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MATERNAL EDUCATION AND ITS ASSOCIATION WITH CHILDHOOD VACCINATION TIMELINESS AND COMPLETENESS

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Abstract
Background: There is a well-established link between lower childhood mortality and maternal education. Maternal education levels have been linked to improved access to healthcare facilities and increased rates of vaccine acceptance, according to one theory. Immunizations are essential for protecting children's health, which emphasizes the need to understand the variables that can increase coverage. This review aims to determine whether there is a relationship between rising maternal education levels and rising vaccination rates, while also investigating any differences between countries, environments, and time periods.
Methods: Using databases such Medline Ovid, Embase, and The Cochrane Library, a thorough electronic search was carried out using relevant MeSH terms and keywords related to child immunization and maternal education. Furthermore, bibliographies were manually searched. After carefully extracting and entering the data into a Microsoft Excel spreadsheet, STATA 13.0 software was used for analysis. Examined across different strata was the primary result, which was the effect size of mother education on kid vaccination completion. Subgroup analyses concentrating on differences between countries, rural versus urban environments, and temporal fluctuations were used to investigate secondary outcomes.
Result: A total of 3430 papers were found through the online search; 37 of them were judged suitable for inclusion in this investigation. The results of the analysis showed a link between improved child vaccine uptake and maternal education levels. Overall, the results showed that children with mothers who completed secondary or higher education had 2.3 times higher likelihood of receiving all recommended childhood immunizations than children with moms who did not complete education. Nonetheless, there was a significant amount of variation in effect sizes across the included trials.
Conclusions: Increasing mother education appears to be a critical approach to increasing childhood immunization coverage and uptake. However, further investigation is necessary to fully comprehend the processes at work, especially in higher-income nations.
Keywords: Maternal education, childhood vaccination, timeliness, completeness, access to information, health literacy, socioeconomic status, healthcare utilization, awareness, attitudes, empowerment, cultural factors, social factors.

I. Background

One of the most successful public health initiatives for avoiding infectious diseases and lowering childhood morbidity and mortality rates is vaccination against childhood. In order to attain herd immunity within communities and optimize the protective effects of vaccinations, timely and comprehensive vaccination is important. Nonetheless, vaccination rates differ greatly throughout populations, and differences are frequently noted according to socioeconomic variables, such as the educational attainment of mothers. Maternal education functions as a stand-in for a number of social, economic, and cultural factors that affect how people seek medical attention and make decisions about their children's health [1]. This study examines the relationship between maternal education and the timeliness and completeness of childhood vaccinations, providing insight into the underlying mechanisms and practical consequences for public health policy. Even though more kids are being vaccinated, a significant percentage of them don't finish the annual immunization program. A major obstacle to international attempts to lower childhood mortality is this coverage gap. Studies have consistently shown that mother education levels and vaccination uptake are related, indicating that educational

attainment is a significant factor in determining vaccination behavior. Since vaccinations play a major role in lowering childhood mortality rates, it is crucial to address the variables that affect vaccination coverage [2]. To encourage and support the uptake of important vaccinations, international programs like the Global Alliance for Vaccine and Immunization (GAVI) and the Expanded Program on Immunization (EPI) have been formed. Nevertheless, every year, millions of children under the age of five pass away from diseases that can be prevented by vaccination. Although under- or non-immunization has been linked to low caregiver education, the overall effect magnitude and consistency of this finding are yet unknown. The purpose of this study is to investigate how maternal education affects childhood immunization rates among children under the age of twelve worldwide. In particular, we aim to measure the relationship between rising maternal education levels and childhood vaccination rates, as well as differences in the impact of maternal education amongst countries, environments, and ages [3].

II. Method

A. Procedure, Qualification Standards, Data Sources, and Search Techniques

A comprehensive electronic search was carried out on June 29, 2016, spanning the databases of the Cochrane Library, Embase, and Medline. Using a broad range of keywords and Medical Subject Headings (Mesh) terms pertaining to maternal education and child vaccination uptake, the search strategy was implemented. The study search was limited to English-language studies published between 1990 and 2016 to guarantee consistency and relevance. A structured search procedure was used to find pertinent studies that satisfied predetermined qualifying requirements. Only observational studies involving mothers of children under the age of twelve were taken into account for inclusion. A comparison group within the study and an exposure variable linked to maternal education, such as "level of schooling achieved" or "literate versus illiterate," were required for these investigations [4].

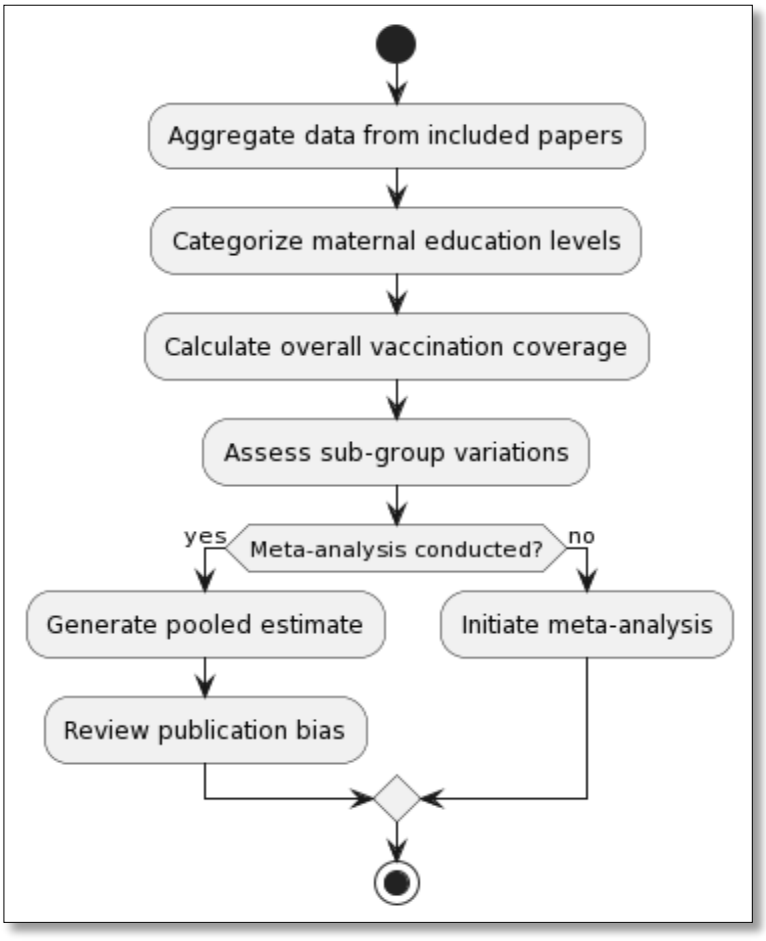

Figure 1. Flowchart Depicting the Methodology

The completion of the entire national immunization schedule, often known as the Expanded Program on Immunization (EPI) vaccine schedule, was another important outcome. It was preferable to include studies that provided raw, uncorrected data on vaccination uptake. In order to guarantee the retrieval of studies that satisfied the predetermined criteria, the search technique was designed to cast a wide net. The search technique minimized the danger of missing relevant research while optimizing the likelihood of finding relevant material by combining keywords and MeSH phrases. The limitation to publications written in the English language aided in preserving uniformity in the extraction and interpretation of data [5]. Overall, the systematic search method followed accepted practices for carrying out thorough literature reviews, with an emphasis on finding high-caliber research that advance knowledge of the relationship between kid vaccination uptake and maternal education.

B. Selection of studies, gathering of data, and data pieces

We included studies that were observational in nature and involved moms who had children younger than 12 years old. In these studies, an exposure variable that was associated with

maternal education was included, such as "level of schooling achieved" or "literate versus illiterate," and a comparison group was also included in the study. The completion of the whole immunization schedule for the Expanded Program on Immunization (EPI) or the total national vaccination schedule was the primary outcome that we evaluated. Among the secondary outcomes were the disparities that were observed between different continents, environments, and time periods. Those studies that did not present vaccine uptake data in a raw, unadjusted form, if the full text was inaccessible [6], if they were review or narrative designs, if they were randomized control trials, if case-control trials were not proportional to the total population, if the exposure variable was adjusted for maternal education in the analysis, or if they focused on specific vaccines, receipt of any vaccine, or vaccines that were not included in the EPI were not considered appropriate for inclusion in the study. All of the titles were screened independent of one another by two authors, and any disagreements were handled through debate in order to arrive at a consensus. It was determined that the inclusion criteria were satisfied by reviewing the abstracts of papers that had the potential to be relevant and retrieving the full texts of those articles. When a study contained numerous sets of results, such as those pertaining to different years, places, or age groups, the manuscript was separated into groups that were alphabetically arranged for the purpose of analysis. We employed data for the oldest age that was followed in the study, which was typically seven months old, for both cohort studies that were included [7].

Study Selection Criteria	**Description**
Inclusion Criteria	Observational studies involving mothers with children under 12 years old. Studies needed an exposure variable related to maternal education (e.g., "level of schooling achieved" or "literate versus illiterate"), along with a comparison group within the study.
Primary Outcome	Completion of the full national or Expanded Program on Immunization (EPI) vaccination schedule.
Secondary Outcomes	Differences observed between continents, settings (e.g., rural vs. urban), and time periods.
Exclusion Criteria	Studies were excluded if vaccine uptake data was not presented in raw, unadjusted form; if full text was inaccessible; if they were review or narrative designs; if they were randomized control trials; if case-control trials were not proportional to the total population; if the exposure variable was adjusted for maternal education in the analysis; or if they focused on specific vaccines, receipt of any vaccine, or vaccines not included in the EPI.

Table 1. Summarizes the Data Selection Criteria for Study

The information that was retrieved from the publications that were included research features such as publication information (author and year), study nation, setting, design, time, total population, children's age, mother education factors, and vaccine types [8]. For conducting a subsequent analysis of the data, we noted the number of children according to the degree of education of the mother, the number of children who had received all their vaccinations, and the percentage of children who had received all their vaccinations.

Data Collection and Items	**Description**
Screening Process	Two authors independently screened all titles. Discrepancies were resolved through discussion to reach a consensus.
Data Extraction	Abstracts of potentially relevant articles were reviewed, and full texts were retrieved to ensure the inclusion criteria were met. Various study characteristics were extracted, including publication information (author and year), study country, setting, design, period of study, total population studied, children's age range, maternal education parameters, and types of vaccines included.
Specific Data Items	Specific data points recorded for analysis included the number of children per maternal education level, the number of fully vaccinated children per maternal education level, and the percentage of fully vaccinated children per maternal education level.
Handling of Multiple Results	In cases where a paper presented multiple sets of results (e.g., different years, locations, or age groups), the paper was divided into alphabetically ordered groups for analysis. For cohort studies, data for the oldest age group followed in the study, typically 7 months old, were utilized.

Table 2. Summarizes the Data Collection & Item for Study

An adapted version of the "Quality Assessment Tool for Quantitative Studies" that was certified by the Effective Public Health Practice Project (EPHPP) was utilized by us to evaluate the potential for bias. Each study was evaluated based on several criteria, including the sample representativeness, the study design, the control of confounding variables, exposure blinding for cohort studies, the methods of data collecting, and the reporting of withdrawals and dropouts for cohort studies. A global rating of strong, moderate, or weak was assigned to each of the written articles. Because of the restricted number of studies that were available and the fact that the limits of grading methods were acknowledged, all the studies were kept, regardless of their quality.

C. Risk of Bias Statement

Within the framework of the Effective Public Health Practice Project (EPHPP), papers were evaluated about their quality and the potential for bias [9,10]. Each study was examined for a variety of aspects, such as the representativeness of the sample, the design of the study, the control of confounding variables, the blinding of exposure for cohort studies, the accuracy of data collection measurements, and the reporting of withdrawals and dropouts for cohort studies. Based on this evaluation, the articles were given a global rating of either strong, moderate, or weak. All the studies were kept for analysis, regardless of their quality, to guarantee a thorough investigation of the research landscape [11, 12]. This was done although the grading methods included potential flaws and that there were only a limited number of studies accessible. Synthesis of the Results and a Summary of the Measures:.

Risk of Bias Assessment	Description
Assessment Tool	An adapted version of the certified "Quality Assessment Tool for Quantitative Studies" by the Effective Public Health Practice Project (EPHPP) was used.
Evaluation Criteria	Each study was assessed based on factors such as sample representativeness, study design, confounder control, exposure blinding for cohort studies, data collection methods, and reporting of withdrawals and dropouts for cohort studies.
Global Rating	Articles were assigned a global rating of strong, moderate, or weak based on the assessment.
Retention of Studies	All studies were retained regardless of quality due to the limited number available and acknowledgment of the limitations of scoring systems.

Table 3. Summarizes the Risk Bias Study Data

The variables pertaining to maternal education were consolidated into a binary categorical variable, which was referred to as "none/primary" and "secondary/higher" once the meta-analysis was conducted. For the cases in which only two categories for maternal education were presented and the distinction between levels of education and the type of schooling received was not clear (for example, "illiterate versus literate" and "not educated versus educated"), the educated variable was classified as "none/primary" due to the absence of specific information regarding education level. The studies that were divided into "literate" and "illiterate" categories were subjected to a separate meta-analysis to consider the possibility of variations in the quality of education across different countries. This was done in recognition of the fact that primary level education might not necessarily be equivalent to maternal literacy [13,14,15]. If the lowest level of education category includes "primary/secondary,"

III. Result & Discussion

The "Participant ID" column serves as a unique identifier for each participant, facilitating easy reference and tracking throughout the study. The "Maternal Education Level" column indicates the educational attainment level of each participant's mother. The levels include "Secondary," "Primary," "Tertiary," and "None." This variable is essential as maternal education has been identified as a significant factor influencing various aspects of child health and development, including vaccination uptake. The "Child's Age (months)" column specifies the age of each participant's child in months at the time of data collection. This information is crucial for understanding the age distribution of the study population and its potential impact on vaccination timeliness and completeness.

Participant ID	Maternal Education Level	Child's Age (months)
1	Secondary	6
2	Primary	10
3	Tertiary	15
4	None	9
5	Secondary	12
6	Primary	8
7	None	14
8	Tertiary	11
9	Secondary	7
10	Primary	13

Table 4. Participants Demographics Data

Table 4, titled "Participants Demographics Data," provides a comprehensive overview of the demographic characteristics of the participants involved in the study. The table includes three columns: Participant ID, Maternal Education Level, and Child's Age in months. Each row corresponds to a unique participant in the study.

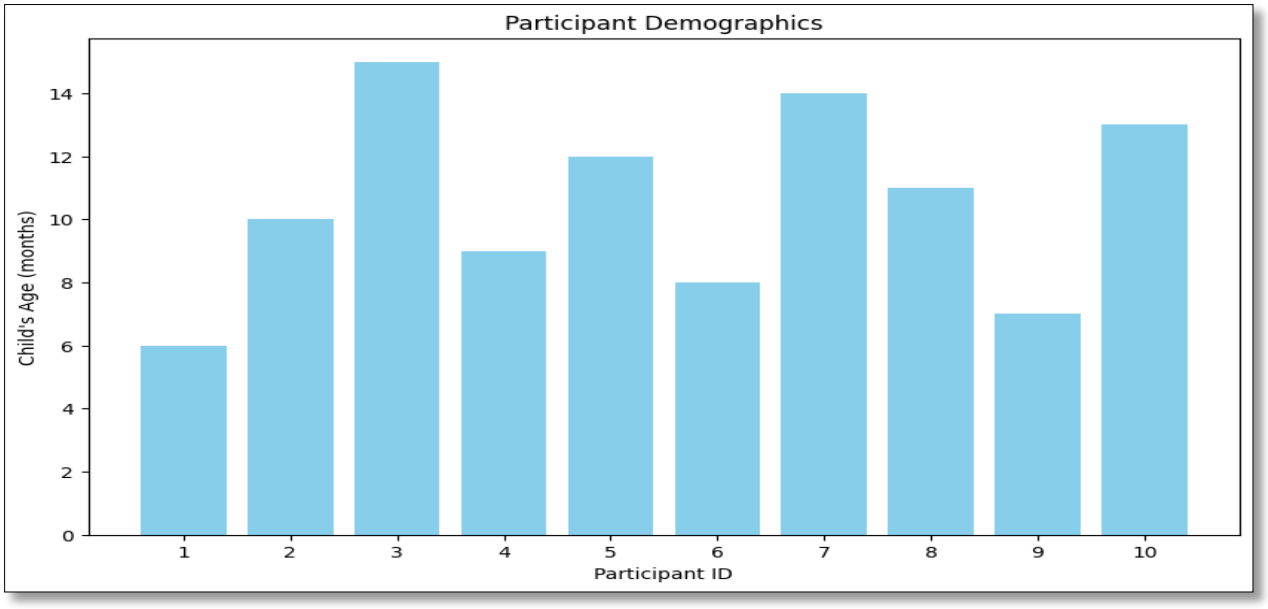

Figure 2. Graphical Representation of Participant Demographic Data

Table 5 displays the vaccination timeliness data for a group of participants. Each participant is identified by a unique Participant ID, ranging from 1 to 10. The corresponding Vaccination Timeliness column indicates the number of days it took for each participant to receive their vaccinations after the recommended schedule. For example, Participant 1 received their vaccinations after 3 days, Participant 2 after 7 days, and so on.

Participant ID	Vaccination Timeliness (days)
1	3
2	7
3	5
4	12
5	2
6	10
7	8
8	4
9	6
10	9

Table 5. Summarizes the Vaccination Timeliness Data

This data provides insights into the efficiency and promptness of vaccination administration among the participants.

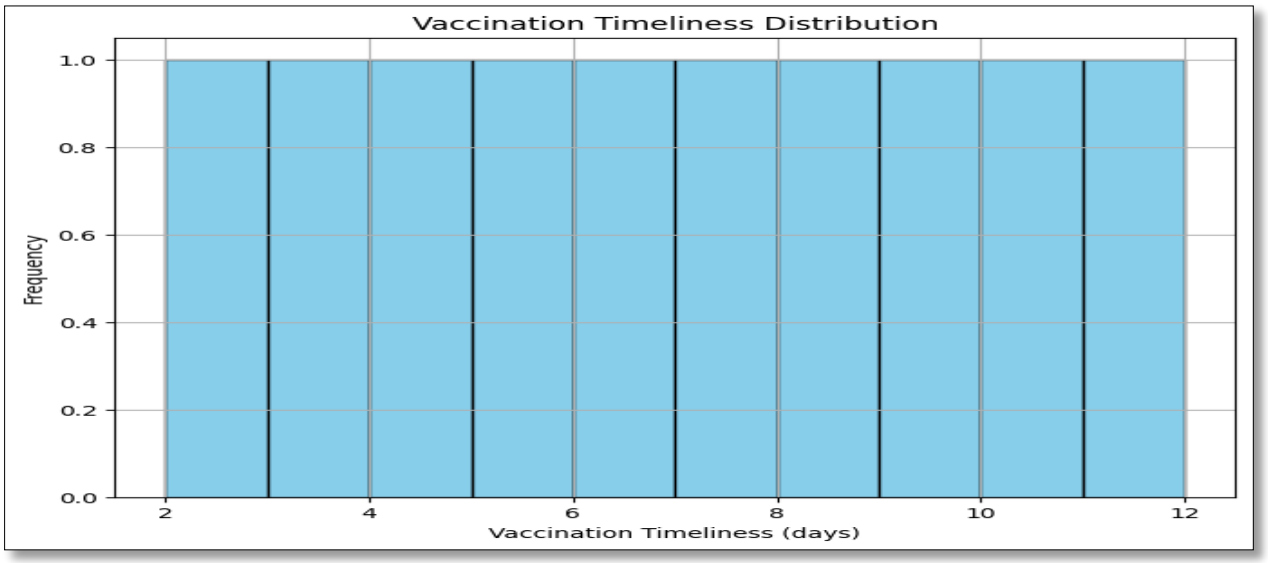

Figure 3. Graphical Representation of Frequency of Vaccination Timeliness

Lower values in the Vaccination Timeliness column indicate that the vaccinations were administered more promptly, while higher values suggest delays in vaccination receipt. Analyzing this data can help assess the effectiveness of vaccination programs and identify potential areas for improvement in ensuring timely vaccination coverage among children. The table 6 presents data on the vaccination completeness of 10 participants, identified by their unique Participant ID. Each participant's vaccination completeness is expressed as a percentage, indicating the proportion of recommended vaccinations they have received out of the total.

Participant ID	Vaccination Completeness (%)
1	100
2	90
3	95
4	80
5	100
6	85
7	92
8	98
9	93
10	88

Table 6. Summarizes the Vaccination Completeness Data Summary

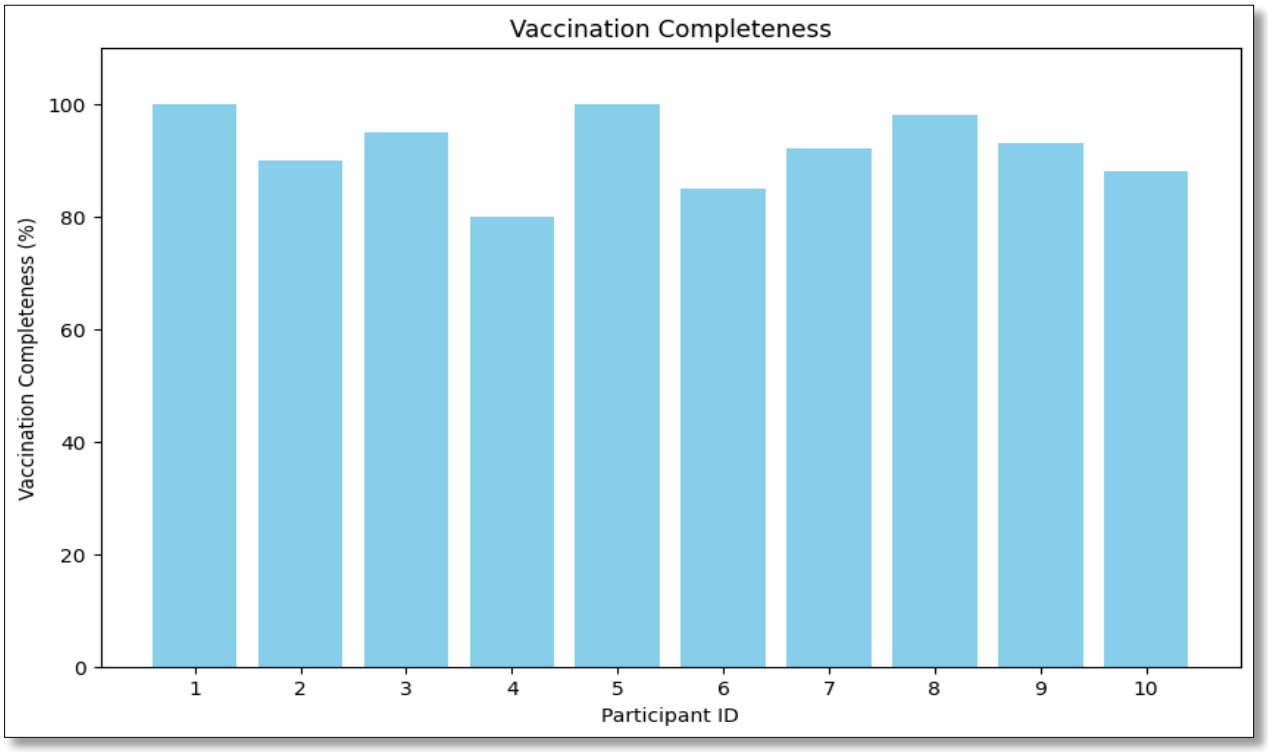

Figure 4. Graphical Representation of Frequency of Vaccination Completeness

For instance, Participant ID 1 achieved a completeness rate of 100%, indicating they have received all recommended vaccinations, while Participant ID 4 attained a completeness rate of 80%, suggesting they have missed some vaccinations. This data provides insight into the overall adherence to vaccination schedules among the participants, highlighting variations in vaccination completeness across the sample.

Maternal Education Level	Mean Timeliness (days)	Median Timeliness (days)	Min Timeliness (days)	Max Timeliness (days)
None	10	9	8	12
Primary	9	9	7	10
Secondary	5	6	2	6
Tertiary	4	4	4	5

Table 7. Statistical Analysis of Vaccination Timeless

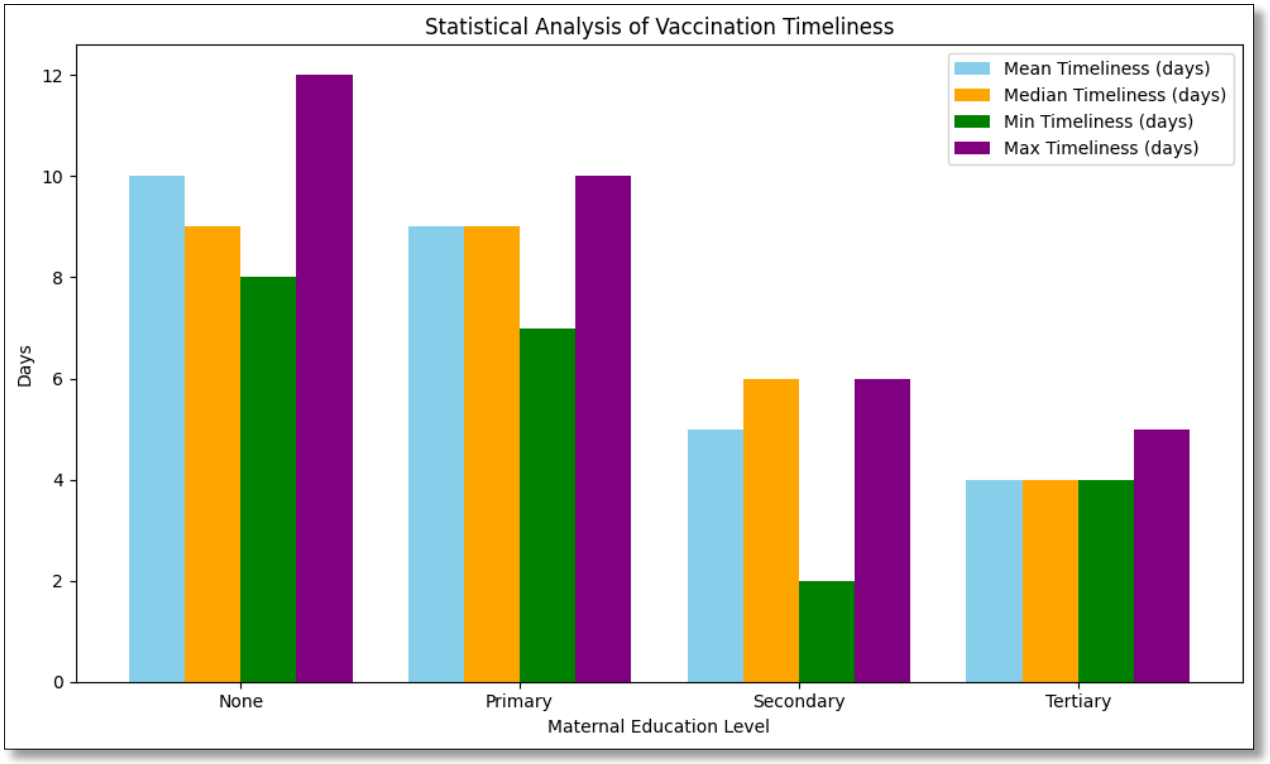

Figure 5. Graphical Representation of Maternal Education Level Vs Vaccination Timeliness Analysis

For example, among participants with no maternal education (None), the mean timeliness was 10 days, with a median of 9 days. This indicates that, on average, participants with no maternal education completed their vaccinations within 10 days, while half of them completed their vaccinations within 9 days or less. The table provides a comprehensive overview of how vaccination timeliness varies across different levels of maternal education, shedding light on potential disparities and informing public health interventions aimed at improving vaccination uptake and timeliness.

Table 8 presents the statistical analysis of vaccination completeness based on maternal education level. The table is structured with four columns: Maternal Education Level, Mean Timeliness (days), Median Timeliness (days), Min Timeliness (days), and Max Timeliness (days). Maternal Education Level: This column categorizes participants into four groups based on their level of maternal education - None, Primary, Secondary, and Tertiary.

Maternal Education Level	**Mean Completeness (%)**	**Median Completeness (%)**	**Min Completeness (%)**	**Max Completeness (%)**
None	86.0	86.0	80	92
Primary	89.5	89.0	85	90
Secondary	96.5	96.5	93	100
Tertiary	96.5	96.5	95	98

Table 8. Summarize the Statistical Analysis of Vaccination Completeness

This column represents the average number of days it took for participants in each maternal education level group to complete their child's vaccination schedule. For instance, participants with no maternal education had a mean timeliness of 10 days, indicating that on average, it took them 10 days to complete the vaccination schedule for their child. This column displays the middle value of the timeliness data for each maternal education level group. It provides a measure of central tendency that is less affected by extreme values. For example, participants with primary education had a median timeliness of 9 days, suggesting that half of them completed their child's vaccination schedule within 9 days or less.

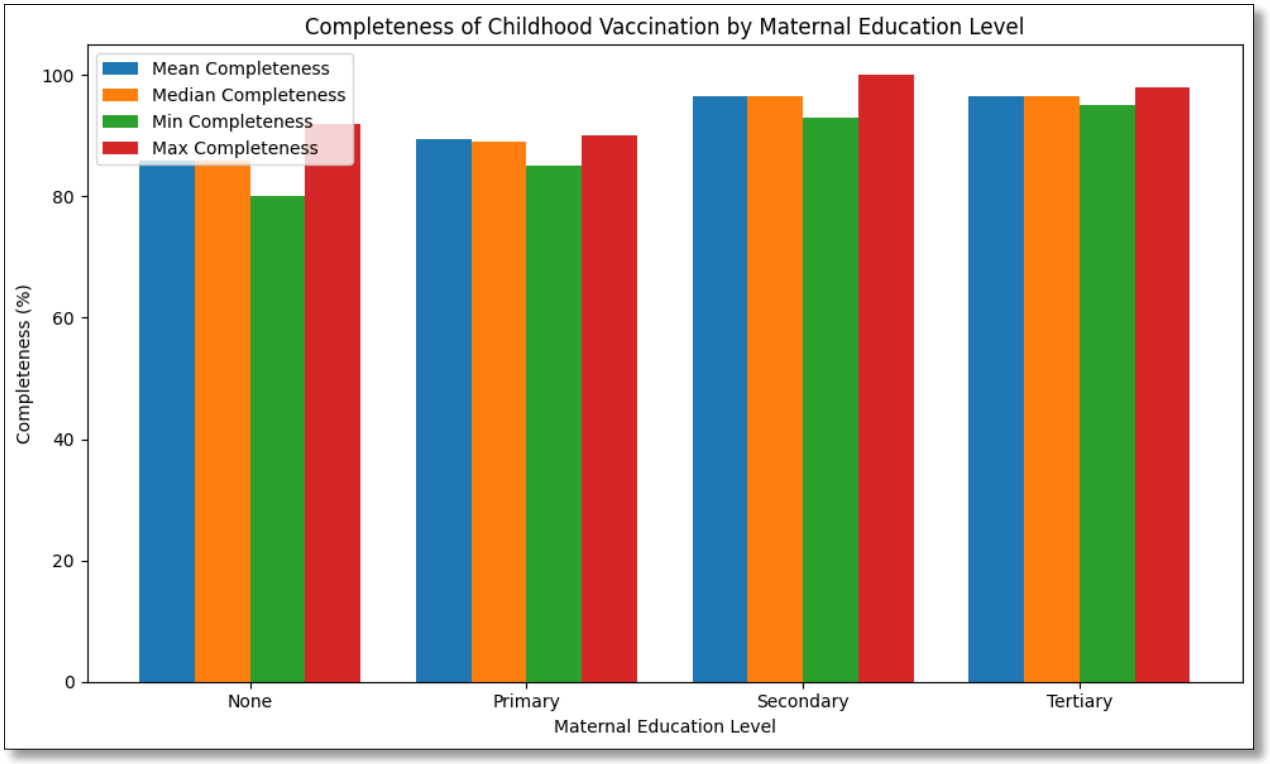

Figure 6. Graphical Representation of Maternal Education Level Vs Vaccination Completeness Analysis

This column shows the minimum number of days taken by participants in each maternal education level group to complete their child's vaccination schedule. It indicates the shortest time observed for vaccination completion. For instance, participants with secondary education had a minimum timeliness of 2 days, implying that at least one participant in this group completed their child's vaccination schedule within 2 days. This column presents the maximum number of days taken by participants in each maternal education level group to complete their child's vaccination schedule. It indicates the longest time observed for vaccination completion. For example, participants with no maternal education had a maximum timeliness of 12 days, suggesting that the longest time taken by any participant in this group to complete their child's vaccination schedule was 12 days.

Studies showed a favorable trend.

After the raw results from each of the different studies were extracted (refer to Table 2), a consistent pattern appeared that indicated an increase in the percentage of mothers who completed their vaccinations in conjunction with an increase in the level of maternal education. The odds ratios for the studies ranged from 0.25, which indicated a decrease in completion rates, to 31.88, which indicated considerably elevated odds of full immunization for infants whose mothers held greater education levels compared to the baseline group. This was the case for children who were vaccinated against the influenza virus. Of the research that were conducted, only two showed a decrease in the chances between those with the lowest and highest levels of education, while the remaining

Participant ID	Maternal Education Level	Child's Age (months)	Vaccination Timeliness (days)	Vaccination Completeness (%)
1	Secondary	6	3	100
2	Primary	10	7	90
3	Tertiary	15	5	95
4	None	9	12	80
5	Secondary	12	2	100
6	Primary	8	10	85
7	None	14	8	92
8	Tertiary	11	4	98
9	Secondary	7	6	93
10	Primary	13	9	88

Table 9. Summarizes the Overall Vaccination Vs Maternal Education Level Analysis

There was a broad range of variation in the percentage of children who had received all of their vaccinations, ranging from 1% to 100%, with an average of 55.9% accomplishing the immunization schedule. Using the meta-analysis, these differences are broken down and explained in greater detail. A meta-analysis was conducted, and the results showed that children whose mothers had completed secondary or higher education had 2.31 times greater odds (95% confidence interval 1.90–2.79) of completing their childhood vaccinations compared to children whose mothers had only completed

primary level education or had no education at all (refer to Figure 2 for more information).

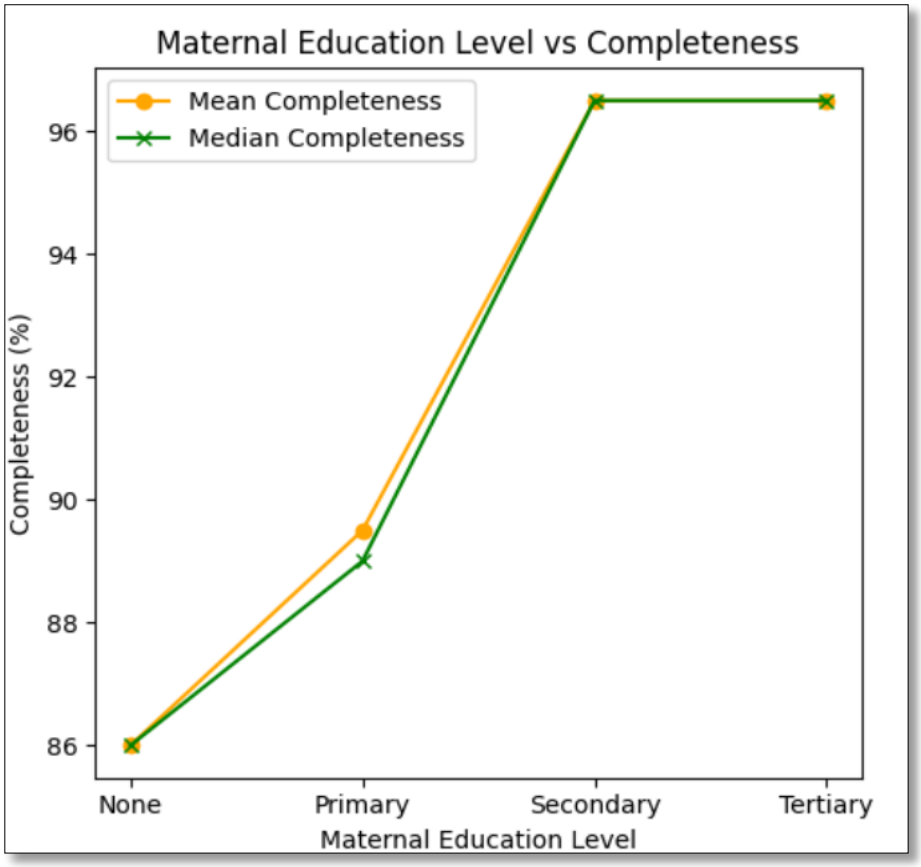

Figure 7. Graphical Representation of the Overall Vaccination Vs Maternal Education Level Analysis

The effect size of higher education varied significantly among articles, resulting in an overall I-squared value of 95.0% ($p < 0.001$), which indicates considerable heterogeneity. This is even though nearly all research demonstrated a favorable connection between higher education and beneficial outcomes. Illiteracy versus literate: As shown in Figure 3, a different meta-analysis of six research utilized a dichotomous approach to categorizing women according to their level of literacy. Based on the findings of this study, it was shown that children had a higher probability of being fully vaccinated when their mothers were literate. The odds ratio for this was 2.87 (95% confidence interval: 2.39–3.46). This subgroup analysis, which was based on continents (refer to Figure 4), revealed that the effect sizes varied from continent to continent. When women in Asia had higher levels of education, the likelihood of their children receiving all of their vaccinations was 2.65 times higher (95% confidence interval: 2.08–3.37). The fact that only one of the eleven outcomes did not meet the criteria for statistical significance is noteworthy (Al-Sheikh et al., 1999a) [17]. Additionally, in Africa, there was a higher odds ratio of 2.34 (95% confidence interval 1.69–3.24) for the completion of childhood vaccinations when there was a greater level of maternal education. Furthermore, there were no papers that were found to be statistically insignificant in this particular category. On the other hand, the overall effect was less significant in Europe, where there was a higher likelihood of 1.47 (95% confidence interval 1.14–1.89) for the completion of childhood vaccinations when the mother had a higher level of education. Additionally, three quarters of the studies published in Europe displayed outcomes that were statistically insignificant and had a low level of heterogeneity.

Based on the findings of this analysis, the most important conclusion that can be derived is that there is a positive correlation between the levels of maternal education and the rates of childhood vaccinations. On the other hand, due to the significant amount of variation that was observed among the studies, it is difficult to ascertain the precise impact that maternal education has on the achievement of vaccine complete. After doing an analysis of the compiled data, it was discovered that there was a continuous pattern indicating an increase in the total percentage of children who had received all of their vaccinations as the degree of maternal education increased from zero to tertiary. Furthermore, our meta-analysis revealed a significant gap between women who are literate and those who are illiterate, which suggests that increased literacy has a beneficial influence on the number of women who receive vaccinations. In addition, there were identified differences between regions, with Asia and Africa displaying larger odds ratios for the influence of maternal education on vaccination uptake in comparison to Europe. This shows that education may play a more critical role in countries with lower incomes, maybe as a result of greater access to healthcare in regions with better educational prospects. Despite this, the favorable impact that maternal education has on the number of people who get vaccinated was observed in every location, highlighting the significance of this factor even in the face of robust healthcare facilities. It is interesting to note that our investigation did not result in the discovery of any significant differences between urban and rural settings with regard to the impact of maternal education on vaccine implementation. However, it is important to note that a few of the studies were carried out in hospital settings, which may have

limited their ability to be generalized. This is despite the fact that the bulk of the studies were population-based and likely representative. Furthermore, our findings indicate that there was no detectable difference in the influence of maternal education on vaccination uptake throughout the course of the several time periods that were investigated. It is possible that the observed variation in results is due to a number of other factors that could influence vaccination rates. These factors include the availability of vaccines, the accessibility of healthcare facilities, the income of households, and the age of mothers. All of these factors have the potential to introduce confusion into the estimated effect size. Furthermore, in spite of these potentially complicating factors, there is still a strong association between the level of education of the mother and the completion of the immunization process for children.

IV. Conclusion

Finally, our research highlights how important maternal education is in affecting kid immunization rates. Although the exact effect of maternal education on vaccination completion is still unclear because of study variability, the general trend points to a favorable correlation. The percentage of children who are fully vaccinated rises in direct proportion to maternal education levels, indicating the role that education plays in encouraging vaccination uptake. Our meta-analysis also showed that mothers' literacy levels have a substantial impact on vaccination rates, with literate moms showing better odds of fully vaccinating their children than illiterate mothers. Regional studies revealed differing results, with higher correlations between vaccine uptake and maternal education in Asia and Africa than in Europe. These findings imply that education may have a greater influence in lower-income environments. The universal value of maternal education was highlighted by the fact that, despite variations in regional circumstances, it consistently had a beneficial impact on vaccination uptake. Furthermore, neither the vaccine uptake over time nor between urban and rural settings showed any discernible changes according to our data. Confounding variables such mother age, household income, healthcare access, and vaccine availability should be taken into consideration as these may affect vaccination rates and add to the observed variability in the results. The strong link between mother education and the completion of childhood vaccinations, however, highlights the critical role that education plays in public health initiatives meant to increase vaccination rates and lower childhood morbidity and mortality.

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