A Community-based study on the distribution and magnitude of childhood illnesses identified by the 4D's approach in Chengalpattu district, Tamil Nadu

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ABSTRACT

Introduction: Childhood diseases or illnesses have great effects on one's life in terms of health, development, and productivity in the future. The 4D concept: Birth Defects, Diseases, Deficiencies, and Developmental delay provides a platform for early diagnosis of childhood illnesses. The prevalence of birth defects is about 6-7 percent of all births in India, nutritional deficiencies are common, and developmental problems occur in almost 10% of all children in the world. Information regarding the prevalence of childhood illnesses based on the 4D concept is lacking in the rural areas of Tamil Nadu, India. This study aims to determine the prevalence of childhood illnesses among the 0-18-year-olds in two rural blocks of Chengalpattu district in Tamil Nadu. **Methodology**: A cross-sectional study was done in two blocks, Thiruporur and Tirukazhukundram, of Chengalpattu district. Eight villages were selected randomly. Data was collected from all permanently residing children within the age group of 0-18 years whose parents gave consent. The tools used in data collection included a pre-tested questionnaire that covered all sociodemographic information. **Result**: Out of 13,236 children evaluated, 2,108 (15.9%) had one or more problems within the framework of the 4D model. Diseases were the most prevalent (56.5%) compared to deficiencies (25.3%), developmental problems (17.3%), and birth defects (0.66%). Dental caries was the predominant type of disease (76%). Severe Acute Malnutrition (59%) and anemia (36%) were the most common deficiencies. Vision problems were the predominant developmental problems. Cleft lip and congenital heart disease were common forms of birth defects. The healthcare services were accessed by 65.22% of the affected children. **Conclusion**: Illnesses affecting childhood represent a major public health problem in rural Chengalpattu. Improving early screening procedures, referral systems, DEIC services, and community awareness is important.

Key-words: Childhood illness, Defects at Birth, Diseases, Developmental delays, Deficiency

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INTRODUCTION

The health of children plays a significant role in determining the general well-being of a population as well as their productivity in the future. Most health problems experienced by children that are not treated at an early age might result in morbidity, disabilities, and a low quality of life. Childhood diseases account for most health problems and are usually associated with four key areas of focus, referred to as the 4D's approach. These four areas include congenital defects, diseases, deficiencies, and developmental delays [1].

Globally, birth defects and developmental disorders among children continue to be one of the most significant public health issues. The number of congenital abnormalities is estimated to occur in about 2–6% of all births across the world [2]. In India, approximately 6–7% of all births include infants who have been diagnosed with birth defects; the total number of cases in India is almost 1.7 million annually, and they cause a significant number of deaths among babies and infants[3]. Nutritional problems among children are quite common in India, where diseases such as anaemia, vitamin deficiency, and malnutrition among preschoolers and school-age children account for a high percentage of all cases. Besides, developmental problems are believed to impact 10%

of all children, especially those within their early ages [4].

Apart from the congenital causes and deficiencies, some prevalent childhood diseases also add to the problem of childhood morbidity. Some of these diseases include dental caries, otitis media, and various respiratory problems [5]. All these conditions could be avoided if proper attention is paid to their early detection and treatment. Developmental disorders are yet another essential factor that contributes to the health challenges faced by children. On a global level, almost 17% of children suffer from developmental issues, whereas in India, it is estimated that the percentage ranges between 6-7%[6].

In India, there have been several initiatives taken in the direction of promoting child health and early identification of health problems among children. One of them is aimed at detecting health problems in children under the following four heads: problems due to birth defects; problems due to diseases; problems due to deficiencies; and problems due to developmental delays or disabilities known as the '4D's [7]. All these problems cumulatively account for a large burden of diseases in children less than 18 years old.

In spite of the significant importance of early detection of childhood illnesses, no data from community-based studies have been reported about the distribution and magnitude of these diseases, especially in the rural settings of Tamil Nadu. The majority of the studies carried out to date have considered institutional data or program/project assessment or perspectives of health service providers, instead of looking into the problem from the point of view of the magnitude of childhood illnesses in the community itself [8–10]. It becomes necessary to know the magnitude and pattern of health problems amongst children in the community for proper planning of preventive and interventional programs. Very few studies have been done to know the distribution of childhood illnesses in the region based on 4D's criteria. Hence, the current study aimed to assess the distribution and magnitude of childhood illnesses identified by the use of 4D's criterion among children between 0-18 years in rural parts of Chengalpattu district, Tamil Nadu.

METHODOLOGY

Study Design: A community-based cross-sectional survey was conducted to determine the prevalence and distribution of childhood illnesses using the 4D's model (Defects at birth, Diseases, Deficiencies, and Developmental delays/disabilities) among children aged 0–18 years residing in rural areas of Chengalpattu district, Tamil Nadu.

Study Area and Sampling: It involved Multi-stage sampling

- **Stage 1:** Two blocks (Thiruporur and Tirukazhukundram) were selected from the eight blocks in the district using simple random sampling.
- **Stage 2:** Four villages were randomly chosen from each block, yielding a total of eight villages representing diversity.
- **Stage 3:** Within each selected village, all households were surveyed to identify eligible children. Census methodology was adopted to cover the entire population of children aged 0–18 years who are permanent residents and whose guardians provide informed consent.

Study Population: All children aged 0–18 years residing in the selected villages during the survey period.

- Inclusion: Permanent residents with guardian consent.
- Exclusion: Temporary residents or those without consent.

Data Collection

- A pretested semi-structured questionnaire was used.
- Domains that were covered: sociodemographic profile, birth history, nutritional status, medical history, developmental milestones, healthcare utilisation, and sources of treatment (government, private, traditional, home remedies, follow-up care).
- For children <12 years: caregiver interviews.
- For adolescents (13–18 years): information obtained from both child and guardian.
- Informed consent obtained after explaining study objectives.

Study Duration: One year, encompassing planning, data collection, entry, and analysis.

Data Management and Analysis

- Data were verified for consistency and entered into Microsoft Excel.
- Statistical analysis performed using IBM SPSS version 21.
- Descriptive statistics (frequency, percentages) will be applied to summarise findings.

RESULTS

The total number of children examined in the study period was 13,236, whose ages ranged from 0 to 18 years old. Out of these children, 2,108 (15.9%) were found to have one or more childhood diseases based on the 4D's concept (birth defects, deficiencies, diseases, and developmental delays, inclusive of disabilities). Diseases formed the biggest proportion of the identified cases, totaling 1,193 (56.5%), while 535

cases (25.3%) had deficiencies, 366 cases (17.3%) had developmental delays including disabilities, and only 14 cases (0.66%) had birth defects, as indicated in Table 1

Table 1: Prevalence of childhood illness

S.no	Childhood illness	Total n = 2108 (15.9%)
1	Defects	14(0.7%)
2	Deficiencies	535(25.5%)
3	Diseases	1193(56.5%)
4	Developmental delays	366(17.3%)

As illustrated in Table 2, of all the sick children, 14 (0.66%) were discovered to suffer from birth defects. In these cases, 8 (57%) of these affected children were found to be aged >6 weeks – 6 years old, whereas 6 (43%) were found to belong to the age category of >6 to 18 years old. Birth defects were categorized as follows: congenital heart disease (CHD) – which was 7 (50%) in number, cleft lip (5 cases, 35%), congenital deafness (1 case, 7%), and Down syndrome (1 case, 7%).

Table 2: Distribution of children according to birth defects, n=14(0.66%)

Defects	Children		
	>6 wks-6 yrs	>6yrs-18 yrs	Total
Cleft lips	5	-	5 (35%)
Congenital deafness	1	-	1(7%)
CHD	1	6	7(51%)
Down syndrome	1	-	1(7%)
Total	8(57%)	6(43%)	14

Out of the total, 535 (25.3%) had nutritional deficiencies. Of these, 426 children (80%) were aged more than 6 weeks but below 6 years, whereas 109 children (20%) were aged between 6 and 18 years. Severe acute malnutrition (SAM) was found to be the most common form of deficiency in 317 (59%) cases, followed by severe anemia in 192 (36%) patients. In addition, obesity was reported in 22 (4%) children, and vitamin D deficiency in 4 (0.7%) children, as seen in Table 3

Table 3: Distribution of children according to Deficiencies n=535(25.3%)

Deficiencies	Children		
	>6 wks-6 yrs	>6yrs-18 yrs	Total
Severe anaemia	98	94	192(36%)
Vitamin -D	3	1	4(1%)
Severe acute malnutrition	317	-	317(59%)
Obesity	8	14	22(4%)
Total	426(80%)	109(20%)	535

Of those who have the diseases, 1,193 children (56.5%) were found to have diseases during their childhood years. Of these, 972 children (81%) were within the age range of >6 to 18 years, and 221 children (19%) had ages ranging from >6 weeks to 6 years. Among the various diseases, the most frequent one was the dental caries, affecting 911 children (76%). The skin was affected by some form of disease among 212 children (18%). The otitis media affected 55 children (5%), and the reactive airway disease affected 12 children (1%). The RHD affected 3 children (0.25%) (Table 4).

Table 4: Distribution of children according to Childhood diseases, n=1193(56.3%)

Diseases	Children		
	>6 wks-6 yrs	>6yrs-18 yrs	Total
Skin conditions	35	177	212(18%)
Otitis media	-	55	55(5%)
RHD	-	3	3(0.3%)
Reactive airway diseases	-	12	12(1%)
Dental caries	186	725	911(75.7%)
Total	221(19%)	972(81%)	1193

There was a total of 366 children, which is 17.3%, with developmental disabilities and disorders. Out of that, 331 children are in the category of age >6 to 18 years, while 35 children were of age >6 weeks to 6 years, as presented in Table 5.

Table 5: Distribution of children according to Developmental delays with Disability n=366(17.3%)

Developmental delays	Children		
	>6 wks - 6 yrs	>6yrs - 18 yrs	Total
Vision impairment	1	109	110(30%)
Neuro-motor impairment	-	3	3(0.9%)
Language delays	18	12	30(8.1%)
Behaviour disorder	1	3	4(1%)
Learning disorder	-	8	8(2%)
Attention deficits hyperactivity	2	-	2(0.5%)
Others	13	153	166(46%)
Irregular period	-	34	34(9%)
Pain during menstruation	-	9	9(2.5%)
Total	35(9.5%)	331(90.5%)	366

Figure 1 displays the age and gender distribution of children with illnesses. Among children aged between 6 weeks and 6 years, there were more boys (356) suffering from diseases than girls (331). Additionally, for those aged between 6 and 18 years, there were more boys (718) than girls (695). These observations clearly indicate that males had more illnesses than females in both age groups. Furthermore, a significantly higher number of children with illnesses belonged to the 6-18 age group compared to the 6 weeks to 6 years age group.

Figure 2 presents the distribution of the various modes of treatment that were provided to the identified children. Most of the children needed treatment due to acute malnutrition (58%), accounting for the largest percentage of treatment procedures. Specialty consultations made up 26%, representing cases that necessitated specialist treatment. Speech therapy comprised 9% of the treatment procedures, suggesting that some of the children had some problems relating to their speech. Four percent of the children required regular medications for existing health issues. Three percent of the children required surgery procedures for certain health problems.

DISCUSSION

In this present study, 2,108 children (15.9%) were diagnosed with childhood illness under the 4D approach, namely defects, deficiencies, diseases, and developmental delays, which include disabilities in a total sample size of 13,236 children aged between 0 and 18 years. The most common morbidities found were diseases (56.5%), deficiencies (25.3%), developmental delays (17.3%), and birth defects (0.66%). This is in accordance with findings from a study conducted by Sharma et al. (2022) [11], which showed that out of 102 children screened under the RBSK scheme, congenital problems and nutritional deficiencies were most prevalent. Similarly, Darivemula et al. (2020) [12] found that diseases and developmental delays were the most common morbidities in 10,571 children screened in Andhra Pradesh.

Heart disease and cleft lip deformities were responsible for the largest percentage of birth defects; heart disease was present in 50%, while cleft lip deformities occurred in 35%. Age-wise distribution revealed that the largest percentage of children suffering from these defects was between six weeks and six years. This is consistent with the study conducted by Sreehari et al. (2019) [13], which revealed that early diagnosis and referral for CHD cases in Kerala had resulted in better outcomes. Congenital heart disease was the most common birth defect among children seen at DEICs in Bhopal, India, according to Bhatia et al. (2020) [5].

The prevalence of malnutrition was found to be 25.3%, mainly characterized by SAM (59%) and anemia (36%). Children below six years of age were more affected by nutritional problems. This is consistent with the study findings from rural Bangladesh by Debnath et al. (2020) [14], where the prevalence of undernutrition and wasting among children below five years old was very high, and that by Gupta et al. (2020) [15] on the positive impacts of SAM treatment on children's growth in India.

In the age category greater than 6 to 18 years, disease was the most prevalent condition, with dental caries (76%) and skin disorders (18%). These observations agree with the findings of studies conducted by Nair et al. (2019) [13] where a similar morbidity pattern prevailed among the children in Kerala, and Kumari et al. (2012) [16] where the highest morbidity was seen among communicable diseases and dental problems in Kanpur. Diseases being the commonest condition among children attending school emphasize the importance of regular health screening and preventive measures at such institutions.

Developmental delay was detected among 17.3% of children; the majority of whom were greater than 6 years old. In their study in the United States, Rosenberg et al. (2008) [17] found that despite a prevalence rate of 13%, only 10% of children with developmental delay availed of the early intervention program. Likewise, Lai et al. (2016) [18] in their study in Taiwan observed that it occurred more commonly among boys and rural children.

In the current research, among children diagnosed with 4D disorders, 1,374 (65.22%) accessed healthcare services. The treatments include SAM management in 58% of the cases, specialty consultation in 26%, speech therapy in 9%, routine medications in 4%, and surgeries in 3%.

On comparing the results with earlier studies, Sharma et al. (2022) [11] noted that less than 50% of children referred under the RBSK scheme accessed the services. The major factors causing the failure to utilize the services were preference for private practitioners and logistics challenges. In another study, Mehta et al. (2020) [19] observed that around 73.4% of children referred to DEICs accessed the services, while 20.1% of referrals remained uncovered owing to manpower and infrastructural constraints. Likewise, B. Rameshbabu et al. (2020) [20] showed different levels of service access based on 4D disorders, including childhood disease at 41.3%, developmental delay at 19.3%, deficiencies at 14.6%, and birth defects at 10.8%.

Sreehari et al. (2019) [13] demonstrated that structured referral systems, such as the Hridyam platform for congenital heart disease in Kerala, significantly improved service utilization, achieving near 100% registration and timely intervention for enrolled cases, and a 30-day post-surgery survival rate of 97.6%, showing the potential impact of system-level digital interventions. Darivemula et al. (2020) [12] in Andhra Pradesh reported utilization for children with childhood diseases at 45.9%, developmental delays at 39.5%, deficiencies at 10.1%, and birth defects at 3.4%, reflecting gaps in engagement, particularly for developmental and rare conditions.

As discussed in the study conducted by Niraj Kumar et al. (2021) [21], 74% of the staff working in the mobile health teams found their training adequate, and 76% felt that their working environment was conducive, thus positively impacting service utilization. Low salaries and difficulties within the community were among the factors associated with underutilization. According to Tiwari et al. (2018) [8], early registration and follow-ups in DEICs increased engagement, especially for developmental delays, with service utilization ranging between 40% and 60%, based on the services.

From the above analysis, it can be seen that service utilization from the 4D program differs significantly from about 39% to 100%. From the review, it is evident that programs that have a good referral system, digitized monitoring, sufficient manpower, and community involvement resulted in high utilization. For instance, Hridyam and DEICs with sufficient staffing attained higher service utilization rates compared to those with infrastructure weaknesses, fewer specialists, and caregiver barriers, as identified by Sharma et al. (2022) and Rameshbabu et al. (2020)[11,20].

More males compared to females suffered from various problems, as evident from the results obtained by Debnath et al. (2020) in Bangladesh and Lai et al. (2016) in Taiwan [14,18]. Older children (aged 6-18 years) faced more difficulties and required medical assistance, thus pointing to the necessity of continued monitoring after early childhood.

The results obtained confirm the need to enhance the efficacy of the existing screening procedures implemented under the RBSK and other programs. This conclusion has been derived by analyzing the evidence presented by Sharma et al. (2022), Sreehari et al. (2019), and Mehta et al. (2020)[11,13,19]. More specifically, enhanced training, additional workforce, better infrastructure, and clear referral procedures lead to increased utilization of health care services by patients. Developmental delays, congenital conditions, and deficiencies in nutrition require particular attention. Community screening, effective referrals, and outreach programs will facilitate early identification of these issues.

In conclusion, it is possible to note that the application of the 4D approach allows for the timely identification of children requiring health care. Nevertheless, significant shortcomings are identified in terms of the utilization of health services, especially with regard to developmental delays and congenital defects.

SUMMARY

This study emphasizes the morbidity in children ages 0-18 years with the concept of 4D Approach. The results show that 15.9% of the total number of children 13,236 had any kind of diseases, with diseases contributing the most to 56.5%, followed by deficiencies 25.3%, developmental conditions 17.3%, and congenital conditions 0.66%. Some of the diseases which included SAM, dental decay, congenital heart diseases, and anemia were seen to be very frequent. Overall, utilization rates for health services were 65.22%, and the highest utilization rates were observed among SAM services (58%) and specialist consultations (26%). Meanwhile, the lowest were speech therapy, medicines, and surgeries. It is suggested that there is a need for improvement in

DEICs and mobile health teams services through manpower and infrastructural development alongside with education and monitoring to increase utilization and reduce disparities. But some limitations include reliance on data from secondary sources, potential underreporting as there may be utilization of health services in other sectors apart from government institutions, and lack of follow-up measures.

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