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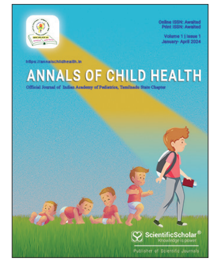

Original Article

Comparative Study of Clinico-demographic Characteristics and Glycemic Control in Urban and Rural Children with Type 1 Diabetes Mellitus

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ABSTRACT

Objectives: Type 1 Diabetes Mellitus (T1DM) is quite prevalent and common and has been rising at an average rate of 3%-4% a year in children and adolescents. Hence, this study was conducted with the aim of comparing the socio-demographic and clinical profiles between urban and rural children focusing primarily on glycemic control and complications.

Material and Methods: A cross-sectional study was conducted among children with type 1 diabetes in a tertiary care hospital in Tamil Nadu. The study was conducted over 9 months. Data were collected using a pre-designed, pre-tested, semi-structured interview schedule based on the Tamil Nadu Type 1 Diabetes Registry. The participants or their informants were interviewed to elicit information on their socio-demographic profile and individual characteristics such as age of onset of diabetes, area of residence, environmental disruptors near home, food habits, birth details, glucose levels, and hemoglobin A1c (HbA1C) at diagnosis, current insulin regimen, total dose of insulin required, and complications such as diabetic ketoacidosis and hypoglycemic episodes. Data collected were entered into an Excel sheet and analyzed using Statistical Package for the Social Sciences version 20.0. Differences between means and standard deviations were expressed using independent samples t-tests.

Results: This cross-sectional study was conducted among 320 children. The study found that the incidence of T1DM was higher in female children. The mean glucose level at the time of diagnosis was 480.4 ± 111.8 mg/dL, and the mean HbA1C value at the time of diagnosis was 12.7% ± 2.8%. Around 56% of children had HbA1C levels higher than 10% at the time of diagnosis, and 11% of children had HbA1C between 6.5% and 10%. 32% of children did not have baseline values. The mean difference between the urban and rural populations for various variables was statistically significant only for HbA1C pre-pump and hypoglycemic episodes. The difference in annual income between the urban and rural populations was also significant.

Conclusion: Rural children are performing as good as the urban children in T1DM management. Most of the rural children are economically deprived in terms of annual parental income; however, they are on par with urban children in terms of glycemic control.

Keywords: Diabetes mellitus, Rural, Socio-economic status, Type I diabetes mellitus, Urban

INTRODUCTION

Diabetes mellitus (DM) is a common chronic metabolic disease characterized by hyperglycemia as a cardinal biochemical feature. The major forms of diabetes are differentiated by insulin deficiency versus insulin resistance: Type 1 DM (T1DM) is characterized by insulin insufficiency caused by an autoimmune attack on the insulin-producing pancreatic beta cells. T1DM is the most common endocrine-metabolic disorder of childhood and adolescence, with important consequences for physical and emotional development.[1]

Individuals with T1DM face serious lifestyle alterations, including a daily requirement for exogenous insulin, the need to monitor their glucose levels, and attention to dietary intake. Morbidity and mortality stem from potential acute metabolic derangements and long-term complications affecting small and large blood vessels, leading to retinopathy, nephropathy, neuropathy, ischemic heart disease, and arterial obstruction with gangrene of the extremities. Acute clinical manifestations are caused by hypo-insulinemic hyperglycemic ketoacidosis; the genesis of T1DM owes to autoimmune mechanisms, and the long-term complications are related to metabolic disturbances[1] (hyperglycemia).

India accounts for most of the children with T1DM in South-East Asia. According to the 6th edition of the International Diabetes Federation diabetes atlas, India has 3 new cases of T1DM/100,000 children aged 0–14 years.[2] The prevalence of diabetes in India is variable, with data showing 17.93 cases/100,000 children in Karnataka, 3.2 cases/100,000 children in Chennai, and 10.2 cases/100,000 children in Karnal (Haryana).[3-5] The bottom line remains that T1DM is quite prevalent and common and has been rising at an average rate of 3–4% a year in children and adolescents. This study was conducted with the aim of comparing the socio-demographic and clinical profiles between urban and rural children.

MATERIAL AND METHODS

A cross-sectional study was conducted among children with type 1 diabetes in a tertiary care hospital in Coimbatore, Tamil Nadu, over a period of 9 months from September 2019 to May 2020. All children aged 2–18 years with T1DM attending the pediatric and endocrinology departments at our hospital, were included in the study. Children with other forms of diabetes, like type 2 DM, neonatal diabetes, or cystic fibrosis-associated diabetes, were excluded.

According to the study conducted by Kumar *et al*., the prevalence of Type 1 DM was 26.6/100,000 in urban areas compared to 4.27/100,000 in rural areas of Karnal district, Haryana, leading to an average prevalence of 10.20/100,000 population.[5] Considering the prevalence of Type 1 DM as 0.0102% (10.20/100,000), with a 95% confidence interval and absolute precision of 10%, the sample size was calculated using a small proportion equal allocation. The sample size was calculated using the formula:

$$n = (Z\ 1\text{-}\alpha + Z1\text{-}\beta)^\wedge 2/[2(\arcsin\sqrt{P1} - \arcsin\sqrt{P2})^\wedge 2]$$

Where,

- P1: Proportion in the first group
- P2: Proportion in the second group
- α: Significance level
- β: Power

The sample size was calculated to be 318.

Institutional ethical committee clearance was obtained before the start of the study, and prior permission was sought from the consultant in charge for the day of data collection. Written valid assent from adolescents and informed consent from the parents/guardians of the children/adolescents were taken, respectively. Data were collected using a pre-designed, pre-tested, semi-structured interview schedule based on the Tamil Nadu Type 1 Diabetes Registry. The interview covered the socio-demographic profile and individual characteristics such as age of onset of diabetes, area of residence, environmental disruptors (exposure to endocrine disrupting chemicals near their homes which included proximity to industrial areas, presence of mobile towers near their residence and exposure to chemical fertilizers, particularly for those living near agricultural fields), food habits, birth details, glucose levels, and hemoglobin A1c (HbA1C) at diagnosis, current insulin regimen, total dose of insulin required, and complications such as diabetic ketoacidosis (DKA) and hypoglycemic episodes.

Data collected were entered into an Excel sheet and analyzed using Statistical Package for the Social Sciences version 20.0. Differences between means and standard deviations were expressed using independent samples t-tests. Basic characteristics were analyzed based on T1DM by sex (Male vs. Female) and demography (Rural vs. Urban). Sex differences and characteristics of demographic variations were analyzed by independent sample tests. $P < 0.05$ was considered statistically significant.

RESULTS

This cross-sectional study was conducted among 320 children. The incidence of T1DM was higher in female children. Among the 320 children with T1DM, 138 (43.1%) were male, and 182 (56.9%) were female. The urban-rural comparison also showed the incidence being higher in female children. The mean age at diagnosis of T1DM was 12.8 years ±7 years. Around 55% of children were diagnosed between the ages of 6–15 years, 15% at 5 years and below, and 30% above 15 years. The mean age at diagnosis in urban children was 12.2 ± 6.9 years, while in rural children, it was 13.1 ± 7 years, indicating a slightly later diagnosis in rural children, which was not statistically significant [Table 1].

As shown in Table 2 approximately 48% of residents in both demographics lived near mobile towers, and 47% of children

Table 1: Difference in clinical characteristics among urban and rural populations.

Variables	Urban (*n*=111)	Rural (*n*=209)	Total (*n*=320)	Significance
Age at diagnosis	12.2±6.9	13.1±7.0	12.8±7.0	0.86
Birth weight (grams)	3007.0±475.4	2988.7±455.7	2995.1±462.0	0.84
Glucose at diagnosis	482.7±106.7	479.2±114.6	480.4±111.8	0.57
HbA1c at diagnosis	12.7±3.0	12.7±2.6	12.7±2.8	0.20
BMI	19±3.9	18.9±4.1	19±4.1	0.29

HbA1c: Hemoglobin A1c, BMI: Body mass index

Table 2: Baseline data of the study participants (*n*=320).

Variables	Frequency (*n*)	Percentage
Gender		
Male	138	43.1
Female	182	56.9
Location		
Urban	111	34.6
Rural	209	65.4
Age at the time of diagnosis		
0–5	49	15.3
6–10	87	27.5
11–15	87	27.2
>15	97	30
Environmental disruptors nearby home		
Industries	45	14.1
Mobile tower	154	47.5
Agriculture	151	46.9
Birth weight		
VLBW	2	0.6
LBW	24	7.5
AGA	294	91.8
Glucose level at the time of diagnosis		
<250	4	1.3
250–400	77	24.1
401–500	98	30.6
>500	141	44.1
HbA1c		
<6.5	1	0.3
6.5–10	37	11.6
>10	177	55.2
Not available	105	32.9
Total	320	100

HbA1c: Hemoglobin A1c, VLBW: Very low birth weight, LBW: Low birth weight, AGA: Appropriate for gestational age

had agricultural fields near their residences, more so in rural areas. Regarding birth weight, 91% of children were in the term/AGA category with birth weights between 2.5 kg and 4 kg, 7.5% had birth weights between 1.5 and 2.49 kg, and only 0.6% had birth weights between 1 kg and 1.49 kg. The mean glucose level at the time of diagnosis was 480.4 ± 111.8 mg/dL. 44.1% of children had glucose levels over 500 mg/dL at diagnosis, 30% had levels between 400 and 500 mg/dL, and 24% had levels between 250 and 400 mg/dL. The mean HbA1C value at diagnosis was 12.7% ± 2.8%. 55.2% of children had HbA1C levels over 10% at diagnosis, 11.6% had HbA1C between 6.5% and 10%, and 32.9% did not have baseline values [Table 2, Figures 1 and 2].

The difference in annual income between the urban and rural populations was significant (P = 0.023). Table 3 shows the relative incidence of hypoglycemia and DKA in the study population.

DISCUSSION

Contrary to the belief that the incidence of T1DM is higher in the urban population, our study showed that the incidence of Type 1 diabetes was higher in rural children compared to urban children. Similar studies by Miller *et al.* in New Zealand[6] and Haynes *et al.* in Australia[7] showed higher incidence in urban children. A study in Haryana by Kalra[4] *et al.* also showed a higher prevalence in urban populations. The higher incidence of T1DM in rural children in our study can be attributed to referral bias, as our tertiary care referral center covers nearby 3–4 districts, catering to more children from rural areas being referred to our hospital. In addition, environmental factors, which are important in the pathogenesis of T1DM in genetically predisposed individuals, could be a contributing factor.

Our study found that rural children are more economically deprived in terms of annual parental income, with 85% of rural families earning <4 lakhs per annum compared to 70% of urban families. This is statistically significant. A study by Shobhana *et al.*[8] showed that the median percentage of income spent on diabetes was 22% for families with T1DM, varying from 59% in the low socioeconomic group to 12% in the high-income group. Despite this economic burden, rural children managed better glycemic control compared to urban children, likely due to institutional support and the

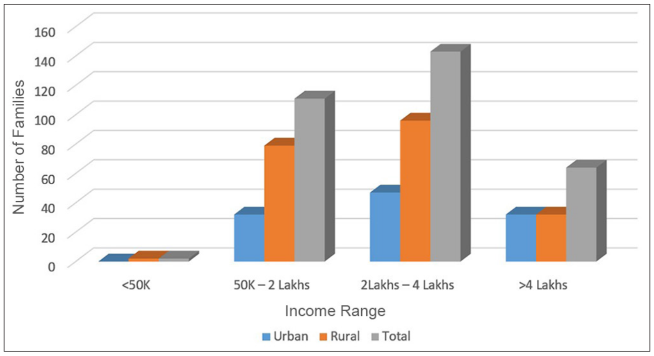

Figure 1: Annual parental income.

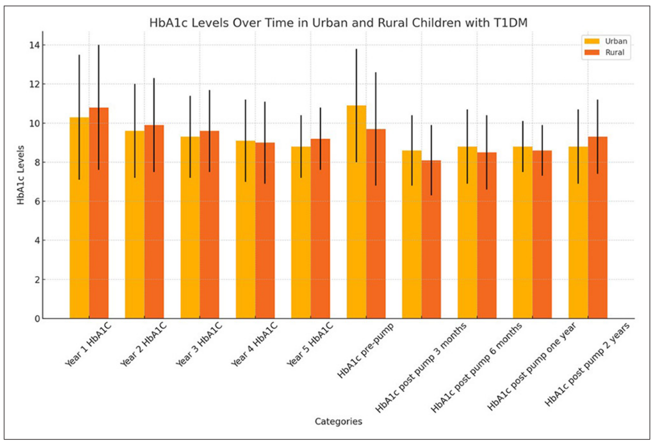

Figure 2: Difference in glycemic control between urban and rural children.

involvement of a non governmental organization (NGO) that supports children from rural underprivileged areas with insulin pump therapy.

The mean age at diagnosis in our study was 12.8 years, comparable to the study by Praveen *et al.*[9] There was no urban-rural difference in age at diagnosis, contrary to the belief that rural children are diagnosed later due to symptom neglect. This indicates some awareness of the problem and the need for medical care, even in rural areas.

There were no significant differences in birth weight and duration of breastfeeding at diagnosis of T1DM between the two populations. Studies by Stene *et al.*[10] showed that the incidence of T1DM increases linearly with birth weight, but 90% of children in our study were appropriate for gestational age. Only 13% in both groups had a duration of breastfeeding <6 months. Approximately 5% of mothers in both groups had gestational diabetes mellitus (GDM), and around 80% of children in both cohorts had no preceding illness.

The mean glucose level at the time of diagnosis was around 480 mg/dL in both demographics, with no statistical significance. The mean HbA1C at diagnosis was similar between cohorts at 12.7%, with no statistical significance. 50% of children presented with DKA at diagnosis,

Table 3: Distribution of variables based on urban and rural population.

Variables	Urban (%)	Rural (%)	Total	*P*-value
Hypoglycemia				
No hypo	46 (41)	87 (42)	133	0.600
<2	13 (12)	19 (9)	32	
3–5	13 (12)	35 (17)	48	
>5	39 (35)	68 (33)	107	
DKA episodes				
No DKA	89 (80.18)	169 (81.16)	258	0.279
<2	17 (14.41)	35 (16.91)	52	
3–5	5 (4.5)	4 (1.93)	9	
>5	1 (0.90)	0	1	
Total	112	208	320	

DKA: Diabetic ketoacidosis

comparable to studies by Praveen *et al.*,[11] Klingensmith *et al.*, and Dabelea *et al.*[12,13] There was no statistical difference between urban and rural children. The high frequency of DKA indicates the need for increased awareness of diabetes signs and symptoms among the public for early diagnosis. Methods promoting earlier diagnosis of diabetes, such as identifying high-risk individuals through family, genetic, and immunologic screening, should be encouraged.

Around 50% of children in both demographics were on basal-bolus analog insulin regimens, with 20% on insulin pumps, 15% on pre-mix analogs, and 15% on pre-mix human insulin. According to international society for pediatric and adolescent diabetes (ISPAD) guidelines, basal-bolus regimens are the most physiological insulin regimens with dose adjustment. Around 75% of children in both cohorts used pen devices, with no significant differences between urban and rural cohorts. Pen injector devices containing insulin in prefilled cartridges are more convenient and flexible to use. Availability of pens can be an issue, but they improve convenience and flexibility.

Our study showed that around 55% of children in both demographics had no physical activity at the time of diagnosis. Age-appropriate physical activity is recommended for children with T1DM for good metabolic control. Studies have shown significant reduction in HbA1C with adequate physical activity.[14,15]

Limitations of the study

Our hospital, being a tertiary care center, receives referrals from nearby districts, mostly from rural areas, leading to a possibility of referral bias. This could explain the higher incidence of T1DM in rural children. In addition, anti-glutamic acid decarboxylase (GAD) antibody testing and C-peptide levels should ideally be done in all children at diagnosis, but due to financial constraints, this was not done for many children.

CONCLUSION

We conclude that rural children are performing as well as urban children in T1DM management. Despite being economically deprived, rural children are on par with urban children in terms of glycemic control. Rural underprivileged children are effectively handling insulin pump technology, showing significant reductions in HbA1C over 1 year and reduced hospital admissions and severe hypoglycemia. Our study also showed a higher prevalence of T1DM in rural children. With governmental support and policy implementation, rural children can perform even better than urban children, improving the lives of these poor, underprivileged children.

Author contributions: RK: Conceptualization, writing and editing; VVS: Data collection, analysis, writing and editing.

Ethical approval: The research/study approved by the Institutional Ethics Committee at Institute Ethics Committee, KMCH, Coimbatore, number EC/AP/767/10/2019, dated 10th October 2019.

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