



Effects of Zinc Supplementation in the Treatment of Acute Watery Diarrhea

Aziz ur Rahman¹, Sardar Khan¹, Wajid Ali², Hayat Ullah Khan¹, Imad Khan¹

¹Department of Pediatrics, Saidu Group of Teaching Hospitals, Swat, KP, Pakistan

²Department of Pediatrics, Khyber Teaching Hospital Peshawar, KP, Pakistan

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Correspondence to: Aziz ur Rahman, Department of Pediatrics, Saidu Group of Teaching Hospitals, Swat, KP, Pakistan.

Email: azizurrahman966@gmail.com

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ABSTRACT

Objectives: To assess the efficacy of Zinc supplements in the treatment of acute watery diarrhea among pediatric patients. **Study design:** Quasi-experimental study **Place and duration of study:** Department of Pediatrics, Saidu Group of Teaching Hospital, Swat, from October 2024 to March 2025. **Methods:** A total of 100 children, aged between 6 months to 5 years, reporting with acute watery diarrhea were included in this study. All study participants received standard treatment including oral rehydration solutions and continued their feeding. Elemental zinc was given at a dose of 20 mg/day (as zinc gluconate syrup 5 mg/5 mL). The efficacy of Zinc supplementation was assessed following a 4-day treatment period. The primary outcome was set as the reduction in frequency of diarrheal episode/24 hours and the proportion of patients achieving resolution of watery stools. Paired t-test was used to compare changes in stool frequency before and after Zinc supplementation while McNemar's test was applied to assess number of patients without watery stools. A p-value of <0.05 was considered statistically significant. **Results:** The mean age of children in this study was 23.76 ±11.58 months (Ranging from 6 months to 56 months). A significant decrease in stool frequency was observed from 6.17±1.23 to 3.4±1.05 after 4 days. Resolution of watery stools was recorded in 28% of the study participants (p<0.001). **Conclusion:** Zinc supplementation significantly reduces stool frequency and improves resolution rates of acute watery diarrhea when given as an adjunct to standard treatment in pediatric patients.

INTRODUCTION

Diarrhea is a digestive disorder marked by an increased frequency of loose or watery stools. Common causes include bacterial infections from pathogens like *Vibrio cholerae*, enterotoxigenic *Escherichia coli* (ETEC), *Shigella*, and *Salmonella* species, as well as viral agents such as rotavirus. Protozoan or parasitic infections may also contribute to the condition, often transmitted through consumption of contaminated water.¹ Acute watery diarrhea (AWD) persists as a major global health threat, particularly in low-resource settings where the children under five years are disproportionately affected causing significant mortality and morbidity issues.^{2,3}

The introduction of oral rehydration solutions (ORS) drastically reduced the incidence of death, from 4.6 million annually in the 1980s to 1.6–2.1 million today but the burden of disease remains alarmingly high, with approximately 1.7 billion childhood cases reported on yearly basis. The combination of ORS and improved sanitation conditions have reduced mortality but the morbidity rates have remained stagnant underscoring the gaps present in managing the severe cases of AWD. Fluid loss, malnutrition and electrolyte imbalance caused by

Diarrhea contributes to health consequences and emphasizes the need for innovative adjunct therapies to complement the benefits of ORS treatment and reduce the severity of acute diarrheal episodes.^{4,5}

Numerous studies have found that the deficiency of an essential micronutrient, Zinc is common among children in developing countries and is linked with increased susceptibility to infections, especially the diarrheal diseases. Strengthening this finding, Zinc supplements have been reported as a promising intervention in the management of AWD. Zinc plays a critical role in immune function, intestinal mucosal integrity, and overall cellular metabolism. Based on the evidence, the WHO and UNICEF have recommended zinc supplementation as an adjunct therapy for the management of acute diarrhea in shape of reducing the duration, severity, and recurrence of diarrheal episodes. Besides this efficacy in acute diarrheal phase, Zinc also decreases the incidence of subsequent infections.⁶

The World Health Organization (WHO) and UNICEF have jointly recommended the Zinc supplementation as an adjunct to ORS for the treatment of AWD in young children. However, the efficacy of this treatment strategy varies

across populations, age groups and etiologies and need to be studied in different geographical locations and demographics to optimize treatment protocols.^{7,8}

Diarrheal infections are a growing concern in developing countries like Pakistan. The 2013 Pakistan Demographic and Health Survey reported that 23% of children aged ≤ 5 years had diarrhea before their participation in the survey. The highest prevalence, 35%, was observed among infants aged 6 to 11 months, coinciding with the introduction of solid foods. Although Zinc was incorporated into diarrhea management protocols, according to the 2013 survey only 2% of children actually received it, with a slight increase to 8% in the 2018 report.⁹ The Swat is a mountainous district located in the Khyber Pakhtunkhwa (KPK) province of northern Pakistan, known for its natural beauty and cultural heritage. Due to its remote terrain, seasonal isolation of communities, and limited healthcare infrastructure, diarrheal diseases constitute a significant public health burden in this area, especially among infants and young children. The average health care cost of an episode of diarrhea in Swat is estimated to be 7624 PKR putting a noticeable burden on the budgets of local population. No specific data regarding efficacy of Zinc supplementation is available in this population of Swat, having distinct environmental exposures, nutritional patterns, and possibly different etiological agents for diarrhea.¹⁰

This study therefore aimed to evaluate the effects of Zinc supplementation as an adjunctive therapy to standard treatment for AWD among children aged 6 months to 5 years in Swat district. The findings of this study will have significant implications for setting diarrhea management protocols in Swat and similar regions throughout KPK province.

METHODOLOGY

This Quasi-experimental study was conducted at the Department of Pediatrics, Saidu Group of Teaching Hospital, Swat, from October 2024 to March 2025, over a period of six months. The approval of conducting the study was taken from the ethical committee of the hospital.

Sample size was calculated as follows:

Precision = 10.00%,

Efficacy of Zinc in reducing the incidence of AWD after 3 days = 14%.¹¹ With a 90% confidence interval, the estimated sample size (n) = 47. We however took a sample size of 100 patients for better statistical outcomes.

A total of 100 children, aged between 6 months to 5 years, reporting with AWD (defined as ≥ 3 loose or watery stools per day for < 14 days) were included in this study using consecutive sampling technique.

Exclusion criteria was set as children with chronic diarrhea (>14 days), severe dehydration requiring IV fluids and bloody stools (dysentery). Moreover, children with severe malnutrition (weight-for-height Z-score < -3), severe systemic illness, history of cystic fibrosis, lactose intolerance were also excluded. Children who had used any Zinc supplementation during last 14 days were also kept in the exclusion list.

A written consent for inclusion was taken from parents/guardian of each children after informing them about study details.

All the baseline demographics and clinical characteristics were recorded for each participant.

All study participants received standard treatment for AWD including ORS and continued their feeding. Elemental zinc was given at a dose of 20 mg/day (as zinc gluconate syrup 5 mg/5 mL) administered with meals or milk. Patients were assessed for the efficacy of Zinc supplementation after completion of day 1, day 2, day 3 and day 4 of the start of the treatment.

Primary outcome was the change in frequency of diarrheal episode during last 24 hours, at day 4 follow up and the number of patients achieving complete resolution (without watery stool) at day 4.

Data were analyzed using SPSS version 26.0. Continuous variables, such as age weight and stool frequency, were presented as mean \pm standard deviation, while categorical variables, such as gender and number of children without watery stool were expressed as frequencies and percentages. Paired t-test was used to compare changes in stool frequency before and after Zinc supplementation while McNemar's test was applied to assess number of patients without watery stools. Statistical significance was established at a p-value of < 0.05 .

RESULTS

The mean age of children in this study was 23.76 ± 11.58 months (Ranging from 6 months to 56 months). The details of demographics and clinical details at the time of enrolment in the study are shown in Table 1.

Table 1
Demographics and baseline clinical parameters (n= 100)

Demographics and baseline clinical parameters		
Age (Mean \pm SD) months		23.76 \pm 11.58
Gender	Male n (%)	57 (57)
	Female n (%)	43 (43)
Duration of symptoms (Mean \pm SD) hours		16.98 \pm 9.98
Weight (Mean \pm SD) Kg		9.36 \pm 2.53

The analysis of the study outcomes showed a consistent and significant decrease in stool frequency at each day follow up compared to the baseline. There was also a statistically significant increase in the number of children without watery stools at day 4 (p < 0.001) as shown in Table 2.

Table 2
Study Outcomes (n =100)

Parameters of assessment	Baseline (n=100)	At 4 days follow up (n=100)	p-value	
Frequency of stool /24 hours	Day 1 (Mean \pm SD)	5.67 \pm 1.24	0.001*	
	Day 2 (Mean \pm SD)	5.16 \pm 1.20	< 0.001 *	
	Day 3 (Mean \pm SD)	6.17 \pm 1.23	4.2 \pm 1.24	< 0.001 *
	Day 4 (Mean \pm SD)		3.4 \pm 1.05	< 0.001 *
Children achieving resolution (without any watery stools) n (%)	0 (0)	28 (28)	< 0.001 **	

Paired t-test*, McNemar's test**.

DISCUSSION

The mean age in our study was 23.76 ± 11.58 months (Ranging from 6 months to 56 months). A significant

decrease in stool frequency was observed consistently from the day 1 ($p<0.001$), day 2 ($p<0.001$), day 3 ($p<0.001$) and the last follow up visit at day 4 from 6.17 ± 1.23 at baseline to 3.4 ± 1.05 , ($p<0.001$). Resolution of watery stools was recorded in 28% of the study participants ($p<0.001$) at end of day 4.

The efficacy of Zinc has been documented in a number of international studies with varying results at different regional and demographic levels. However, the results recorded in population belonging to regions with compromised health status and limited health facilities are more relevant to our study participants.

In a study conducted in Sindh, Pakistan, Laghari G et al. evaluated the effect of Zinc supplementation on AWD in children (28 days–5 years). The Zinc group in this study showed significantly reduced diarrheal frequency ($p<0.00001$) and improved stool consistency ($p=0.01$) by day 3, supporting inclusion of Zinc as mandatory therapy for pediatric diarrhea in Pakistan.¹² A study conducted in the rural area of Sindh province by Channar IA et al, found that both Zinc tablet and suspension were equally effective in reducing the frequency of stool from 5.6 ± 2.51 (Day 1) to 1.7 ± 0.94 (Day 3) in children aged 6-59 months.¹³ A recent study conducted in the urban area of KPK province by Jahan A et al. evaluated Zinc supplementation for the efficacy on AWD in children (6 months-5 years). The Zinc group showed significantly faster resolution (3.34 ± 1.27 days) versus controls (4.74 ± 1.56 days, $p=0.000$). These findings demonstrated Zinc's clear benefit in reducing diarrhea duration in pediatric patients.¹⁴

F Sadiq et al. studied the effect of Zinc supplementation on AWD in 100 children (6 months–5 years) at Mardan, Pakistan. The results shared that Zinc significantly reduced diarrheal frequency (3.88 ± 1.11 vs. 4.58 ± 1.03 , $p=0.001$) and watery stools (42% vs. 70%, $p=0.05$) and enhanced the recovery process (14% vs. 2%, $p=0.026$). Zinc thereby proved effective in pediatric diarrhea management.¹¹

Jabeen S et al. used Zinc supplementation at varying strengths (5–20 mg) and shared that approach of using Zinc significantly improved diarrheal outcomes in children under five. Treated children exhibited earlier improvements in stool consistency and a greater reduction

in frequency compared to controls, proving its benefits in population belonging to developing world.¹⁵

Abd El-Ghaffar YS et al. work on the subject in a different angle and gave daily Zinc supplementation to children aged 6 months to 5 years over a period of four months. The results showed that the diarrheal episodes and stool frequency significantly decreased in these children ($P<0.05$) proving crucial role of these supplementation in diarrhea management in pediatric population.¹⁶ Barffour MA et al. also evaluated Zinc's effects on diarrhea in 3,407 rural children (6-23 months). Therapeutic Zinc significantly reduced the incidence of diarrhea by 36% ($p=0.004$) and duration by 16% ($p=0.03$) in children >18 months versus placebo, highlighting the Zinc's age-dependent benefits for diarrheal management.¹⁷

The results of our study are aligned with these studies and provide a useful data for a geographical population with a mountainous rural region having unique life style and limited access to health facilities. This data add to already proven benefits of Zinc in the management of AWD. These results will help our pediatricians and general physicians in the area of Swat to manage the cases of AWD in children on the basis of real life local evidence.

The limitations of our study include the absence of a control group, however, in presence of evidence present for the benefits related to Zinc treatment in international and national studies conducted in other parts of the Pakistan, it was not considered appropriate to keep a group of children with AWD without the expected benefits of Zinc treatment.

CONCLUSION

Zinc supplementation significantly reduces stool frequency and improves resolution rates of AWD when given as an adjunct to standard treatment in pediatric patients. The findings support WHO and UNICEF recommendations, highlighting the role of Zinc in enhancing recovery in the incidence of AWD. Given the high burden of diarrheal diseases in regions like Swat, integrating Zinc into treatment protocols could mitigate morbidity and cut the overall healthcare costs. Further research in this diverse populations is suggested to optimize therapeutic strategies.

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