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What is the Impact of COVID-19 Pandemic, Season and Temperature on Prevalence of Childhood Diarrhoeal Cases and Treatment in India during 2018-2021– A 41 Months Cross-Sectional Research Study?

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Abstract

Globally diarrheal illness is the second leading reason behind death in kids underneath 5 years accounting for 525 000 kids death annually, which can be treated and prevented if timely interventions are applied as well as can be prevented through safe drinking-water with adequate sanitation and hygiene. Global prevalence of childhood diarrhoea is about 1.7 billion cases per annum. SARS-CoV utilize the Angiotensin-converting enzyme 2 (ACE2) with the serine protease TMPRSS2 for S protein priming. ACE2 and TMPRSS2 are expressed in lung, as well as small intestinal epithelia, added to this the ACE2 is expressed in the oesophagus, liver, and colon; SARS-CoV-2 binds strongly with ACE2 (10–20 times) compared with other SARS-CoV. The purpose of this research is to examine the epidemiology of childhood diarrheal events during COVID-19-period and comparing it with the pre-pandemic period of 2018-2019 as well as monthly-seasonal-temperature variations during different months of pre-pandemic and pandemic period associated diarrhoea to identify any changes in the usual seasonal pattern of childhood diarrheal events. A total of 11171113 eligible childhood diarrhoea (0-5 years) and 1704819 Childhood diarrhoea treated in Inpatients (0-5 years) were analyzed during the 41 month study period. A total of 11171113 (mean-272466.2; [95% Conf. Interval means] 250375.4-294556.9) childhood diarrhoea (mean-; [95% Conf. Interval means]) (0-5 years), 1704819 (mean 41580.95-; [95% Conf. Interval means 36458.75-46703.15])childhood diarrhoea treated in Inpatients (0-5 years), 7603860 (mean 185460-; [95% Conf. Interval means 159578.8-211341.2])were included in this study on an all-India basis. The 41 months of study when grouped into two groups as pre-pandemic era and pandemic era shows that the Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) were MAX in July 2019 monsoon season during pre-pandemic period with 418722 cases ([95% CONF. INTERVAL] 299758.7-338763.3; STD. ERR.-9427.519; MEAN-319261; STD. DEV-46185.22; and MIN-261319 in December 2019, post monsoon season, See table- 1, 3, and 4; figure-5 and 6. During the COVID-19 pandemic period Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) were MAX in February 2020 winter season during pre-pandemic period with 284075 cases ([95% CONF. INTERVAL] 188170.3 - 224635.3; STD. ERR.- 8600.616; MEAN-206402.8; STD. DEV- 35461.25; and MIN-158007 in April 2020.

Keywords: Seasonal Variation; Diarrhoea; COVID-19; India; Prevalence; Temperature Variation

Abbreviations: WHO: World Health Organization; GIT: Gastro-Intestinal Tract; ACE2: Angiotensin-Converting Enzyme 2; HMIS: Health Management Information System; MoHFW: Ministry of Health and Family Welfare; UTs: Union Territories; IMD: Indian Meteorological Department; CDC: Centre for Disease Control; NCDC India: National Centre for Disease Control; Std: Standard; err: Error; max: Maximum; min: Minimum; dev.: Deviation; obs: Observation.

Introduction

Background/Rationale

Diarrhoea is defined by World Health Organization (WHO) as the passage of three or a lot of loose or liquid stools per day. (GIT) Gastro-intestinal Tractinfection, by microorganism and parasitic organisms through contaminated food or drinking-water, or from person to person as a result of poor hygiene may cause diarrhoea apart from idiopathic causes where causative agent is not known. Globally diarrheal illness is the second leading reason behind death in kids underneath 5 years accounting for 525 000 kids death annually, which can be treated and prevented if timely interventions are applied as well as can be prevented through safe drinking-water with adequate sanitation and hygiene [1]. Global prevalence of childhood diarrhoea is about 1.7 billion cases per annum [2]. In the past, for many kids, severe dehydration and fluid loss were the most significant causes of dying but now, different causes like septic microorganism infections account for increasing proportion of all diarrhoea-associated deaths. Exclusive breastfeeding is protecting and protects young kids additionally from the severity of diarrhoea [3].

One review study done by Ferdinando D'Amico et al. which was based on studies related to diarrhoea in patients of SARS-CoV-2 infection, through a search on PubMed, Web of Science and EMBASE, up to March 2020 found that diarrhoea was a common symptom in infections due to coronavirus in up to 30% of patients with MERS-CoV and only 10.6% of patients with SARS-CoV [4]. SARS-CoV utilize the Angiotensin-converting enzyme 2 (ACE2) with the serine protease TMPRSS2 for S protein priming. ACE2 and TMPRSS2 are expressed in lung, as well as small intestinal epithelia, added to this the ACE2 is expressed in the oesophagus, liver, and colon; SARS-CoV-2 binds strongly with ACE2 (10–20 times) compared with other SARS-CoV [5]. Several reports indicate viral RNA shedding in stool detectable longer time period than in nasopharyngeal swabs [6]. Several factors are associated for increase in SARS-CoV-2 cases and mortality in India during 2021 related to environmental, host and agent factors [7]. The National Family Health Survey 4 shows that the prevalence of childhood diarrhoea has increased from 9 percent to 9.2% from 2016 to 2020 in India and NFHS-5 found that Bihar has the highest rural (12.6 per cent) and urban (13.9 per cent) prevalence among all states [8].

The climatic conditions differ in different geographical locations which influences other diseases such as COVID-19 in India [9,10]. Despite one of the most populous (next to china) country of the world with great variations of seasons/temperature, till today the researcher has not seen or read any adequate country-based research conducted across states and UTs (union territories) of India on cumulative basis for evaluating the impact of COVID-19 pandemic, season and temperature on prevalence of diarrhoea cases and mortality in India during 2018-2021in the general population. The researcher felt need of this study due to above-mentioned truths and facts, hence we conducted an HMIS based (health management information system) cross sectional research study with data from all the 36 states and UTs of India including data of all private/rural/public and urban health facilities registered with HMIS of Government of India-MoHFW (Ministry of Health and Family Welfare) [11].

The medical doctor researcher of this study with experience of 18 years has suspected unusual trends on prevalence of diarrheal cases and mortality during his regular duties at various Government hospitals during the ongoing pandemic of COVID-19, which raised the title-mentioned research question. Hence the researcher started this study to investigate the research question mentioned in the title by collecting and analyzing accredited data of HMIS (Health Management Information System). The objective of this study is to inform and alert the health system administrators, policy-makers, caregivers, medical doctors, health department administrators, patients, decision-makers, international agencies like CDC (centre for disease control), NCDC India (National centre for disease control), WHO (World Health Organization), researchers, and citizens of India, etc with findings of this research study based on accredited data study to take necessary steps to ensure safety of lives during the COVID-19 period, seasonal and temperature variations in the prevalence of diarrhoea in India. This research study will also prompt international agencies and global researchers to find out the title mentioned research question in their country / geographical locations. The first global COVID-19 patient was from Wuhan in China during December 2019; while in India on January 27, 2020, a 20 yr old female was identified as first COVID-19 patient [9]. Hence for this study we have taken period before 1st January 2020 as pre-pandemic era and from 01-01-2020 onwards as pandemic era.

Objectives

The purpose of this research is to examine the epidemiology of childhood diarrheal events during COVID-19-period and comparing it with the pre-pandemic period of 2018-2019 as well as monthly-seasonal-temperature

variations during different months of pre-pandemic and pandemic period associated diarrhoea to identify any changes in the usual seasonal pattern of childhood diarrheal events. The researcher hopes that the findings of this study will open a new platform for discussion in the scientific community as well as it will help to inform and alert the health system administrators, policy-makers, caregivers, medical doctors, health department administrators, patients, decision-makers, international agencies like CDC (centre for disease control), NCDC India (National centre for disease control), WHO (World Health Organization), researchers, and citizens of India, etc with findings of this research study based on accredited data study to take necessary steps to ensure safety of lives during the COVID-19 period, seasonal and temperature variations in the prevalence of diarrhoea in India. This novel cross-sectional study has the key objective to analyze the impact of monthly-seasonal-temperature variations of important diarrheal events during and before COVID-19 with the utilization of time-bound data. The title mentioned study question is not explored to date in India by any studies. There are several confounders such as longitude, rainfall, snowfall, rural, urban, altitude, latitude, diet, age, type of facilities, socioeconomic factors, economic status, education, beliefs, treatments, etc. For this study these confounders including variations among States and UTs are not taken into account as for a deep understanding and research a primary survey is essential which is beyond the scope of researchers due to an economic constrains and support; hence we are analyzing secondary accredited data.

The key aim is to determine the impact of COVID-19 pandemic, season and temperature on prevalence of childhood diarrhoeal cases and treatment in India during 2018-2021 with available data of 36 states and UTs on a cumulative basis from data source HMIS. The researcher will investigate different state and UTs by geographical regions in coming version according to temperature ranges as India is having a broad variations in temperature across various States and UTs.

Methods

Study Design

This cross-sectional study was HMIS data-based retrospective research study conducted across all public –private -rural - urban health facilities of 36 states and UTs (union territories) of India registered on HMIS.Data collection from HMIS registered all health facilities across 36 states and UTs of India were initiated from 1st January 2018 marking Winter season as January - February and were followed for four seasons according to the apex body Indian Meteorological Department (IMD) divisions of season; i.e., Winter Season starting from 1st Jan to Feb last, Pre-Monsoon Season Mar to May, Monsoon Season Jun to Sep, Post-Monsoon Season from Oct to Dec. On mean temperature basis, the coldest season was Winter Season Jan-Feb, whereas Monsoon Season June to September was recorded as the hottest according to the IMD data.

Setting

This study evaluated the impact of COVID-19 pandemic, season and temperature on prevalence of diarrhoeal cases and mortality in India during 2018-2021 i.e. 1st January 2018 to 31st May 2021. This research study examined/ investigated Childhood diarrhoea (0-5 years), Childhood diarrhoea treated in Inpatients (0-5 years), across 36 states and UTs of India during 41 months of study from 1st January 2018 to 31st May 2021. Microsoft office and Stata15.1 were utilized for data collection and analysis. The researcher feels that more data should be utilized for such studies which will be available in the next version.

Participants

Eligible participants were any childhood diarrhoea (0-5 years), childhood diarrhoea treated in Inpatients (0-5 years) due to diarrhoeal diseases across 36 states and UTs of India during 41 months of study from 1st January 2018 to 31st May 2021registered on HMIS.

Ethical Considerations

Ethical approval was not applicable. No human or animal trial etc. was done or involved them in any process that requires ethical approvals. The data utilized is available in public domain and we had not disclosed any hidden data. Ethical approval is not applicable for such studies in India.

Variables

The key variables for this research study were the meteorological variables data from IMD and diarrhoea related data from HMIS which are enlisted below in (Tables 1-4). The meteorological data for 2021 is not taken into account and will be considered in next version with full diarrhoeal data of 2021 from HMIS which is not available till today 08-07-2022, 09-55 AM.

Meteorological Data

Year	Winter Season Jan-Feb (°C)	Pre-Monsoon Season Mar-May(°C)	Monsoon Season Jun-Sep (°C)	Post-Monsoon Season Oct-Dec(°C)
2020	20.79	27.58	28.45	23.75
2019	20.71	28	28.6	23.49
2018	21.24	28.16	28.28	23.55

statistical analysis of temperature data							
Variable	**Obs**	**Mean**	**Std. Dev.**	**[95% Conf. Interval]**	**Std. Err.**	**Min**	**Max**
Winter Season Jan-Feb (°C)	3Year	20.91	0.29	20.20 - 21.62	0.16	20.7	21.2
Pre-Monsoon Season Mar-May(°C)	3 Year	27.91	0.3	27.17 - 28.66	0.17	27.6	28.2
Monsoon Season Jun-Sep(°C)	3Year	28.44	0.16	28.05 -28.84	0.09	28.3	28.6
Post-Monsoon Season Oct- Dec(°C)	3 Year	23.59	0.14	23.26 - 23.93	0.08	23.5	23.8

Table 1: All India mean seasonal temperature (°C) and statistical analysis of temperature data.

Diarrhoea Data

Variable	Childhood Diseases - Diarrhoea(0-5 years)	Childhood Diseases - Diarrhoea treated in Inpatients(0-5 years)
18-Jan	266881	39479
18-Feb	270755	43635
18-Mar	297218	49522
18-Apr	307904	53383
18-May	351520	58852
18-Jun	368392	61572
18-Jul	376029	60162
18-Aug	358269	57289
18-Sep	322860	52549
18-Oct	296373	45580
18-Nov	277535	41972
18-Dec	274413	44289
19-Jan	279733	47006
19-Feb	275715	48987
19-Mar	296055	49583
19-Apr	304548	57560
19-May	361145	65197
19-Jun	390155	65521
19-Jul	418722	71140
19-Aug	377544	62795
19-Sep	351699	53421
19-Oct	301101	44416

19-Nov	276380	40996
19-Dec	261319	39376
20-Jan	266382	42131
20-Feb	284075	48957
20-Mar	255809	40692
20-Apr	158007	17563
20-May	175039	17924
20-Jun	191291	18977
20-Jul	216483	18971
20-Aug	200187	17921
20-Sep	200639	18784
20-Oct	187175	18251
20-Nov	183192	18957
20-Dec	187559	21257
21-Jan	193205	24511
21-Feb	204566	30620
21-Mar	240323	45254
21-Apr	199524	33011
21-May	165392	16756
Total	11171113	1704819

Table 2: Childhood diarrhoea (0-5 years), Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases from 1st January 2018 to 31st May 2021.

Data Sources/Measurement

Temperature data were collected from IMD whereas the diarrhoea data were collected from HMIS. Measurements were done with the help of Microsoft Office and Stata15.1 software to find out the impact of COVID-19, season and temperature on the prevalence of childhood diarrhoea (0-5 years), childhood diarrhoea treated in Inpatients (0-5 years) due to diarrhoeal diseases from 1st January 2018 to 31st May 2021across 36 states and union territories of India.

Bias

Data of consecutive three years were considered to reduce the bias. Further, mean temperature of seasons and mean of variables were compared for bias reduction. In the next version, geographical division of India on the basis of temperature and more years will be added for bias reduction and generalizability.

Study Size

A total of 11171113 (mean- 272466.2; [95% Conf. Interval means] 250375.4-294556.9)childhood diarrhoea (mean [95% Conf. Interval means]) (0-5 years), 1704819 (mean 41580.95-; [95% Conf. Interval means 36458.75-46703.15]) childhood diarrhoea treated in Inpatients (0-5 years), 7603860 (mean 185460-; [95% Conf. Interval means 159578.8- 211341.2]) were included in this study on an all-India basis. The study population for this novel research study consisted of any childhood diarrhoea (0-5 years), childhood diarrhoea treated in Inpatients (0-5 years) due to diarrhoea across 36 states and union territories of India of both the sexes registered on HMIS, see Table 2 and 3 for details.

Quantitative Variables

See Tables 1 and 2.

Statistical Analysis

The statistical analysis was done using Microsoft Office and Stata15.1 statistical software. Various statistical details were calculated but only few such as mean, ± standard deviation, as well as 95% C. I (confidence interval) and standard errors etc. were used in this version, see Tables 1 and 3. Comparisons of variables and statistical analysis

for each year is discussed below among the four seasons / different years / different months / pre-pandemic and pandemic era described in words and charts.

Stats	Childhood– Diarrhoea (0-5 years)	Childhood - Diarrhoea treated in Inpatients (0-5 years)
obs	41	41
mean	272466.2	41580.95
sum	11171113	1704819
max	418722	71140
min	158007	16756
range	260715	54384
sd	69987.35	16228.04
se(mean)	10930.19	2534.39
p50	275715	44289
Std. Err.	10930.19	2534.394
[95% Conf. Interval means]	250375.4- 294556.9	36458.75-46703.15

Table 3: Statistical analysis of Childhood diarrhoea (0-5 years), Childhood diarrhoea treated in Inpatients (0-5 years) due to diarrhoeal diseases from 1st January 2018 to 31st May 2021.

Results

Meteorological Data Analysis Results

The overall mean temperature (Degree Celsius) ± (SD) standard deviation recorded in Winter Season of study period during Jan-Feb (°C), were 20.91 ± 0.29, with 95% Conf. Interval 20.20- 21.62, Std. Err. .16, Min 20.71, and Max 21.24; The mean temperature (degree Celsius) ± standard deviation recorded in Pre-Monsoon Season Mar- May(°C), were 27.91 ± 0.30, with 95% Conf. Interval 27.17- 28.66, Std. Err. .17, Min 27.58, and Max 28.16; The mean temperature (degree Celsius) ± standard deviation recorded in Monsoon Season Jun-Sep(°C), were 28.44 ± 0.16, with 95% Conf. Interval 28.05- 28.84, Std. Err. .09, Min 28.28, and Max 28.6; The mean temperature (degree Celsius) ± standard deviation recorded in Post-Monsoon Season Oct-Dec(°C) were 23.59 ± 0.14, with 95% Conf. Interval 23.26- 23.93, Std. Err. .08, Min 23.49 and Max 23.75 see Table-1 and Figure 1 [12].

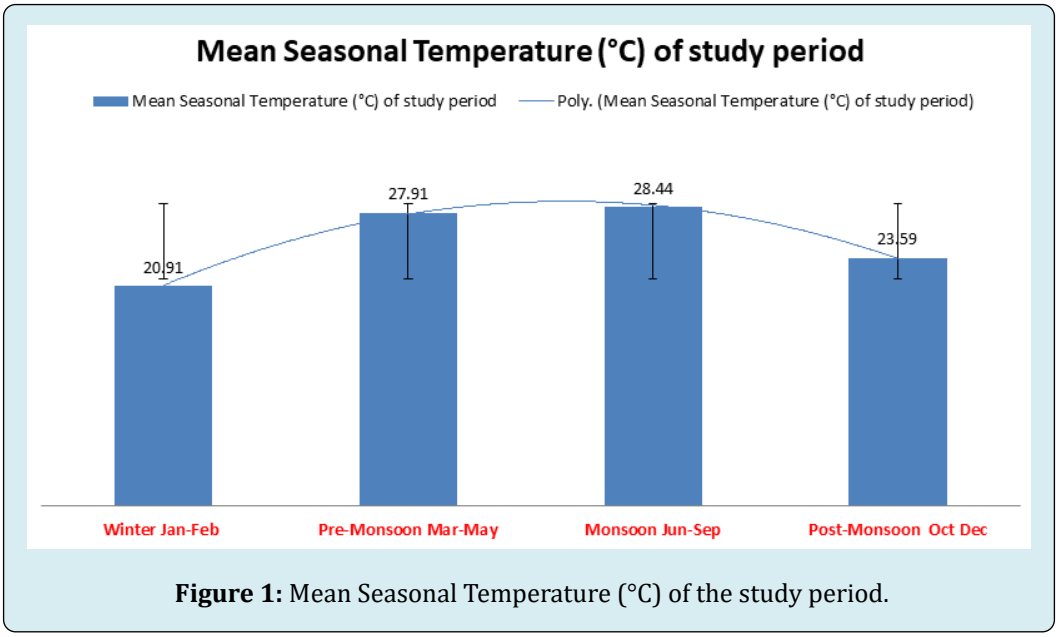

Figure 1: Mean Seasonal Temperature (°C) of the study period.

Total Childhood Diarrhoea (0-5 Years) and Childhood Diarrhoea Treated in Inpatients (0-5 Years) due to Diarrhoeal Diseases from 1st January 2018 to 31st May 2021

A total of 11171113 eligible childhood diarrhoea (0-5 years) and 1704819 Childhood diarrhoea treated in Inpatients (0-5 years) were analyzed during the 41 month study period. The analysis of monthly / seasonal / COVID-19 variations of eligible Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) different months of different years and combined all years is discussed below as per timeline for better understanding.

2018- Monthly /Seasonally Prevalence of Childhood Diarrhoea (0-5 Years) and Childhood Diarrhoea Treated in Inpatients (0-5 Years) due to Diarrhoeal Diseases

The total number of childhood diarrhoea (0-5 years) and childhood diarrhoea treated in Inpatients (0-5 years) observed in 12 months of2018 from were 3768149 and 608284 respectively; Mean- 314012.42 and 50690.33 respectively; Max / month- 376029 and 61572 respectively; Min / month – 266881and 39479 respectively for cases and inpatient treatments and no. of Obs-12 for each (one / month). Childhood diarrhoea cases period prevalence was highest in the month of July-18(376029) while lowest monthly prevalence was found in January-2018 (266881). Childhood diarrhoea cases treated in Inpatients period prevalence was highest in the month of June-2018(376029) while lowest monthly prevalence was found in January-2018 (266881).

The mean seasonal childhood diarrhoea cases period prevalence were highest in monsoon June to September (mean temperature 28.28°C) with mean number childhood diarrhoea cases 356387.5 followed by pre monsoon March to May (mean temperature 28.16°C) with mean cases 318880.67, post monsoon, October to December, (mean temperature 23.55°C) with mean cases 282773.67, and lowest in Winter Season Jan to Feb (mean temperature 21.24°C) having mean cases 268818 and See Table 1,2 and Figure 2. It was observed that the prevalence of mean childhood diarrhoea cases increased with increase in temperature.

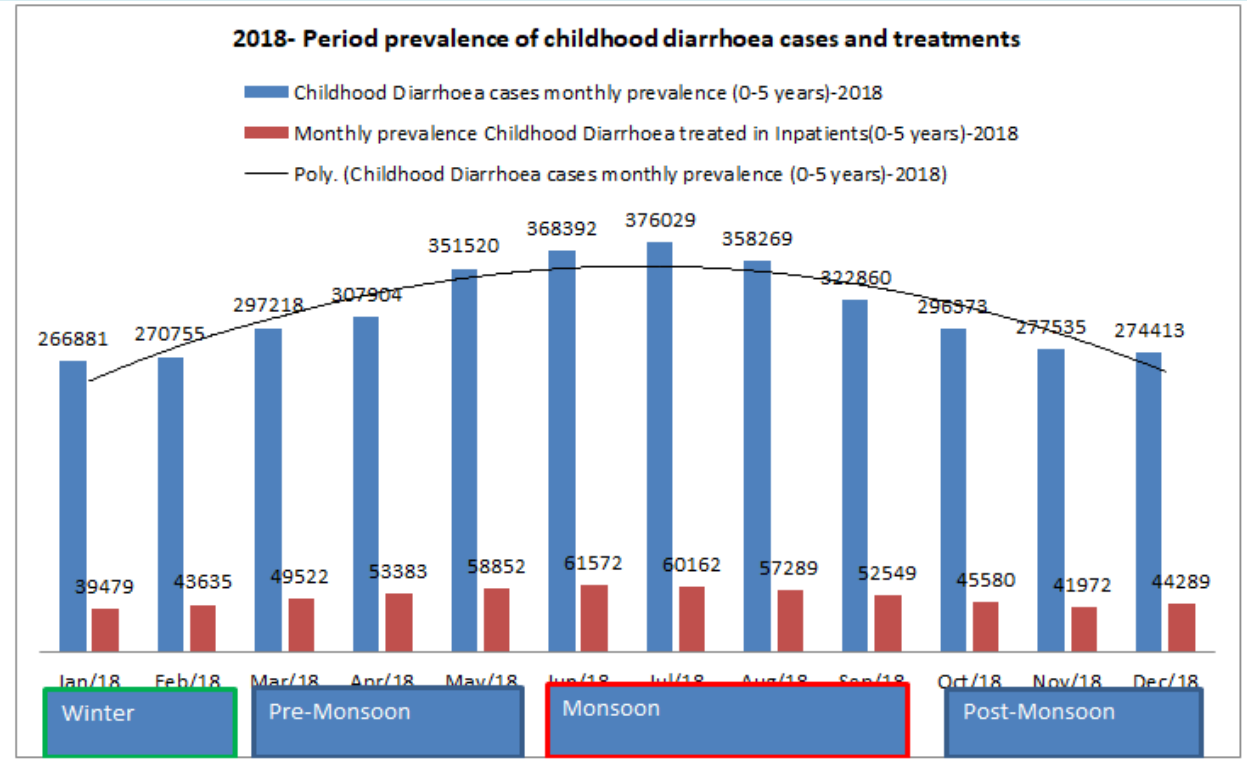

Figure 2: Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases in 2018.

The mean seasonal childhood diarrhoea treated in Inpatients period prevalence were highest in monsoon June to September (mean temperature 28.28°C) with mean number childhood diarrhoea cases treated in Inpatients 57893 numbers followed by pre monsoon March to May (mean temperature 28.16°C) with mean number of cases treated in Inpatients 53919, post monsoon, October to December, (mean temperature 23.55°C) with mean cases treated in Inpatients 43947, and lowest in Winter Season Jan to Feb (mean temperature 21.24°C) having mean cases treated in Inpatients 41557 and See table-1, 2, and figure-2. It was observed that the prevalence of mean childhood diarrhoea cases treated in Inpatients increased with increase in temperature.

2019- Monthly /Seasonally Prevalence of Childhood Diarrhoea (0-5 Years) and Childhood Diarrhoea Treated in Inpatients (0-5 Years) Due to Diarrhoeal Diseases

The total number of childhood diarrhoea (0-5 years) and childhood diarrhoea treated in Inpatients (0-5 years) observed in 12 months of2019 from were 3894116 and 645998 respectively; Mean- 324509.7 and 53833.2 respectively; Max / month- 418722 and 71140 respectively; Min / month- 261319 and 39376 respectively for cases and inpatient treatments and no. of Obs-12 for each (one / month). Childhood diarrhoea cases period prevalence was highest in the month of July-2019 (418722) while lowest monthly prevalence was found in December- 2019 (261319).

The mean seasonal childhood diarrhoea cases period prevalence were highest in monsoon June to September 2019 (mean temperature 28.6°C) with mean number childhood diarrhoea cases 384530 followed by pre monsoon, March to May 2019 (mean temperature 28°C) with mean cases 320582.67, post monsoon, October to December 2019, (mean temperature 23.49°C) with mean cases 279600, and lowest in Winter Season Jan to Feb 2019 (mean temperature 20.71°C) having mean cases 277724 and See table-1, 2, and Figure-3. It was observed that the prevalence of mean childhood diarrhoea cases increased with increase in temperature. Added to this the prevalence pattern of 2019 was almost similar to previous year 2018.

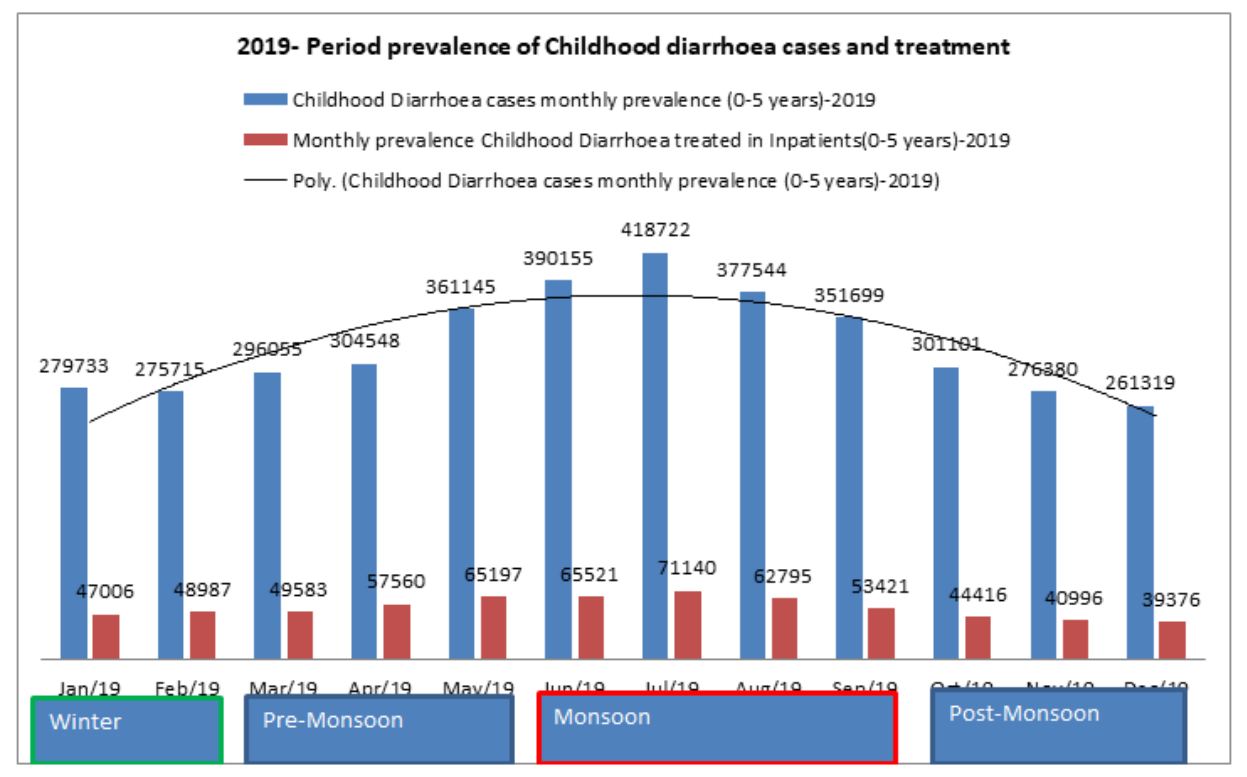

Figure 3: Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases in 2019.

The mean seasonal childhood diarrhoea cases treated in Inpatients (0-5 years)period prevalence were highest in monsoon June to September 2019 (mean temperature 28.6°C) with mean number childhood diarrhoea cases treated in Inpatients (0-5 years) 63219.25 followed by pre monsoon, March to May 2019 (mean temperature 28°C) with mean cases treated in Inpatients 57446.67, Winter Season Jan to Feb 2019 (mean temperature 20.71°C) having mean cases treated in Inpatients 47996.5 and lowest in post monsoon, October to December 2019, (mean temperature 23.49°C) with mean cases treated in Inpatients (0-5 years) 41596,See table-1, 2, and figure-3. The prevalence pattern of 2019 was almost similar to previous year 2018 except the inpatients treatment was lowest in post-monsoon instead of winter season.

2020- Monthly /Seasonally Prevalence of Childhood Diarrhoea (0-5 Years) and Childhood Diarrhoea Treated in Inpatients (0-5 Years) due to Diarrhoeal Diseases during COVID-19 Period

The total number of childhood diarrhoea (0-5 years) and childhood diarrhoea treated in Inpatients (0-5 years) observed in 12 months of2020 from were 2505838 and 300385 respectively; Mean- 208819.83 and 25032.08 respectively; Max / month- 284075 and 48957 respectively; Min / month- 158007 and 17563 respectively for cases and inpatient treatments and no. of Obs-12 for each (one / month). Childhood diarrhoea cases period prevalence was highest in the month of February-2020(284075) while lowest monthly prevalence was found in April -2020 (158007). Here it is important to mention that there is an abrupt shift in monthly as well as annual and seasonal prevalence of Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases during the COVID-19 pandemic period. The question arises why? This will be discussed in discussion part.

The mean seasonal childhood diarrhoea cases period prevalence were highest in Winter Season Jan to Feb 2020 (mean temperature 20.79°C) having mean cases 275228.5 followed by monsoon, June to September 2020 (mean temperature 28.45°C) with mean number childhood diarrhoea cases 202150, pre monsoon, March to May 2020 (mean temperature 27.58°C) with mean cases 196285, and lowest in post monsoon, October to December 2020, (mean temperature 23.75°C) with mean cases 185975.33, See table-1, 2, and Figure 4. It was observed that the prevalence of mean childhood diarrhoea cases increased in winter season. Added to this the prevalence pattern of seasonal childhood diarrhoea cases changed significantly compared to 2019 and 2018.

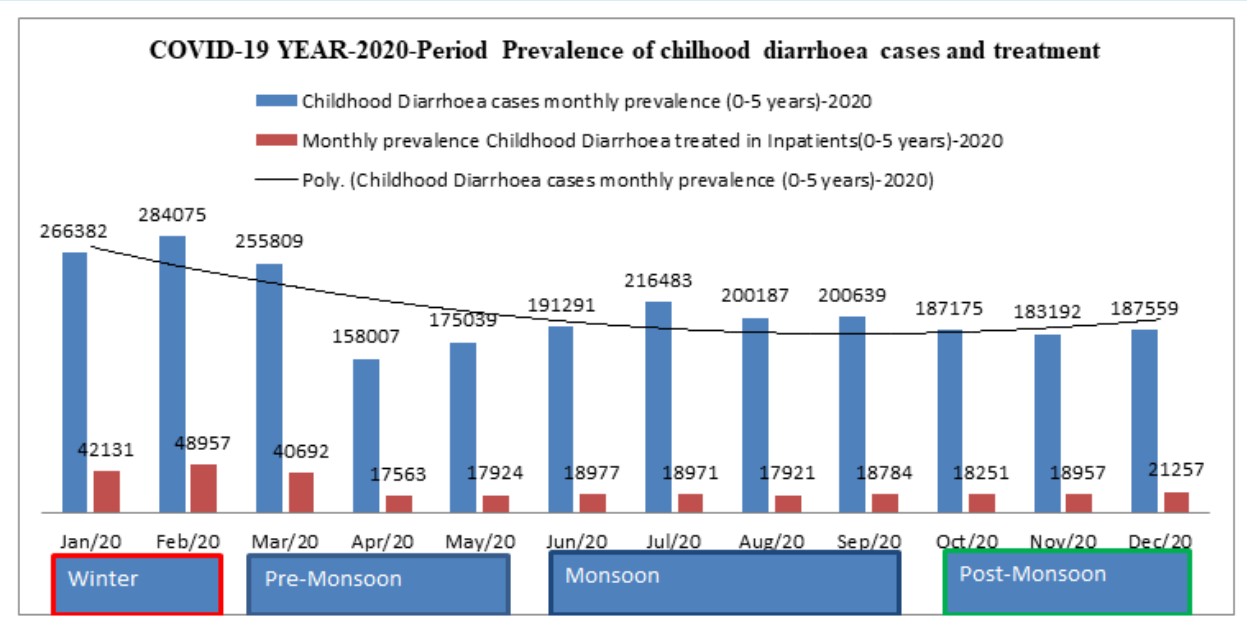

Figure 4: Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases in 2020.

The mean seasonal childhood diarrhoea cases treated in Inpatients period prevalence were highest in Winter Season Jan to Feb 2020 (mean temperature 20.79°C) having mean treated in Inpatients cases 45544 followed by pre monsoon,

March to May 2020 (mean temperature 27.58°C) with mean treated in Inpatients cases 25393, post monsoon, October to December 2020, (mean temperature 23.75°C) with mean treated in Inpatients cases 19488.33,and lowest in monsoon, June to September 2020 (mean temperature 28.45°C) with mean number childhood diarrhoea cases treated in Inpatients 18663.25, See table-1, 2, and figure-4. It was observed that the prevalence of mean childhood diarrhoea cases treated in Inpatients increased in winter season. Added to this the prevalence pattern of seasonal childhood diarrhoea treated in Inpatients cases changed significantly compared to 2019 and 2018. This change may be due to COVID-19 impact which is discussed in other section.

2021- Monthly /Seasonally Prevalence of Childhood Diarrhoea (0-5 Years) and Childhood Diarrhoea Treated in Inpatients (0-5 Years) due to Diarrhoeal Diseases during Covid-19 Period

The complete data of 2021 was not available and as a medical doctor the researcher feels that diarrhoeal outbreaks are unpredictable hence mathematical modelling or linear regression are not applied to predict the future data. This will be discussed in next version with full data availability. Only Figure 5 below is presented to readers as per available accredited data.

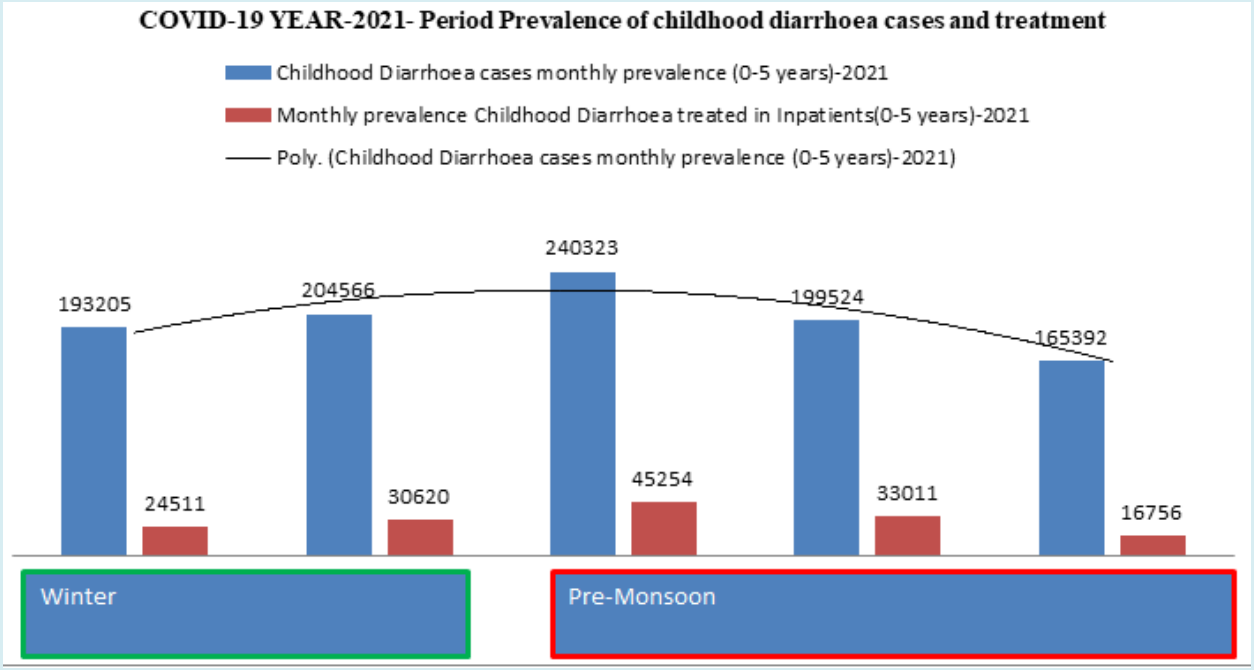

Figure 5: Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases in 202.

2018-2019-2020-2021 Combined

Analysis of Monthly /seasonally Prevalence of Childhood diarrhoea (0-5 years) and Childhood diarrhoea treated in Inpatients (0-5 years) due to Diarrhoeal diseases -The 41 months of study when grouped into two groups as pre-pandemic era and pandemic era shows that the Monthly / seasonally Prevalence of Childhood diarrhoea (0-5 years) were MAX in July 2019 monsoon season during pre-pandemic period with 418722 cases ([95% CONF. INTERVAL] 299758.7- 338763.3; STD. ERR.- 9427.519; MEAN-319261; STD. DEV- 46185.22; and MIN-261319 in December 2019, post monsoon season (Table 1, 3 & 4; Figures 5 & 6).

During the COVID-19 pandemic period Monthly / seasonally Prevalence of Childhood diarrhoea (0-5 years) were MAX in February 2020 winter season during pre-pandemic period with 284075 cases ([95% CONF. INTERVAL] 188170.3 - 224635.3; STD. ERR.- 8600.616; MEAN-206402.8; STD. DEV- 35461.25; and MIN-158007 in April 2020. The impact of COVID-19 on mean seasonal Prevalence of Childhood diarrhoea and treatment in Inpatients will be discussed in next version.

Stat	Childhood Diseases - Diarrhoea(0-5 years) – Pre-pandemic period	Childhood Diseases - Diarrhoea(0-5 years) –pandemic period	Childhood Diseases - Diarrhoea treated in Inpatients(0-5 years) – Pre-pandemic period	Childhood Diseases - Diarrhoea treated in Inpatients(0-5 years) – pandemic period
Mean	319261	206402.8	52261.75	26502.18
Min. / month	261319	158007	39376	16756
Max. / month	418722	284075	71140	48957
Obs	24	17	24	17
Std. Dev.	46185.22	35461.25	9133.012	11214.68
sum	7662265	3508848	1254282	450537
range	157403	126068	31764	32201
se(mean)	9427.519	8600.616	1864.268	2719.961
p50	302824.5	199524	51066	18977
[95% Conf. Interval]	299758.7- 338763.3	188170.3 - 224635.3	48405.22- 56118.28	20736.12 - 32268.24

Table 4: Comparison of Pre-pandemic and pandemic period.

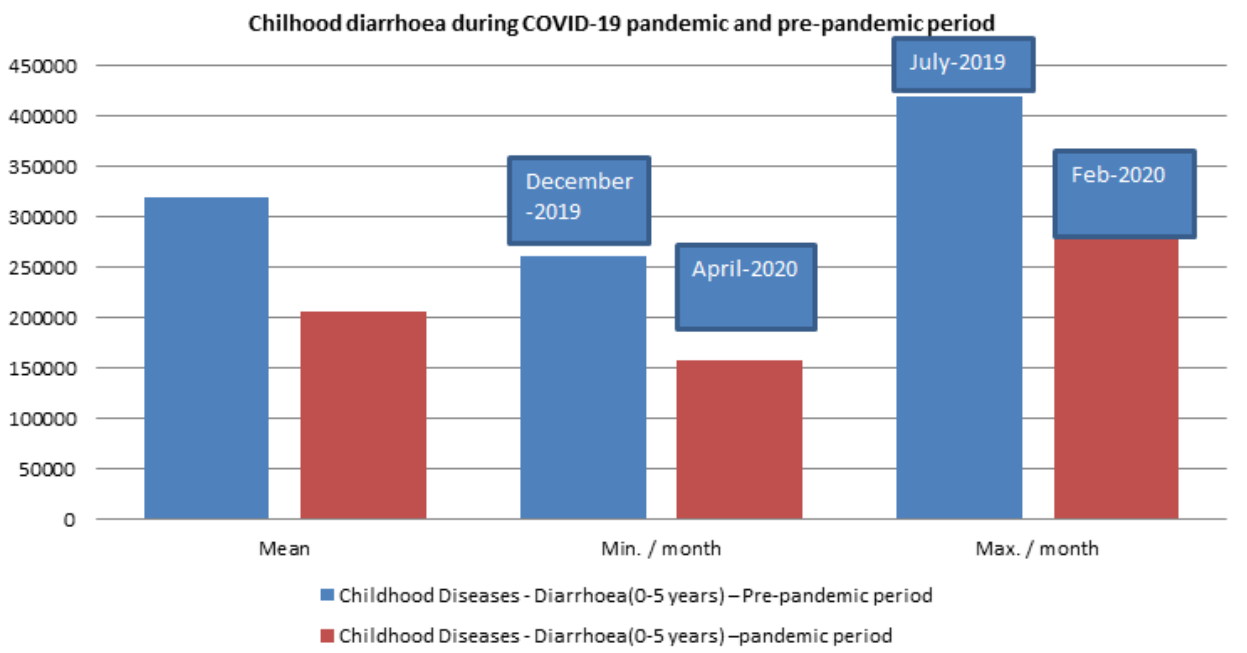

Figure 6: Comparison of childhood diarrhoea during Pre-pandemic and pandemic period.

The 41 months of study when grouped into two groups as pre-pandemic era and pandemic era shows that the Monthly /seasonally Prevalence of Childhood diarrhoea treated in Inpatients (0-5 years) were MAX in July 2019 monsoon season during pre-pandemic period with 71140 cases ([95% CONF. INTERVAL] 48405.22-56118.28; STD. ERR. - 1864.268; MEAN-52261.75; STD. DEV- 9133.012; and MIN-39376 in December 2019, post monsoon season.During the COVID-19 pandemic period Monthly /seasonally Prevalence of Childhood diarrhoea treated in Inpatients (0-5 years) were MAX in February 2020 winter season during pre-pandemic period with 48957 cases ([95% CONF. INTERVAL] 20736.12 - 32268.24; STD. ERR.- 2719.961; MEAN-26502.18; STD. DEV- 11214.68; and MIN-16756 in May 2021 See Table- 1, 3, and 4; Figure 7.

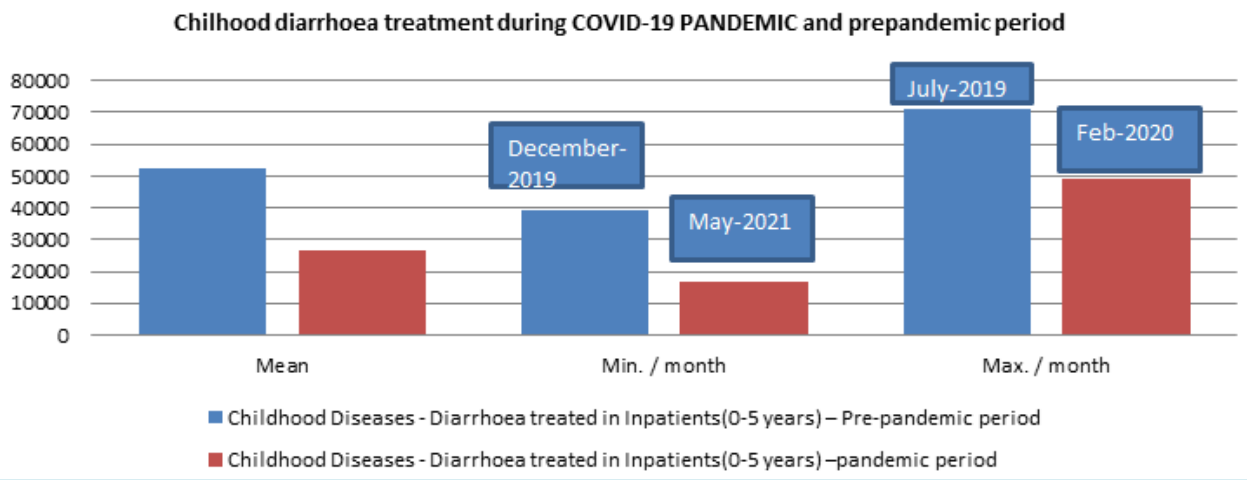

Figure 7: Comparison of childhood diarrhoea treatment during Pre-pandemic and pandemic period.

Discussion

This research study revealed that during the COVID-19 pandemic period monthly /seasonally trends of prevalence of childhood diarrhoea has changed as compared to pre-pandemic period. Why? Why winter diarrhoea is found to be more prevalent during COVID-19 pandemic era instead of usual previous trends of greater prevalence in summer (monsoon-premonsoon)? Usually during summer and rainy season diarrhoea is quite common in children's mainly caused by bacterial infections while viral diarrhoea particularly caused by rotavirus infection occurs commonly during dry cool winter months in India [13]. One research study done Vishwanath et. al. In eastern India found that the rotavirus (RV) positivity decreased, with decrease in hospital admissionsas the average humidity, temperature, and rainfall increased, as well as incidence of rotavirus cases was inversely related with average temperature, humidity, and rainfall which is peculiar to winter seasons in India [14]. The COVID-19 era is found to reduce pollution but does not have any significant impact on reducing the temperature, added to this we are not having data related to stool tests to prove that this change was due to increased rotavirus infection [15]. Of course the immunization coverage was reduced in India among children's due to COVID-19 which may have increased the winter diarrhoea compared to summer diarrhoea [16]. The lockdown may have reduced the prevalence of childhood diarrhoea during COVID-19 is also a possibility. Like this there are several research questions originating from this research study. Last but not least there may be massive faulty reporting.

Strength and Limitations

There are no such descriptive crosses sectional broad epidemiological studies on the impact of COVID-19 pandemic, season and temperature on prevalence of childhood diarrhoeal cases and treatment in India during 2018-2021 considering 36 states and UTs of India on a cumulative basis. This exceptional novel research study is based on accredited data hence reliable, specific, measurable as well as time-bound, which encompasses records of all cases and treatments for titled research questions in India. A more thorough deep study with primary researched data in relation to title mentioned question is needed but not possible by the researcher due to lack of funds and support from Government or any other agencies. Hence the researcher is doing this study with available resources.

Conclusion and Recommendation

The researcher feels that more study and deep investigation is required to further explore the research question. The usual recommendation for diarrhoea is as follow.

1. Access to safe drinking-water.
2. Use of improved sanitation.
3. Hand washing with soap.
4. Exclusive breastfeeding for the 1st six months of life.
5. Good personal and food hygiene.
6. Health education concerning however infections unfold.
7. Rotavirus vaccination.

Key recommendation to treat childhood diarrhoea is the following:

1. Rehydration with oral rehydration salts (ORS) solution: ORS, low osmolality formula,
2. Rehydration could need IV fluids just in case of severe dehydration or shock.
3. Zinc supplements
4. Nutrient-rich foods
5. Consulting a health care provider, especially for management of persistent looseness of the bowels, or

once there's blood within the stool, or if there are signs of dehydration.

6. Adequate nutrition is vital to up natural defenses, beginning with exclusive breastfeeding for the primary 6 months of life.

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