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LITERATURE REVIEW

KNOWLEDGE AND ATTITUDE OF FARMERS TOWARDS ANTIMICROBIAL RESISTANCE IN ASIA: A SYSTEMATIC REVIEW AND META-ANALYSIS

Pengetahuan dan Sikap Peternak terhadap Resistensi Antimikroba di Asia: Tinjauan Sistematis dan Meta-Analisis

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ABSTRACT

Background: Antimicrobial resistance is a severe threat to public and environmental health. The agricultural sector contributes significantly to resistance, where antimicrobials are used as prophylaxis, growth promoters, and for treatment. A series of studies have been conducted to assess farmers' knowledge and attitude levels with varying results, particularly in Asia, one of the world's largest producers of livestock products. **Purpose:** To review the pooled estimated level of knowledge and attitude towards antimicrobial use and resistance in Asia. **Methods:** A literature search was conducted according to PRISMA in Scopus, PubMed, Google Scholar, and Embase for studies up to 30 April 2023. Quality was assessed using the Newcastle-Ottawa Scale (NOS) for cross-sectional studies. Outcomes were further categorized into constructs under knowledge and attitude. Random-effect meta-analysis was conducted using STATA 17. **Results:** 11 studies and 2131 subjects were included with fair to excellent quality. From the meta-analysis, the following knowledge and attitude levels were estimated: definition [55.7% (95%CI: 37.3%-74%)] and cause [60.6% (95%CI: 40.5%-80.6%)] of antimicrobial resistance; the negative impact of antimicrobials [62.6% (95%CI: 16.9%-100.0%)]; use of antimicrobials for treatment [47.8% (95%CI: 6.1%-89. 4%)], prophylaxis [58.5% (95%CI: 28.5%-88.5%)], growth promoter [39% (95%CI: 23.1%-54.9%)]; discontinuation of antimicrobials upon improving conditions [42.5% (95%CI: 15.4%-69.5%)]. **Conclusions:** Farmers in Asia have moderate knowledge of antimicrobial resistance but still exhibit attitudes that support resistance.

ABSTRAK

Latar Belakang: *Resistensi antimikroba merupakan ancaman serius bagi*

*kesehatan masyarakat dan lingkungan. Sektor peternakan berkontribusi besar terhadap timbulnya resistensiantimikroba yang digunakan sebagai profilaksis, growth promoter, dan untuk pengobatan. Serangkaian penelitian telah dilakukan untuk menilai tingkat pengetahuan dan sikap peternak dengan hasil yang bervariasi, khususnya di Asia sebagai salah satu produsen hasil ternak terbesar di dunia. **Tujuan:** Mengkaji tingkat pengetahuan dan sikap para peternak di Asia terkait penggunaan dan resistensi antimikroba. **Metode:** Pencarian literatur dilakukan sesuai dengan PRISMA di Scopus, PubMed, Google Scholar, dan EMbase untuk studi hingga 30 April 2023. Kualitas penelitian dinilai menggunakan Newcastle-Ottawa Scale (NOS) untuk studi cross-sectional. Hasil dari studi dikategorikan ke dalam konstruk dibawah pengetahuan dan sikap. Meta-analisis model acak dilakukan menggunakan STATA 17. **Hasil:** Terdapat total 11 studi dan 2131 subjek dengan kualitas cukup hingga sangat baik. Dari meta-analisis, diperoleh estimasi tingkat pengetahuan dan sikap sebagai berikut: definisi resistensi antimikroba [55.7% (95%CI: 37.3%-74%)]; penyebab resistensi [60.6% (95%CI: 40.5%-80.6%)]; dampak negatif antimikroba [62.6%(95%CI: 16.9%-100.0%)]; penggunaan antimikroba untuk pengobatan [47.8% (95%CI: 6.1%-89.4%)], profilaksis [58.5% (95%CI: 28.5%-88.5%)], growth promoter [39% (95%CI: 23.1%-54.9%)]; dan penghentian pemberian antimikroba saat kondisi hewan membaik [42.5% (95%CI: 15.4%-69.5%)]. **Kesimpulan:** Peternak di Asia memiliki pengetahuan sedang mengenai resistensi antimikroba namun masih menunjukkan sikap yang mendukung resistensi.*

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as a grave global health concern, posing significant challenges to global public health (1). AMR occurs when microorganisms can withstand the effects of drugs initially intended to eliminate them, rendering such treatments ineffective. The unrestricted utilization of antibiotics contributes to the acceleration of AMR, resulting in escalated medical expenses and mortality rates (2). As microorganisms acquire resistance to antimicrobials, they also gain an increased capacity to proliferate in animals, humans, and the environment (3).

While the circumstances surrounding antimicrobial resistance may vary across regions and countries, it is evident that Asia, home to more than 70% of the global population, serves as a significant epicentre of this issue. The Antimicrobial Resistance in the Asia Pacific & Its Impact meeting held in Singapore highlighted vital challenges faced by countries in the Asia-Pacific region concerning AMR. These challenges include the unclear understanding of the burden of AMR, inadequacies in healthcare systems, the absence of a formal network dedicated to addressing AMR, and the lack of accessible data for global sharing.

The obstacles hindering progress in controlling AMR in the Asia-Pacific region are vast and impact both low-to-middle-income and high-income countries (LMICs) (4).

Inadequate infection control measures, mismanagement of antimicrobials, environmental contaminants, presence of agricultural waste, and the movement of individuals and animals infected with resistant bacteria all contribute to the dissemination of AMR. In the agricultural sector, antimicrobials serve various purposes, including therapeutic, prophylactic, and growth promotion applications, as they play a significant role in animal production (3). The global consumption of antimicrobials in animals is estimated to surpass that in humans. Many antimicrobial classes crucial for human medicine are also prescribed for animals. This practice has been associated with outbreaks of infectious diseases caused by multidrug-resistant organisms transmitted through food sources (5,6).

The emergence and dissemination of antibiotic-resistant bacteria (ARB) and antibiotic-resistant genes (ARGs) along the entire farm-to-plate continuum pose a significant concern. Antimicrobial resistance (AMR) in pre- and post-harvest systems presents a notable risk of contamination or infection, directly affecting

farmers, agricultural practitioners, and consumers (7). Farmers, regarded as the frontline defenders against AMR, play a pivotal role in understanding practices that may foster or hinder AMR proliferation. Appreciating the significance of antimicrobial resistance (AMR) is paramount for farmers, as it directly impacts their productivity, economic gains, and the long-term viability of their agricultural operations.

Numerous studies have been conducted to assess the knowledge and attitudes of farmers, yielding varying outcomes, particularly in Asia, a major global producer of livestock products. Therefore, this meta-analysis aims to evaluate the aggregated levels of knowledge and attitudes towards antimicrobial use and resistance in Asia.

METHODS

Search Strategy

The articles included in this meta-analysis were discovered through searches on electronic databases, following the guidelines provided in the checklist of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Protocols (8). Two authors (MMAZA and NA) conducted searches in PubMed/MEDLINE, EMBASE, SCOPUS, and Google Scholar for studies up to 30 April 2023. Predetermined key terms such as knowledge, attitude, farmers, and antimicrobial resistance were used - alongside appropriate Boolean operators and Medical Subject Headings (MeSH) where applicable. Eligible studies were retrieved and managed using Excel 2016.

Eligibility Criteria

In selecting articles, the following inclusion criteria were used: (1) cross-sectional study design, (2) accessible full-text, (3) conducted on farmers in the Asian continent, (4) reported proportions of knowledge and attitude, (5) published in a peer-reviewed journal, and (6) written in Indonesian or English. Studies that did not quantitatively report specific proportions related to knowledge and attitude were excluded. Letters to editors, editorials, preprints, and conference proceedings were also excluded.

Study Outcomes and Measurement

The primary outcome of this meta-analysis was the proportion of good knowledge and attitude of farmers surrounding antimicrobial use and resistance. The operational definition of knowledge covered the understanding of antimicrobial's definition, causes, animal-human transmission, curative effects, adverse effects, and withdrawal time. In defining a good attitude, the following were considered: intention to use, stoppage, regulation, seeking professional advice, urgency, and potential harm towards humans, animals, and the environment.

Selection and Data Extraction

Duplicates were first removed using Excel 2016. The screening process for relevant articles was carried out through two stages. Initially, the titles and abstracts were screened based on the predetermined criteria outlined in the search strategy. Subsequently, potential articles were selected for further assessment based on the eligibility criteria. At this stage, articles deemed irrelevant or fell outside the scope of the study were excluded.

The data extraction process followed the format specified by JBI (9), including details such as the first author, publication year, location, sample size, and proportions of participants with favourable knowledge and attitudes. The type of farming, data collection tool, and other outcome measures were also extracted. Relevant antimicrobial use and resistance questions were extracted and further categorized into appropriate subgroups qualitatively. Any discrepancies between the two reviewers regarding data extraction were resolved through discussion.

Risk of Bias Assessment

In this study, the modified Newcastle Ottawa scale for cross-sectional studies checklist was employed to assess the included studies' internal validity (risk of bias) (10). MMAZA carefully read the full text of each article and completed the quality assessment checklist. NA independently conducted the exact process. Any disagreements were resolved through group discussions. The scores ranged from 0 to 10, calculated based on the checklist for each study. Consequently, the risk of bias for the articles was classified into three categories: low risk (scores of 8-10), medium risk (scores of 5-7), and high risk (scores of 0-5).

Data Processing and Analysis

Extracted data was reported descriptively in tabular format. Prevalence meta-analysis was conducted using the statistical software package STATA 17. The Cochrane Q statistic was used to assess the heterogeneity of studies. The

heterogeneity level was measured using the I2 (%) value, where percentages of 25%, 50%, and 75% represented low, moderate, and high heterogeneity, respectively. As the observed heterogeneity exceeded 50%, the random effect model was employed for the analysis (11). The outcomes were presented as a pooled proportion with a 95% confidence interval for knowledge and attitude, visually displayed in a forest plot.

RESULTS

Characteristics of Individual Studies

This systematic review and meta-analysis evaluated the pooled knowledge and attitudes of farmers in Asia on AMR and antimicrobial use. All of the selected studies (n = 11) (12,13,22,14–21) comprised 2,131 (ranging from 13 to 420) participants, of which 789, 444, 436, and 462 were poultry, ruminant, pig, and aquaculture farmers, respectively (Figure 1). All studies employed a cross-sectional study design, with the majority using pre-validated questionnaires. All of the included studies were conducted between 2018 and 2022 (Table 1). The intended outcomes extracted from the included studies are shown in Table 2. Forest plots of the intended outcomes are attached as Appendix 1 and 2.

Knowledge About Antimicrobial Use and Resistance

Six studies reported on the overall knowledge of participants about the definition of antimicrobials (12–17) and withdrawal time in antimicrobial usage (12,14,15,18–20), where 48.14% (95%CI: 15.90-80.39%) and 60.20% (95%CI: 16.79-103.61%) participants had positive knowledge. Three studies reported knowledge about animal-human microbial transmission (13,14,19) and adverse effects following antimicrobial use (13,14,19) where 68.09% (95%CI: 53.63-82.54%) and 62.64% (95%CI: 16.86-108.41%) demonstrated good knowledge. In addition, among four studies 55.68% (95%CI: 37.28-74.07%) and 60.55% (95%CI: 40.48-80.61%) farmers understood the definition (13–15,20) and common etiologies (14,15,18,19) of AMR. From a total of 877 samples reported by four studies (13,14,19,21), 39.97% (95%CI: 23.01-56.93%) of participants believed that all antimicrobials have the same curative effects towards animals (Table 3).

Attitude Towards Antimicrobial Use and Resistance

Three studies reported attitudes of participants towards stopping antimicrobial administration when condition improves (13,14,19), regulating antimicrobial use (14,15,19), and the urgency of antimicrobial usage as a pressing issue (13,19,20) where 42.47% (95%CI: 15.41-69.54%), 63.86% (95%CI: 30.33-97.39%), and 54.54% (95%CI: 22.75-86.337%) participants hold good attitudes. Five studies reported that 47.77% (95%CI: 6.14-89.4%), 58.51% (95%CI: 28.48-88.54%), 38.98% (95%CI: 23.12-54.85%) participants agreed in using antimicrobial to treat illness (12,15,16,18,20), as prophylaxis (14–16,18,20), and growth promoters (14,15,18–20), respectively. Attitudes of participants towards seeking of professional advice was reported in 8 studies (12–15,18–21) where the pooled proportions of participants with good attitude was 69.40% (95%CI: 35.57-100.00%) (Table 4).
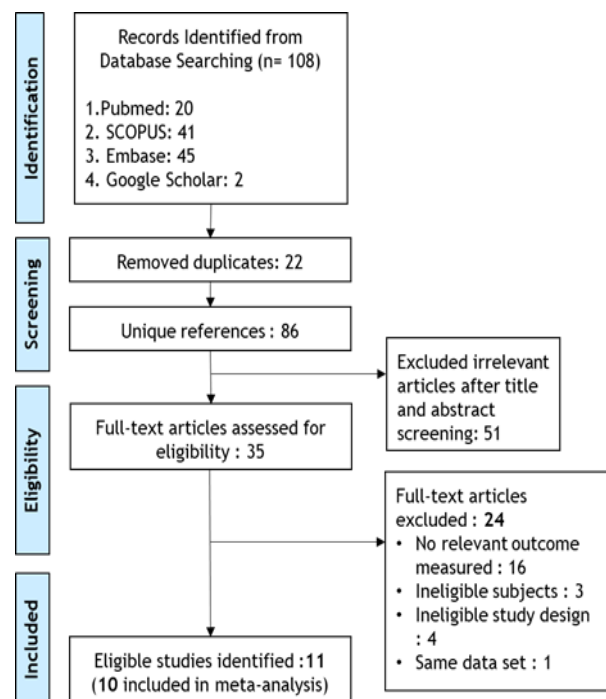

Figure 1. PRISMA Flowchart

Table 1
Demographic Characteristics of The Included Studies

Author (Year)	Location	Sampling Date	n	Subject characteristics	Questionnaire Collection Method	Outcome measure(s)	NOS Score	Risk of Bias
Efendi et al. (2022)	Indonesia	March to July 2021	132	small-scale broiler farmers	Face to face interview	Knowledge, attitude, behaviour	9	Very good
Ozturk et al. (2019)	Turkey	NA	360	cattle farmers	Face to face interview	Knowledge, attitude, practices	7	Good
Ali et al. (2022)	Malaysia	NA	70	fish farmers	Offline, Self-administered	Knowledge and awareness	3	Unsatisfactory
Ting et al. (2021)	Timor Leste	August to September 2020	165	small-scale pig farmers	Face to face interview	Knowledge	9	Very good
Sadiq et al. (2018)	Malaysia	June to September 2017	84	ruminant farmers	Online, self-administered	Knowledge and attitude	8	Good
Hassan et al. (2021)	Bangladesh	October 2019 to March 2020	420	poultry farmers	Offline, Self-administered	Knowledge, attitude, practices	8	Good
Pham-Duc (2019)	Vietnam	September 2017 to January 2018	392	Medium livestock and aquaculture farmers	Face to face interview	Knowledge, attitude, practices	9	Very good
Dyar et al. (2020)	China	19 to 25 July 2015	271	backyard pig farmers	Face to face interview	Knowledge, attitude, practices	9	Very good
Lambrou et al. (2021)	Nepal	July to August 2018	150	commercial poultry farmers	Face to face interview	Knowledge	8	Good
Fajar et al. (2021)	Indonesia	May 2020	13	broiler farmers	Face to face interview	knowledge and attitude	9	Very good
Purnawarman et al. (2020)	Indonesia	NA	74	broiler farmers	Face to face interviews	Knowledge, attitude, practices	8	Good

Table 2
Outcome and Subgroups of Knowledge and Attitude from Included Studies

Outcome	Efendi et al. (2022)	Ozturk et al. (2019)	Ting et al. (2021)	Sadiq et al. (2018)	Hassan et al. (2021)	Pham-Duc et al. (2019)	Dyar et al. (2020)	Lambrou et al. (2021)	Fajar et al. (2021)	Purna warman et al. (2020)
Knowledge, n (%)										
Definition of antimicrobials	-	-	21 (12.70)	37 (44)	387 (92.10)	112 (28.60)	97 (35)	-	-	56 (76)
Definition of antimicrobial resistance	-	-	47 (56)	47 (56)	238 (56.70)	301 (77)	-	49 (32.70)	-	-
Causes of antimicrobial resistance	101 (76.50)	259 (72)	-	-	261 (62.10)	125 (32)	-	-	-	-
Animal-human antimicrobial transmission	-	223 (62)	51 (61)	51 (61)	338 (80.50)		-	-	-	-
All antimicrobials have the same curative effect towards animals	-	144 (40)	60 (71)	60 (71)	121 (28.10)		-	-	2 (15.39)	-
Negative effects following antimicrobial use	-	133 (48)	45 (54)	45 (54)	408 (97.10)		-	-	-	-
Withdrawal time in use	122 (92.40)	320 (89)	-	-	231 (55)	380 (97)	-	-	-	-
Attitude, n (%)										
Use antimicrobials to treats illness	16 (12.10)	-	5 (0.03)	-	-	305 (78)	137 (50)	143 (95.30)	-	-
Use antimicrobials as prophylaxis	128 (97)	-	-	-	264 (62.90)	223 (57)	48 (18)	87 (58)	-	-
Use antimicrobials as growth promotors	95 (72)	147 (41)	-	-	182 (43.30)	103 (26.40)	-	20 (13.30)	-	-
Antimicrobial administration should be stopped when condition improves	-	247 (59)	-	21 (25)	140 (33.33)		-	-	-	-
Antimicrobials use should be regulated	-	198 (55)	-	-	183 (43.60)	364 (93)	-	-	-	-
Proper antimicrobial use should be based on veterinary advice, drug labels, national policies	120 (90.90)	180 (50)	3 (0.01)	73 (87)	371 (88.30)	364 (93)	-	102 (68)	10 (76.92)	-

(Continued)

Table 2
Continue

Outcome	Efendi et al. (2022)	Ozturk et al. (2019)	Ting et al. (2021)	Sadiq et al. (2018)	Hassan et al. (2021)	Pham-Duc et al. (2019)	Dyar et al. (2020)	Lambrou et al. (2021)	Fajar et al. (2021)	Purna warman et al. (2020)
Attitude, n (%)										
Antimicrobial resistance is a pressing issue	-	277 (77)	-	48 (57)	-	--	-	44 (91.70)	-	-
Antimicrobial resistance can harm animal, human, and environmental health	12 (9)	309 (86)	-	49 (58)	338 (80.50)	272 (69.40)	-	49 (100)	-	-

Table 3
Pooled Prevalence of Knowledge about Antimicrobial Resistance and Use Among Farmers in Asia

Knowledge	No of study	Sample size	Percentage, (%)	95% CI	I^2 (%)	p
Definition of antimicrobials	6	1,406	48.14	15.90,80.39	99.58	0.00
Definition of antimicrobial resistance	4	1,406	55.68	37.28,74.07	97.34	0.00
Causes of antimicrobial resistance	4	1,304	60.55	40.48,80.61	98.39	0.00
Animal-human antimicrobial transmission	3	864	68.09	53.63,82.54	94.86	0.00
All antimicrobials have the same curative effect towards animals	4	877	39.97	23.01, 56.93	95.62	0.00
Negative effects following antimicrobial use	3	864	62.64	16.86,108.41	99.64	0.00
Withdrawal time in use	6	1,619	60.20	16.79, 103.61	99.93	0.01

Table 4
Pooled Prevalence of Attitudes towards Antimicrobial Resistance and Use Among Farmers in Asia

Attitude	No of study	Sample size	Percentage, (%)	95% CI	I² (%)	p
Use antimicrobials to treat illness	5	1,110	47.77	6.14, 89.4	99.82	0.02
Use antimicrobials as prophylaxis	5	1,365	58.51	28.48, 88.54	99.54	0.00
Use antimicrobials as growth promotors	5	1,454	38.98	23.12, 54.85	97.81	0.00
Antimicrobial administration should be stopped when condition improves	3	864	42.47	15.41, 69.54	98.52	0.00
Antimicrobials use should be regulated	3	1,172	63.86	30.33, 97.39	99.51	0.00
Proper antimicrobial use should be based on veterinary advice, drug labels, national policies	8	1,716	69.40	35.57, 100.00	99.83	0.00
Antimicrobial resistance is a pressing issue	3	594	54.54	22.75, 86.33	98.37	0.00
Antimicrobial resistance can harm animal, human, and environmental health	6	1,538	56.02	30.99, 81.05	99.35	0.00

DISCUSSION

Overall, >50% of farmers included in this meta-analysis had good knowledge about antimicrobial resistance and its use, with a few exceptions. Surprisingly, 48.14% of farmers in Asia fully understood the definition of antimicrobials in the first place. A similar meta-analysis by Al Sattar et al (22) on the knowledge and practice of poultry farmers on antimicrobials also reported sub-par knowledge of AMR (43%) despite most (66%) knowing how resistance may arise. In another review by Mckernan et al (23) on factors influencing the behaviour of using antimicrobials in agriculture, farmers in Asia (Cambodia, China, Bangladesh, India, Indonesia, Vietnam, Thailand, and Malaysia) displayed a limited understanding of antimicrobials and their potential implications towards health.

While the findings suggest that farmers in Asia possess awareness (62.64%) regarding the adverse consequences and potential for zoonotic transmission (68.09%) associated with antimicrobial use, there is still a prevalent issue of excessive and inappropriate use, as well as insufficient awareness, within the animal production sector throughout the region. Livestock and fish producers in Southeast Asia, facing the dual challenge of meeting escalating domestic demand and catering to the export market, heavily depend on the utilization of antimicrobials (24).

In comparison to knowledge, farmers in Asia still tended to use antimicrobials as prophylaxis (58.51%). More concerningly, most farmers denied using antimicrobials to treat (47.77%) and stopped when the animals were clinically healthy (42.47%). These results are different from the ones reported by Al Sattar et al. (22), which stated treatment as the primary purpose of using antimicrobials (65%), followed by prophylaxis (45%) and growth promoters (29%).

Interestingly, a significant proportion of farmers (54.54%) acknowledged the pressing nature of antimicrobial resistance (AMR) and recognized its potential to harm both humans and the environment (56%). Notably, the problem of AMR gene transfer is further exacerbated by inadequate sanitation practices and the absence of proper waste treatment and biocontainment measures in numerous farms across Southeast Asia (24). Using human and livestock excreta as fertilizers in fish ponds creates an optimal environment for transferring AMR genes or bacteria between animal species, leading to subsequent contamination of water sources (23). Furthermore, farmers in Southeast Asia do not perceive themselves as being responsible for ensuring responsible antimicrobial usage, possibly due to a lack of standardized and consistent data collection and reporting processes in the Asia-Pacific region, thereby hindering accurate assessment of the AMR burden and the impact of interventions implemented in the region (4).

Regarding good attitudes and values (25), farmers who strongly desired to be perceived as "good farmers" by their peers demonstrated a higher likelihood of supporting measures to promote responsible antimicrobial use. This study revealed that 69.40% of farmers preferred seeking advice from higher-ranking and more knowledgeable advisors before using antimicrobials. However, various challenges, such as economic vulnerability, narrow profit margins, limited access to funding facilities, inadequate financial resources for veterinary consultations, and subpar farming structures, practices, and infrastructure, have contributed to the continued dependence on antimicrobials in agriculture (23).

Research Limitations

It is critical to recognise several limitations while conducting this meta-analysis. The inclusion criteria only considered journal articles published in English and Indonesian, excluding other potential sources such as pre-print articles in local databases. This limitation limits the study's comprehensiveness. Furthermore, the observed high heterogeneity among the included studies can be attributed to various factors, including differences in the tools and questionnaires used to assess knowledge and attitude components. Another area for improvement is the small sample size in some studies, which may limit the findings' generalizability to the respective countries' populations. It is critical to keep this in mind when interpreting the results. Furthermore, some of the studies in this analysis reported limited relevant outcomes, raising concerns about their validity.

CONCLUSION

In conclusion, AMR represents a critical global health concern that requires immediate attention. This meta-analysis showed that knowledge about antimicrobials in Asian farmers was satisfactory. However, the majority still agreed on several attitudes promoting AMR development. Policymakers should consider such shortcomings, especially when farmers are regarded as the frontline defenders against AMR.

CONFLICT OF INTEREST

The authors declare no conflict of interest. No funding was received in the making of this paper.

AUTHOR CONTRIBUTION

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