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Original Article

Iodine Deficiency Disorder Survey among 6 to 12 Years Children in Rural Areas of Raichur District

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Abstract

Introduction: The survey was to carry out as per the "Revised Policy Guidelines of the National Iodine Deficiency Disorders Control Program." The present survey was done in rural areas of Raichur during the period of February 2020 and March 2020.

Objectives: The objectives of the survey were: (1) To know the prevalence of goiter among children between 6 and 12 years. (2) To assess the level of iodization in salt sample collected from houses of children. (3) To determine urinary iodine excretion level in school children.

Materials and Methods: A total of 30 villages and 2700 children, 90 children in each village were selected using the method of population proportionate to size sampling. Only rural areas were included. Goiter was graded clinically. Salt sample from home was collected from every 5th child. Urine for iodine estimation was collected from every 10th child.

Results: Goiter prevalence was 18.6%. About 12.9% were of Grade 1 and 5.7% were of Grade 2 goiter. There was no difference in prevalence with respect to age groups. Prevalence of goiter was more in boys than girls. Iodine level was adequate in 47% of the samples and <15 ppm in 63% of the samples. Urine Iodine level was adequate among 45.5% of the children

Conclusion: The present survey showed mild–to-moderate Goiter severity among 6–12 years children in rural areas of Raichur district. Goiter is endemic and is considered as public health problem in rural areas of Raichur district based on clinical and laboratory indicators.

Key words: Goiter, Iodine deficiency, Salt iodine levels, Urine iodine estimation

INTRODUCTION

Iodine (atomic weight 126.9 g/atom) is an essential component of the hormones produced by the thyroid gland. Thyroid hormones, and therefore iodine, are essential for mammalian life. Iodine (as iodide) is widely but unevenly distributed in the earth's environment. Most iodide is found in the oceans (≈50 μg/L), and iodide ions in seawater are oxidized to elemental iodine, which volatilizes into the atmosphere and is returned to the soil by rain, completing the cycle. However, iodine cycling in many regions is slow and incomplete and soils and ground water become deficient in iodine. Crops grown in these soils will be low in iodine, and humans and animals consuming food grown in these soils become iodine deficient.[1]

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In plant foods grown in deficient soils, iodine concentration may be as low as 10 μg/kg dry weight, compared to ≈1 mg/kg in plants from iodine-sufficient soils. Iodine deficient soils are most common in inland regions, mountainous areas and areas of frequent flooding, but can also occur in coastal regions.[2]

Iodine is an essential micronutrient required for normal body growth and mental development. Nutritional iodine deficiency reckons its impact right from development of

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the fetus to all ages of human beings. It could result in many disorders such as abortion, still birth, mental retardation, deaf mutism, squint, dwarfism, goiter, and neuromotor defects. Iodine deficiency during pregnancy leads to decreased availability of thyroxine to the fetus which leads to the decreased synthesis of thyroxine which is an essential hormone manufactured by thyroid gland of the fetus. The decreased availability of thyroxine prevents the normal development of the fetal brain and body, condition which at birth can be diagnosed with the help of sophisticated investigations. Most of these disorders are permanent and incurable. Iodated salt consumed daily offers complete protection against all iodine deficiency disorders (IDD) our country is self-sufficient in production of iodinated salt.

The most serious adverse effect of iodine deficiency is damage to the fetus. Iodine treatment of pregnant women in areas of severe deficiency reduces fetal and perinatal mortality and improves motor and cognitive performance of the offspring. Severe iodine deficiency *in utero* causes a condition characterized by gross mental retardation along with varying degrees of short stature, deaf mutism, and spasticity that is termed as cretinism.

There is cross-sectional evidence that impairment of thyroid function evidenced in mothers and neonates in conditions of mild-to-moderate iodine deficiency affects the intellectual development of their offspring. Aghini-Lombardi *et al.* reported that in children aged 6–10 years in an area in Tuscany who had mild iodine deficiency (64 μg iodine/day), the reaction time was delayed compared with matched controls from an iodine sufficient area (142 μg iodine/day).[3]

Iodine deficiency is found everywhere including plains, riverine areas, and even the coastal regions. Studies conducted all over India have shown prevalence of Goiter. Out of 587 districts in India, 282 have been surveyed for IDD and 241 were found goiter endemic. After Implementation of National IDD Control Programme (NIDDCP) in the year 1992, India, has made considerable progress towards IDD elimination. Recently, <5% total goiter rate (TGR) was found in nine out of 15 districts studied in 11 states by Indian Council of Medical Research.

The present IDD survey was done in rural areas of Raichur district according to the guidelines of Nutrition department, Directorate Health and Family Welfare services, Bengaluru. The objectives of survey were to know prevalence of goiter among 6–12 years of school children; to determine urinary iodine excretion (UIE) level in urinary samples of school children; and to study the iodization status of salt samples collected from households of school children.

Four methods are generally recommended for assessment of iodine nutrition in populations: Urinary iodine concentration (UI), the goiter rate, serum thyroid-stimulating hormone, and serum thyroglobulin.[4]

MATERIALS AND METHODS

The IDD survey was conducted in rural areas of Raichur district in Karnataka state. The survey was done according to state nutrition cell guidelines. The staff who was involved in the survey were given basic training in examination and collection of samples, according to the guidelines provided. The 30 villages were selected using the method of population proportionate to size sampling and the survey was done in the government primary schools of these villages among the children in the age group of 6 to 12 years.

Selection of Villages using Proportionate Population Sampling Method

Zila panchayat office, Raichur was approached to obtain the list of all the villages of Raichur district to select 30 villages according to the guidelines. These villages were selected after calculating cluster interval and the first village was selected randomly. The present survey was carried out only in rural areas of Raichur district. The government primary schools of these villages were visited for the IDD survey.

Selection of Students from Each Village

On visiting the school, the list of all children aged 6 to 12 years was collected and a sample of 90 children in the age group of 6 to 12 years from the school was selected systematically. Out of these 90 children, 45 were boys and 45 were girls. If the attendance rate of the children in the school was 90% or more, all the 90 children were selected from the school itself. If the attendance rate was less or the total number of children in 6- to 12-year age group was not sufficient, the remaining sample was collected from out of school children in the households till the desired sample size was achieved. After allocation of total sample to schools and out of school, the next step was selection of sample of children from the school. The children were selected from each age group in the school using systematic sampling.

Even after this if the desired sample size of 90 children from each village was not achieved then the school of nearest village was approached and samples were collected.

Examination for Classification of Goiter

According to the WHO grading system, the goiter grades have been classified into three grades as Grade 0, Grade 1 and Grade 2:

- Grade 0: No palpable or visible goiter or no goiter
- Grade 1: A mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible, when the neck is in normal position. It moves upward in the neck as the subject swallows. Nodular alteration can occur even when the thyroid is not enlarged or goiter palpable but not visible
- Grade 2: A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated or goiter visible and palpable [Photo 1].

Selecting Children for Collection of Salt and Urine Samples

Out of 90 children selected, every fifth child was selected to collect salt sample from the households. Thus, 18 samples in each village were collected for the estimation of Iodine in the salt. Hence, a total of 540 samples of salt were collected for Iodine estimation from 30 villages.

Among the children who were asked to collect the salt sample from the households, every alternate child was asked to collect the urine sample in the school. Preservative was added to urine sample immediately after collecting the sample. Thus, nine urine samples in each village were collected for the estimation of Iodine in urine. Hence, a total of 270 samples of urine were collected for Iodine estimation from 30 villages.

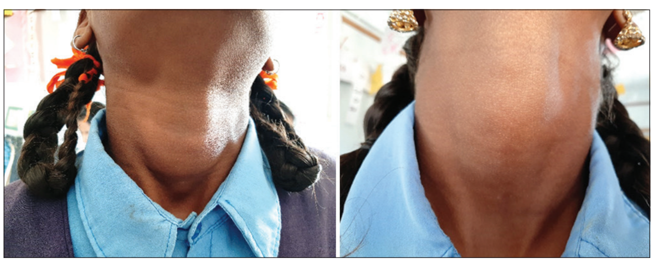

Photo 1: Goiter swellings found during survey

Laboratory Tests for Salt Sample and Urine Sample

After the survey was done in each village, the salt and urine samples collected were transported to Laboratory of MRHRU at PHC, Sirwar, an affiliated center to RIMS, Raichur and NITM, ICMR Unit, Belagavi. The Iodine content of salt was estimated by iodometric titration method and UIE levels in urine samples were estimated by Wet digestion method (Sandell -Kolthoff).

Guidelines of the NIDDCP for Analysis of Results

1. Endemic District: The district is declared as endemic district if the TGR is above 5% in the children of the age group 6–12 year surveyed
2. Severity of Public Health is graded as: Mild (TGR 5–19.9%); moderate (TGR 20–29.9%) and severe (TGR >30%).
3. Severity of public health is graded as mild (median UIE 50–99); moderate (median UIE 20–49) and severe (median UIE <20).
4. Proportion of urine samples with low median UIE <100 should be <20%
5. Iodine level of salt samples should be >15 ppm at the consumer/household level
6. Proportion of households consuming adequately iodized salt(>15ppm) should be >90%.

RESULTS

The study participants are evenly distributed according to age and gender and the difference was not statistically significant [Table 3].

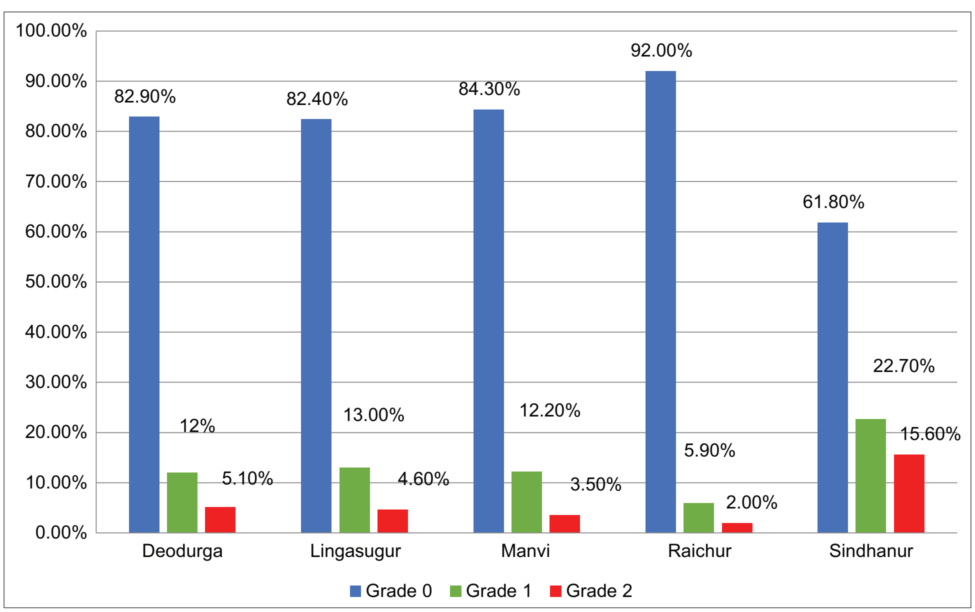

Figure 1: Distribution of the prevalence of goiter among children according to talikas. *P* < 0.001.

When children wear grouped in a particular age group, increasing trend in the prevalence of goiter was seen. Prevalence was maximum in the age group of 12 years both in case of goiter Grades 1 and 2 [Table 4].

The prevalence of goiter was more among girls than boys and the difference was significant at $P < 0.1$ [Table 5].

Table 1: The spectrum of IDD

Fetus	Miscarriage, stillbirths congenital anomalies increased perinatal morbidity and mortality endemic cretinism
Neonate	Neonatal goiter, neonatal hypothyroidism endemic neurocognitive impairment increased susceptibility of the thyroid gland to nuclear radiation
Child and adolescent	Goiter, (Subclinical) hypothyroidism impaired mental function retarded physical development increased susceptibility of the thyroid gland to nuclear radiation
Adult	Goiter with its complications hypothyroidism impaired mental function spontaneous hyperthyroidism in the elderly iodine-induced hyperthyroidism increased susceptibility of the thyroid gland to nuclear radiation

IDD: Iodine deficiency disorders

Distribution of the Prevalence of Goiter among Children According to Talukas

The prevalence of goiter TGR was found to be maximum in Sindhanur taluk (38.3%) and minimum in Raichur taluk (7.9%) [Figure 1].

The prevalence of goiter among children when plotted against the occupations of fathers, maximum prevalence was seen among the children whose fathers were agriculturists (Goiter prevalence in children – 23.9%) and self-employed (Goiter prevalence in children – 23.9%). The difference in prevalence of goiter in this distribution was found to be significant [Table 6].

The prevalence of goiter among children when plotted against the occupations of fathers, maximum prevalence was seen among the children whose mothers were agriculturists (Goiter prevalence in children – 22.9%) and laborers (Goiter prevalence in children – 19.3%). The difference in prevalence of goiter in this distribution was found to be significant [Table 7].

The overall prevalence of goiter was more in mixed diet individuals than among having vegetarian diet. The difference was not found to be significant [Table 8].

Table 2: Methods for assessment of iodine nutrition in populations

Indicator	Age group	Advantages	Disadvantages
Median UI (μg/L)	School-age children, adults and pregnant women	1. Spot urine samples are easy to obtain 2. Relatively low cost external quality control program in place	1. Not useful for individual assessment 2. Assesses iodine intake only over the past few days Meticulous laboratory practice needed to avoid contamination 3. Sufficiently large number of samples needed to allow for varying degrees of subject hydration
Goiter rate by palpation (%)	School-age children	1. Simple and rapid screening test: Requires no specialized equipment	1. Specificity and sensitivity are low due to a high inter-observer variation 2. Responds only slowly to changes in iodine intake
Goiter rate by ultrasound (%)	School-age children	1. More precise than palpation reference values established as a function of age, sex, and body surface area	1. Requires expensive equipment and electricity 2. Operator needs special training 3. Responds only slowly to changes in iodine intake
TSH (mIU/L)	Newborns	1. Measures thyroid function at a particularly vulnerable age 2. Minimal costs if a congenital hypothyroidism screening program is already in place 3. Collection by heel stick and storage on filter paper is simple	1. Not useful if iodine antiseptics used during delivery 2. Requires a standardized, sensitive assay 3. Should be taken by heel-prick at least 48 hours after birth to avoid physiological newborn surge
Serum or whole blood Tg (μg/L)	School-age children and adults	1. Collection by finger stick and storage on filter paper is simple 2. International reference range available 3. Measures improving thyroid function within several months after iodine repletion	1. Expensive immunoassay 2. Standard reference material is available, but needs validation

TSH: Thyroid stimulating hormone; Tg: Thyroglobulin; UI: Urinary iodine concentration

Majority of the salt samples (62.96%) were having Iodine level <15 ppm which included four samples with zero Iodine level. The Iodine level was between 15 and <30 ppm in 25.92% of the samples. Only 11.11% of samples were having Iodine level more than 30 ppm [Table 9].

The difference in levels of Iodine in salt samples according to gender was not significant at $P < 0.05$ [Table 10].

More than half of the children (54.5%) had UIE <100 μg/L [Table 11].

Table 3: Socio-demographic profile of study population

Variables	Frequency	Percentage
Age (years)		
6	373	13.8
7	381	14.1
8	398	14.7
9	392	14.5
10	386	14.3
11	379	14.0
12	391	14.5
Gender		
Female	1350	50.0
Male	1350	50.0
Father occupation		
Father occupation	15	0.6
Father occupation	39	1.4
Father occupation	1015	37.6
Father occupation	423	15.7
Father occupation	1142	42.3
Father occupation	66	2.4
Mother occupation		
Died	4	0.1
Professional	9	0.3
Agriculture	659	24.4
Self-employed/business	142	5.3
Labor	1103	40.9
Housewife	768	28.4
Unemployed	15	0.6
Diet		
Vegetarian	375	13.9
Mixed	2325	86.1
Age group		
6–7	754	27.9
8–9	790	29.3
10–11	765	28.3
12	391	14.5

The difference in levels of UIE according to gender was significant at $P < 0.05$ [Table 12].

DISCUSSION

In India, the previous studies had shown that no states or union territories were free from IDD although being preventable disorders.[5,6] For assessment of the severity of the iodine deficiency of any geographical area, WHO/UNICEF/ICCIDD had established the criteria on the basis of total goiter prevalence (palpable and visible goiter).[7] Any geographical area is classified as endemic for iodine deficiency when a total goiter prevalence rate in that area is more than 5% among school children aged 6–12 years.[8] With an objective to find the prevalence of IDD in district Raichur, we conducted goiter survey in 2700 school children aged 6–12 years and found that the total goiter prevalence was 18.6% [95% CI 17.14%–20.11%] which means goiter is a mild public health problem in Raichur district.

Based on UIE levels, IDD is mild-to-moderate public health problem. The reasons for this might be availability of non-iodized salt for human consumption. There is a complete ban on sale of non-iodized salt. However, the study shows that there is still availability of non-iodized salt in the rural areas. Non-iodized salt is cheaper and sold in loose compared to packed iodized salt.

One more finding found during the survey that few of the schools were using non-iodized salt in cooking mid-day meals for school children. Those schools were informed not to use non-iodized salt.

The presence of goiter among boys and girls was almost equal with fewer gender differences. This finding proved that individual sex has no role in IDD and it is the consumption of iodine as salt with foods that makes the difference.

We found a unique pattern in the prevalence of goiter with age. The prevalence of goiter was found to be rising from 6 years and maximum in 12 years age group. The increased

Table 4: Distribution of children according to goiter grade in particular age group

Father occupation	Father occupation (%)			Father occupation (%)	Father occupation (%)
	0	1	2		
6–7	632 (83.8)	86 (11.4)	36 (4.8)	122 (16.2)	754 (100.0)
8–9	635 (80.4)	114 (14.4)	41 (5.2)	155 (19.6)	790 (100.0)
10–11	623 (81.4)	93 (12.2)	49 (6.4)	142 (16.6)	765 (100.0)
12	308 (78.8)	54 (13.8)	29 (7.4)	83 (21.2)	391 (100.0)
Total	2198 (81.4)	347 (12.9)	155 (5.7)	502 (18.6)	2700 (100)

P-value=0.207

Table 5: Distribution of the prevalence of goiter among children according to the gender

Gender	Goiter grade (%)			Total (%)
	0	1	2	
Female	1077 (79.8)	184 (13.6)	89 (6.6)	1350 (100)
Male	1121 (83.0)	163 (12.1)	66 (4.9)	1350 (100)
Total	2198 (81.4)	347 (12.9)	155 (5.7)	2700 (100)

P-value=0.062

Table 6: Distribution of the prevalence of goiter among children according to father's occupations

Father's occupation	Goiter grade (%)			Total (%)
	0	1	2	
Died	14 (93.3)	0 (0.0)	1 (6.7)	15 (100.0)
Professional	33 (84.6)	4 (10.3)	2 (5.1)	39 (100.0)
Agriculture	773 (76.2)	164 (16.2)	78 (7.7)	1015 (100.0)
Self-employed/ business	322 (76.1)	72 (17.0)	29 (6.9)	423 (100.0)
Labor	1001 (87.7)	97 (8.5)	44 (3.9)	1142 (100.0)
Unemployed	55 (83.3)	10 (15.2)	1 (1.5)	66 (100.0)
Total	2198 (81.4)	347 (12.9)	155 (5.7)	2700 (100.0)

P<0.001

Table 7: Distribution of the prevalence of goiter among children according to mother's occupations

Mother occupation	Goiter grade (%)			Total (%)
	0	1	2	
Died	4 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)
Professional	7 (77.8)	2 (22.2)	0 (0.0)	9 (100.0)
Agriculture	508 (77.1)	100 (15.2)	51 (7.7)	659 (100.0)
Self-employed/ business	122 (85.9)	12 (8.5)	8 (5.6)	142 (100.0)
Labor	891 (80.8)	148 (13.4)	64 (5.8)	1103 (100.0)
Housewife	655 (85.3)	81 (10.5)	32 (4.2)	768 (100.0)
Unemployed	11 (73.3)	4 (26.7)	0 (0.0)	15 (100.0)
Total	2198 (81.4)	347 (12.9)	155 (5.7)	2700 (100.0)

P=0.015

Table 8: Distribution of the prevalence of goiter among children according to the type of diet consumed

Type of diet	Goiter grade (%)			Total (%)
	0	1	2	
Vegetarian	310 (82.7)	52 (13.9)	13 (3.5)	375 (100.0)
Mixed	1888 (81.2)	295 (12.7)	142 (6.1)	2325 (100.0)
Total	2198 (81.4)	347 (12.9)	155 (5.7)	2700 (100.0)

P=0.113

demand of thyroid hormone with advancing age may be attributed to this relation of age and prevalence. The World Health Organization urged to implement universal salt iodization and iodine supplementation strategies for preventing and controlling IDD. National goiter control program was launched in 1962 by Government of India and renamed NIDDCP in 1992 with the aim to reduce the prevalence of IDD to below 10% by 2010.[9] After 28 years of implementation of NIDDCP, the present study shows that the national program has had much impact in lowering down the prevalence of goiter.

Table 9: Distribution of salt samples according to the Iodine level estimation

Salt iodine level	Frequency	Percentage
0 ppm	04	0.74
0.1–14.999 ppm	336	62.22
15–29.999 ppm	140	25.92
≥30 ppm	60	11.11
Total	540	100.0

Table 10: Association of gender and salt iodine level

Salt iodine level	Female (%)	Male (%)	Total (%)
0 ppm	0 (0.0)	4 (1.4)	4 (0.7)
0.1–14.999 ppm	170 (64.6)	166 (59.9)	336 (62.2)
15– 29.999 ppm	60 (22.8)	80 (28.9)	140 (25.9)
≥30 ppm	33 (12.5)	27 (9.7)	60 (11.1)
Total	263 (100.0)	277 (100.0)	540 (100.0)

P=0.067

Table 11: Distribution of salt samples according to the urine iodine level

Urine iodine level	Frequency	Percentage
<20 μg/L	34	11.7
20–49.99 μg/L	36	12.4
50–99.99 μg/L	88	30.3
≥100 μg/L	132	45.5
Total	290	100

Table 12: Association between gender and urine iodine level

Urine iodine level	Female (%)	Male (%)	Total (%)
<20 μg/L	24 (16.9)	10 (6.8)	34 (11.7)
20–49.99 μg/L	15 (10.6)	21 (14.2)	36 (12.4)
50–99.99 μg/L	38 (26.8)	50 (33.8)	88 (30.3)
≥100 μg/L	65 (45.8)	67 (45.3)	132 (45.5)
Total	142 (100.0)	148 (100.0)	290 (100.0)

P=0.040

CONCLUSION

The present study shows total goiter prevalence of 18.6% in the rural areas of Raichur district indicating that it is still an endemic area, where goiter remains a significant public health problem. Although the prevalence of goiter has been reduced over years, it is still endemic. The proportion of households consuming adequately iodized salt (median UIE ≥100 μg/l) is far below the recommended level. Effect of geographical locations, dietary factors, storing salt techniques, cooking techniques, and interaction of iodine with other nutrients is some areas where further research can be done in future.

LIMITATIONS OF THE STUDY

1. All students were examined for the presence of goiter, but salt iodine testing and urine iodine testing was done for every fifth and tenth child. Testing for salt iodine and urine iodine in children with Grade 1 or 2 goiter may indicate the causal factors for goitre in that child
2. A subset of the selected students was asked to bring salt samples from their homes for testing for iodine levels. Many households have reported consumption of both common salt and crystal salt; but the salt sample testing was done only for one sample that was brought by the students. This may not give the accurate picture of the pattern of consumption of iodized salt in the community.

RECOMMENDATIONS

1. Efforts must be made to ensure that the quality of iodized salt meets the required standards at the consumer level
2. Strict implementation of legislative measures to check the sale of non-iodated salt starting from manufacture level to retail store
3. Educating the retailers about importance of iodated salt and counseling them not to sell non-iodated salt by making them aware of punishments for selling non-iodated salt
4. Educating public about benefits of consumption of iodated salt. Awareness programs to educate the community about the hazards of consumption of un-iodized salt should be undertaken
5. Health personnel in the respective health centers to have strict vigilance on implementation of regulations
6. Periodic surveys to find out the prevalence of IDD to find out the burden of disease.

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