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REVIEW PAPER

Anemia – a scourge to maternal and child development in Bihar, India

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ABSTRACT

Introduction and aim. Anemia remains a leading contributor to years lived with disability (YLDs), being responsible for 50.3 million (5.82%) YLDs worldwide and 19.3 million (12.03%) YLDs in India, respectively. Results of the National Family Health Survey 2019-2021 (NFHS-5) suggest a high burden of anemia in India among women of reproductive age and children aged 6-59 months at the national level (57%, 67.1%), and in the state of Bihar, India (63.5%, 69.4%). Iron deficiency is the leading cause, accounting for more than half the cases. Anemia bodes harmful implications for both the mother and child, with long-lasting consequences for the latter. Anemia control programs have yielded little benefit despite efforts stretching over five decades. This narrative review aims to highlight the burden of anemia and the probable factors behind it among under-5 children and women of reproductive age in the Indian state of Bihar.

Material and methods. The paper is a narrative review. The following databases were used to search and select literature: PubMed, Web of Science, Scopus, and Google Scholar. In addition, the websites of relevant government departments and national health programs were searched for pertinent material.

Analysis of the literature. A multitude of reasons seem to be behind the unabated high prevalence in Bihar: low socioeconomic status, gender disparities, traditional customs and practices, food insecurity, lack of diverse diets, poor consumption, and no adherence to iron and folic acid (IFA) supplements, groundwater contamination with arsenic and fluoride, and supply chain mismanagement, all playing roles of varying degree.

Conclusion. An all-encompassing approach and not merely the provision of IFA supplements are necessary to unravel the intricate web of factors that lead to anemia.

Keywords. anemia, diet habits, heavy metal toxicity, iron deficiency anemia, maternal child health services, socioeconomic factors

Introduction

Anemia remains a major unresolved public health problem, affecting around 1.8 billion people and accounting for nearly 50.3 million or 5.82% of years lived with disability (YLDs) worldwide, with the burden concentrated in low and middle-income countries.[1,2]

As of 2019, The World Health Organization (WHO) estimates that one in every three women in the reproductive age group (15-49 years), amounting to over half a billion women worldwide are anemic. It also estimates that 39.8% or 269 million children aged 6-59 months are anaemic.[3] The Indian context is much grimmer and anemia is one of the leading contributors to YLDs [19.3 million or 12.03%].[2] Findings of the National Family Health Survey 2019-2021 (NFHS-5) have revealed that one in every two women in the reproductive age group

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and two in every three children in the age group of 6-59 months in India are anemic, with an estimated prevalence of 57% for the former and 67.1% for the latter group (Fig.1).[4]

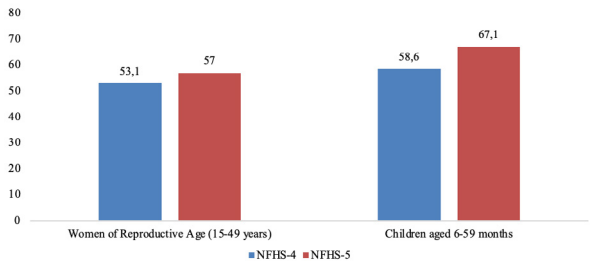

Fig. 1. Prevalence of anemia among women of reproductive age and children aged 6-59 months in India (Source: NFHS-5 India Report)[4]

It is a matter of great concern that despite the introduction and implementation of several programs over the years to curb anemia, these figures have only risen over the previous estimates of the National Family Health Survey 2015-16 (NFHS-4), a prevalence of 53.1% and 58.6% for anemia in women of reproductive age group (15-49 years) and children in the age group of 6-59 months respectively.

Aim

This narrative review aims to highlight the burden of anemia and the probable factors behind it among under-5 children and women of reproductive age group in the Indian state of Bihar.

Material and methods

The paper is a narrative review. The following databases were used to search and select literature: PubMed. Web of Science, Scopus, Google Scholar. In addition, the websites of relevant government departments and national health programs were searched for pertinent material.

Analysis of the literature

Etiological determinants

Anemia is a disorder of red blood cells, characterized by a decrease in the oxygen-carrying capacity either due to a reduction in the number or a decrease in the amount of hemoglobin of red blood cells. The WHO defines anemia in pregnant women and children aged 6-59 months as a hemoglobin level of <11g/dl.[5]

The etiology of anemia is varied but most commonly nutritional in origin. Nutritional causes include Iron deficiency (ID) and micro-nutrient deficiencies like folate, vitamin B12 & vitamin A. ID is the predominant cause, with more than half the cases in South Asia & Africa attributable to it.[1,6] Blood loss, either gynecological or due to parasitic infestations like hookworms commonly encountered in South-East Asia, and Africa is the leading cause of ID. Other common causes of ID include insufficient intake during a period of increased requirement (Infancy, adolescence in girls, pregnancy), poor absorption (Celiac disease, H. Pylori infection) and anemia of Chronic Disease (ACD) (chronic kidney disease, chronic heart failure, inflammatory bowel diseases).[6]

Haemoglobinopathies (Thalassemia, sickle cell disease), hemolytic anemias and infections (HIV, Tuberculosis, and Malaria) comprise some of the common non-nutritional causes.[7]

Consequences of anaemia

Anemia, irrespective of its etiology, causes fatigue and weakness, hindering work capacity and productivity.[8] Haas et al. found that ID states require a higher energy cost to perform the same amount of work.[9] A diminished capacity to work has not only economic implications but also social consequences in the form of a decreased ability to perform household activities and childcare,[8] which has special emphasis in a conservative country like India where women are the primary caretakers of households.

Generally viewed as a benign condition, anemia can turn fatal. Anemia during gestation predisposes the woman to a higher chance of developing post-partum hemorrhage and higher mortality.[10] A multi-level analysis by Daru et al showed that the odds of mortality are twice as high in severe anemia (Hemoglobin level <7g/dl) than in those without.[11]

The health of the mother and her child are closely intertwined. A woman's health status, even before pregnancy, has a bearing on the development and health of her future offspring. Birth outcomes and chances of neonatal and infant survival are adversely affected by maternal ill-health. Pre-term births, stillbirths, low birth weight and higher neonatal and perinatal mortality rates are some of the complications seen more frequently in anemic pregnant women.[10,12] Children born to anemic mothers have lower hemoglobin levels and are at an increased risk of anaemia.[13] A cohort study in rural Bihar found the hemoglobin level to be 0.2g/dl lower than children born to non-anemic women.[14]

Iron is also essential for early brain development due to its involvement in several biochemical processes, a deficiency of which could impede cognition and neurodevelopment.[15] Evidence, however, is equivocal. A Costa Rican study concluded that infants with chronic ID anemia (IDA) had lower cognitive scores and failed to catch up with their non-anemic peers, even when followed up to adulthood.[16] Some studies have also found an association between low hemoglobin levels and post-partum depression,[17] further compromising the well-being and health of both mother and child.

The phase spanning between 6-59 months of life is a vital and vulnerable period. The young child's nutritional needs begin to outgrow the nourishment provided by breast milk, a gap to be bridged by complementary feeding. Improper feeding practices compromise the child's nutritional status with long-term consequences. ID in these children has been linked with poor cognitive and motor development and long-lasting behavioral changes. They are also prone to recurrent respiratory and intestinal infections and struggle to gain weight.[18]

India's fightback

India's programmatic efforts to tackle anemia stretch back over five decades, commencing with the National Nutritional Anemia Prophylaxis Programme (NNAPP) in 1970, which focused mainly on prophylactic supplementation of iron and folic acid (IFA) in pregnant women, nursing mothers, women with intra-uterine devices and children aged 1-5 years.[19] The focus eventually shifted from prevention to management, with the NNAPP rechristened as the National Nutritional Anemia Control Program (NNACP) in 1991.[20] An ICMR evaluation of the program in 1992 saw an increase in the dose of elemental iron for adults to 100mg from 60mg.[21] A policy review concerning IFA supplementation expanded the scope of beneficiaries in 2007.[22] Recognizing the high susceptibility of adolescents and their importance as future functioning members of society, the Ministry of Health and Family Welfare (MoHFW) launched the Weekly Iron Folate Supplementation (WIFS) program in 2012.[23] The year 2013 saw the convergence of the existing IFA supplementation program under the umbrella of the National Iron Plus Initiative (NIPI), which adopted a life-cycle approach (Table 1).[24]

The Government of India launched the POSHAN Abhiyaan in 2018, an overarching scheme aimed at holistically viewing and enriching nutritional outcomes in children, pregnant, and lactating women.[25] Anemia Mukt Bharat (AMB),[26] an intensified version of the NIPI, was formulated and implemented as a part of POSHAN. AMB follows a 6×6×6 strategy, consisting of six beneficiaries, six interventions and six institutional mechanisms.

A non-governmental initiative worth noting is the Reduction in Anemia through Normative Innovations (RANI) project funded by the Bill & Melinda Gates Foundation. It aims at reducing anemia among Women of Reproductive Age (15-49 years) in Odisha, India.[27]

It is also pertinent to mention programs like the Integrated Child Development Services (ICDS), one of the world's largest for early childhood nutrition and development since its inception in 1975. Although the program doesn't directly target anemia, it adopts a comprehensive outlook, striving to improve nutritional outcomes, reducing the burden of malnutrition, and other nutritional

Table 1. List of anemia programs, salient features, beneficiaries, and dose of elemental iron

Year	Program	Salient features	Beneficiaries	Dose of elemental iron
1970	**National Nutritional Anemia Prophylaxis Program (NNAPP)**	----------	Children (1-5 years)	20 mg
			Pregnant women	60 mg
			Lactating women & IUD acceptors	60 mg
1991	**National Nutritional Anemia Control Program (NNACP)**	Three-pronged strategy: i. Promotion of consumption of iron-rich foods. ii. Promotion of IFA supplement consumption in vulnerable groups. iii. Detection and treatment of Hb <7g/dl.	Children (1-5 years)	20 mg
			Pregnant & Lactating women	100 mg
2007	**National Nutritional Anemia Control Program (NNACP)**	The scope of beneficiaries expanded – Children of age 6-12months, 6-10 years and adolescents included	Children (6 to 60 months)	20 mg (Syrup) 30 mg
			Children (6-10 years)	100 mg
			Adolescents (11-18years) Pregnant & lactating women	100 mg
2012	**Weekly Iron Folate Supplementation (WIFS)**	6th to 12th class adolescent boys and girls aged 10-19 years enrolled in government, government-aided/municipal schools. Out-of-school adolescent girls are also covered Weekly IFA supplementation using a fixed-day approach & Biannual deworming	School-going adolescent boys and girls	100 mg
			Out-of-school adolescent girls	100 mg
2013	**National Iron Plus Initiative (NIPI)**	Life-cycle approach Comprehensive coverage of vulnerable age groups Weekly/biweekly supplementation of iron and folic acid.	Children (6-60 months)	20 mg (Syrup)
			Children (5-10 years)	45 mg
			Children (10-19 years)	100 mg
			Pregnant & lactating women	100 mg
			Women of Reproductive Age (WRA)	100 mg
2018	**Anemia Mukt Bharat (AMB)**	6x6x6 Strategy Reduce anemia prevalence by three percentage points between the years 2016 and 2022. Switch from 100mg to 60mg of elemental iron	Children (6-60 months)	20 mg (Syrup)
			Children (5-10 years)	45 mg
			Children (10-19 years)	60 mg
			Pregnant & lactating women	60 mg
			Women of Reproductive Age (WRA)	60 mg

diseases in children aged 0-6 years, pregnant, and lactating mothers via supplementary nutrition.[28] Another nutritional intervention is providing one hot cooked meal to every school-going child studying in Classes I-VIII in Government & Government-Aided Schools under the PM POSHAN (POshan SHAkti Nirman) Scheme. Earlier known as the 'National Program for Mid-Day Meal in Schools, the program mainly aims to improve the nutritional status of school-going children and encourage children from disadvantaged backgrounds to attend school regularly to minimize dropout rates.[29]

The scenario in Bihar, India

Bihar in Eastern India, the third most populous state in the country[30] and a socio-economically backward region, is amongst the worst performers in terms of health indicators, especially infant mortality, under-5 mortality, malnutrition and anemia in women and children. While the infant mortality rate (IMR) and under-5 mortality rate (U5MR) of Bihar have shown a downward trend, The NFHS-5 factsheet shows that this progress has been unsatisfactory. At an IMR of 46.8 (per 1,000 live births) and an under-5 mortality rate of 56.4 (per 1,000 live births) against a national average of 35.2 and 41.9, respectively, Bihar stands as the second worst performer in India concerning these indices. The state also witnesses a high burden of child undernutrition. Stunting has been observed in 43% of under-5 children, and 41% are underweight, the second highest and the highest levels in the country. An estimated 63.5% of women in the reproductive age group (15-49 years) and 69.4% of children in the age group of 6-59 months are anemic (Fig.2), a rise of 3.2% and 5.9%, respectively over the previous estimates of the NFHS-4.[4]

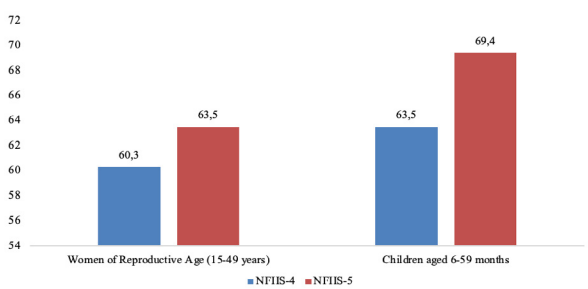

Fig. 2. Prevalence of anemia among women of reproductive age and children aged 6-59 months in Bihar (Source: NFHS-5 India Report)[4]

Anemia – is it socioeconomic or nutritional?

Anemia is often erroneously viewed as a nutritional disease when it is as much a result of socioeconomic determinants as of nutrition. Poor women and children are less likely to obtain hygienic, adequate, and balanced nutrition and often live in poor sanitary conditions, leading to higher rates of infectious diseases. Helminthic infections like hookworm result in blood loss and IDA. A cross-sectional survey in four districts of Bihar found that 42% of school-going children were infected with hookworms,[31] indicating a need for periodic deworming in this population. A poor socioeconomic status also results in a lower level of education, which is associated with a greater risk of anemia in women.[7] Higher education levels among mothers result in a better understanding of nutrition and dietary practices, consequently lowering rates of anaemia in young children.[32] In countries like India, the predilection of anemia in women can be due to the difference in opportunities afforded to male and female children. On average, girls are given less childcare, nutrition, and education, have lower participation levels in the workforce and are married off at a younger age compared to boys.[33] A common phenomenon, seen particularly in rural India, is that women consume leftover food after the rest of the household has eaten. The resultant compromise in nutritional status renders them vulnerable to nutritional disorders, including but not limited to anemia. The NFHS-5 data reveals that only 55% of women in Bihar are literate compared to 76.4% of men.[4] This figure is well below the national average of 71.5% literacy in women and could be one of the factors contributing to the high prevalence of anemia in the state.

Dietary diversity and food security

Dietary diversity refers to the number of food groups consumed over a period. A diverse diet helps meet daily nutritional requirements, especially those of micro-nutrients. A poorly diversified diet is associated with an increased risk of anaemia,[34] and found to be a strong predictor of stunting in children aged 6-59 months.[35] The diet in India is predominantly plant-based and cereal-rich, with most of the iron derived from non-heme sources such as legumes, millets, soybean, nuts, dried fruits and green leafy vegetables.[36]

Results of a baseline survey in Purnia district, Bihar, as a part of the SWABHIMAAN project, found that approximately 75% of pregnant women lived in food-insecure households and their diet mainly consisted of a mix of grains, pulses, and vegetables. Minimum dietary diversity was met by only 33.5% of pregnant women, and an astonishingly low percentage (3.3%) of them incorporated micronutrient-rich nuts & seeds in their diets. Consumption of heme-rich food like meat, poultry and fish (32.7%), vitamin A-rich fruits and vegetables (22.6%), and other fruits (13%) that could stave off anemia was low.[37] Although half the women were consuming green leafy vegetables, there is a definite need to boost these numbers.

The young child is dependent on its mother for its nutritional needs, either breastfeeding in the initial six months or complementary feeding later. A formative

study in Bihar showed that women lacked awareness about the frequency and quantity of feeding. They also succumbed to myths and indulged in harmful practices like withholding certain key food groups from children, negatively impacting dietary diversity.[38]

Findings from the Comprehensive National Nutritional Survey (CNNS 2016-18) reveal that a dismal 13.2% of children aged 6-23 months in Bihar achieved minimum dietary diversity.[39] The situation wasn't much different in children aged 2-4 years as few ate flesh foods (11.4%), legumes and nuts (27.5%), and fruits and vegetables (35.8%).

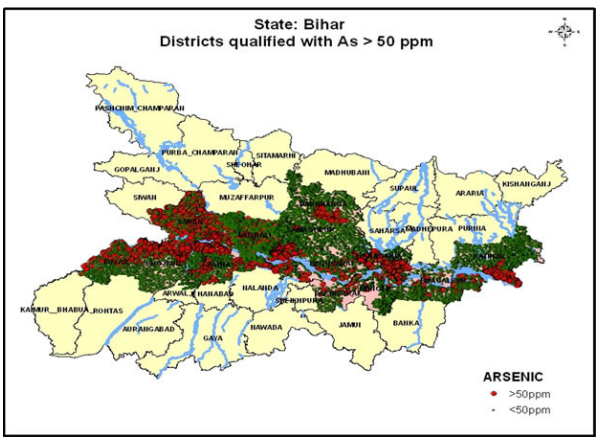

Fig. 3. State map of Bihar depicting Arsenic hotspots (Source: http://phedbihar.gov.in/WaterQuality.aspx)[45]

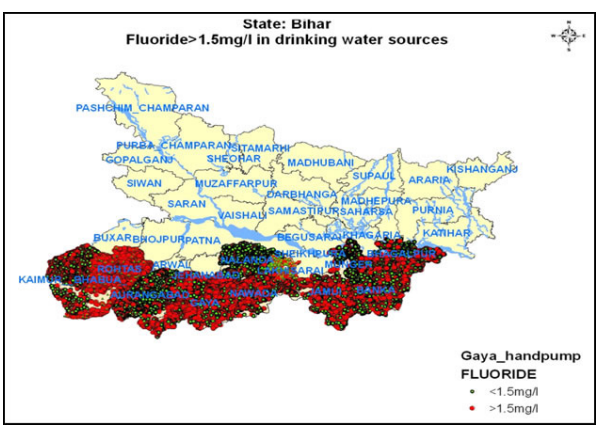

Fig. 4. State map of Bihar depicting Fluoride hotspots (Source: http://phedbihar.gov.in/WaterQuality.aspx)[45]

IFA consumption and adherence

Wendt et al concluded that IFA consumption was associated with higher educational levels and socioeconomic status. They also found that the likelihood of consuming IFA tablets for more than 90 days was higher if they had at least four antenatal (ANC) visits.[40] Only 1 in 4 (25%) of pregnant women in Bihar attended at least 4 ANC check-ups,[4] which would explain the low proportion of expecting mothers consuming IFA supplements for more than 100 days (18%) and more than 180 days (9.3%). A study in Southern India assessing compliance to IFA supplements among pregnant women determined that forgetfulness and adverse effects were the major factors contributing to non-compliance.[41]

The menace of arsenic and fluoride in water

Bihar is also afflicted with the menace of groundwater contamination. Elements like Arsenic and Fluorine enter the human body via drinking water and produce grown using contaminated water. Arsenic is known to change erythrocyte morphology, resulting in their death. It also diminishes bone marrow activity leading to anemia, thrombocytopenia, and leukopenia.[42] Fluoride, on the other hand, is a peculiar entity. Some amount of fluoride in drinking water is essential for optimum dental health due to its enamel-protecting property. However, excess levels can wreak havoc on the skeletal system and teeth, and lower hemoglobin levels and other red blood cell indices.[43] Of the 38 districts in Bihar, 22 report groundwater arsenic levels higher than the WHO provisional guideline of 10 µg/L,[44] 13 of them have levels more than 50ppm (Fig.3), and 11 have groundwater fluoride levels over 1.5mg/L (Fig.4).[45] These numbers portray a lamentable situation wherein many, to this day, lack access to safe drinking water in Bihar, rendering them vulnerable to ill health.

Iron folate coverage and supply chain issues

The primary strategy of anemia control program in India is the periodic provision of IFA supplements to the beneficiaries. Coverage of beneficiaries and stocks for distribution should be adequate. The Anemia Mukt Bharat Scorecard 2019-20 (Q4) placed Bihar at rank 14 with a coverage of 12.2%, 15.7%, 47.6%, and 77.6%, respectively, among children aged 6-59 months, children aged 5-9 years, adolescents (10-19 years) and pregnant women.[46] Additionally, IFA coverage saw a steep fall in the subsequent year (2020-21), with Bihar slumping to rank 21. This decline could be the effect of the COVID-19 pandemic, which extensively disrupted routine life and led to widespread lockdowns.

The supply chain is a vital cog in the machinery of any intervention-based program and a failure in any link deprives the target population of its intended benefits. An assessment of the supply chain for AMB conducted in two aspirational districts in each state (August 2019) found the lead time to be 41 weeks in Bihar.[47] The lead time is the time interval between placing an order and its delivery to the recipient. The slowest activities were the tender/purchase order (13 weeks), procurement and delivery (10 weeks) and block-level distribution (11 weeks).

The assessment also found significant gaps in the indent, ranging from 68% for IFA-red to 87% for IFA syrup. Procurement gaps were huge, with little receipt of IFA supplements. A long procurement time of almost four months resulted in the unavailability of IFA supple-

ments at health facilities, evidenced by the fact that only three districts in Bihar had IFA-Red available in all four quarters of the year. None met the criterion for IFA syrup, IFA-blue and IFA-pink.

The state warehouses lacked space for appropriate storage of the supplements. They were also short-staffed, with the existing staff ill-equipped to handle the inventory, increasing the chances of drug damage and expiration. Insufficient transport vehicles and the lack of a distribution plan compounded the delay of supplies.

Another concerning aspect is the absence of an integrated Management Information System (MIS) in the IFA supply chain. The DVDMS (Drug & Vaccine Distribution System) exists only at the district level in most states, and the levels below follow a manual system of reporting. This is not strictly adhered to, affecting the procurement process as there is no feedback available from the lower-level facilities.

Conclusion

Anemia rages relatively unabated in India, especially in a socio-economically backward state like Bihar. Tackling these surging levels requires a comprehensive approach that involves uplifting the socio-economic status of the weaker strata of society, and improving education levels, particularly among women. This will improve child-rearing and curb harmful practices like withholding certain food groups in young children. Expecting mothers and those with young children should be counselled on appropriate feeding practices and the importance of dietary diversity.

Measures to mobilize expecting mothers to the ANC clinics and steps to counsel them regarding nutrition and IFA supplements are needed to address the low consumption of IFA supplements for the recommended duration. A directly observed IFA supplementation program akin to the Directly Observed Treatment, Short-course (DOTS) strategy for Tuberculosis (TB) could be experimented with to combat the issue of forgetfulness. Parenteral iron options can be explored for women unable to tolerate oral iron supplements.

Access to potable drinking water is a human right, and it is disheartening that people lack access to it even today. Swift action is needed to ensure access in areas that bear the brunt of contamination, as prolonged exposure is known to cause irreparable damage.

Unlike its predecessors that focused predominantly on information, education & communication (IEC) activities, the AMB program incorporates a novel intensified year-round Behavior Change Communication (BCC) campaign among its interventions. It has also expanded the list of beneficiaries and strengthened institutional mechanisms for its implementation. These suggest that the program holds great potential in overcoming the barriers surrounding anemia. However, an assessment of the program indicates that coverage has been poor in Bihar. Intensified efforts need to be undertaken to address the same. The DVDMS should be extended to the lower-level facilities and the staff trained on proper reporting, and monitoring for timeliness and accuracy of reported data. Further operational research is thus, of paramount importance, to address the long procurement time and other deficiencies.

Declarations

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Author contributions

Conceptualization, S.K.N., C.M.S. and Sa.P.; Methodology, Sh.P., R.R. and B.N.N.; Writing – Original Draft Preparation, R.R., Sh.P. and BNN.; Writing – Review & Editing, S.K.N., R.R., B.N.N., Sh.P., M.V., CM.S. and Sa.P.; Visualization, Sh.P.

Conflicts of interest

The authors declare no conflicts of interest.

Data availability

Data supporting the results of this study shall, upon appropriate request, be available from the corresponding author.

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