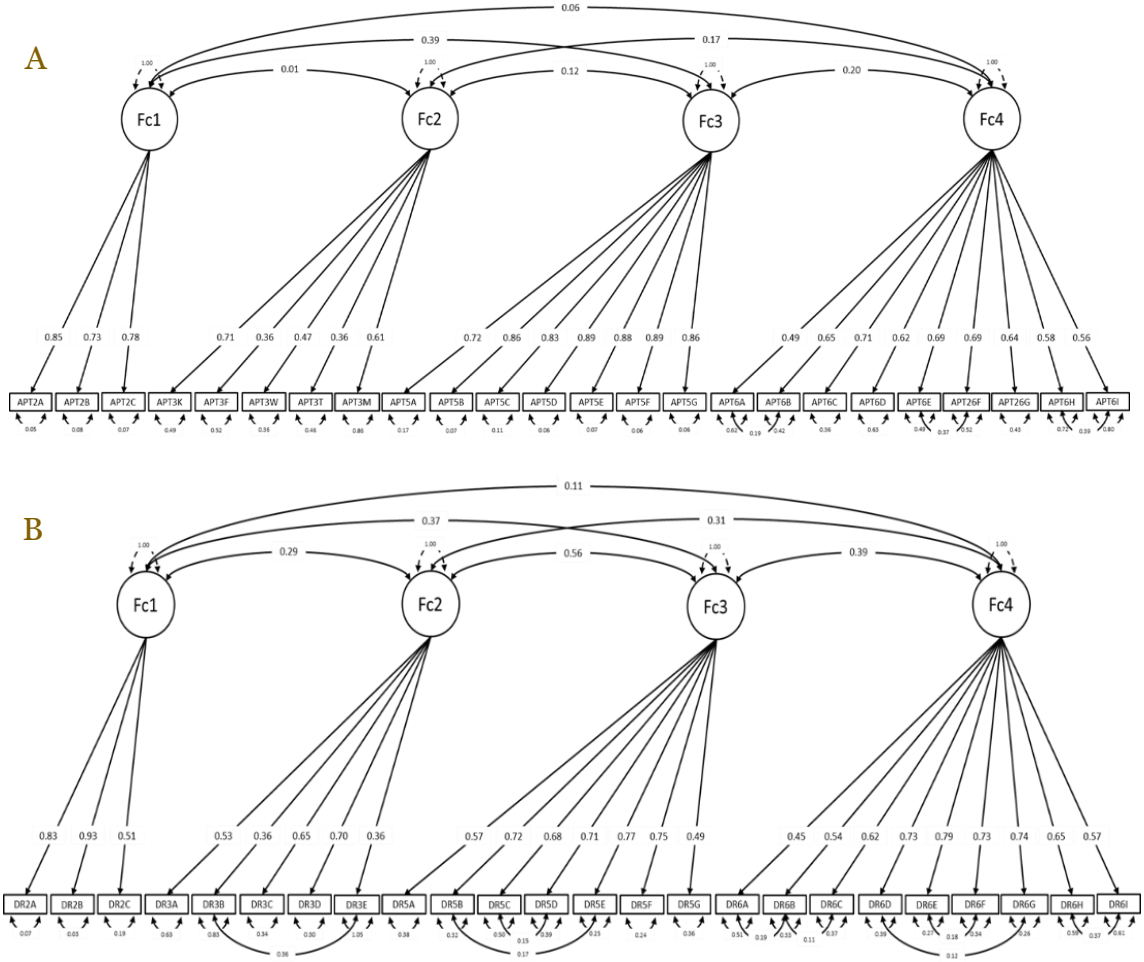

Figure 2. Path diagram for pharmacists (A) and physician (B) instruments.

Heterotrait-Monotrait ratio values are <0.85, indicating that the instrument meets the criteria for discriminant validity. This suggests that the measured items or constructs can be distinguished from one another according to the desired dimension or domain. Such analysis provides confidence that the instrument can effectively differentiate between the aspects being measured, thus supporting the discriminant validity of the instrument (**Table 6**).

Table 6. Heterotrait-Monotrait ratio for physicians and pharmacists

Group	Attitude	Communication	Collaboration area	Barriers
Physician	1.00			
	0.291	1.00		
	0.431	0.614	1.00	
	0.154	0.311	0.401	1.00
Pharmacist	1.00			
	0.152	1.00		
	0.394	0.168	1.00	
	0.082	0.157	0.164	1.00

Reliability analysis

Reliability tests indicated that both instruments had Cronbach's alpha scores above 0.6, confirming their consistency and reliability (**Table 7**). Thus, the results support the conclusion that the "KOMPAK" instrument is a highly reliable and valid tool for use in Indonesia.

Table 7. Reliability for physicians' and pharmacists' instruments

Domain	Indicator	Cronbach's alpha	Interpretation	Indicator	Cronbach alpha	Interpretation
Attitude	DR2.A	0.78	Reliable	APT2.A	0.82	Reliable

Domain	Indicator	Cronbach's alpha	Interpretation	Indicator	Cronbach alpha	Interpretation
	DR2.B			APT2.B		
	DR2.C			APT2.C		
Communication	DR3.A	0.66	Reliable	APT3.A	0.62	Reliable
	DR3.B			APT3.B		
	DR3.C			APT3.C		
	DR3.D			APT3.D		
	DR3.E			APT3.E		
Collaboration area	DR5.A	0.86	Reliable	APT5.A	0.95	Reliable
	DR5.B			APT5.B		
	DR5.C			APT5.C		
	DR5.D			APT5.D		
	DR5.E			APT5.E		
	DR5.F			APT5.F		
	DR5.G			APT5.G		
Barriers	DR6.A	0.87	Reliable	APT6.A	0.86	Reliable
	DR6.B			APT6.B		
	DR6.C			APT6.C		
	DR6.D			APT6.D		
	DR6.E			APT6.E		
	DR6.F			APT6.F		
	DR6.G			APT6.G		
	DR6.H			APT6.H		
	DR6.I			APT6.I		

Discussion

The results present the Cronbach's alpha reliability values of 0.88 for the physician instrument and 0.83 for the pharmacist instrument, these findings demonstrate a high level of consistency in participant responses. This evidence further supports the reliability of the instruments and their capability to provide stable measurements of collaboration between physicians and pharmacists in Indonesia. A previous study used forward-backward translation, cultural adaptation, and strict tests for validity and reliability, such as Cronbach's alpha and CFA [26]. This method is similar to the ones used in the KOMPAK study, which confirmed an instrument for measuring how well pharmacists and physicians in Indonesia work together. This shows how important it is to ensure that the instrument is relevant to the target population and reliable.

The translation process seeks to produce various language versions of the original instrument that maintain equivalent meaning across different cultural contexts [27]. It is advisable to engage multiple translators rather than relying on a single individual, as this approach mitigates potential bias and enhances fairness in the translation outcomes [28]. The translation process consists of two stages: forward translation, in which the original instrument is translated into the target language, and backward translation, wherein a linguist unfamiliar with the original instrument re-translates the instrument produced during the forward translation stage [29]. In this stage, no changes were made to add or remove items, and no significant issues were identified following the translation back into English.

The result of the feasibility test for both the physician and pharmacist instruments indicated that the goodness of fit statistics for each model met the expected standards. For the physician instrument, the CFI value was 0.94, the TLI was 0.93, the RMSEA was 0.05, and the SRMR was 0.07. These indicators collectively demonstrated a good fit of the physician instrument model to the data. Similarly, for the pharmacist instrument, the CFI value was 0.94, the TLI was 0.93, the RMSEA was 0.06, and the SRMR was 0.05, confirming that the goodness of fit criteria for the pharmacist instrument model also met established standards.

The CFI and TLI values for both instruments exceeded the reference limits (>0.92), indicating a good fit with the data. Additionally, the RMSEA and SRMR values were below the reference limits (<0.07 and <0.08, respectively), reflecting low approximation error and minimal residuals. Convergent validity was assessed to measure the extent to which indicators or questions within the measurement instruments agreed or were positively correlated while measuring the same concept. Several parameters were used to evaluate convergent validity, including factor loading values, composite reliability, and variance extracted. The analysis in the present study revealed that each indicator adequately reflected or was positively correlated with the measured concept or factor, although one item in the trust domain of both instruments was removed due to a factor loading value below 0.35. Overall, the instruments demonstrated positive convergent validity results. In discriminant validity, the Heterotrait-Monotrait ratio analysis in the present study indicated that both the physician and pharmacist instruments met the criteria for discriminant validity, with a ratio value of less than 0.85, suggesting that the measured items or constructs can be distinguished from one another according to the desired dimensions or domains. Model modifications enhanced the goodness of fit, as shown in the construct path diagram. Modification indices revealed improvements in subdomains DR6E and DR6F for the physician instrument and APT6E and APT6F for the pharmacist instrument. Reliability tests using Cronbach's alpha indicated adequate reliability for both instruments, with values exceeding 0.6, confirming that the KOMPAK instruments consistently measure the intended items. This instrument was subsequently adopted in Kuwait by Al Bassam and colleagues to evaluate similar collaborations between physicians and pharmacists [16].

This study is the inaugural investigation in Indonesia analyzing the collaborative dynamics between physicians and pharmacists, focusing on attitudes, experiences, communication strategies, perceptions of the pharmacist's role, potential avenues for enhanced collaboration, and obstacles to cooperative practice. This study's results furnish quantifiable data to evaluate the collaboration between doctors and pharmacists in healthcare services. The gathered information can serve as a foundation for health authorities to formulate targeted interventions, promote the establishment of optimal interprofessional relationships, and foster collaborative practices in clinical settings in Indonesia. Furthermore, these findings hold substantial significance for comparison with prior studies conducted in other nations. This research enhances the understanding of the collaborative dynamics between physicians and pharmacists within the healthcare context, as evidenced in the Middle East [30-32] and globally [33-35].

This study demonstrates that the majority of participants (almost 98%) concur that collaboration between physicians and pharmacists might enhance patient outcomes. While the percentage of physicians and pharmacists exhibiting a favorable disposition towards collaborative practice aligns with research conducted in Canada and Kuwait [15,16], this finding surpasses earlier studies in Croatia, the United States, Iran, and Slovakia [32,33,35,36]. Female participants had a stronger propensity to endorse positive views towards collaborative activities compared to their male counterparts, consistent with existing literature and the higher prevalence of female participants relative to males.

In this study, physicians engaged in collaboration with pharmacists less frequently and held fewer favorable views regarding collaboration, especially with the pharmacist's clinical function. This may stem from the professional ethos of certain physicians, who typically perceive themselves as solely accountable for patient outcomes and exhibit reluctance to engage other healthcare workers, such as nurses, in the process. In Indonesia, both physicians and pharmacists favor communication through telephone (including WhatsApp), written papers (such as prescriptions, medical record reports, or other supporting materials), and in-person interactions. The findings of our study closely align with those of two prior investigations conducted in Canada and Kuwait [15,16], wherein telephone and face-to-face contact ranked first and second, respectively, followed by fax and social media interactions.

Pharmacists in Indonesia exhibit a preference for telephone contact over face-to-face interaction, based on the results obtained. During our field observations and data collection, numerous pharmacist participants indicated that a hierarchical disparity exists between doctors and pharmacists in Indonesia, with doctors seen to hold a superior position in patient care. This contrasts with findings in Kuwait [16], where, despite a similar hierarchical structure among

doctors, pharmacists possess the authority to proactively engage with physicians to enhance patient care services.

The attitudes of physicians and pharmacists regarding the pharmacist's position significantly influence collaborative practices within healthcare systems [15,37]. Physicians anticipate that pharmacists will contribute by (i) enhancing patient adherence; (ii) advising on drug interactions; (iii) counseling patients on prescribed medications; (iv) supplying drug information to aid physicians in therapeutic decisions; (v) preparing formulations; (vi) assisting with dosage adjustments; (vii) managing adverse drug reactions; (viii) advising on modifications to drug therapy. From the pharmacist's perspective, the following order is observed: (i) physicians enhance patient adherence; (ii) counsel patients regarding their prescriptions; (iii) assist in managing adverse drug reactions; (iv) provide guidance on drug interactions; (v) offer drug information services; (vi) facilitate drug dosage modifications; (vii) prepare formulations; (viii) recommend alterations to drug therapy. The paramount objective of collaboration is to enhance patient compliance.

Participants under 40 had considerably more favorable perceptions of prospective collaboration than those aged 40 and above, consistent with other research findings [33]. To facilitate effective interprofessional collaboration, it is essential to identify and devise interventions that mitigate barriers to its implementation [38,39]. Both professions concur that the primary impediments to realizing collaborative objectives between physicians and pharmacists encompass insufficient face-to-face communication, time constraints, the necessity for consensus among various healthcare professionals, and the potential fragmentation of patient care resulting from the involvement of multiple practitioners. These findings align with the outcomes of prior studies conducted in Canada, Iran, and Slovakia. In Canada, time constraints, financial settlements, and engagement with other health experts were seen as significant obstacles to collaborative practice [15,30]. The absence of direct communication and the possible fragmentation of patient services due to the participation of several health providers are significant barriers in Iran [31]. In Slovakia, insufficient compensation, fragmentation of patient services due to the participation of many health professionals, and time constraints were identified as significant obstacles to collaborative practice [33]. In Kuwait, time constraints and inadequate compensation are the primary barriers to collaboration [16].

Strategies must be implemented to surmount obstacles to this partnership, necessitating the active involvement of physicians, pharmacists, and health authorities in addressing these issues. Pharmacists may allocate more time if there were a clearer comprehension of the distinctions between the tasks of pharmacists and pharmaceutical technicians [40,41]. Should pharmacists disengage from dispensing and medication preparation responsibilities, they could allocate additional time to enhance patient care activities. Moreover, prior research demonstrates that collaboration with clinical pharmacists can alleviate physician workload and enhance patient care, as clinical pharmacists possess the capability to assess medication records, identify medication non-adherence, rectify prescribing errors, and detect therapeutic duplication [30,32,35]. Consequently, the use of collaborative practices within Indonesia's health service system could alleviate physicians' burden and enhance time efficiency.

Upon analyzing the results of multiple studies, we conclude that enhancing collaboration between physicians and pharmacists in Indonesia must commence at the university level. We advocate for the establishment of institutional regulations to govern this matter, particularly inside hospitals, to enhance the interaction time between physicians and pharmacists. The design of their respective practice rooms should be positioned in closer proximity. Another suggestion is to enhance the frequency of direct interactions between physicians and pharmacists, for instance, through regularly scheduled meetings mutually established by both sides to discuss cases of sickness and treatment. Another factor to consider is the compensation received by these two occupations.

The present study has several strengths and weaknesses. The strengths include: (i) a large participant pool of physicians and pharmacists representing three regions of Indonesia (West, Central, and East), indicating that the KOMPAK instrument is relevant and valuable for stakeholders across various health practice contexts; (ii) the validation process yielded insights regarding interprofessional collaboration, revealing that geographical differences influence the

challenges faced by physicians and pharmacists, with fewer physicians in Eastern Indonesia compared to the West. The roles of the Indonesian Pharmacists Association (IAI) and the Indonesian Physicians Association (IDI) were crucial in participant recruitment. However, several important limitations require careful scientific consideration in our study. First, the involvement of specialists was limited, with only 42 professionals willing to participate, a significant methodological constraint, despite their crucial role in interprofessional collaboration (IPC) in Indonesia. Second, although our data collection covered western, central, and eastern Indonesia, there were still geographical disparities, especially in remote areas. These areas likely have unique professional dynamics and could be the focus of further research, for example, by comparing IPC in urban and rural areas. Third, the cross-sectional study design only provides a brief overview of IPC in Indonesia and may not reflect changes in interprofessional relationships over time. Beyond the methodological constraints, we propose several strategic steps for future research. First, the geographical scope should include remote and marginalized areas. Second, mixed methods that combine quantitative data and qualitative insights should be used. Third, developing longitudinal research to track the development of interprofessional collaboration from education to practice. Fourth, exploring the evolution of collaborative competencies among students from various health disciplines. Future research could also address important questions, such as how collaborative skills from academic training develop in the professional world, what interventions are most effective for enhancing collaboration, and whether interdisciplinary exposure during undergraduate education can change patterns of professional interaction.

Conclusion

The KOMPAK instrument exhibited strong validity and reliability, with a good fit to the data and satisfactory discriminant validity. The final version consists of 24 items and is reliable for measuring collaboration between physicians and pharmacists in Indonesia, demonstrating a well-defined structure and strong internal consistency for assessing interprofessional collaboration practices. Therefore, its use is recommended in future studies within the Indonesian context.

Ethics approval

Protocol of the present study was reviewed and approved by the Ethical Committee of Faculty of Public Health, Universitas Hasanuddin, Makassar, Indonesia (Approval number: 3969/UN4.14.1/TP.01.02/2023). Additionally, research permits were obtained from local authorities at each research site, including authorization from the hospitals, which serve as the primary focus of this research.

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request. The Indonesian version of the KOMPAK instrument for Physicians and Pharmacists can be accessed through this link: https://dx.doi.org/10.6084/m9.figshare.28021082. For permission to use the KOMPAK instrument, please contact the first or corresponding authors.

Declaration of artificial intelligence use

This study utilized artificial intelligence (AI) tools and methodologies in the following capacities: for manuscript writing support, AI-based language models such as ChatGPT, Claude, and QuillBot were employed to provide: (a) language refinement (improving grammar, sentence structure, and readability of the manuscript); (b) content summarization (assisting in concisely summarizing findings and conclusions); and (c) technical writing assistance (providing suggestions for structuring complex technical descriptions more effectively and drawing conclusions). We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

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