SYSTEMATIC REVIEW/META ANALYSIS

Childhood Vaccination Among Arab Parents: A Meta-Analysis of Knowledge, Attitudes, And Practices

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ABSTRACT

Background: Childhood vaccination is crucial for preventing infectious diseases, yet parental concerns and hesitations persist. Understanding and assessing parental knowledge, attitudes, and practices (KAP) regarding vaccines is essential, as these factors influence confidence in vaccination and adherence to immunization schedules.

Methods: This meta-analysis synthesized evidence on Arab parents' KAP toward childhood vaccination, based on a systematic review of eligible studies and pooled analysis using a random-effects model.

Results: Fifteen studies were included: 14 reported knowledge scores (9,035 participants), 13 reported attitudes (8,523 participants), and 7 reported practices (5,106 participants). The pooled estimates were 0.73 for good knowledge (95% CI: 0.62–0.81), 0.83 for positive attitudes (95% CI: 0.74–0.89), and 0.77 for good practices (95% CI: 0.64–0.86), all with high heterogeneity (I^2 >97%). Meta-regression showed persistent variability (I^2 = 92.7%, 99.2%, 98.7%), with no significant link between KAP scores and the proportion of mothers.

Conclusion: This meta-analysis highlights a strong association between good parental knowledge and positive attitudes, which translate into favorable vaccination practices. However, high heterogeneity across studies due to differences in design, populations, and cultural context limits the generalizability of findings. These findings underscore the need for targeted educational interventions to enhance parental vaccine awareness and uptake.

Keywords: Knowledge, Attitudes, Practices, Parents, Vaccination, Immunization, Arab

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INTRODUCTION

Humans have long sought ways to protect themselves from infectious diseases, and vaccines have emerged as one of the most important medical discoveries.[1] Efforts began in the 15th century and evolved in 1796 when Edward Jenner demonstrated that cowpox infection provided immunity to smallpox, leading to the first effective vaccine.[2] This success paved the way for further developments, including the rabies vaccine developed by Louis Pasteur in 1885, which marked a turning point in vaccinology and enabled the development of vaccines for diseases such as cholera and plague, greatly improving public health.[3] In 1974, WHO launched the Expanded Programme on Immunization (EPI) to ensure that essential vaccines are available to children worldwide. The EPI is the cornerstone of public health efforts to protect children from infectious diseases.[4] Vaccines have helped prevent 2–3 million child deaths each year from vaccine-preventable diseases.[5]

Under the current circumstances, rumors, and misinformation about vaccines, especially after the COVID-19 pandemic, parents are hesitant and afraid to vaccinate their children, creating gaps in herd immunity that could lead to epidemics.[6,7] The results of some studies show that many parents in Middle Eastern countries are still hesitant to vaccinate their children against COVID-19, which remains an important public health issue.[8] This hesitancy is mainly due to a lack of trustworthy information about how safe and effective the vaccines are, worries about possible side effects that may not have been reported, and doubts about how quickly the vaccines were developed and approved.[9-11] In 2023, nearly 14.5 million infants missed the first dose of diphtheria and pertussis vaccine, highlighting significant gaps in access to immunization and other essential health services, in addition to 6.5 million children who were only partially vaccinated.[12] This brings the total number of children suffering from under-immunization to 21 million, with nearly 60% of these children living in 10 countries: Afghanistan, Angola, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Nigeria, Pakistan, Sudan, and Yemen.[13]

Vaccination knowledge, attitudes, and practices (KAP) studies assess three main aspects: knowledge (what people know about vaccines), attitude (how they feel about vaccination), and practice (whether they follow vaccination recommendations). Studies have found that good parental knowledge and attitudes towards vaccinations increase the chances of their children being vaccinated with all required vaccines, and thus, ensuring good vaccine coverage in the country.[14-17]

Conducting a meta-analysis of existing studies on parental KAP in Arab societies is essential for understanding general patterns. This is due to differences in research methodologies, sampling techniques, recruitment process, and findings, in addition to cultural and regional variations. A meta-analysis also helps in understanding mediating variables and discovering how these factors influence parental attitudes, thereby providing reliable conclusions. It also contributes to building a strong evidence base by providing accurate insights into the impact of parental knowledge and practices on vaccination rates. Furthermore, to our knowledge, there is no meta-analysis of parental knowledge, attitudes, and practices in Arab countries, which is one of the reasons for conducting this study. Therefore, this analysis aimed to assess the pooled level of KAP regarding child vaccination among Arab parents, defined as parents residing in Arab League member countries.

METHODOLOGY

Study Design: This meta-analysis was conducted to synthesize existing literature on Arab parental KAP regarding childhood vaccination. The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and reproducibility.[18]

Search Strategy: Two independent reviewers conducted a comprehensive literature search using electronic databases, including PubMed, Web of Science, and Google Scholar. The search covered studies published up to March 2025, with no language restrictions, provided that an English or Arabic translation was available. The following keywords and Boolean operators were used: "Arab parents" OR "Middle Eastern parents" AND "childhood vaccination" OR "immunization" AND "knowledge" OR "attitudes" OR "practices."

Inclusion and Exclusion Criteria: Studies were included in this meta-analysis if they assessed the knowledge, attitudes, or practices of Arab parents residing in Arab countries regarding childhood vaccination, and if they were cross-sectional or cohort studies. Additionally, the studies had to report quantitative data with sufficient statistical detail for meta-analysis and be published in peer-reviewed journals. Studies were excluded if they focused on non-Arab populations or healthcare professionals, or if they were reviews, editorials, conference abstracts, qualitative studies, or lacked relevant data or extractable statistics. For consistency, "vaccination practices" were defined as parental adherence to national childhood immunization schedules within the first year of life, unless otherwise specified by the original study.

Data Extraction: Two independent reviewers extracted data using a standardized form. The extracted information included study characteristics (author, year, country, sample size, study design), population demographics (age, gender, education level, socioeconomic status), measures of parental KAP towards childhood vaccination, and statistical measures. When available, we also extracted how KAP was quantified in each study, including scoring

thresholds used to classify "good," "moderate," or "poor" knowledge, attitudes, and practices. Good" knowledge was typically defined as a score of ≥70% correct responses on knowledge-related items. Discrepancies between reviewers were resolved through discussion, and if needed, a third reviewer was consulted to reach a consensus.

Quality Assessment: The quality of the included studies was assessed using the Newcastle-Ottawa Scale for observational studies. Studies were classified as low, moderate, or high quality based on selection, comparability, and outcome assessment criteria.

Data Synthesis and Statistical Analysis: A meta-analysis was conducted using R-Studio statistical software. Given the expected variability among studies, a random-effects model was applied to better account for heterogeneity. Heterogeneity was assessed using the I^2 statistic and Cochran's Q test. Subgroup analyses were performed based on country, study quality, and parental education level.

RESULTS

Screening process: A total of 513 titles were retrieved from two databases. After removing 260 duplicates, 253 records remained for screening, of which 226 were excluded for not meeting the inclusion criteria. Following full-text evaluation of 27 studies, 12 were excluded for being outside the scope or lacking extractable data. Ultimately, 15 studies met the eligibility criteria and were included in this review, as shown in the PRISMA flow diagram (**Figure 1**).

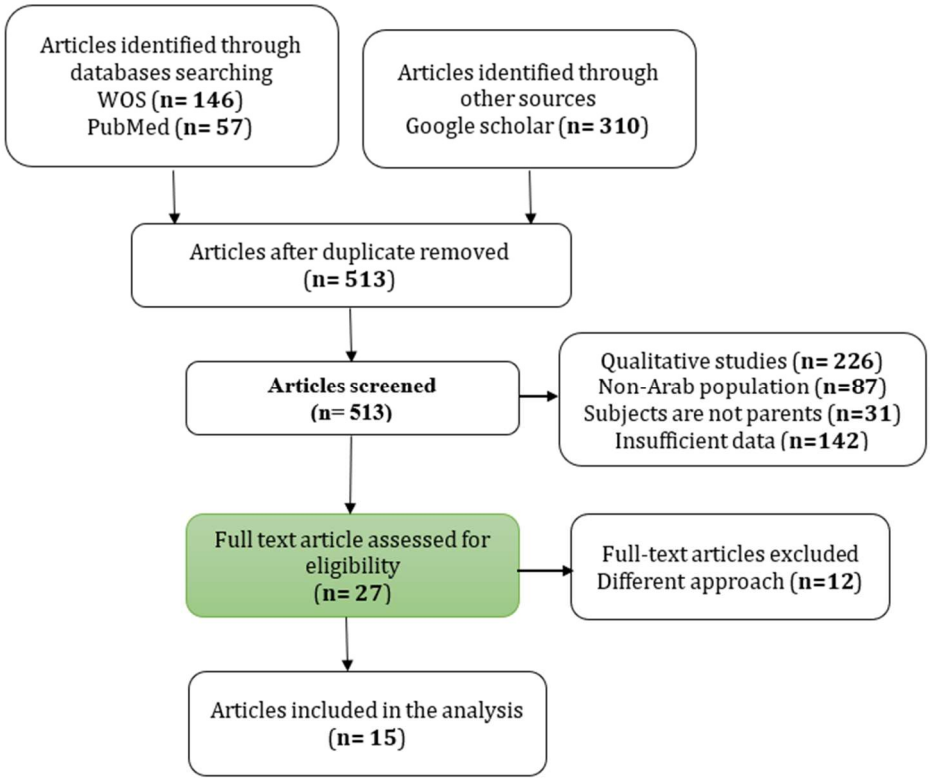

Figure 1: PRISMA Chart

The majority of studies (73%) were conducted in Saudi Arabia (11 studies)[15,17,19-27], while the remaining studies covered Iraq[16], Yemen[28], Sudan[29], and Lebanon[14]. A total of 9,455 participants were included across all studies (range: 210[29]–2,785[14]). Structured questionnaires were the primary data collection tool in 80% of the studies (n=12), with recruitment methods split between direct interviews (60%) and self-administered questionnaires (40%).

Participant age varied, with some studies starting at

18 years and others including individuals over 50. Mothers constituted the largest group (68.4%, range: 32%[24]–100%[21,26,29]). The number of children per study ranged from 1 year[22,17] to over 3 years[24,28,27], with most studies focusing on children aged 2 years or older. The majority of participants held a university degree, predominantly a bachelor's degree, except in Sudan, where most participants were illiterate[29], as detailed in **Table 1**

Pooled Estimate of Good knowledge: A meta-analysis was conducted to evaluate parental knowledge of children's vaccines across 14 independent studies, comprising 9,035 participants. Knowledge rates varied widely, ranging from 27%[14] to 94%[26], with substantial differences in confidence intervals. Using a random-effects model, the pooled knowledge estimate was 0.73 (95% CI: 0.62–0.81), indicating statistical significance.

Table 1: **Characteristics of the included studies (n=15)**

First author last name, Year	Country	Sample Size	Type of questionnaire	Recruitment Process	Age of parents in years†		% of mothers	% of fathers	Highest % number of child % (No.)	Highest % of education level		Study Quality
					Mothers	Fathers				Mothers	Fathers	
Matta, 2020[14]	Lebanon	2785	Structured	direct interview	40.14 ± 13.45		63.10	34.30	NA	University (51.1)		Moderate
Alghamdi, 2023[15]	Saudi Arabia	301	Structured	self-administered	31–50 (81.7%)		68.10	31.90	NA	University (91.0)		Moderate
Alqassim, 2022[19]	Saudi Arabia	447	Structured	direct interview	30-39 (44.1%)		53	47	41.8 (1–2)	University (51.0)		Moderate
Alruwaili, 2018[20]	Saudi Arabia	367	Online	self-administered	20-30	31-40	NA	NA	28.6 (1)	Secondary (75.5)	University (47.7)	High
Abuharba, 2022[21]	Saudi Arabia	397	Structured	direct interview	20-30	20-30	100	0	47.3 (2)	University (97.5)	University (97.5)	High
Altuwayjiri, 2021[22]	Saudi Arabia	404	Structured	self-administered	35.7 ± 7.5	41.8± 8.1	60.60	39.40	NA	Post (71.5%)	Post (86.9%)	Moderate
Mobark , 2022[23]	Saudi Arabia	403	Online	self-administered	18-30		61	39	NA	Bachelor (76.2)		Moderate
Habib, 2018[24]	Saudi Arabia	600	Structured	direct interview	31.1± 2.5		32	68	47 (>3)	Bachelor (61)		Moderate
Bamatraf, 2018[28]	Yemen	400	Structured	self-administered	30-39		73	27%	43.5 (>3)	Bachelor (34)		Moderate
Alshammari, 2021[25]	Saudi Arabia	1200	Structured	direct interview	30–39		48.80	51.20	41.6 (2–3)	Bachlor (81.8)		High
Mohammed, 2021[29]	Sudan	210	Structured	direct interview	30-40		100	0	NA	Illiterate (38.1)		Moderate
Almutairi, 2021[26]	Saudi Arabia	262	Online	self-administered	25-31		100%	0	34.4 (2-3)	Bachelor or higher (61.8)		Moderate
Al-lela, 2014[16]	Iraq	528	Structured	direct interview	NA		NA	NA	NA	NA		Moderate
Yousif, 2014[27]	Saudi Arabia	731	Structured	direct interview	30-39		63.60	36.40	45.3 (>3)	Bachelor (56.1)		Moderate
Alshammari, 2018[17]	Saudi Arabia	420	Structured	direct interview	20-29		66	34	58.6 (1)	Bachelor or higher (79.8)		Moderate

†The age of parents was reported either as mean ± SD for both mothers and fathers, or as the highest percentage of parents within a specific age group; Newcastle-Ottawa Scale scores

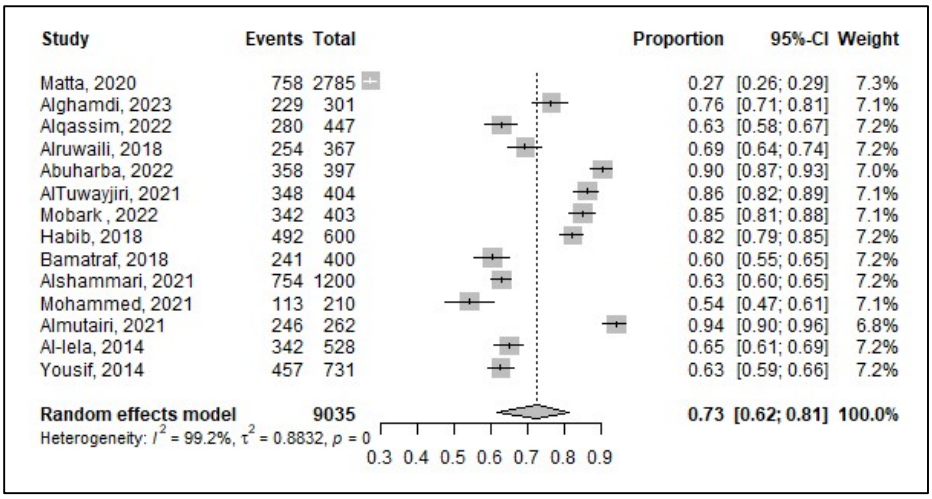

Figure 2: Forest plot of the percentage of good knowledge of parents toward child vaccination across studies

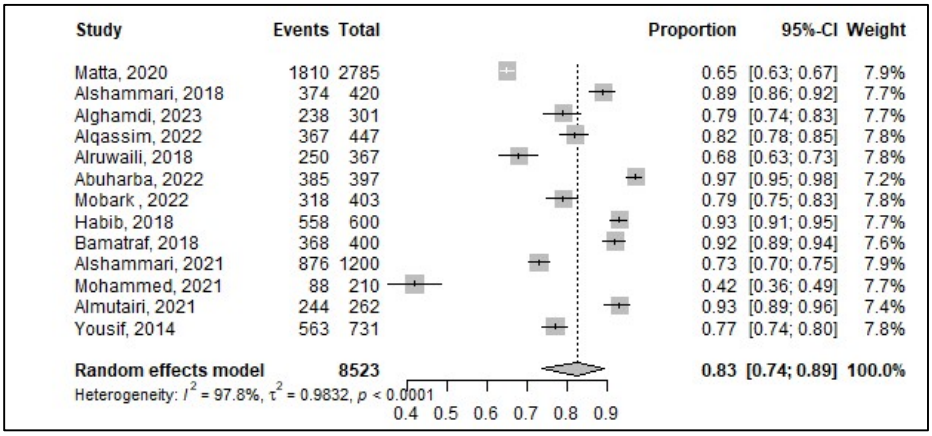

Figure 3: Forest plot of the percentage of positive attitudes of parents toward child vaccination across studies

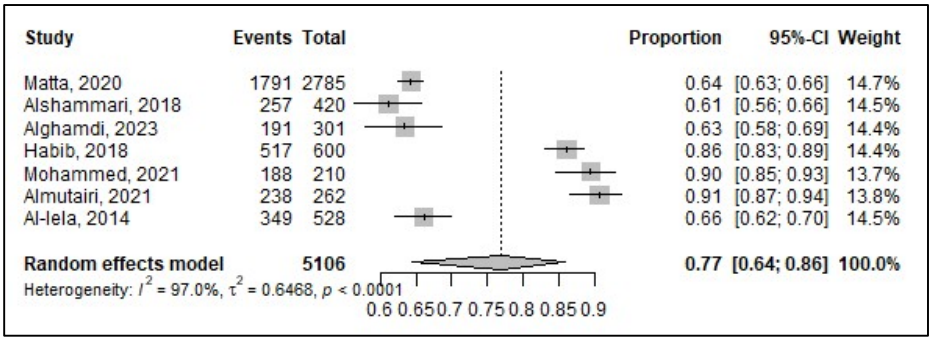

Figure 4: Forest plot of the percentage of good practices of parents on child vaccination across studies

Heterogeneity was extremely high (I^2 = 99.2%), suggesting that nearly all observed variance stems from true differences across studies. This variability may be attributed to demographic, cultural, and educational differences among participants. The estimate remains robust, as the confidence interval does not include zero, reinforcing the strength of the findings (**Figure 2**)

Pooled Estimate of Positive Attitudes: A meta-analysis of 13 independent studies, involving 8,523 participants, assessed parental attitudes toward children's vaccines. Positive attitude rates varied widely, ranging from 0.42[29] to 0.97[21], with substantial differences in confidence intervals. Using a random-effects model, the pooled estimate was 0.83 (95% CI: 0.74–0.89), indicating statistical significance.

Heterogeneity was high (I^2 = 97.8%), suggesting that nearly all variability resulted from true differences across studies rather than random variation. The τ^2 value (0.9832) further confirmed significant variation in study estimates, likely due to differences in study design and implementation.

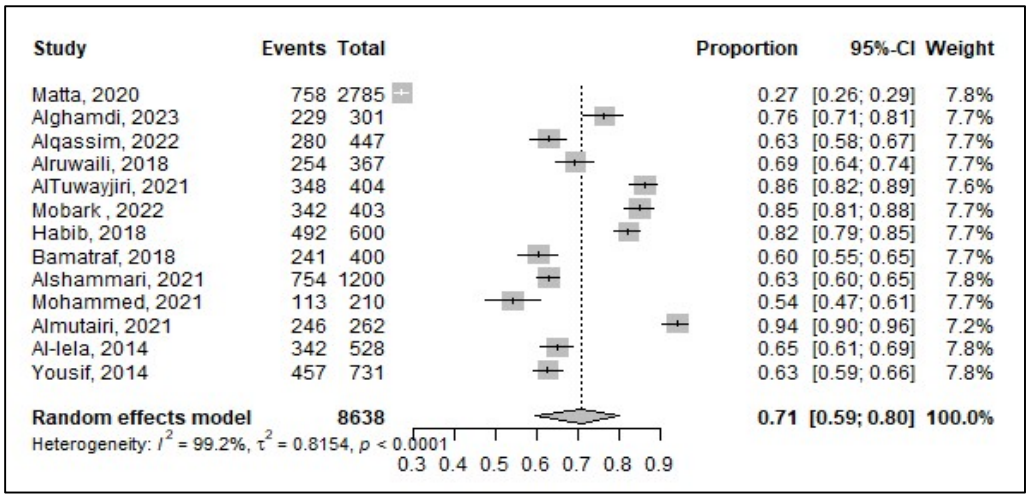

Figure 5: Forest plot of the percentage of good knowledge of parents toward child vaccination across studies after sensitivity analysis

The highest proportion was observed in Abuharba, 2022[21] (0.97, 95% CI: 0.95–0.98), while the lowest was in Mohammed, 2021[29] (0.42, 95% CI: 0.36–0.49). Larger studies, such as Matta, 2020 [14], contributed more to overall precision, with a weight of 7.9%. Despite high heterogeneity, the overall estimate remains robust and statistically significant, as the confidence interval does not include zero (**Figure 3**)

Pooled Estimate of Good Practices: A meta-analysis of seven independent studies, involving 5,106 participants, assessed parental practices regarding children's vaccines. Study sample sizes ranged from 210[29] to 2,785[14], with positive practice rates varying from 0.61[17] to 0.91[26]. Using a random-effects model, the pooled estimate was 0.77 (95% CI: 0.64–0.86), confirming statistical significance.

Heterogeneity was high (I^2 = 97.0%), indicating substantial differences across studies. The τ^2 value (0.6468) further supported significant variability, suggesting that differences stem from study design and implementation rather than random variation. Some studies[26,29] reported narrow confidence intervals, reflecting high estimation accuracy.

Despite the high variance, the results remain robust and statistically significant, as the confidence interval does not include zero, reinforcing the reliability of the findings (**Figure *4***)

Sensitivity Analysis: Sensitivity analysis revealed that excluding Abuharba, 2022[21], from the knowledge assessment increased the pooled estimate from 0.7257 to 0.7061. This shift was more pronounced than with other studies. The revised 95% confidence interval (0.5941–0.7977) was narrower, suggesting improved precision. Although heterogeneity remained high (I^2 = 99.2%), its reduction upon omitting this study indicates that it contributed disproportionately to overall variability (**Figure *5).***

For positive attitudes toward child vaccination, removing individual studies caused only minor fluctuations in the pooled estimate, ranging from 0.6991 (excluding Almutairi, 2021[26]) to 0.7543 (excluding Matta, 2020[14]). This stability suggests that no single study disproportionately influenced the overall result (**Supplementary Figure 1**). Sensitivity analysis for parental practices was not conducted due to the limited number of studies reporting practice scores.

Meta-regression analysis: A meta-regression analysis was conducted to examine the relationship between the percentage of good knowledge, positive attitudes, and good practices with the percentage of mothers who completed the questionnaire. The results from the meta-regression showed high residual heterogeneity for knowledge, attitude, and practice scores (I^2 = 92.7%, 99.2%, and 98.7%, respectively), indicating substantial variation between the studies that was not explained by the moderator. The test for the percentage of mothers was not statistically significant (p = 0.6241, 0.321, and 0.534, respectively), suggesting no strong evidence for an association between the moderator and the practice scores.

Publication bias: To evaluate potential publication bias, a funnel plot using logit-transformed proportions was generated. Visual inspection suggested asymmetry, with studies clustering more densely on the right-hand side (**Supplementary Figure 2**).

Egger's regression test confirmed this asymmetry (z = 5.17, p < 0.0001), indicating the presence of small-study effects or publication bias. The regression intercept (limit estimate as standard error approaches zero) was −0.85 (95% CI: −1.59 to −0.11), supporting this observation.

However, the trim-and-fill method estimated zero missing studies on the left side, suggesting that publication bias may not substantially influence the pooled effect size.

The observed high heterogeneity (I^2 = 99.01%) should also be considered, as it can independently contribute to funnel plot asymmetry.

DISCUSSION

This is the first meta-analysis to assess parental knowledge, attitudes, and practices regarding vaccines in Arab countries. The pooled estimates indicated good levels across all domains: knowledge (0.73, 95% CI: 0.62–0.81), attitudes (0.83, 95% CI: 0.74–0.89), and practices (0.77, 95% CI: 0.64–0.86). These findings suggest that positive knowledge and attitudes are reflected in corresponding practices.

However, substantial heterogeneity was observed across all outcomes (I^2 = 99.2% for knowledge, 97.8% for attitudes, and 97.0% for practices). This variability likely stems from cultural, environmental, and educational differences among participants, as well as methodological inconsistencies across studies.

Knowledge Levels and Influencing Factors: The sample size of the included studies played a critical role in knowledge estimates. The study with the largest sample (n = 2,785) reported the lowest knowledge level at 27% (95% CI: 0.26–0.29)[14], while a smaller study (Almutairi, 2021; n = 262) reported the highest level at 94% (95% CI: 0.89–0.96)[26]. Similarly, Alshammari's study, with a sample size of 1,200, reported a moderate knowledge level of 63% (95% CI: 0.60–0.65)[25]. This disparity suggests that larger studies may capture greater variability due to diverse cultural, educational, and social backgrounds a study done by Al-Marshoudi, 2021 shows the same results[30], whereas smaller studies tend to have more homogeneous samples, resulting in higher knowledge estimates such as in Patel Trushitkumar, 2017 study[31].

Data collection methods also influenced knowledge levels. Studies using direct interviews, such as Matta's study, reported lower knowledge rates, while those using self-administered questionnaires, like Almutairi's study[14,26], showed higher rates. This indicates that self-reporting may lead to overestimation due to social desirability bias.

Educational attainment emerged as a key determinant of knowledge. In studies with a high proportion of university-educated parents, such as Abuharba, 2022 (97.5%) and Almutairi, 2021 (61.8%), knowledge levels were 90% (95% CI: 0.87–0.93) and 94% (95% CI: 0.89–0.96), respectively.[21,26] In contrast, in Sudan (Mohammed, 2021), where 38.1% of parents were illiterate, knowledge was significantly lower at 54%.[29] Voo, 2021 also demonstrated in his study the close relationship between a high level of knowledge and a high level of education, which in turn leads to a decrease in hesitation.[32]

Attitudes Toward Vaccination: Several studies reported exceptionally high positive attitude rates, including Abuharba, 2022 (97%, 95% CI: 95%–98%)[21], Habib, 2018 (93%, 95% CI: 91%–95%)[24], and Almutairi, 2021 (93%, 95% CI: 89%–96%)[26]. In all these studies, a high percentage of parents were university graduates (97.5%, 61%, and 61.8%, respectively), reinforcing the link between higher education and positive attitudes toward vaccination.

Moderate attitude levels (65%–80%) were observed in studies such as Alghamdi, 2023 (79%, 95% CI: 74%–83%)[15], Alruwaili, 2018 (68%, 95% CI: 63%–73%)[20], and Mobark, 2022 (79%, 95% CI: 74%–83%)[23]. These studies relied on online or self-administered questionnaires, suggesting that participants may have felt more comfortable expressing their opinions without social pressure.

The lowest recorded attitude level was in Mohammed, 2021 (42%, 95% CI: 36%–49%)[29], where high illiteracy rates (38.1%) were likely a contributing factor. This aligns with the observed correlation between lower knowledge and negative attitudes toward vaccination. The study of farmers in the northern region of Bangladesh also showed that educational level was closely related to attitudes towards vaccination, with the majority of the study sample not being graduates, which was offset by lower levels of positive attitudes.[33]

A direct relationship was evident between knowledge and attitudes. For instance, in Almutairi, 2021, where knowledge reached 94%, positive attitudes were similarly high at 93%[26]. Conversely, in Mohammed, 2021, knowledge was low (54%), and attitudes followed suit (42%) [29]. On the other hand, Asghar, 2025 study showed that moderate knowledge (87%) was met with moderate attitudes (77%).[34]

Vaccination Practices and Determinants: Sample size significantly influenced practice estimates. The largest study (Matta, 2020; n = 2,785)[14] reported a relatively low practice rate of 64%, while the smallest study (Almutairi, 2021; n = 262)[26] reported the highest at 91%. This discrepancy suggests that smaller studies may yield inflated estimates due to limited representativeness, whereas larger studies better capture real-world variability.

Data collection methods also played a role. Studies using self-administered questionnaires, such as Almutairi, 2021[26], reported higher practice rates (91%), while those relying on face-to-face interviews, such as Matta, 2020[14], reported lower rates (64%), and Alshammari, 2018 [17] also reported lower rates (61%). This could be attributed to social desirability bias in self-reported responses, where participants may overstate their adherence to vaccination practices. Another example of the impact of data collection methods is a study conducted in Jordan, which included 1477 participants. Despite the large sample size, the use of a self-administered questionnaire resulted in a 77% practice rate.[35]

A notable anomaly was observed in Mohammed, 2021, where despite low knowledge (54%) and attitudes (42%), the practice rate was remarkably high at 90%. This discrepancy suggests that factors beyond knowledge and attitudes, such as maternal age

and social norms, may influence vaccination behaviors.[29]

Limitations

Cross-sectional studies have inherent limitations that affect the accuracy of results. A major limitation is their inability to establish causality, as data are collected at a single point in time, restricting analysis to associations rather than causal relationships. Selection and response bias are also concerns, as samples may not fully represent the target population. These studies cannot assess changes over time or detect trends. Controlling for confounders is often difficult, which may compromise the validity of conclusions. Additionally, the limited number of studies on parental KAP toward vaccines in the Arab world, combined with substantial heterogeneity in study design, populations, and cultural contexts, restricts the generalizability of findings. This review may also be subject to publication bias due to the exclusion of grey literature and non-peer-reviewed sources. Furthermore, restricting inclusion to English and Arabic studies introduces potential language bias, which may limit the comprehensiveness of the evidence base.

Conclusion

This meta-analysis reveals a strong correlation between parental knowledge, positive attitudes, and effective vaccination practices. While these factors are generally aligned, considerable variation exists due to differences in sample size, educational levels, data collection methods, and cultural influences. These findings highlight the importance of tailored public health strategies (e.g., specific educational campaigns) and the need for standardized research methods to better understand and improve vaccination behaviors across diverse populations.

Author contribution: SA and MM contribute equally on this analysis**.**

No use of generative AI tools: We declared not using any AI tool to prepare this manuscript.

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