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# Anthropometric Measurements, Dietary Intake and Biochemical Parameters of Children with Type 1 Diabetes

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**ABSTRACT:**

*The study deals with the assessment of nutritional status of type 1 diabetes (N=50; 24 girls & 26 boys from age group of 10-15 yrs). Anthropometric measurements & dietary intake of subjects were recorded. Based on three day's dietary recall, nutrient intake of subjects was calculated. Biochemical parameters were recorded from the data files of subjects. 57.69% boys & 41.66% girls had family history of diabetes. Minimum age at the time of diagnosis of diabetes was 2 yrs among boys & 3 yrs among girls. Subjects found taller & lighter than the reference standards for age. Subjects showed deficient intake of energy but excess intake of protein as compared to recommended dietary allowances. Subjects showed deficient intake of carotene, riboflavin, niacin, calcium, phosphorus, zinc & iron. Subjects showed higher intakes of thiamine, folic acid & vitamin C. Glycated hemoglobin levels of girls & boys were found exceeding the standard value. Mean fasting & post meal blood glucose levels of subjects were found higher. Blood cholesterol (total & LDL) of subjects was found to be under control. During the period of growth & development, management of a metabolic condition like diabetes is crucial. Proper dietary choices are needed to meet the requirements of energy as well as macro- & micro-nutrients.*

***Keywords****: recommended dietary allowance, dietary recall, energy, micronutrients.*

**INTRODUCTION:**

Type 1 diabetes in children is a condition in which pancreas no longer produces the insulin one needs to survive. The cases need to replace the missing insulin. Type 1 diabetes in children used to be known as juvenile diabetes or insulin-dependent diabetes. Although type 1 diabetes in children requires consistent care, advances in blood sugar monitoring and insulin delivery have improved the daily management of type 1 diabetes in children.

The signs and symptoms of type 1 diabetes in children usually develop quickly, over a period of weeks. These include increased thirst and frequent urination, extreme hunger, weight loss, fatigue, irritability or unusual behavior & blurred vision etc. (http://www.webmd.com/diabetes/guide/type-1-diabetes & http://www.diabetes.org/diabetes-basics/type-1/).

The exact cause of type 1 diabetes is unknown. In most people with type 1 diabetes, the body's own immune system which normally fights harmful bacteria and viruses mistakenly destroys the insulin-producing (islet) cells in the pancreas. Genetics may play a role in this

process, and exposure to certain viruses may trigger the disease. The known risk factors for type 1 diabetes include family history & genetic susceptibility**.** Anyone with a parent or siblings with type 1 diabetes has a slightly increased risk of developing the condition. The presence of certain genes indicates an increased risk of developing type 1 diabetes.

Type 1 diabetes is the third most common chronic condition in children and adolescents in the world. Type 1 diabetes is managed by a combination of insulin replacement and balancing of diet and exercise in order to maintain glycemic control and prevent the occurrence of complications. Glycemic control, which is directly linked to complication rates, is monitored by the measurement of glycosylated haemoglobin, which reflects the mean blood glucose level over the previous 2 to 3 months. Lowering glycosylated haemoglobin has been associated with a reduction of microvascular and neuropathic complications of diabetes (Glastras et al., 2005).

It is generally accepted that in order to effectively manage diabetes, education about components of management such as blood glucose monitoring, insulin replacement, diet & exercise must be delivered to the case and family. Management of diabetes requires lifestyle changes. Medical nutrition therapy is an integral component of diabetes management and of diabetes self-management education. For individuals receiving fixed doses of insulin, day-to-day consistency in the amount of carbohydrate is important. The contributions of carbohydrate to energy intake should be individualized based on nutrition assessment, metabolic profiles, and treatment goals (http://care.diabetesjournals.org/content/27/suppl_1/s36.full.pdf+html). Proper dietary care & insulin dose management is needed for a diabetic to lead healthy life. Making healthy food choices every day has both immediate and long-term effects. With education, practice, and assistance from a dietitian and/or a diabetes educator, it is possible to eat well and control diabetes.

The aim of this study was to evaluate the nutritional status of children with type 1 diabetes.

## METHODOLOGY:

### Study Area and Sample Population:

For this study, 50 type 1 diabetics were studied (N=50: 24 girls and 26 boys from age group10 to 15 yrs) which were purposively selected from a reputed diabetes trust & clinic of Nagpur city, Maharashtra. Table 1 shows age wise distribution of subjects.

**Table 1: Age Wise Distribution of Subjects**

| S.No. | Subjects | Number of Subjects | AGE (YEARS) | | |
|---|---|---|---|---|---|
| | | | Mean | SD | Range |
| 1 | Girls | 24 | 13.08 | 1.69 | 10-15 |
| 2 | Boys | 26 | 12.96 | 1.68 | 10-15 |

**Data Collection:** The data was collected by questionnaire-cum-interview method.
**Disease specific information:** Information about age at the time of diagnosis of diabetes, family history of diabetes, insulin type and mode of use of insulin etc. was recorded.

**Anthropometric measurements:** Body measurements like height, weight, mid upper arm circumference (MUAC), waist circumference, hip circumference & shoulder width of subjects were recorded using standard procedures & equipments.

**Dietary Information & nutrient intake:** Accurate information on dietary intake helps in assessing the nutritional status of the individual and also for determining the relationship between nutrient intake and deficiency diseases. Information about food habits, common dietary pattern & meal timings was collected from subjects.

24 hours dietary recall method for three day's was used to know the food intake of subjects. Based on this, nutritive value of diets of subjects was calculated using standard food values given by Gopalan et al. (2012). Nutrient intake of each subject was compared with recommended dietary allowance (RDAs)(NIN/ICMR, 2009).

**Biochemical Investigation:** Information about blood levels of hemoglobin, glycosylated hemoglobin, fasting & post meal blood glucose and lipid profile of the subjects were recorded from their regular reports.

**Statistical Analysis:** Mean, standard deviation, range & percentage values were calculated. Comparisons between observed parameters and reference standards/RDAs were done using student's 't' test.

## RESULTS AND DISCUSSION:

### Disease Specific Information:

**Table 2: Data on Disease Specific Information**

| S. No. | Parameters | Subjects (N=50) | |
|---|---|---|---|
| | | Girls (n=24) | Boys (n=26) |
| 1 | **Age at the Time of Diagnosis of Diabetes (Yrs)** | | |
| | M± SD | 8.33±2.71 | 8.81±2.56 |
| | Range | 3.00-13.00 | 2.00-13.00 |
| 2 | **Family History of Diabetes (%)** | | |
| | Yes | 41.66 | 57.69 |
| | No | 58.33 | 42.30 |
| 3 | **Insulin Doses (Units/Day)** | | |
| | M± SD | 3.25±0.44 | 3.04±0.20 |
| | Range | 3.00-4.00 | 3.00-4.00 |
| 4 | **Insulin Type (%)** | | |
| | Huminsulin | 91.66 | 100 |
| 5 | **Mode of Use of Insulin (%)** | | |
| | Injection | 100 | 100 |
| | Pen or Pump | 0 | 0 |

Age at the time of diagnosis of diabetes was noted as 8.33±2.71 yrs for girls & 8.81±2.56 yrs for boys. Minimum age at the time of diagnosis of diabetes was 2 yrs among boys & 3 yrs among girls. 57.69% boys & 41.66% girls had family history of diabetes. 100% of the subjects preferred injection over other devices for insulin delivery and the only type of insulin

used by subjects was Hum insulin. Daily doses of insulin injected by subjects ranged from 3 to 4 units.

**Anthropometric Measurements:**

Table 3 shows data on anthropometric indices of subjects.

**Table 3: Anthropometric Measurements of Subjects**

| S. No. | Parameters | Subjects (N=50) | |
|---|---|---|---|
| | | Girls (n=24) | Boys (n=26) |
| 1 | **Height (cm)** | | |
| | M± SD | 160.95±10.60 | 159.58±10.40 |
| | Range | 136-182 | 138-179 |
| | Standard | 150.55 | 150.58 |
| | % excess | +6.9 | +5.97 |
| | **'t' values** | **4.78*** | **2.23**** |
| 2 | **Weight (kg)** | | |
| | M± SD | 38.09±11.00 | 37.58±9.30 |
| | Range | 22-71 | 26-71 |
| | Standard | 41.38 | 40.8 |
| | % deficit | -7.95 | -7.9 |
| | **'t' values** | **3.25*** | **2.03**** |
| 3 | **Mid Upper Arm Circumference (cm)** | | |
| | M± SD | 24.85±4.50 | 23.63±3.30 |
| | Range | 18-34 | 16-32 |
| 4 | **Waist Circumference (cm)** | | |
| | M± SD | 70.29±7.90 | 71.54±9.90 |
| | Range | 53-100 | 51-100 |
| 5 | **Hip Circumference (cm)** | | |
| | M± SD | 80.92±10.81 | 82.00±11.22 |
| | Range | 64-117 | 67-117 |
| 6 | **Shoulder Width (cm)** | | |
| | M± SD | 34.38±2.26 | 34.38±3.81 |
| | Range | 30-40 | 26-42 |

*-significant at both 5% & 1% levels ($p<0.01$)

**-significant at 5% level but insignificant at 1% level ($0.01<p<0.05$)

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Irrespective of age & gender, subjects were found to be taller than the reference standards for age (t=4.78 & 2.23 for girls & boys, respectively). In contrast to height, subjects were unable to meet the standards for body weight for age & height (t=3.25 & 2.03, for girls & boys, respectively).

Ferrante et al. (1999) found a high percentage of underweight subjects (11.5% of the entire sample) among 96 diabetics from age group of 3-19 yrs. In contrast, Elinahypponen et al. (2000) reported that boys and girls (<15 years of age) who developed type 1 diabetes were heavier and taller throughout childhood.

MUAC values were found to be lower than the reported values of 25.12 & 25.62 cm, respectively for girls & boys aged 10-15 yrs (McDowell, M.A., 2009). Reference biacromial breadth/shoulder width for age given by CDC's Vital & Health Statistics (McDowell, M.A., 2009) for girls & boys from age group of 10 to 15 yrs is 34.33 & 35.1 cm, respectively. The findings of the present study are closer to the reported reference values for shoulder width for age & gender (Table 3).

In comparison with the reference standard of waist & hip circumference for age & gender given by CDC's Vital & Health Statistics (McDowell, M.A., 2009)(71.08 & 72.52 cm for waist circumference & 86.8 & 83.98 cm for hip circumference), the mean values of girls & boys under study were found to be less.

**Nutrient Intake:**

100% of the subjects were vegetarians, with common dietary pattern noted as 3.00 meals/day and subjects followed regular meal timings.

Mean daily intake of energy, energy giving nutrients & total dietary fiber (TDF) is shown in Table 4.

**Table 4: Data on Mean Intake of Energy, Energy Giving Nutrients & Fiber**

| S. No. | Nutrients | Subjects (N=50) | |
|---|---|---|---|
| | | Girls (n=24) | Boys (n=26) |
| 1 | **Energy (kcal)** | | |
| | M± SD | 1624.04±270.24 | 1657.75±403.29 |
| | Range | 1049-2111.00 | 175.70-2080 |
| | RDA | 2010 | 2190 |
| | % deficit | -19.20 | -24.30 |
| | 't' values | 6.62* | 9.93* |
| 2 | **Carbohydrates (g)** | | |
| | M± SD | 252.04±63.24 | 285.31±54.99 |
| | Range | 139.80-365 | 153.10-365 |
| | % Energy from Carbohydrates | 64.82 | 68.84 |
| 3 | **Protein (g)** | | |
| | M± SD | 44.86±4.48 | 47.47±7.51 |
| | Range | 33.00-59.99 | 35.90-63.33 |
| | RDA | 40.4 | 39.9 |
| | % excess | +11.03 | +18.97 |
| | 't' values | 2.38** | 4.84* |
| | % Energy from Protein | 11.53 | 11.45 |
| 4 | **Fat (g)** | | |
| | M± SD | 44.26±3.22 | 46.05±2.22 |
| | Range | 38.81-51.60 | 40.07-51.60 |
| | % Energy from Fat | 25.61 | 25.00 |
| 5 | **Total Dietary Fiber (g)** | | |
| | M± SD | 40.68±58.25 | 27.27±4.03 |
| | Range | 18.05-45.41 | 19.23-35.99 |

*-significant at both 5% & 1% levels (p<0.01)
**-significant at 5% level but insignificant at 1% level (0.01<p<0.05)

Subjects showed deficient intake of energy as compared to RDAs (percent deficit: -19.20 & -24.30 and t=6.62 & 9.93, respectively for girls & boys). Lower calorie intake was reflected in deficient weight gain of subjects. Percentage of energy derived from three major nutrients i.e. carbohydrates, protein & fat was found to be 64.82-68.84, 11.53-11.45 & 25.61-25.00, respectively.

Central to dietary management in type 1 diabetes is monitoring carbohydrate intake. Carbohydrates have a direct impact on the blood sugar level. Eating a consistent amount of carbohydrates at each meal can help to control blood sugar levels. Mean daily carbohydrate intake was computed as 252.04±63.24 g & 285.31±54.99 g, respectively for girls & boys. Carbohydrates must be matched with the dose of carbohydrate. Diabetologists & diabetic dieticians should make an attempt to derive curb: insulin ratio so that dietary carbohydrate intake can be regulated in such a way to match the intake so that proper utilization of carbohydrates can take place for energy supply.

Subjects consumed higher amounts of daily protein (Table 4). Percent excess was calculated as 11.03 for girls & 18.97 for boys. (t=2.38 & 4.84, respectively).

Mean daily total fat intake of subjects was found to be in the range of 38.81 to 51.60 g. Juvenile diabetics can stress upon quality fat so as to reduce bulk of the diet.

A diet that is high in fibre (25 to 30 grams per day) may help to control blood sugar levels. Mean daily intake of TDF was noted as 40.68±58.25 g & 27.27±4.03 g, respectively for girls & boys. However, minimum intake of TDF was recorded as 18.05 g in girls & 19.23 g in boys. Diabetics should consume adequate amounts of fibre for better control of blood sugar.

Data on daily mean intake of vitamins & by subjects is shown in Table 5.

***Table 5: Data on Daily Intake of Vitamins by Subjects***

| S. No. | Vitamins | Subjects (N=50) | |
|---|---|---|---|
| | | **Girls (n=24)** | **Boys (n=26)** |
| 1 | **Carotene (µg)** | | |
| | M± SD | 1799.18±883.89 | 1793.60±600.35 |
| | Range | 627.60-5647.80 | 1181.20-4161.0 |
| | RDA | 4800 | 4800 |
| | % deficit | -62.52 | -62.63 |
| | **'t' values** | **58.36*** | **25.68*** |
| 2 | **Thiamine (mg)** | | |
| | M± SD | 2.96±0.99 | 3.03±0.86 |
| | Range | 0.78-4.47 | 1.72-4.57 |
| | RDA | 1.0 | 1.1 |
| | % excess | +196 | +175.45 |
| | **'t' values** | **1.18** | **12.06*** |
| 3 | **Riboflavin (mg)** | | |
| | M± SD | 1.16±0.45 | 1.24±0.61 |

| | | | |
|---|---|---|---|
| | Range | 0.06-1.98 | 0.06-1.90 |
| | RDA | 1.2 | 1.3 |
| | % deficit | -3.33 | -4.61 |
| | **'t' values** | **1.14** | **0.75** |
| 4 | **Niacin (mg)** | | |
| | M± SD | 10.59±2.25 | 10.23±1.55 |
| | Range | 5.95-15.08 | 4.93-12.72 |
| | RDA | 13.00 | 15.00 |
| | % deficit | -18.53 | -31.8 |
| | **'t' values** | **5.35*** | **16.44*** |
| 5 | **Folic Acid (µg)** | | |
| | M± SD | 223.65±76.o7 | 186.85±51.26 |
| | Range | 86.50-361.90 | 124.07-329.00 |
| | RDA | 140 | 140 |
| | % excess | +59.75 | +33.46 |
| | **'t' values** | **13.71*** | **4.68*** |
| 6 | **Vitamin C (mg)** | | |
| | M± SD | 145.04±65.36 | 109.85±35.50 |
| | Range | 66.30-351.10 | 55.40-164.00 |
| | RDA | 40 | 40 |
| | % excess | +262.65 | +174.62 |
| | **'t' values** | **7.83*** | **23.28*** |

*-significant at both 5% & 1% levels ($p<0.01$)

**-significant at 5% level but insignificant at 1% level ($0.01<p<0.05$)

't'-values without any mark show insignificant difference at both 5% and 1% levels ($p>0.05$).

Irrespective of gender, subjects showed deficient intake of carotene, riboflavin & niacin (% deficit: -62.52 & -62.63; -3.33 & -4.61 & -18.53 & -16.44, respectively with t values ranged between 0.75 to 58.36).

Subjects showed higher intakes of thiamine, folic acid & vitamin C as compared to RDAs (t=1.18 & 12.06; 13.71 & 4.68 & 7.83 & 23.28, respectively).

Table 6 depicts data on daily intake of minerals by subjects.

***Table 6: Data on Daily Intake of Minerals by Subjects***

| S. No. | Minerals | Subjects (N=50) | |
|---|---|---|---|
| | | Girls (n=24) | Boys (n=26) |
| 1 | **Calcium (mg)** | | |
| | M± SD | 411.75±111.27 | 377.74±159.94 |
| | Range | 184.13-665.60 | 65.80-783.40 |
| | RDA | 800 | 800 |
| | % deficit | -48.53 | -52.78 |
| | 't' values | 17.13* | 0.43 |
| 2 | **Phosphorus (mg)** | | |
| | M± SD | 747.09±302.43 | 722.79±330.29 |
| | Range | 453-1325.60 | 70.21-1325.60 |
| | RDA | 800 | 800 |

| | | | |
|---|---|---|---|
| | % excess | -4.59 | -9.65 |
| | 't' values | 0.65 | 0.92 |
| 3 | **Iron (mg)** | | |
| | M± SD | 18.76±3.29 | 19.35±2.89 |
| | Range | 13.79-27.90 | 15.42-27.61 |
| | RDA | 27.00 | 21 |
| | % deficit | -30.51 | -7.85 |
| | 't' values | 13.19* | 2.94* |
| 4 | **Magnesium (mg)** | | |
| | M± SD | 313.58±111.32 | 301.88±126.18 |
| | Range | 161.00-581.79 | 88.23-654.20 |
| | RDA | 160 | 160 |
| | % excess | +95.98 | +88.68 |
| | 't' values | 7.06* | 5.76* |
| 5 | **Zinc (µg)** | | |
| | M± SD | 6.36±1.92 | 7.09±2.95 |
| | Range | 2.79-10.25 | 3.53-14.69 |
| | RDA | 9.00 | 9.00 |
| | % deficit | -29.33 | -21.22 |
| | 't' values | 2.25** | 4.77* |
| 6 | **Sodium (mg)** | | |
| | M± SD | 2226.46±191.28 | 2159.13±86.99 |
| | Range | 2057.75-2895.0 | 2052.6-2379.80 |
| 7 | **Potassium (mg)** | | |
| | M± SD | 1280.39±684.14 | 1281.20±553.48 |
| | Range | 209.01-2501.90 | 385.10-2687.90 |

*-significant at both 5% & 1% levels ($p<0.01$)
**-significant at 5% level but insignificant at 1% level ($0.01<p<0.05$)
't'-values without any mark show insignificant difference at both 5% and 1% levels ($p>0.05$).

Both girls & boys showed deficient intake of calcium & phosphorus (t=17.13 & 0.43 & % deficit: -48.53 & -52.78 for calcium & t=4.65 & 0.92 & % deficit: -4.59 & -9.65 for phosphorus, respectively).

Anaemia can be prevalent among young girls & boys because of deficient intake of iron. For this study, both the groups of diabetics were found to be deficient as far as consumption of dietary iron is concerned. Girls & boys consumed significantly lower quantity of iron as compared to RDAs (t=13.19 & 2.94, respectively). This was attributed to lack of iron rich sources in daily diets of subjects. Similar observations were noted for mean intake of zinc (t=2.25 & 4.77 with % deficit: -29.33 & -21.22 for girls & boys, respectively).

Subjects consumed significantly higher amounts of magnesium as compared to RDAs (t=7.06 & 5.76 with % excess calculates as +95.98 & +88.68, respectively for girls & boys). Mean sodium & potassium intakes of girls & boys under study were calculated as 2226.46±191.28 & 2159.13±86.99 mg and 1280.39±684.14 & 1281.20±553.48 mg, respectively. Lower intake

of potassium as compared to sodium could be attributed to lack of fresh fruits & vegetables in the diet & consumption of extra salt by the subjects.

**Biochemical Parameters:**

Data on biochemical parameters of subjects is shown in Table 7.

***Table 7: Data on Biochemical Parameters of Subjects***

| Sr. No. | Parameters | Subjects (N=50) | |
|---|---|---|---|
| | | Girls (n=24) | Boys (n=26) |
| 1 | **Haemoglobin (g/dl)** | | |
| | M± SD | 11.99±0.98 | 11.45±1.41 |
| | Range | 10.30-13.40 | 7.50-13.20 |
| 2 | **Glycosylated Hemoglobin (%)** | | |
| | M± SD | 8.99±1.08 | 9.90±2.77 |
| | Range | 7.60-11.20 | 7.20-17.40 |
| 3 | **Fasting Blood Glucose (mg/dl)** | | |
| | M± SD | 100.53±8.23 | 123.16±78.55 |
| | Range | 92-115 | 82-368 |
| 4 | **Post Meal Blood Glucose (mg/dl)** | | |
| | M± SD | 128.60±17.69 | 138.00±66.25 |
| | Range | 112.00-190.0 | 111.00-400.0 |
| 5 | **Total Cholesterol (mg/dl)** | | |
| | M± SD | 176.64±6.08 | 176.24±7.96 |
| | Range | 167-187.60 | 160.00-187.2 |
| 6 | **LDL Cholesterol (mg/dl)** | | |
| | M± SD | 120.77±5.75 | 117.90±6.86 |
| | Range | 110.30-130.0 | 100.10-129.0 |
| 7 | **HDL Cholesterol (mg/dl)** | | |
| | M± SD | 54.07±10.38 | 52.59±9.00 |
| | Range | 32.20-69.00 | 35.00-67.00 |
| 8 | **Triglyceride (mg/dl)** | | |
| | M± SD | 109.43±9.61 | 103.26±9.55 |
| | Range | 99.20-125.00 | 87.20-121.0 |

Mean haemoglobin level of girls & boys was noted as 11.99±0.98 & 11.45±1.41 g/dl; with t value showed significant difference for boys when compared to standard cut off value of 12 g/dl ($t=9.16$, $p<0.01$). Percent deficit was found to be -0.08 & -4.58 for girls & boys, respectively.

Glycated haemoglobin shows control over blood glucose level for the previous three months. As compared to the standard norm (6.55%), this level among girls & boys was found to be higher ($t=1.33$, $p>0.05$ & $7.55$, $p<0.01$, respectively). It shows that the diabetics are in need of proper supervision & dietary care.

Girls managed to control their fasting blood glucose whereas boys showed mean fasting blood glucose value significantly above the mid-point of reference level 0f 80-110 mg/dl

(t=3.02; % excess: +29.64). Mean post meal blood glucose levels of girls & boys were found to be insignificantly higher than the standard reference (t=0.49 & 0.75, p>0.05).

Both the groups of subjects had blood total & LDL cholesterol levels below the reference standard values of 200 & 130 mg/dl (t=25.11 & 14.57 and 10.14 & 11.00 with % deficit: -11.68 & -11.88 and -7.10 & -9.30, respectively for girls & boys). Mean HDL cholesterol values of girls & boys were found to be higher than the reference standard of >40 mg/dl (t=2.48 & 1.79, respectively). Mean blood triglyceride level of subjects was found to be under control (t=94.30 & 46.56 with % deficit: -37.28 & -40.82, respectively for girls & boys) when compared with reference standard level.

From the results of this study, it was seen that juvenile diabetics were found to be lighter as compared to the desired weight standards. Dietary intake of energy was found to be deficient which resulted in weight loss. At younger age, girls & boys require energy for growth & development. Diabetes at young age needs proper care to lead healthy life. Diets of cases were found to be deficient in essential micronutrients. Parents along with dietitian should make an attempt to plan out balanced meals for juvenile diabetic cases so as to fulfill the demands of essential micronutrients.

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