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Effectiveness of Educational Interventions in Changing Parental Antibiotic Use Behaviour: A Systematic Review

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ABSTRACT

Background: Antibiotics are essential for treating bacterial infections but are ineffective against viral illnesses. Parental misconceptions often lead to the inappropriate use of antibiotics, contributing to antimicrobial resistance. While educational interventions aim to improve parental awareness, their effectiveness in changing actual behaviour remains unclear. This systematic review aimed to evaluate the effectiveness of educational interventions in modifying parental antibiotic use behaviour, assessing whether increased knowledge translates into responsible antibiotic practices.
Methods: A systematic search was conducted in Scopus, EBSCO Discovery Service (EDS), Google Scholar, and Science Direct for studies published between January 1, 2014, and December 31, 2024. Studies assessing educational interventions targeting parental knowledge, attitudes, and behavioural outcomes related to antibiotic use were screened and reviewed.
Results: Of 1,921 articles screened, seven met the inclusion criteria. While all studies reported improved parental knowledge and attitudes, only three assessed actual behavioural changes. Most studies lacked objective behavioural outcome measures, limiting conclusions on intervention effectiveness. Geographically, only one study was conducted in Asia (Hong Kong), with no studies from Malaysia, highlighting a significant regional research gap.
Conclusion: This review underscores the scarcity of studies evaluating behavioural outcomes in parental antibiotic use interventions, particularly in Southeast Asia. Future research should prioritise robust study designs that assess real-world behavioural changes to develop effective, region-specific educational programs.

Keywords: Antibiotic use; Antimicrobial resistance; Parental behaviour; Educational interventions; Behaviour change

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INTRODUCTION

Antimicrobial resistance (AMR) is an escalating global health threat, with the misuse and overuse of antibiotics being major contributors to the emergence of resistant bacteria (1). Inappropriate antibiotic use accelerates the development of resistance, reducing the effectiveness of treatments and increasing the burden of infectious diseases (2). In children, this issue is particularly concerning, as upper respiratory tract infections (URTIs) are among the most common illnesses in this population, often leading to unnecessary antibiotic prescription (3). The World Health Organization (4) reports that children experience 4 to 6 respiratory infections per year, making them frequent recipients of antibiotics, even when not medically necessary. Despite fewer than 10% of URTIs being bacterial (5,6), antibiotics are still widely prescribed, contributing to AMR and posing long-term risks to children's health (7,8).

Parental misconceptions about antibiotics play a crucial role in this problem. Many parents believe that antibiotics are necessary for common viral infections, leading them to pressure healthcare providers for prescriptions or self-medicate their children with leftover antibiotics (9). This inappropriate use increases the likelihood of antibiotic resistance and exposes children to unnecessary side effects. Research has shown that improving parental knowledge and awareness can influence antibiotic-related decisions (10,11). However, knowledge alone does not always translate into responsible antibiotic practices, as behavioural and cultural factors also shape parental decision-making (12). Addressing AMR, therefore, requires more than just educational campaigns. It demands interventions that effectively change parental behaviours toward antibiotic use.

Educational interventions have been widely implemented to address AMR by increasing awareness, promoting rational antibiotic use, and dispelling common misconceptions (13). These programs, delivered through various formats such as digital media, printed materials, and face-to-face sessions, typically aim to improve parents' understanding of antibiotic resistance, appropriate indications for antibiotic use, and the risks associated with overuse. While many studies report that these interventions enhance parental knowledge and attitudes (14,15), it remains unclear whether they lead to actual behaviour change. Simply increasing awareness does not always result in responsible antibiotic use, as factors such as healthcare accessibility, cultural beliefs, and physician-parent interactions play a role in shaping behaviour (16). Therefore, the effectiveness of these interventions should be evaluated not only based on knowledge and attitude improvements but also on their impact on real-world antibiotic use behaviours among parents.

Despite the growing number of intervention studies on antibiotic use, a systematic evaluation of their effectiveness in modifying parental behaviours is still lacking, particularly in non-healthcare settings. Most existing studies focus on healthcare providers, such as antimicrobial stewardship programs in hospitals, leaving a significant research gap regarding the public, especially parents (17). Furthermore, there is limited data on such interventions in low and middle income countries (LMICs), where antibiotic misuse is often more prevalent due to easy access to over-the-counter antibiotics and limited healthcare regulations (18). A better understanding of how educational interventions influence parental behaviours across different socioeconomic and cultural contexts is essential for developing targeted strategies to combat AMR.

To address this gap, this systematic review evaluates how many educational intervention studies have measured actual behavioural changes in parental antibiotic use and assesses the effectiveness of these interventions in modifying parental practices, rather than just improving knowledge and attitudes. This review is based on several key assumptions: that parental misconceptions significantly contribute to antibiotic misuse, that educational interventions can influence behaviour, and that findings from diverse settings can inform broader public health strategies. By examining these factors, this review provides a comprehensive evaluation of the role of educational interventions in shaping parental behaviours and offers insights into the development of effective, culturally relevant strategies for combating AMR. The findings will contribute to the evidence base for designing more effective public health interventions to inform policymakers on how to strengthen antibiotic stewardship efforts at the community level and potentially reduce healthcare costs and improve long-term public health outcomes.

METHODS

This systematic review was designed according to the PICOS (Participants, Intervention, Comparison, Outcomes, and Study Design)

criteria as stated in **Table 1** and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA) guidelines as in **Figure 1**. The search was conducted using four electronic databases: Scopus, EBSCO Discovery Service (EDS), Google Scholar, and ScienceDirect. The search included studies published between January 1, 2014, and December 31, 2024, that evaluated the effectiveness of educational interventions aimed at modifying parental knowledge, attitudes, and behaviours regarding proper antibiotic use.

The search strategy was designed to identify relevant studies using keyword terms such as ("Intervention" OR "Program" OR "Educational Intervention") AND ("Behaviour change" OR "Practice change" OR "Adherence" OR "Compliance") AND ("Parent" OR "Caregiver") AND ("Antibiotic use" OR "Antimicrobial stewardship"). The study selection process followed predefined inclusion and exclusion criteria. Studies were included if they were primary research articles employing randomised controlled trials (RCTs), non-RCTs, observational cohort studies, case-control studies, cross-sectional studies, or qualitative research that evaluated an educational program focused on modifying parental knowledge, attitudes, or behaviours related to antibiotic use. Studies were required to report at least one measurable outcome related to parental behaviour change, adherence to antibiotic prescriptions, knowledge improvement or attitude shifts. Only articles published in English were included. This restriction was due to resource and language

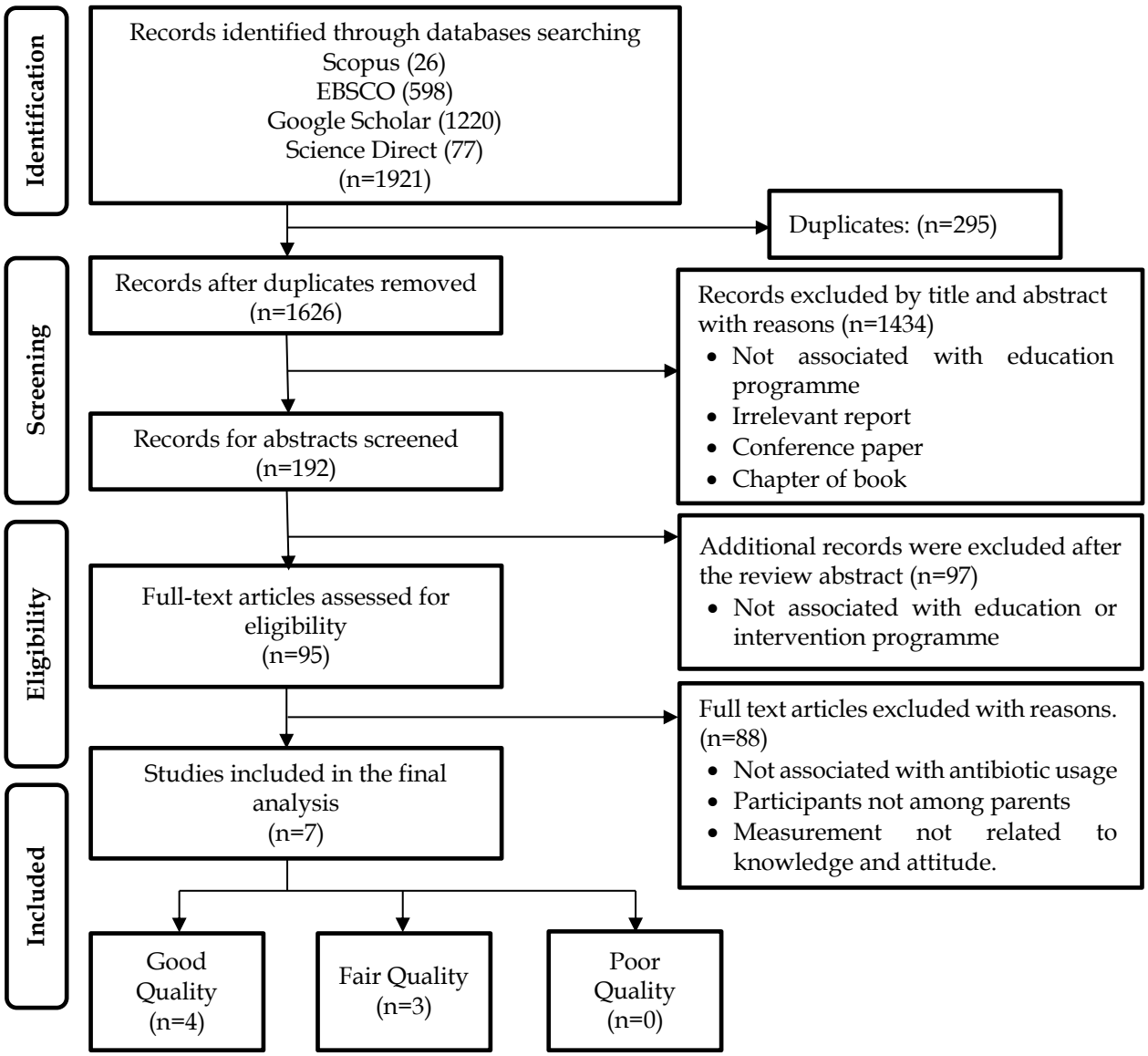
limitations, as translation capacity was not available during the review process. Studies were excluded if they were review articles, conference papers, dissertations or abstracts without full-text availability. Additionally, articles that did not explicitly examine educational interventions for parents in the context of antibiotic use were excluded.

At first, potential articles were identified based on the searching process. Titles and abstracts independently reviewed by two researchers to determine relevance. Second, the full-text selected articles were retrieved if the articles appeared to meet the inclusion criteria. Third, the full texts were screened to ensure alignment with the aim of systematic review. The articles were removed if they did not meet the eligibility criteria. Any disagreements between reviewers were resolved through discussion, and if necessary, a third reviewer was consulted to reach a consensus. The final selection included only studies that met all inclusion criteria and passed the quality assessment. Data extraction was performed systematically by collecting relevant details from each selected study, including author(s), year of publication, study setting, study design, population characteristics, sample size, intervention details, study tools, outcome assessment methods, and key findings related to parental knowledge, attitudes, and behaviours regarding antibiotic use. In cases where additional clarification on study results or methodology was required, the original authors were contacted. Quantitative data were interpreted using measures such as mean, median, and percentage changes, while qualitative data were synthesised narratively. The final selection of studies was tabulated, summarised, and presented in a structured narrative synthesis.

Table 1: PICOS Criteria Employed to Design the Review

Criteria	Description
Participants	Parents
Intervention/exposure	Educational intervention/program
Comparison	NA
Outcomes	Parental knowledge, attitude or behaviours regarding proper antibiotic use
Study design	Quantitative study - Observational study, cohort study, cross-sectional study, case-control, randomise controlled trial, quasi-experimental trial, Qualitative study

Figure 1: PRISMA Flow Diagram



Assessment of Risk of Bias

The risk of bias for the selected studies was assessed using The Cochrane Collaboration's Risk of Bias Tool (19). All included studies were susceptible to recall bias, as they relied on participants' recollection of past experiences, which could be subject to memory distortion over time. This limitation may have influenced parental perceptions and the accuracy of their responses, particularly given that many parents have previously used antibiotics or sought guidance from healthcare professionals, potentially shaping their recall and reporting (20).

To determine study quality, a grading system was applied based on the number of low-risk assessments across different bias domains. Studies were categorised as high quality if they had at least two low-risk ratings in the selection bias domain and at least three low-risk ratings across other domains, including performance bias, detection bias, attrition bias, reporting bias, and other biases. Studies were classified as moderate quality if they had at least one low-risk rating in the selection bias domain and at least two low-risk ratings in all other domains. Lastly, studies were considered poor quality if they had at least one low-risk rating in the selection bias domain and at least one low-risk rating in all other domains. The detailed risk of bias assessment is summarised in **Tables 2** and **Table 3.**

Table 2: Cochrane Collaboration's Tool for Assessing Risk of Bias (21)

Bias domain	Source of bias	Support for judgment	Review authors' judgment (assess as low, unclear, or high risk of bias)
Selection bias	Random sequence generation	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence.
	Allocation concealment	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen before or during enrolment.	Selection bias (biased allocation to interventions) due to inadequate concealment of allocations before assignment.
Performance bias	Blinding of participants and personnel	Describe all measures used, if any, to blind trial participants and researchers from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Performance bias due to knowledge of the allocated interventions by participants and personnel during the study.
Detection bias	Blinding of outcome assessment	Describe all measures used, if any, to blind outcome assessment from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Detection bias due to knowledge of the allocated interventions by outcome assessment.
Attrition bias	Incomplete outcome data	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomised participants), reasons for attrition or exclusions where reported, and any inclusions in analyses for the review.	Attrition bias due to amount, nature, or handling of incomplete outcome data.
Reporting bias	Selective reporting	State how selective outcome reporting was examined and what was found.	Reporting bias due to selective outcome reporting.
Other bias	Anything else, ideally pre-specified	State any important concerns about bias not covered in the other domains in the tool.	Bias due to problems not covered elsewhere.

RESULT

A total of 1,921 articles were initially identified through database searches. After screening titles and abstracts, 95 full-text articles were assessed for eligibility. Of these, seven studies met the inclusion criteria and were included in the final analysis. The remaining 87 studies were excluded as they were either unrelated to educational programs on antibiotic usage or did not involve parents as participants. Consequently, only seven studies were included in the final synthesis (**Figure 1**).

Table 3: Approach to formulating summary assessments of risk of bias for each important outcome (across domains) within and across trials (21)

Risk of bias	Interpretation	Within a trial	Across trials
Low risk of bias	Bias, if present, is unlikely to alter the results seriously	Low risk of bias for all key domains	Most information is from trials at low risk of bias
Unclear risk of bias	A risk of bias that raises some doubt about the results	Low or unclear risk of bias for all key domains	Most information is from trials at low or unclear risk of bias
High risk of bias	Bias may alter the results seriously	High risk of bias for one or more key domains	The proportion of information from trials at high risk of bias is sufficient to affect the interpretation of results

Study Characteristics

The seven studies included in this review were conducted across diverse geographical settings, including Denmark, Nigeria, Ghana, Hong Kong, Egypt, Macedonia, and Australia, reflecting a broad international interest in improving parental practices related to antibiotic use. Most studies employed a quasi-experimental or pre- and post-test design (five studies), while two studies used randomized controlled trials (RCTs). The sample sizes varied widely, with most targeting parents of young children. The interventions also differed in approach and delivery methods. Educational tools used included printed booklets (22,26), one-on-one pharmacist counselling and group education with flipcharts (23), AMR themed storytelling through schoolchildren (24), social media peer support via Facebook (25), mass media campaigns with regulatory measures (27), and decision aids versus fact sheets (28). Follow-up periods ranged from immediate post-intervention assessment to as long as two years.

Regarding behavioural impact, only three studies (22,26,27) assessed and reported real changes in parental practices concerning antibiotic use. These studies also demonstrated sustained behaviour change over follow-up periods of 3 months to 1 year. The remaining four studies assessed knowledge and attitudes but did not evaluate actual behavioural outcomes, and all had immediate or short-term follow-up periods (ranging from 2 weeks to immediate post-intervention), limiting the ability to assess long-term effectiveness. Overall, the findings indicate that interventions with longer follow-up durations, structured educational content and tools that actively engage parents, such as booklets or mass media are more likely to result in and sustain behavioural changes in antibiotic usage. A detailed summary of the seven studies' characteristics is provided in **Table 4.**

Quality Appraisal

Out of seven studies, four articles met 100% criteria and could be regarded as good quality and three articles met 80% of the criteria, regarded as (medium quality) of criteria designated by Cochrane rating. A detailed summary of the quality appraisal is illustrated in **Table 5**.

Findings of Parental Knowledge for Proper Antibiotic Usage

A prospective pre–post intervention study conducted in Denmark involving 344 parents used simple random sampling to distribute a validated knowledge questionnaire and provided an educational booklet as the intervention (22). Parents' average number of correct answers to questions significantly increased from 1.35 (95% CI: 0.91; 1.79) to an average of 14.81 correct answers at follow-up. Parental knowledge improved following the intervention. Parents with lower education and Danish nationality showed a greater knowledge improvement from baseline to follow-up compared to parents with higher education and foreign nationality (22).

A cross-sectional study conducted in southern Nigeria involving 60 parents used convenience sampling and included an educational component in one study arm (23). The second group filled out the questionnaire again after learning about it as a group. Before and after education, the sixty participants' mean scores on how much they knew about antibiotics and how they used them were 36.1±6.467 versus 46.7±4.027 ($p \leq 0.0001$) and 29.82±4.949 versus 36.92±3.997 ($p \leq 0.0001$). One-on-one education had a mean score of 46.7±4.027 on antibiotic knowledge and 43.3±6.249 ($p=0.022$) on antibiotic use, and group education had a mean

score of 35.93±4.608 (p=0.039). A lot of parents didn't know much about antibiotics and how to use them, but that changed after they were taught. Paediatric carers responded better to one-on-one education than to group education when it came to changing their thoughts and actions (23).

Table 4: Comparison of Studies on Educational Interventions for Parental Antibiotic Use

No	Author & Year	Study setting	Participant	Study design	Intervention Tool	Follow-up period	Measured behaviour changes (Impact on Practice)	Sustained behaviour change?
1.	Hansen et al. 2023	Denmark	344 parents	Quasi-experimental (pre-post-test, one group)	Booklet on childhood infections & antibiotics	Follow up after 6 months of intervention	Yes. Measured changes in parental decision-making on antibiotics	Yes. Follow-up after 6 months showed sustained impact.
2.	Aika & Enato. 2023	Southern Nigeria	60 parents	Quasi-experimental (pre-post-test, two groups)	One -on-one pharmacist education vs. group education with a flipchart	Immediately after the intervention	No. Only assessed on knowledge and attitude, not measuring real behaviour changes (practice)	NA – Immediate follow-up
3.	Appiah et al. 2022	Ghana	115 parents	Quasi-experimental (pre-post-test, one group)	AMR-themed animation & storytelling intervention through schoolchildren	Immediately after the intervention	No. Only assessed on knowledge and attitude, not measuring real behaviour changes (practice)	NA – Immediate follow-up
4.	Or & Ching. 2022	Hong Kong	48 parents	Randomized controlled trial (RCT)	Peer-supported social media (Facebook) education	Follow up after 2 weeks of intervention	No. Only assessed on knowledge and attitude, not measuring real behaviour changes (practice)	NA – Immediate follow-up (2 weeks)
5.	Abd El-Kader & Mohammed. 2021	Egypt	130 mothers	Quasi-experimental (pre-post-test, one group)	Educational session with a booklet	Follow up after 3 months of intervention	Yes. Measured changes in parental real behaviour changes (practice)	Yes. Follow-up after 3 months showed sustained impact.
6.	Verica Ivanovska et al. 2018	Yugoslav Republic of Macedonia	1,203 parents	Quasi-experimental (pre-post-test, one group)	Mass media campaigns & regulatory measures	Follow-up annually for 2 years.	Yes. Measured changes in parental real behaviour changes (practice)	Only sustained impact at one-year follow-up. Impact faded after one year.

7.	Coxeter et al. 2017	South-East Queenslan d, Australia	120 parents	Randomized controlled trial (RCT)	Decision aids vs. fact sheets	Immediat ely after the interven tion	No. Only assessed on knowledge and attitude, not measuring real behaviour changes (practice)	NA – Immediate follow-up

Table 5: Summary Assessment of Risk of Bias

Author & Year	*Selection bias		Performance bias	Detection bias	Attrition bias	Reporting bias	Other bias	
	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Anything else, ideally pre-specified	Summarize the quality of paper
Hansen et al. 2023	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Unclear Risk	Unclear Risk	Good
Aika & Enato. 2023	Low Risk	Unclear Risk	Low Risk	Low Risk	Low Risk	Unclear Risk	Low Risk	Medium
Appiah et al.2022	Low Risk	Low Risk	Unclear Risk	Low Risk	Low Risk	Low Risk	Low Risk	Good
Or et al. 2022	Low Risk	Unclear Risk	Unclear Risk	Low Risk	Low Risk	Unclear Risk	Low Risk	Medium
Abd El-Kader & Mohammed. 2021	Low Risk	Low Risk	Low Risk	Low Risk	Unclear Risk	Low Risk	Unclear Risk	Good
Ivanovska et al. 2018	Low Risk	Low Risk	Low Risk	Low Risk	Unclear Risk	Unclear Risk	Low Risk	Good
Coxeter et al. 2017	Low Risk	Unclear Risk	Unclear Risk	Low Risk	Low Risk	Low Risk	Low Risk	Medium

***Main domain - selection bias**
Good quality: Should have 2 low risks in selection bias as domain and at least 3 low risks in all others (performance bias, detection bias, attrition bias, reporting bias and other bias
Moderate quality: At least 1 low risk in selection bias as domain and at least 2 low risks in all others (performance bias, detection bias, attrition bias, reporting bias and other bias
Poor quality: At least 1 low risk in selection bias as domain and 1 low risk in all others (performance bias, detection bias, attrition bias, reporting bias and other bias

A randomized study in Ghana involving 200 parents and children selected from two schools delivered AMR education using two different approaches storytelling in one school and drawing activities in the other (24). No control group said, "Antibiotics will cure any infection" (p=0.021, χ2=0.711; 88% vs. 50%), in the storytelling intervention (p=0.043) or the drawing intervention (p=0.019). Using an AMR animation made with ideas from kids in school could change how much parents know about AMR (24).

A randomized controlled trial conducted in Hong Kong involved 48 parents and was carried out using a two-arm study design (25). Then, a random sample was chosen in the intervention group to assess their knowledge. These parents would join a Facebook page about antibiotic use. This website would let people connect with each other and make friends. It was statistically significant (p=0.039) at p<0.05. A strong negative correlation (R=-0.78 at p<0.001) was found between parents' belief that antibiotics could be stopped once their children felt better and the support they got from their Facebook friends. Overall, there was not a big difference between the two groups when it came to the scale. Early signs are good, and learning more about how to use antibiotics properly will help lower antimicrobial resistance (25).

A quasi-experimental study in Egypt used convenience sampling to examine the experiences of 130 mothers (26). A validated questionnaire was used to test their knowledge. Before the test, the percentages were 71.6 for the poor category, 23.1 for fair, and 5.3 for good. Following the test, the percentages shifted to 3 for poor, 15.4 for fair and 81.6 for good. Additionally, in the next follow up the percentages were slightly changed to 6.4 for poor, 19.2 for fair, and 75.5 for good. These indicated that the health education session contributed to improved understanding of antibiotic usage among participants (26).

A randomized study conducted in North Macedonia involved 1,203 parents of children under 15 years old who were interviewed using questionnaires, with surveys administered across three administrative regions before and after the intervention between May 2014 and May 2016 (27). The study found that a significant proportion of parents believed antibiotics could help with colds and flu, with 38%, 37%, and 38% of respondents thinking antibiotics were effective for colds and 45%, 40%, and 48% believing the same for flu in 2014, 2015, and 2016, respectively. In 2014, 76% of participants understood that improper antibiotic use could lead to ineffectiveness, and 85% were aware of antibiotic side effects. Although these percentages increased in 2015, they declined in 2016, falling below the initial levels. Additionally, 80% of parents recognised that antibiotics could eliminate bacteria (27).

The subsequent authors are from the Republic of Macedonia, formerly part of Yugoslavia (27). Their study comprised 1203 parents and utilised a randomized design. The sampling method was chosen randomly. The study involved interviewing parents of children under fifteen years of age using questionnaires. Surveys were conducted in three administrative regions of the country before and after the intervention, spanning from May 2014 to May 2016. In addition, the study revealed that the parents thought that antibiotics would help colds and flu get better faster (38, 37, and 38% for colds and 45, 40, and 48% for flu in 2014, 2015, and 2016). In 2014, 76% of those who answered knew that antibiotics might not work if they are used incorrectly, and 85% knew about the side effects of antibiotics. They both went up in 2015, but they went down in 2016 and were lower than they were at the start 80% of parents knew that antibiotics could get rid of germs (27).

A study conducted in South-East Queensland, Australia, employed a two-arm, parallel-group randomized trial with 120 parents, using a computer-generated randomization sequence (28). Participants were allocated to receive either a fact sheet (n=60) or a decision aid (n=60). The intervention group participants demonstrated a higher level of informed choice (57%) in comparison to the control group participants (29%; 95% confidence interval [CI] 11–45%; p<0.01). Additionally, the intervention group participants exhibited superior total knowledge (MD 2.8; 95% CI 2.2–3.5; p<0.01), conceptual knowledge (MD 0.7; 95% CI 0.4–1.1; p<0.01), and numerical knowledge (MD 2.1; 95% CI 1.6–2.5; p<0.01).In a hypothetical situation, the decision assists well-informed parents in making a more informed choice regarding antibiotic use compared to fact sheets (28).

Overall, the seven studies included in this review consistently demonstrated that educational interventions improved parental knowledge and attitudes towards antibiotic use. Most studies employed pre- and post-designs with validated questionnaires to assess outcomes. Significant improvements in knowledge scores were reported across various settings such as Denmark, Nigeria, Egypt, and Ghana. For instance, reported marked improvements in knowledge with sustained effects at follow-up (22,26). One-on-one pharmacist-led education was found to be more effective than group sessions in improving attitudes and knowledge (23). Indirect education through schoolchildren using storytelling and drawing was also shown to have a positive impact (24). Digital interventions like the Facebook-based peer showed potential, although their effect was less pronounced (25). While previous report reported mixed results, showing improvements in knowledge but less consistent changes in behavior, the overall findings indicate that structured and targeted educational programs can effectively enhance parental understanding and, in some cases, promote better practices in antibiotic use (27,28).

Table 6: Summary Intervention Studies: Parental Knowledge for Proper Antibiotic Usage

Author & Year	Study setting	Study design	Partici-pant	Sampling method	How the outcome was assessed	Main Findings
Hansen et al. 2023	Denmark	Prospectiv e pre-post Interven-tion study	344 par ents	A simple random method	Validated question-naire (Score marks) (Intervention: only distri-buted a booklet)	Intervention: Parents received a booklet on antibiotics. Results: Significant improvement in correct responses (+1.35 questions, 95% CI: 0.91–1.79). Average correct answers increased to 14.81 at follow-up. Knowledge improvement was higher among: Parents with lower education levels. Parents born in Denmark compared to foreign-born parents.
Aika & Enato. 2023	Southern Nigeria.	Cross-sectional study	60 parents	Conve-nience sampling technique	One arm on education. The second arm refilled the questionnaire after a group education.	Mean scores before and after education on antibiotic knowledge & use: Pre-education: 36.1±6.467 → Post-education: 46.7±4.027 (p≤0.0001). Pre-education attitude: 29.82±4.949 → Post-education: 36.92±3.997 (p≤0.0001). One-on-one vs group education: One-on-one: More effective for knowledge (46.7±4.027 vs 43.3±6.249, p=0.022). Attitude improvement: One-on-one (37.9±3.044) vs Group (35.93±4.608, p=0.039). Findings: Many paediatric caregivers had poor initial knowledge, but education significantly improved knowledge & attitudes. One-on-one education was more effective than group education in changing attitudes and behaviors.
Appiah et al.2022	Ghana	Rando-mized design	parents	Random-ly selected children were studied	The children from the two schools were first engaged with AMR lessons, with one school using storytelling, the other school using picture drawing, and none serving as a control	Children from two schools received AMR (antimicrobial resistance) lessons using either: Storytelling method or Picture drawing method The control group received no intervention. Results: Misconception reduction: "Antibiotics cure any infection" improved significantly (p=0.021). Storytelling (p=0.043) and picture drawing (p=0.019) improved knowledge. Using animations based on children's ideas could improve parents' AMR knowledge.

Author & Year	Study setting	Study design	Partici-pant	Sampling method	How the outcome was assessed	Main Findings
Or et al. 2022	Hong Kong	A cluster rando-mized controlled trial with two arms were imple-mented	48 parents	Simple random	Parents in the intervention group would join a Facebook Page of Antibiotic Use, this online platform would allow participants to build a social network.	Parents in the intervention group joined a Facebook page on antibiotic use. Significant negative correlation (Pearson coefficient=−0.78, p<0.001) between peer support on Facebook and belief that antibiotics could be stopped when a child felt better. No significant difference between groups on the overall scale. Preliminary results suggest social media can help improve knowledge on antibiotic use.
Abd El-Kader & Moham med. 2021	Egypt	A quasi-experime ntal design	130 mothers	Conve-nience sampling technique	Validated questionnaire The Cronbach's al pha score of 0.92	Knowledge improvement: Pre-test: Poor=71.6%, Fair=23.1%, Good=5.3%. Post-test: Poor=3%, Fair=15.4%, Good=81.6%. Follow-up post 3 month: Poor=6.4%, Fair=19.2%, Good=75.5%. Health education significantly improved knowledge among participants.
Coxeter et al. 2017	South-East Queen-sland, Aus-tralia	Two-arm, parallel-group, rando-mised trial	parents	Randomis ed using a computer - generated rando-misation sequence	Receive a decision aid (n=60) or fact sheet (n=60)	Baseline (mean± SD) Control group: 4.5±1.5 Intervention: 4.5±1.5 Post Intervention (mean±SD) Control group: 8.2±1.7 Intervention: 5.4±1.3
Ivanov ska et al. 2018	Yugos-lav Republic of Mace-donia	Rando-mized design	parents	Random-ly	Interviewing parents of children younger than 15 years of age through a question-naire. Pré–and post-intervention surveys were conducted in May 2014–16 in three administra-tive regions in the country.	82% of parents (2014) knew antibiotics are effective against bacteria. Only 30% (2014) understood that antibiotics are not effective against viruses. 9% increase in awareness about antibiotic effectiveness over time (not statistically significant). Many parents still believed antibiotics helped colds and flu: Colds: 38% (2014), 37% (2015), 38% (2016). Flu: 45% (2014), 40% (2015), 48% (2016). Awareness of antibiotic resistance increased in 2015 but declined in 2016 (lower than baseline). Average knowledge scores: 2014: 2.7 out of 4. 2015: Increased to 2.9. 2016: Dropped back to 2.7. 80% of parents knew antibiotics kill bacteria by the end of the study.

Intervention Studies: Parental attitude for proper antibiotic usage

A quasi-experimental study was carried out by (26), involving 130 mothers in Egypt. They utilised convenience sampling to assess parental sentiments and employed validated questionnaires to measure parental knowledge. The high Cronbach's alpha score of 0.92 indicated strong reliability. Prior to the intervention, 81.55% of parents expressed dissatisfaction, while 18.5% reported feeling satisfactory. Following the intervention, there was a significant shift, with only 11.5% expressing dissatisfaction and 88.5% reporting satisfaction. During the follow-up, 21.8% expressed dissatisfaction, whereas 78.2% reported a lack of satisfaction, indicating an increased awareness among participants regarding the prudent use of antibiotics.

A study using a random design, involving 1,203 parents in the Yugoslav Republic of Macedonia, was conducted (27). They administered questionnaires randomly to parents of children under 15 years old. Surveys were conducted before and after the intervention in three administrative regions of the country from May 2014 to 2016. Pretest 2014 - 20% of parents preferred to give antibiotics even if unnecessarily to their children, over wait and see if the symptoms would resolve spontaneously. Around 30% of parents were unsatisfied if no antibiotic was prescribed to their children when they considered it necessary, and similar percentage would seek another doctor as a result of that. About a quarter of parents would stop the antibiotic treatment when the symptoms of their child improve. The percentages of parents holding these attitudes did not change significantly over time.

In South-East Queensland, Australia, carried out a two-arm, parallel-group randomized trial with 120 parents, employing a computer-generated randomization sequence (28). Parental attitudes were assessed, and participants were randomly assigned to receive either a decision aid (n=60) or a fact sheet (n=60). Baseline attitude towards antibiotic use was positive in 18% of participants in the intervention group and 19% of participants in the control group, while a greater proportion of intervention group participants (42%) had a positive intention to future antibiotic use than in the control group (32%). This suggests that decision aids better-equipped parents to make informed decisions regarding antibiotic use compared to fact sheets in a hypothetical scenario. The details of the information are tabulated in **Table 7**.

DISCUSSION

Antibiotic misuse is a serious global health concern, contributing to the rise of antimicrobial resistance (AMR) (2,29). The findings of this systematic review suggest that educational interventions may plan an important role in improving parental knowledge and practices regarding antibiotic use. While all the reviewed studies reported some level of effectiveness, the nature and impact of these interventions varied.

This study has important implications for the design, implementation, and evaluation of behavioural change interventions related to antimicrobial resistance (AMR). To enhance their effectiveness, such interventions should be guided by evidence based theories and take into account relevant cultural factors (30). The selection of appropriate theoretical frameworks depends on the specific behavioural outcomes targeted. For instance, behavioural theories can be categorized based on whether the intervention aims to decrease, increase or modify certain behaviours, thereby allowing for a more focused and strategic approach to promoting positive behavioural change (31).

The studies included in this review employed different intervention methods, ranging from printed booklets and online platforms to structured educational sessions and interactive learning techniques like storytelling and picture drawing (22,24,25). This diversity in delivery formats such as digital, print, and face-to-face reflects the heterogeneity of educational approaches and underscores the need to evaluate which formats are most effective in different contexts. A key distinction was that some interventions were passive, providing information without direct engagement (22) while others encouraged interaction and decision-making (28). Notably, previous study focused on empowering parents to make informed choices rather than simply increasing knowledge (28). This suggest that decision aids may offer a useful model for future interventions, though further evaluation is needed. While most interventions demonstrated an overall improvement in parental knowledge, there were variations in effectiveness.

Table 7: Summary Intervention Studies: Parental Attitude for Proper Antibiotic Usage

Author & Year	Study setting	Study design	Participant	Sampling method	How the outcome was assessed	Main Findings	Remarks
Abd El-Kader et al 2021	Egypt	A quasi-experimental design	130 mothers	Convenience sampling technique	Validated Questionnaire The Cronbach's alpha score of 0.92	Attitude Pre Test Unsatisfactory =81.55 Satisfactory =18.5 Post Test Unsatisfactory =11.5 Satisfactory =88.5 Follow up Unsatisfactory =21.8 Satisfactory=78.2	Increased the participants' level attitude about the judicious use of antibiotics
Ivanovska et al. 2018	Yugoslav Republic of Macedonia	Randomized design	1203 parents	Randomly	Interviewing parents of children younger than 15 years of age through a questionnaire. Pré– and post-intervention surveys were conducted in May 2014 - 2016 in three administrative regions in the country.	Pre-test 2014 - 20% of parents preferred to give antibiotics even if unnecessarily to their children, over waiting and seeing if the symptoms would resolve spontaneously. Around 30% of parents were unsatisfied if no antibiotic was prescribed to their children when they considered it necessary, and similar percentage would seek another doctor as a result of that. About a quarter of parents would stop the antibiotic treatment when the symptoms of their child improve. The percentages of parents holding these attitudes did not change significantly over time.	80% of parents knew that antibiotics could kill bacteria,
Coxeter et al. 2017	South-East Queensland, Australia	Two-arm, parallel group, randomised trial	120 parents	Randomised using a computer-generated randomisation sequence	Receive a decision aid (n=60) or fact sheet (n=60)	Baseline attitude towards antibiotic use was positive in 18% of participants in the intervention group and 19% of participants in the control group, while a greater proportion of intervention group participants (42%) had a positive intention for future antibiotic use than in the control group (32%)	The decision aids prepared parents to make an informed choice about antibiotic use more than fact sheets, in a hypothetical situation

For instance, previous study found that one on one education was more impactful than group education in fostering behavioural change among caregivers (23). Similarly, another study observed a strong negative correlation between social media peer support and misconceptions about antibiotic use, suggesting that interactive and socially engaging interventions might have a greater influence on knowledge retention than traditional methods (25). These findings imply that interventions which actively engage participants may be more effective, though more comparative studies are needed to confirm this.

Several studies reported improvements in mothers' knowledge regarding appropriate antibiotic use, observed both immediately after the educational sessions and at follow-up. However, the extent and sustainability of these changes varied across contexts. Factors such as the use of simple and accessible language and the motivation of mothers, particularly those with young children, may have contributed to these outcomes. Similar results were reported in Jordan (32), and in the United Arab Emirates (33), where awareness campaigns were associated with increased public knowledge. While these findings are encouraging, they should be interpreted cautiously, as knowledge gains do not always equate to behavioural change.

Despite these promising findings, several uncertainties remain that warrant further investigation. One key issue is the inconsistent link between knowledge improvement and actual behaviour change. While many interventions successfully increased parental understanding, this did not always translate into responsible antibiotic practices. This disconnect may be influenced by cultural norms, healthcare access, or conflicting advice from providers. Future studies should explore these behavioural barriers through qualitative methods or mixed methods designs to better understand the underlying causes.

Alternative explanations for this gap include the possibility that knowledge alone is insufficient to overcome habitual behaviours, social pressures, or structural barriers such as limited access to healthcare professionals. In some cases, parents may rely more on past experiences or community advice than on newly acquired information. Additionally, trust in healthcare providers and the perceived urgency of a child's illness may override rational decision-making. These factors suggest that educational interventions should be complemented by broader strategies such as improving healthcare communication, reducing antibiotic availability without prescription, and addressing cultural beliefs to achieve sustained behavioural change.

Additionally, geographic and socioeconomic gaps in the included studies may affect the generalizability of the findings (34). Most studies were conducted in high-income or urban settings, which may not reflect the realities of rural or low-resource environments. The limited representation of low- and middle-income countries (LMICs) in the dataset highlights the need for more context-specific research. Tailoring interventions to local contexts, especially in LMICs, will be essential for ensuring their effectiveness and scalability.

Moreover, future research should incorporate subgroup analyses to better understand how intervention effectiveness varies across different formats (e.g., digital vs. face-to-face), parental demographics (e.g., education level, socioeconomic status), and cultural contexts. This would allow for more targeted and impactful intervention designs.

Educational interventions appear to play an important role in improving parental understanding of antibiotic use [35]. However, variations in intervention types, effectiveness, and knowledge retention highlight the need for ongoing research. Future studies should aim to refine educational methods, ensure sustainability, and explore region-specific challenges, including subgroup differences and behavioural barriers to enhance the overall impact of these interventions

Strengths

This systematic review demonstrates several notable strengths that enhance its methodological rigor and practical relevance. It employs a comprehensive literature search across multiple databases, ensuring inclusion of all relevant studies on parental education and antibiotic use, which reduces bias and increases reliability[36]. The review also critically appraised study quality using a validated tool, strengthening confidence in its findings and aligning with international standards [37]. Its novelty lies in being the first review to evaluate the effectiveness of educational interventions in improving parents' knowledge and attitudes toward appropriate antibiotic use, filling a critical gap in the literature and complementing prior work on parental health literacy and contextual factors. By consolidating existing research, it provides valuable evidence to guide culturally relevant educational strategies,

particularly in Malaysia, where inappropriate antibiotic use among children remains a pressing public health issue (6) Finally, the review informs both policy and practice by demonstrating the potential of educational initiatives to reduce antibiotic misuse, supporting interventions that are evidence-based and adaptable to diverse cultural and healthcare contexts (38). Collectively, these strengths highlight the review's methodological rigor, practical impact and contribution to future research and policy development.

CONCLUSION

This systematic review aimed to comprehensively evaluate the effects of educational programs on parental knowledge and attitudes regarding proper antibiotic use. A thorough literature search was conducted, identifying relevant studies across various databases. The selected studies included diverse populations, interventions, and outcome measures related to parental awareness and antibiotic usage.

Overall, the findings indicate that educational programs have a positive impact on improving parental knowledge about antibiotic use. Attitudinal changes were also observed, with parents demonstrating increased awareness of appropriate antibiotic use and the potential consequences of misuse. Despite certain limitations, these findings contribute to evidence-based practices for promoting responsible antibiotic use among parents.

However, this review highlights a significant gap in research, as no intervention studies have specifically targeted parents in Malaysia. Given that Malaysia faces similar challenges related to antimicrobial resistance (AMR), future research should focus on developing and evaluating educational programs tailored to the Malaysian context. Such programs should incorporate culturally sensitive approaches to ensure their effectiveness in improving parental knowledge and attitudes toward antibiotic use.

LIMITATIONS

This review includes studies with varying designs and outcome measurement methods, which may introduce heterogeneity and make it difficult to synthesize findings into definitive conclusions. As a result, the review presents its findings narratively rather than through meta-analysis. Additionally, this review is limited to studies published in English, which may have led to the exclusion of relevant research published in other languages, potentially omitting valuable evidence. This language restriction may limit the generalizability of the findings, especially in regions where significant research is published in local languages.

Furthermore, the review did not conduct formal subgroup analyses due to variability in study designs and outcome reporting. This limits the ability to explore how intervention effectiveness may differ across specific populations, intervention types, or cultural settings. Future reviews with more standardised data could address this gap through stratified or subgroup analysis. This review may also be subject to publication bias, as studies with positive findings are more likely to be published and indexed in the databases searched. While formal assessments such as funnel plots or Egger's test were not feasible due to the narrative synthesis approach, this potential bias should be considered when interpreting the overall effectiveness of interventions. Additionally, the exclusion of non-English studies due to resource constraints may have introduced language bias, potentially omitting relevant findings from non-English-speaking regions. This limitation should be considered when interpreting the generalizability of the results.

RECOMMENDATIONS

Based on the findings of this study, several recommendations are proposed to benefit both nurses and healthcare organisation in reducing the prevalence of low back pain. Following of these research findings, the researcher had developed some recommendations which may benefits to the nurses as well as the employer in order to deliver excellent care to the patients. The importance of correct technique in body mechanic need to be reinforced frequently by conducting scheduled continuous nursing education besides enforcement by the managerial level while handling patients at bedside. Reinforcement also can be done during orientation week before the new nurses are enrolled in the actual department. Organization also could allocate devices which helps nurses as well as other healthcare provider such patient's lifting devices or continuous chest compression machine especially for those cases that require prolonged resuscitation. Those devices may increase work satisfaction as well as reducing physically and mentally exhaustion among the nurses. Due to increase job satisfaction and reduced burn out at the workplace, employer would be able to manage their cost effectively in

reducing overtime pay provided with proper and sufficient employment in order to increase productivity to the organization and delivering safe care to the patients.

CONFLICT OF INTEREST

All authors declare no competing interests.

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AUTHOR CONTRIBUTIONS

MAMKB: Study conceptualization, data curation, checking initial draft, data analysis, and finalized manuscript.
AJMA: Study conceptualization, data curation, data analysis, and preparation of initial and final draft.
KTA & SB: Revised the manuscript critically for important intellectual content, prepared the final draft of the manuscript.

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