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Risk factors for incomplete vaccination schedules in pediatric hematology -oncology patients in a secondary care hospital

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Abstract
Vaccination is one of medicine's greatest discoveries. Millions of lives have been saved thanks to this invaluable public health strategy. Every year, the World Health Organization coordinates with health authorities in various countries to reach a larger segment of the global population with vaccines. However, the last ten years have presented a clinical and logistical challenge, as global vaccination coverage has declined due to various factors, including sociocultural and economic factors, infrastructure problems within each country's health system, and the 2019 pandemic. In Mexico, recent years have seen a significant decline in adherence to vaccination schedules across the population. However, specific vulnerable populations are more susceptible to infectious diseases, such as individuals with hematological malignancies. These populations often experience immunosuppression and a lack of information among the general population and within some sectors of the healthcare system, which hinders adherence to the national vaccination schedule. This study aims to identify risk factors associated with incomplete vaccination schedules in children with hematological malignancies in remission treated at a secondary-level hospital. A structured questionnaire was administered to the guardians of patients in the pediatric oncology service of Regional General Hospital No. 1 in Orizaba, Veracruz. The results were analyzed using SPSS version 24, which showed that the main barriers to completing vaccination schedules for these patients included incorrect medical decisions, lack of public awareness regarding the vaccination schedule, and infrastructure problems. Similarly, among sociodemographic factors, patient age was one of the main factors associated with incomplete vaccination schedules. It was concluded that educational interventions and updated protocols are essential to improve coverage in this vulnerable population.

Keywords: Vaccination, pediatric hematology-oncology, risk factors, incomplete schedule, immunization

Introduction

Childhood vaccination has been one of the most effective strategies in the prevention of infectious diseases; however, in recent years, adherence to national and international vaccination schedules has not reached the objectives established globally by the World Health Organization, which has generated outbreaks and resurgence of diseases that were thought to be controlled and which can be prevented with the application of biologicals [1, 2].

According to statistics from the World Health Organization, in 2021 the global vaccination rate decreased to 81%, 5% lower than in 2020. The vaccination rate for influenza vaccines is 71%, the vaccination rate for hepatitis B is 42%, and the vaccination rate for measles and Streptococcus is 71%. Pneumonia, poliomyelitis, rotavirus, and German measles saw coverage rates of 51% and 80%, respectively, and 49% and 66%. Arguably, the emergence of the 2020 pandemic exacerbated the global coverage gap, as vaccination programs worldwide were neglected in favor of prioritizing treatment for the virus that was ravaging the human population at the time. However, this decline in global vaccination coverage may have implications for the future, such as the resurgence of certain diseases like smallpox [3, 4, 5].

Several factors influence this public health problem, including: Public ignorance about vaccines is one of the main causes of under-vaccination. Patients' misconceptions about the effects of vaccines on the body are another relevant factor that has not been recognized and that significantly interferes with completing childhood vaccination in our country and the rest of the world [6, 7, 8]. These are modifiable aspects that should be addressed through strategies during primary care consultations, as well as during visits to secondary care specialists [9]. Within the child population, there are vulnerable groups, such as cancer patients, specifically hematologic cancer patients. In these patients, adherence to vaccination schedules is compromised by multiple factors, including immunosuppression induced by aggressive treatments, medical and social misinformation, and the lack of updated vaccination schedules for this specific population [10]. In 2018, Chile updated its national immunization program, including a section with recommendations for hematological malignancies and solid tumor patients in that country. One of the many side effects of chemotherapy is marked bone marrow aplasia, which leads to immune alterations affecting both humoral and cellular components. Some studies mention a loss of humoral immunity against various vaccine antigens, which persists even 15 months after the end of chemotherapy [11, 12].

In Mexico, in 2008 a study was conducted at the National Institute of Pediatrics, which reported that 59.5% of hospitalized children had incomplete regimens, and that 45.5% of these cases were due to erroneous

contraindications, many of them due to inadequate medical decisions [13].

This study focuses on identifying risk factors that contribute to incomplete vaccination schedules in pediatric hematological -oncological patients in remission, treated at a secondary-level hospital in Orizaba, Veracruz. The objective is to generate evidence that will allow for improvements in immunization strategies for this vulnerable population in the region.

Materials and methods

A descriptive, cross-sectional, retrospective, and observational study was conducted at the Regional General Hospital No. 1 of Orizaba, Veracruz, between December 2024 and June 2025. The study population included 76 tutors of pediatric hematological -oncological patients in remission, who met previously established inclusion criteria. The data collection instrument was a structured questionnaire with 10 dimensions, designed to assess risk factors related to incomplete vaccination schedules. The first dimension includes the identification form, which contains the sociodemographic information of the patient and their guardian. The second dimension primarily covers the family's socioeconomic level. The third dimension evaluates the vaccination record, noting any missing vaccines or delays in their administration. The fourth dimension assesses missed vaccination opportunities, analyzing the frequency and regularity with which patients visit the clinic for primary care. The fifth-dimension addresses mismanagement of vaccination schedules; in this section, guardians were asked if their vaccination schedule had ever been restarted and, if so, which medical personnel performed the restart. The sixth dimension addressed the lack of vaccination records, questioning guardians about why their children lacked vaccination records from birth until the age at which they developed cancer. The seventh dimension assessed the simultaneous administration of *vaccines*, while the eighth evaluated the availability of vaccines in healthcare facilities and its impact on adherence to the vaccination schedule. Finally, the ninth and tenth dimensions assessed unjustified fears, misconceptions held by both healthcare personnel and guardians, and false contraindications presented by staff. These dimensions evaluated aspects such as the belief that vaccines caused illnesses.

The information was collected in the waiting room of the pediatric oncology service, after obtaining informed consent. The data were entered into an Excel spreadsheet and subsequently analyzed using SPSS version 24. Descriptive statistics were applied to qualitative variables (frequencies and percentages) and quantitative variables (measures of central tendency). A multiple logistic regression model was used to identify risk factors.

Results

Within the first dimension we were able to show that the main underlying pathology was acute lymphoblastic leukemia with 74 patients (97%), and 2 (2.6%).

The sociodemographic risk factors of the guardian and the patient were also evaluated. Of the 76 guardians, 47 (62%) reported that their children had incomplete vaccination schedules. Regarding the patients' ages, the minimum age was 2 years, and the maximum age was 14 years. The mean age was 7.08 years, with a standard deviation of 2.756; the median age was 7.00 (Figure 1).

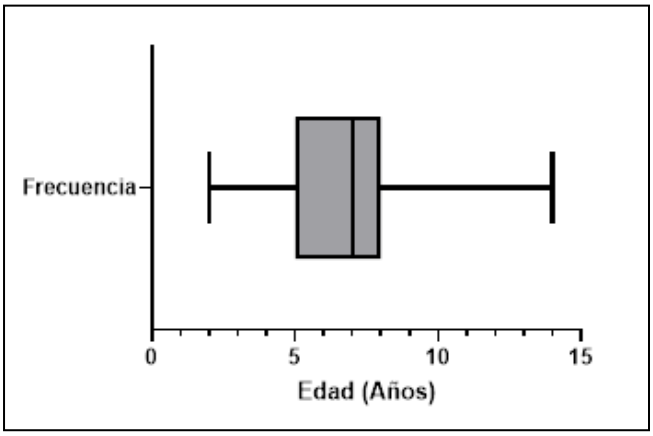

Fig 1: Age

Age distribution graph n: 76.

In the second dimension, certain factors that influence the socioeconomic level of families are evaluated, among the most relevant was the maximum education of the tutors, of the 76 tutors in total, 27 of them (35.5%) studied secondary school, 30 (39.5%) high school, 17 (22.4%) studied some degree, and 2 (2.6%) did not complete any degree of studies.

The third dimension assesses which biologicals had not been applied or if there was a delay in any of them, the vaccine that is least applied in the patients was the DPT booster, anti-influenza and the MMR booster, because within that life range (2 to 6 years) the disease occurred or some of the children were still in the chemotherapy phase.

The fourth dimension of the data collection instrument evaluates the missed vaccination opportunities, in it 37 guardians (48.7%) said that it was due to a lack of information that they did not have their complete schedule, 34 (44.7%) responded that it was due to the underlying pathology (cancer) and 5 guardians did not vaccinate them due to an unfounded fear of vaccines.

The fifth dimension focuses on the mismanagement of vaccination schedules; here it was shown that of the 76 children (100%), none had had their vaccination schedule restarted, even though they were already in the remission and surveillance phase.

In the sixth dimension where those who did not have their vaccination schedule were identified, it was found that 69 guardians (90.8%) had the national vaccination card and 7 (9.2%) had lost the vaccination card at some point, so there was no vaccination history.

The seventh dimension assesses the non-simultaneous administration of vaccines; however, in this dimension, all guardians said that they were never denied the simultaneous administration of vaccines before their children presented the oncological pathology.

The eighth dimension reviewed the availability of biologicals in the units where they went to the application of *vaccines*, 71 guardians responded that before presenting the disease their children had never been denied vaccination due to lack of biological, and 5 responded that they were denied the BCG vaccine because it was missing, however it was applied to them a few months later.

Dimension number nine identified the factors associated with unjustified fears and erroneous beliefs on the part of guardians and health personnel, where 53 (69.7%) of them believed that it was dangerous to vaccinate children due to the oncological disease even when the pediatric oncology service had discharged them and they were only under

surveillance, 20 (26.3%) guardians did not accept vaccination because they believed that another type of disease could develop, and 3 (3.9%) said they believed that vaccines were not beneficial to the health of their children.
Finally, in dimension ten, false contraindications were observed, in which 70 (92.1%) guardians stated that certain health personnel denied them vaccination due to their children's underlying disease, even when they were already in the remission and monitoring phase, 2 (2.6%) commented that they had been denied the vaccine due to fever and 4 (5.3%) because they were under treatment with some antibiotic.
Regarding the attitude of the health personnel, it was observed that 70 guardians (92.1%) were clearly informed of the effects and possible reactions of the vaccine applied, and only 6 (7.9%) were offered the missing vaccines when they went to first and second level consultations.

Table 1: Median and ranges

Variable	Median	Minimum	Maximum
Child's age	7.00	2	14
Gender of the minor	2.00	1	2
Age of guardian	31.50	21	46
Tutor's occupation	2.00	1	3
Tutor's education	2.00	1	4
Underlying illness of the child	1.00	1	2
Missed vaccination opportunities	2.00	1	3
Not having vaccination history	1.00	1	2
Unjustified fears about vaccination and erroneous beliefs of guardians and health personnel	1.00	1	3
False contraindications	1.00	1	3
Attitude of healthcare staff	1.00	1	2

In the table we can observe the medians of the variables, as well as the ranges within which they were found, in terms of the child's age. The median age was 7 years, with a range of 2 to 14 years. Regarding the child's gender, the distribution showed a median of 2 (male), with values between 1 (female) and 2 (male). On the other hand, the age of the guardian the median age was 31.5 years, with a range of 21 to 46 years. The median occupation of the tutor was 2 (employee), with values between 1 (homemaker) and 3 (teacher). Regarding education the tutor's education level was median at 2 (high school), with a range from 1 (secondary school) to 4 (no schooling). The child's underlying illness had a median of 1 (acute lymphoblastic leukemia), with values between 1 and 2 (Willms tumor). Missed vaccination opportunities the median was 2 (due to underlying pathology), with a range from 1 (lack of information) to 3 (due to fear of vaccines).
For those without vaccination records, the median was 1 (having a vaccination card), with values between 1 and 2 (loss of the vaccination card). Unjustified fears about vaccination and misconceptions held by guardians/healthcare personnel were contributing factors. The median was 1 (believes that vaccination is dangerous due to their child's underlying condition), with a range of 1 to 3 (believes vaccines are not beneficial). Regarding false contraindications, the median was 1 (the vaccine is denied due to the child's underlying condition), with a range of 1 to 3 (the vaccine is denied because the child is on antibiotic treatment). Finally, regarding the attitude of healthcare personnel, the median was 1 (the type of vaccine and possible reactions to the vaccine administered to the child are clearly explained), with values between 1 and 2 (the missing vaccines are offered during the consultation).
On the other hand, the regression was statistically significant with an F=2.50, p= 0.19, β-1=0.19 The OR value = was. 23, which indicates that 23% of the change in score can be explained by the model with the variables age of the tutor, occupation, schooling, missed vaccination opportunities, lack of vaccination history, unjustified fears, false contraindications and staff attitude.

Table 2: Regression model summary

Model	R	R squared	adjusted R-squared	Standard error of the estimate	Change statistics				
					Change in R squared	Change in F	gl1	gl2	Sign. Change in F
1	.480 [a]	.230	.138	2,558	.230	2,507	8	67	.019

Finally, when analyzing the results meticulously, it was evident that the age of the guardian yielded positive β values (.403), which turned out to be statistically significant (p=0.001), meaning that it is a significant risk factor for children with some hematological-oncological pathology to have incomplete vaccination schedules.

Discussion

The results confirm that incomplete vaccination schedules in pediatric hematology -oncology patients are multifactorial. Medical misinformation, both among healthcare personnel and caregivers, represents a critical barrier. The lack of specific protocols for resuming vaccination schedules after chemotherapy contributes to the omission of essential *vaccines*, such as MMR and influenza.
International literature, such as the recommendations of the Chilean Ministry of Health, suggests that patients in remission can receive live vaccines three months after completing chemotherapy, and that booster doses should be administered for those given during treatment. However, in Mexico, these guidelines are neither clearly established nor widely disseminated.
Furthermore, vaccine shortages and limited infrastructure in secondary-level hospitals exacerbate the problem. Implementing educational campaigns for medical personnel and caregivers, as well as updating vaccination schedules

for immunocompromised patients, are urgent measures.
This study provides local evidence that can be used to design targeted interventions in regional hospitals. Complete vaccination in this population not only protects the patient but also contributes to herd immunity, reducing the risk of outbreaks in vulnerable communities.

Conclusion

The results obtained in this study allow us to conclude that incomplete vaccination schedules in pediatric hematology - oncology patients are a consequence of a combination of institutional, medical, and sociocultural factors. The main cause identified was the presence of false medical contraindications, which highlights a critical gap in the knowledge and application of current immunization guidelines in immunocompromised populations. This finding coincides with that reported by Hernández-Ávila *et al*. and other authors who point to deficiencies in the monitoring and updating of vaccination schedules in Mexico.
Furthermore, unjustified fear on the part of caregivers and a lack of clear information about the safety and efficacy of vaccines in this vulnerable group contribute significantly to under-vaccination rates. International literature, such as the studies by Pope *et al*. and Bourque *et al*., reinforces the need to strengthen doctor-patient communication and implement educational campaigns targeting caregivers and healthcare personnel.
While the attitude of medical staff is mostly positive, greater proactivity is needed in offering and administering *vaccines*, especially in cancer remission settings where immunization can be safely resumed. International recommendations, such as those issued by the Chilean Ministry of Health and the Spanish Association of Pediatrics, offer viable models for adapting vaccination schedules to the specific needs of these patients.
In conclusion, a comprehensive strategy is needed that includes ongoing training for healthcare personnel, updating national immunization schedules, and strengthening community education to ensure equitable and safe access to vaccines for pediatric hematology -oncology patients. Vaccination in this group is not only an essential preventive measure but also an act of health justice that can significantly improve their quality of life and clinical prognosis.

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