

The correlation and determinants of cost-benefit analysis of measles vaccines among the medical centers providing Expanded Program on Immunization (EPI)

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Author's Contribution

¹ Conceptualization analysis and investigation,

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Article Info.

Conflict of interest: Nil

Funding Sources: Nil

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A B S T R A C T

Introduction: Measles is a highly contagious viral infection, vaccine-preventable diseases claim the lives of nearly 30 million people each year around the world, including 17% of children under the age of 5.

Methodology: This was a descriptive and cross-sectional investigation. Retrospective data collection was used. We looked at medical centers that provided EPI administrations.

Results: Around 8% of the youngsters in the study were found to have measles, according to the health center's records. There are an undetermined number of measles-infected children. Only 12% of those surveyed had received the measles vaccine, and the vast majority (88%) had never received the shot. According to statistical analysis, the study's r square value is $r=0.35$, which is considered to be an intermediate direct relationship (Wastage of vaccine and total cost). It illustrates that if there is no system of checks and balances on vaccine waste, it could have an impact on the overall cost of the vaccination. Vaccines wastage shows a positive association with Dose wastage $x^2= 438.8$ (p-value 0.002). the breakage of vaccine vial $x^2 = 369.6$ (p-value 0.015), expiration of vaccines $x^2 = 1068$ (p-value 0.006), cold chain maintenance $x^2 = 79.99$ (p-value 0.014) & inventory missing was $x^2 646.9$ (p-value 0.004) showed statistical significance.

Conclusion: The elimination of any disease would be contributed by the parallel factors one of that includes also financial state. In less time and cost we can vaccinate the number of children and can achieve universal coverage of immunization.

Keywords: Cost effectiveness, epidemiology, measles, public health, vaccine

Cite this article as: Nimra M, Irshad H, Hasnain MM, Ishaque SM. The correlation and determinants of cost-benefit analysis of measles vaccines among the medical centers providing Expanded Program on Immunization (EPI). *JSTMU* 2021; 4(2):110-116.

Introduction

When someone has measles, it spreads quickly from them to others. Children are especially vulnerable because of their lower levels of immunity, and the most common complications associated with measles include encephalitis, diarrhea, an inability to eat, pneumonia, and otitis media. Fever and severe rashes all over the body are the main symptoms, and the sufferer can spread the virus to others.¹ The world is following sustainable developmental goals in 2030 to achieve maximum health. Although the evolution of vaccination in the early years of

life helped a lot in the reduction of global mortality and morbidities still many regions of the world are devoid of these due to multiple reasons. So far we have been able to eradicate only one disease that is small pox, for the total elimination of these diseases it needs a very systematic plan and implementation of all SOP's.² Well educated and dedicated working staff, procurement of vaccines, maintenance of sera's and vaccines such as cold chain instruments, transportation and delivery system, logistics, usage of vaccines proper disposal of

syringes, correct data recording, awareness of the community, regional, religious and political support, constant monitoring and evaluation these are the factors which when all work simultaneously can give the hope of eradication of the diseases globally.³ Vaccines are one of the best wellbeing mediations that realize huge decreases in irresistible infections weight load.

Vaccination of children against early life tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus and measles is also helping to reduce mortality and morbidity in Pakistan since 1978, not only vaccination of this disease and also a number of new vaccines such as hepatitis B, Hib and pneumococcal vaccine (PCV10) were introduced. These vaccines including Hemophilus influenza type b, 88 percent of the Punjab province's population have been immunized, making it possible to eradicate maternal and neonatal tetanus and other tetanus-causing diseases in 2016.⁴ It has been estimated that in Vietnam 26,000 deaths & 5.7 million diseases cases were prevented by the active and prompt working of EPI, \$1000 to 27000\$ cost-effectiveness were recorded on the preclusion of per death.⁵

Elimination or reduction in the measles outbreak will need a lot of focuses on the improvement of surveillance, handsome amount to the workers, maintenance of cold chain or the suitable medium for vaccination, community awareness campaigns and advocacy of the people, availability of vaccines at the health facility, this strategy may increase the coverage rate up to 60 % to 90%.⁶ Immunization and vaccination programs are necessary for the elimination and eradication of measles from any region, for achieving this target more than 95 % vaccines (MCV1 & MCV2) coverage should be there.⁷

In several aspects, immunization is a unique form of human services mediation. Vaccines serve as a preventative measure and are typically given to healthy individuals when they are young. However can cause a (little) danger of genuine unfriendly impacts in immunization beneficiaries. In a perfect world, immunization projects are taken off with a long haul, population wide, general wellbeing objective as a top priority, considering the regularly generous for the most part positive and defensive roundabout impacts in unvaccinated gatherings (for instance, neonates, people with stifled resistant frameworks, and the older) by

method for decreased course of preventable pathogens in the more extensive populace.⁸ The more prominent effect of triggered campaign in low-inclusion circumstances is to a great extent the aftereffect of progressively visit triggered campaign. In the Yemen-like circumstance, a touchy serologic trigger (i.e., 10% weakness in kids) prompts TCs being led in 10 out of the initial 15 y from arrangement execution, basically turning into a normal occasion.⁹ Use of internet of things also paying their part, eHealth is prevailing almost all over the world, mobile and smart phones innovation would be much helpful in the registration of care givers and vaccination receiver's hence the surveillance can be achieved; a little cost at an initial point can prevent huge loss afterward. The 78% of coverage has been analyzed by using a direct phone call in immunization campaigns.¹⁰ This policy of using technology is not even feasible but also less time consuming, identification of the next child and its next dose and also creating awareness among the low literate communities.^{11,12}

It's a dilemma that day by day public health finances are reducing in developing countries due to other political priorities. Any public health policy developed for the promotion of health will surely work such as the vaccination at early stages of life, early diagnosis and prompt treatment, immunization programs have reduced 60 % and more mortalities at child hood life.¹⁰ Public awareness program have a significant impact on the community's sociological and behavioral health, a study gave the results of more than 50 % of population tends to immunize their kids in order to avoid measles after the electronic and social media campaigns.^{13,14} The evidence shows that professional birth attendants have a significant role in the measles immunization as it is 1.5 times more likely to vaccinate as the children being birth by the unprofessional birth attendants or health care providers (OR = 1.49, 95% CI: 1.43–1.56).¹⁵

World health organization and other global health agencies are more focusing on immunization/ vaccination and aimed to reduce the mortalities and morbidities for the achievement of sustainable development goals, despite such efforts and expenses in African region it has been estimated that 28000 deaths occurred annually due to measles.¹⁶ The issue arises mainly due to the least coverage by the unstable and weak immunization

programs and health system of most of the low and middle-income countries. The two-dose schedule is not following by all the health systems and thus collapsing the aim of health for all.^{16,17}

In 2013 all the six regions of world health organization collectively decide to work on the elimination of measles by 2020. Multiple strategies & policies were launched, such as for appropriate surveillance and accurate diagnosis of disease Global Measles and Rubella Laboratory Network (GMRLN) were created. GMRLN is developing constantly and in January 2017 it has 703 labs working in 191 countries. It also ensures the quality control and quality assurance for the consistent methods and operations, validities and accuracies, provision of best quality results and training.¹⁸ In spite of these chronicled triumphs, immunization isn't only a story from an earlier time. Stanley listed twenty-two ailments and diseases for which powerful vaccines exist yet in addition forty-seven others for which adequately compelling immunizations are not accessible.¹⁹

A total of seven Infectious illnesses, a considerable lot of which are preventable, stay a main source of overall mortality. For example, around 6.3 million kids more youthful than age five bite the dust every year, and about portion of these passings are the aftereffect of pneumonia (frequently brought about by flu or pneumococcus); loose bowels (regularly brought about by rotavirus); or different illnesses brought about by conceivably immunization preventable contaminations, for example, measles, lockjaw, tuberculosis, and intestinal sickness.²⁰ Environmental change modifies conditions and enables creatures to thrive in beforehand unfriendly situations. Populations are increasingly versatile, and globalization and expanded urbanization consider more noteworthy development of individuals and microorganisms, along these lines adding to sickness transmission.²¹

The well economical and financial condition of any family has a great effect on the immunization coverage as parallel with financial status educational and attitude towards disease and prevention is also lower as compare to developed and educated population, a study from less developed area shows that more than 40 % of children were not fully immunized (95% CI (0.083-0.077) and 78 % were uneducated mothers were there among unimmunized children.^{22,11} Another study also supports

the determinants of education and financial condition in the unequal immunization of the measles among children, education and knowledge about disease occurrence, treatment and prevention (AOR = 0.02, 95% CI: 0.001, 0.68) and low socio economic condition also have a negative effect on vaccination (AOR = 0.15, 95% CI: 0.1, 0.43).^{13,16} The study's goals include ensuring equal access to health care for all people, regardless of their socioeconomic status. Individuals will receive low-cost medicine, including vaccines. The study's objective include identification of the cost variables and addressing the issues such as measles outbreaks, and to evaluate the factors that can speed up the immunization process after lowering the cost.

Methodology

The study was done at the capital territory area of Islamabad. The duration of the study was 3 months. The primary source of information was the Islamabad extended immunization program. Regulating and coordinating the National Health Services Ministry Islamabad. It comprises all children under the age of five in the locality (rural and urban) Descriptive and cross-sectional research methods were employed during the examination We looked at medical centers that gave EPI administrations and found a few that did. Misuse of vaccine usage structures, resistance development registers, and month-to-month EPI reports provided information on immunization use. For vaccine and consumable costs, UNICEF-WHO value projections were used. Unit costs for auto incapacitate, weakening and security boxes were also used to estimate vaccine and consumable costs. A variety of expenditures (such as labor, transportation and EPI running) were acquired through meetings and direct surface estimations of structures as well as the abuse of various records (such as vaccination sessions plans, count sheets, staff pay vouchers and receipts and building gathering archives) in addition to support for virus chain running, amortization for structures and 'moving stock' and iceboxes.

The cold chain at EPI was fully exploited for the program. Staff expenses were calculated by multiplying their compensation by the amount of time they spent on EPI trainings and then adding any extra compensation they received during that time period. Inoculation

sessions, vaccine transportation, disclosing (vaccination and disease observation), coordination gatherings, supervision, and cold chain temperature checking and maintenance are among the activities under consideration. In order to analyze the data and information, Excel programmers used a spreadsheet created for the purpose of information aggregation.

The number of fully immunized youngsters was the primary indicator of success (children who got dosages of measles). The expenses of the region health facility administration were shared to the facility focuses by procedure in extent to target populace secured. The different markers utilized were the normal expense per portion utilized (all out costs/complete dosages utilized) and the normal expense per portion regulated (absolute costs/all out dosages managed - the stuff to direct a portion. Null hypothesis shows there is no standard correlation between Wastage of vaccine and total cost of vaccine while Alternative hypothesis shows there is significant standard correlation between two variables that are wastage of vaccine and total cost of vaccine.

The ethical consideration and consent was taken from the educational institute (Hamdard University Islamabad), Official consent from the authorization EPI, Ministry of health, different health care facilities were taken. Data will be used only for the intention of research and data analysis. The confidentiality and inscrutability of participants should be secured. Regression analysis was done and for vaccine production and chi-square was applied for the association of vaccine wastage with other factors & p-values was analyzed.

Results

Frequency of vaccinated and no vaccinated children:

Around 8% of the youngsters in the study were found to have measles, according to the health center's records. The number of measles-infected youngsters that are unidentified was unknown. Only 12% of those surveyed had proof of receiving the measles vaccine, and the vast majority (88%) had never had the shot as shown in Figure 1.

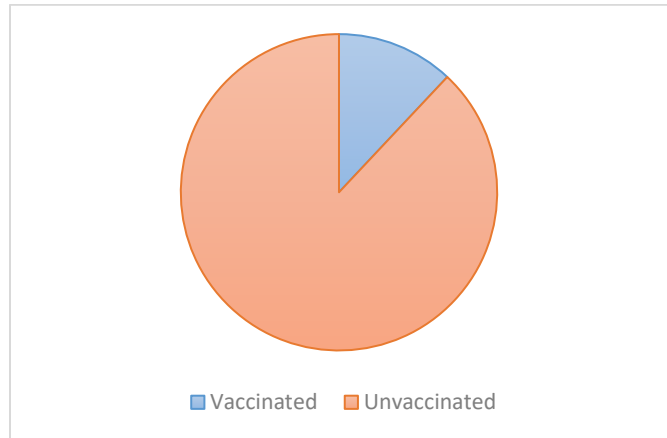


Figure 1: Percentage of vaccinated children present in the study

Significance of the study:

The analysis of results shows that the p value is (0.002) that is less than our alpha α value that is 0.05. The p-value, on the other hand, reveals the results that are statistically significant, such as ours (p-value 0.002) at a 95% confidence level as shown in Table 1.

Table 1: Significance of the study at 5 % level

	Intercept	
Coefficients	103.3791	2.661327
Standard Error	54.78353	1.086844
t-Stat	1.887046	2.448674
P-value	0.002839	0.002381

Table 2: Upper & lower values at 95% confidence interval

	Intercept	
Coefficients	103.379	2.66133
Standard Error	54.7835	1.08684
t-value	1.88705	2.44867
P-value	0.00284	0.00238
Lower 95%	9.94931	0.41302
Upper95%	216.707	4.90964

Correlation analysis:

The statistical analysis of results have shown that the r square value of the study $r = 0.35$ fall in the intermediate

direct relation category between the variables (wastage & total cost of vaccine). It has shown that there was a positive correlation between wastage of vaccine and the total cost charge of vaccine as shown in Table 3 and 4.

Table 3: Correlation analysis of vaccine wastage and total cost of

Regression Statistics	
Multiple R	0.454
R Square	0.356
Adjusted R square	0.172
Standard Error	59.78

Table 4: Cost applied on various important variables used in preparation and final shape of measles vaccine

Variables	Purchasing price rupees
Vaccine concentrate	20 – 25
Material used in preparation	08 – 10
Electricity consumption	12 – 15
Transport / fuel charges	15 – 18
Packaging	05 – 08
Cold chain	20 – 28
Salaries of workers	50 – 60
Total	150 – 170

The variable cost shows that if we reduce the electricity bills, we can decrease our purchase values if we shifted this electricity consumption to solar panels that are much cheaper than the electricity per unit which is one of the most important factors. By reducing the expenses, the coverage of immunization may be increase toward the universal or 80 % to 90%. This value will help in the long after effects in the economics and social status of individual as well as the state or country level, which eventually make the nation prosper and developed.

Association of vaccine’s wastage with the different factors:

Table 2 reported the associations of dependent variables with outcome of interest i.e. vaccines wastage. Using Chi-square test, vaccines wastage showed a positive association with Dose wastage $\chi^2= 438.8$ (p-value

0.002). Breakage of vaccine vial $\chi^2 = 369.6$ (p-value 0.015), expiration of vaccines $\chi^2 = 1068$ (p-value 0.006), cold chain maintenance $\chi^2 = 79.99$ (p-value 0.014) & inventory missing was $\chi^2 646.9$ (p-value 0.004) showed statistically significant relationship with cost effectiveness of vaccine wastage. Statistical analysis showed that vaccine’s wastage and trained & skillful staff were strongly associated $\chi^2 462.5$ (p<0.05). The analysis also revealed that open vial wastage of vaccines was more prevalent (21%) than the vials which whole dose was administrated (27.8%). The results were given in Table 5 below.

Table 5: Association of vaccines wastage with other factors

Variable Category	Vaccine wastage		χ^2	p value
	Yes= 43 %	No=57 %		
Dose wastage				
< than 2 dose per 10 doses	31	00	438.8	0.002
> than 2 dose per 10 doses	12	00		
Breakage of vial				
> than 20 vial per 100 vials	9	00	369.6	0.015
< than 20 vial per 100 vials	34	00		
Expiry of vaccine				
Yes	20	02	1068	0.006
No	23	55		
Cold chain maintenance				
Yes	10	57	79.99	0.014
No	33	00		
Trained & skillful Staff				
trained	34	49	462.5	0.036
Untrained	09	08		
Open vial wastage				
Yes	21	04	388.9	0.001
No	22	53		
Missing of inventory				
Yes	15	06	646.9	0.004
No	28	51		

Discussion

Elimination of any disease could be contributed by the parallel factors one of that includes also financial state. In less time and low cost, we can vaccinate the more number of children and can achieve herd coverage of immunization. Under vaccination remains dilemma to worldwide that a huge number of

children are devoid of vaccination and being neglected by the immunization programs.

There were 2058 (30%) kids unvaccinated and 4889 (70%) inoculated for measles. Among those detailing inoculation, 773 (16%) detailed by means of dated card, 3990 (82%) through maternal review, and 126 (3%) by means of stamped card. In our study it also shows that just 12% of the children were vaccinated rest of them never immunized with measles vaccine. Whenever uncovered, 90% of unvaccinated explorers without other proof of measles invulnerability become sick with measles. This hazard is diminished to 7% among uncovered voyagers with 1 MMR immunization and 3% among explorers with 2 MMR inoculations.^{2,23,24} In a setting with high gauge inoculation inclusion levels, SMS updates combined with motivators altogether improved vaccination inclusion and practicality.

Given that worldwide vaccination inclusion levels have stagnated around 85%, the utilization of impetuses may be one choice to arrive at the staying 15%. Routine child immunization is one of the best and practicality general wellbeing mediations that have extensively decreased worldwide youngster grimness and mortality.^{2,25} The impact of positive surrounding on the extent of youngsters with DPT3 was an expansion of 12.4 rate focuses contrasted with control (95% CI: 3.9 to 21.0, $p=0.005$), contrasted and an increment of 16.7 rate focuses (95% CI: 8.2 to 25.2, $p<0.001$) when the data was contrarily encircled.²⁴ Be that as it may, there was no distinction when the 2 data gatherings were contrasted and one another (95% CI: -5 to 13, $p=0.352$). Looking over all the auxiliary results, the surrounding of data had no impact, except for information of avoidance. Results remained subjectively a similar when we balanced appraisals with the incorporation of covariates and when utilized a Bonferroni amendment to manage the issue of different theory testing.²⁶

In any case, every year, an expected 18.7 million kids under 1 year of age don't get fundamental inoculation as a component of an extended program of vaccination (EPI) around the world, and a huge number of kids kick the bucket from immunization preventable sicknesses.^{27,28} Due to social issues and inadequate gratefulness for vaccination, guardians and parental figures overlook or disregard the

significance of inoculation or finishing the whole arrangement of antibodies. As an outcome, there is a continuation of the polio plague, huge measles episodes, and high illness weight of antibody preventable infections in children. Discoveries from a pilot study evaluating the beneficial vaccination inclusion utilizing SMS content and robotized calls demonstrated an a lot higher reaction to the computerized call (78%) than SMS instant messages (3%; individual correspondence).^{29,30}

Childhood immunization still stays one of the savviest preventive procedures against mortality and dreariness among kids. Vaccination spares the lives of up to 3,000,000 kids, each year. High paces of antibody inclusion could avoid an extra 1.6 million deaths a year among kids younger than five. The objective of the national EPI is to guarantee full immunization of children against preventable maladies.

EPI is a standard action inside the open social insurance framework. What's more, time explicit mass inoculation battles and entryway to-entryway exercises are consistently actualized the nation over to help increment routine inoculation take-up.³⁰ Vaccine production's cost effectiveness can be achieved by adopting E-health various mechanisms. By subsidizing various vaccines and go towards direct recruitment regardless of tenders so only good quality products can be acquired. By addressing those determinants which are very much contributing towards cost as mentioned in results in Table 1, the multi dose vaccine to make it more affordable and also increasing the efficiency. Electricity is a major factor in cost increasing while switching of electricity to solar panel and systems can help in cost effectiveness.¹

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