

# The 50 Most-Cited Articles about Diet During the First 1000 Days of Life and Early Childhood Caries: A Bibliometric Analysis

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# ABSTRACT

**Objective:** To evaluate the characteristics of the 50 most cited articles on the relationship between diet during the first 1000 days of life and early childhood caries (ECC). **Material and Methods:** Web of Science Core Collection (WoS-CC) database was searched. The following data were extracted from each article: article title, the number of citations, authors, country, keywords, year of publication, study design, and topic. Poisson regression was used to determine associations between citations and bibliometric data (p<0.05). **Results:** The Articles were published between 1992 and 2019 and had been cited from 36 to 3252 times. The United States led the publications (26%), followed by Australia (16%), England (14%) and Brazil (12%). Most studies were cross-sectional [38%]; the most cited article was the literature review (56%). The most cited topic was ECC and breastfeeding (53%). Literature reviews (RR = 5.287; 95% CI = 2.92–9.58) published by authors from Brazil (RR = 3.653; 95% CI = 1.35–9.88) and on ECC and breastfeeding (RR = 2.434; 95% CI = 1.32–4.48) had a higher citation rate in WoS-CC. **Conclusion:** The relationship between the diet during the first 1000 days of life and ECC has received increased research attention in the last decade.

Keywords: Infant; Diet; Dental Caries; Bibliometrics; Journal Impact Factor.

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#### Introduction

The period between conception and the second year of life, comprising the first 1000 days, is dynamic. Disturbances in this phase can impact the individual's growth and development [1]. The diet during this period plays a vital role in development and will impact adult health in the long term [1]. Thus, developing healthy eating habits early in life continues [2].

Poor nutrition in early childhood is associated with the risk of developing chronic non-communicable diseases [3], which have increased in prevalence and severity. Therefore, the World Health Organization recommends reducing sugar consumption and not offering it to children before the age of two years [4]. Early contact with sugar has long-term repercussions, increasing the risk of conditions such as obesity [5], cardiovascular diseases [6], type 2 diabetes [3] and tooth decay [7]. These chronic diseases impact individuals' quality of life and overload healthcare systems [1-3]. Among these, dental caries is a sugar-biofilm-dependent disease influenced by social determinants [7,8]. Early introduction of sugar at the end of the first year of life is positively associated with tooth decay at subsequent ages [9,10].

Bibliometrics can be used to identify articles with the most significant impact on the research and clinical communities. This approach provides the basis for the development of new lines of research, techniques, and theories [11], provides researchers with information about the leading institutions and research groups on a given topic [11], and also assists journal editors in identifying topics of interest for publication [12]. While bibliometric studies have been conducted in various fields of medicine and dentistry [12-15], they have not been carried out to examine the relationship between diet during the first 1000 days of life and early childhood caries (ECC). Studies highlighting the importance of actions and interventions related to a child's diet contribute to disseminating scientific knowledge to support health practices, especially with an emphasis on developing healthy habits and constructing public health policies [3,5-7,16]. This study aimed to identify the characteristics of publications on the relationship between the diet during the first 1000 days of life and ECC through bibliometric analysis of the 50 most cited articles on this topic.

# Material and Methods

### **Bibliographic Search**

Two trained and calibrated researchers carried out a comprehensive search, without filters and restrictions on languages and year of publication, in the Web of Science Core Collection (WoS-CC) (Clarivate Analytics, Clarivate Plc, Philadelphia, USA) with the following search string: (child OR children OR childhood OR child, preschool OR "preschool child" OR "preschool children" OR infant OR infants OR newborn OR newborns OR youth OR youths OR pediatric OR pediatrics OR paediatric OR paediatrics OR pedodontics) AND TS=(Diet OR Nutrition OR Nutritional OR Physiology OR "Breastfeed" OR "Breastfeeding" OR "Breast Feeding" OR "Breast Feeding" OR "Breast Feeding" OR "Breast Feeding" OR "Wet Nursing" OR "Complementary Feeding" OR health OR development OR "First 1000 days" OR "sugar" OR "sugars" OR "sucrose" OR "dietary sugars" OR "carbonated beverages" OR "carbohydrates" OR "Lesion, Carious" OR "Lesions, Carious" OR "Caries, Dental" OR "Carious Dentins" OR "Dentin, Carious" OR "Dentin, Carious" OR "Dental OR "Dental OR "Dental White Spot, Dental White Spot, Dental White Spots, Dental White Spots, OR "Caries lesion" OR "Early childhood caries" OR "dental caries" OR "dental cavities" OR "decayed teeth" OR "decayed tooth" OR carious OR "dont decay" OR "carious OR "Carious OR "Carious OR "Carious OR "Meter Nursing" OR "Early childhood caries" OR "Dental OR "Dental Caries" OR "Carious OR "Carioos OR "Dental White Spots, Dental White Spots, OR "Carious OR "Carious OR "Carious" OR "Carious OR "Carious OR "Carious OR "Carious" OR "Carious OR "Carious OR "Carious OR "Carious" OR "Carious" OR "Carious OR "Carious OR "Carious OR "Carious" OR "Carious OR "Carious Dentins" OR "Carious" OR "Carious" OR "Carious" OR "Carious Dentins" OR "Carious OR "White Spot, Dental" OR "Carious Dentin" OR "Carious Dentins" OR "Carious" OR "White Spot, Dental" OR "Carious OR "Carious Dentin" OR "Carious Dentins" OR "Carious" OR "Carious" OR "Carious" OR "Carious OR "Carious OR "Carious Dentin" OR "Carious Dentin" OR "Carious Dentin" OR "Carious Den

OR ICDAS). In bibliometric studies, indexed and non-indexed terms (MeSH terms) cover as many relevant articles as possible.

# Inclusion and Exclusion Criteria

Clinical trials, systematic reviews with or without meta-analysis, literature reviews, observational studies, laboratory studies, case reports, and case series focusing on the relationship between the diet during the first 1000 days of life and ECC were included. Editorials, letters to the editor, and book chapters were excluded. The number of citations organized the articles in descending order. Three researchers selected the articles based on the title and abstract. If there was a tie in the number of citations, then the citation density (the number of citations per year) was considered, followed by the number of citations in Scopus. The number of citations for these articles in the Web of Science All Databases (WoS-AD), Scopus, and Google Scholar were collected for comparison.

#### Data Extraction

The following bibliometric parameters were extracted from the papers: authors, year of publication, title, language, study design, keywords, summary, institutions, countries, continents, journal, total number of citations, citation density, position in the list of citations, and other topics of interest. The study designs were classified as literature review, laboratory studies, case report, case series, cross-sectional study, case-control study, cohort study, clinical trial, and systematic review with and without meta-analysis. The topics of interest considered were ECC – etiology and prevention, ECC and breastfeeding, ECC and diet, and diet and the oral microbiota. Self-citations were included in the study.

Bibliometric networks were generated by using the VOSviewer [17] to analyze authorship. A collaborative density map was constructed, in which the authors with more articles in the top 50 were included based on more expressive schematic drawings, with interconnected terms positioned closer together. The MapChart website [18] illustrated the distribution of publications and citations across countries and continents.

### Data Analysis

Poisson regression was used in SPSS Statistics, version 24.0 (IBM Corp., Armonk, NY, USA) [19] to determine associations between the total number of citations in WoS-CC and bibliometric data (study design, country, central theme, and period of publication). All tests used a significance level of 5% (p < 0.05). The study design was analyzed in three categories: literature review, observational (longitudinal, cross-sectional, and case-control), and others (systematic review, clinical trial, and experimental research). The topics of interest were analyzed in three categories: ECC and breastfeeding, ECC and diet, and others. All variables that presented a p-value < 0.20 were included in the final model. The results are expressed as the rate ratio (RR) with a 95% confidence interval (CI) and a significance level of 5% (p<0.05).

# Results

The search yielded 10682 articles. The top 50 most cited articles received a total of 7621 citations. The total number of citations was higher in the other databases (8010 in WoS-AD, 7744 in Scopus, and 18389 in Google Scholar). There were 36–3252 citations per article. The most cited article was a literature review, "Breastfeeding in the 21st Century: epidemiology, mechanisms, and lifelong effect," by Victora et al., published in *The Lancet.* Fourteen articles had more than 100 citations and a density ranging from 5.5 to 464.6 (Table 1).



The oldest article, by Matee et al., is from 1992, and the most recent, by Moynihan et al., is from 2019. By decade, from 1990 to 1999, there were 10 articles with 747 citations; from 2000 to 2009, there were 17 articles with 1418 citations; and from 2010 to 2020, there were 23 articles and 5393 citations.

Table 1. Top	50 early-life die	t articles related	to ECC with	more than 100 cit	ations.
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No.	Article	Number of Quotes	Citation Density		
1	Victora CG, Bahl R, Barros AJD, França GVA, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effects. Lancet 2016; 387(10017):475-490.	3252	465		
2	Moynihan PJ, Kelly SAM. Effect on caries of restricting sugars intake. J Dent Res 2014; 93(1):8-18.	511	57		
3	Tinanoff N, Baez RJ, Diaz Guillory C, Donly KJ, Feldens CA, McGrath C, et al. Early21053childhood caries epidemiology, etiology, risk assessment, societal burden, management,education, and policy: Global perspective. Int J Paediatr Dent 2019; 29(3):238-248.53				
4	Gussy MG, Waters EG, Walsh O, Kilpatrick NM. Early childhood caries: Current evidence for etiology and prevention. J Paediatr Child Health 2006; 42(1-2):37-43.	152	9		
5	Gibson S, Williams S. Dental caries in pre-school children: Associations with social1476class, toothbrushing habit and consumption of sugars and sugar-containing foods.Caries Res 1999; 33(2):101-113.6				
6	Milnes AR. Description and epidemiology of nursing caries. J Public Health Dent 1996; 56(1):38-50.	141	5		
7	Tinanoff N, Reisine S. Update on Early Childhood Caries since the surgeon general's1319report. Acad Pediatr 2009; 9(6):396-403.				
8	Phantumvanit P, Makino Y, Ogawa H, Rugg-Gunn A, Moynihan P, Petersen PE, et al. WHO global consultation on public health intervention against Early Childhood Caries. Community Dent Oral Epidemiol 2018; 46(3):280-287.	123	25		
9	Tham R, Bowatte G, Dharmage S, Tan D, Lau M, Dai X, et al. Breastfeeding and the risk of dental caries: A systematic review and meta-analysis. Acta Paediatr 2015; 104:62-84.	122	15		
10	Hallett K, O'Rourke P. Social and behavioral determinants of early childhood caries. Aust Dent J 2003; 48(1):27-33.	118	6		
11	Dzidic M, Collado MC, Abrahamsson T, Artacho A, Stensson M, Jenmalm MC, et al. Oral microbiome development during childhood: An ecological succession influenced by postnatal factors and associated with tooth decay. ISME J 2018; 12(9):2292-2306.	113	23		
12	Iida H, Auinger P, Billings RJ, Weitzman M. Association between infant breastfeeding and Early Childhood Caries in the United States. Pediatrics 2007; 120(4):e944-952.	108	7		
13	Tinanoff N, Palmer CA. Dietary determinants of dental caries and dietary recommendations for preschool children. J Public Health Dent 2000; 60(3):197-206.	106	5		
14	Dye BA, Shenkin JD, Ogden CL, Marshall TA, Levy SM, Kanellis MJ. The relationship between healthy eating practices and dental caries in children aged 2–5 years in the United States, 1988–1994. J Am Dent Assoc 2004; 135(1):55-66.	104	5		

The continent with the highest number of contributing countries in the top 50 most cited articles was Europe, and the continent with the highest number of citations was South America (Figure 1). The United States led the publications (26% of articles and 1164 citations), followed by Australia (16% of articles and 720 citations), England (14% of articles and 945 citations), and Brazil (12% of articles and 3640 citations) (Figure 1). The most cited article is by Brazilian authors (3252).

The top 50 articles have been published in 25 journals. Thirty-four percent of the journals appear only once, 8% appear twice, and only two seem more than five times. The journal that published the most on the topic was *Community Dentistry and Oral Epidemiology* (12 articles), followed by *Caries Research* (6 articles) and *Journal of Dental Research* (4 articles). The first two journals were published over three decades. Regarding the number of citations, the five most cited journals were *The Lancet* (3252 citations), *Community Dentistry and Oral* 

Epidemiology (931 citations), Journal of Dental Research (696 citations), Caries Research (517 citations) and Journal of Public Health Dentistry (247 citations).

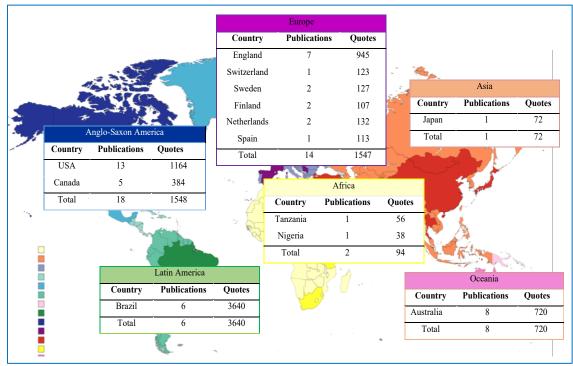


Figure 1. Distribution of publications and citations in the top 50 on a diet related to ECC in the first 1000 days of life by countries and continents.

There were 218 authors in the top 50 most-cited articles. The most cited authors were CG Victora, R Bahl, AJD Barros, GVA Franca, S Horton, J Krasevec, S Murch, MJ Sankar, N Walker, and Rollins NC (3252 citations each), followed by CA Feldens (724 citations) and MR Vitolo (391 citations). CA Feldens was the most frequent author (8 articles). The most interacting conglomerate occurs between five groups: CA Feldens, P Phantuvanit, N Pitts, N Tinanoff, and P Moynihan (Figure 2).

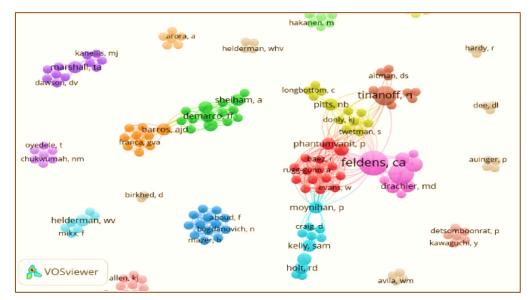


Figure 2. Collaboration network between top 50 authors on a diet related to ECC in the first 1000 days of life.



The majority of studies were cross-sectional (38%), followed by cohort studies (24%), literature reviews (18%), randomized controlled trials (10%), and systematic reviews (10%). The type of study with the most citations was literature reviews (4285 citations). The topic with the most publications was ECC and diet (22 articles, 1910 citations), followed by ECC – etiology and prevention (15 articles, 1522 citations), ECC and breastfeeding (11 articles, 4007 citations), and diet and the oral microbiota (2 articles, 182 citations). All topics, except diet and oral microbiota, showed increased publications and citations over the decades. The most cited topic was ECC and breastfeeding.

The final regression model demonstrated that literature reviews (RR = 5.287; 95% CI = 2.92-9.58) published by authors from Brazil (RR = 3.653; 95% CI = 1.35 - 9.88) and on ECC and breastfeeding (RR = 2.434; 95% CI = 1.32-4.48) had a higher citation rate in WoS-CC (Table 2).

Variables	N (%)	Total Number of Citations			
		Unadjusted RR (95% CI)	p <b>-</b> value	Adjusted RR (95% CI)	p-value
Study Design					
Literature review	4.285(56.0)	4.244 (0.94–19.21)	0.061	5.287 (2.92–9.58)	< 0.001
Observational	2.102(28.0)	0.625 (0.31-11.25)	0.184	1.17(0.48 - 2.83)	0.731
Others	1.234(16.0)	1		1	
Country					
Brazil	3.640(48.0)	6.676 (1.36–32.87)	0.020	3.653(1.35 - 9.88)	0.011
USA	1.164(15.0)	0.985 (0.64–1.50)	0.945	0.522(0.25 - 1.09)	0.083
Others	2.817(37.0)	1		1	
Topics of Interest					
ECC and breastfeeding	4.007(53.0)	3.634 (0.81–16.25)	0.091	2.434(1.32 - 4.48)	0.004
ECC and diet	1.910(25.0)	0.866 (0.52–1.44)	0.578	1.068(0.38 - 1.97)	0.900
Others	1.704(22.0)	1		1	
Publication Period					
1990-1999	747(10.0)	0.319 (0.10–1.03)	0.056	0.594 (9.30–1.16)	0.127
2000-2009	1.481 (19.0)	0.372 (0.12–1.17)	0.090	0.784 (0.44–1.39)	0.404
2010-2020	5.393(71.0)	1		1	

 Table 2. Poisson regression between the total number of citations in the Web of Science (Core Collection section) and bibliometric data.

N: Number of Publications; RR: Rate Ratio; CI: Confidence Interval.

# Discussion

This work evaluated the 50 most cited articles on the relationship between diet during the first 1000 days of life and ECC. This topic is quite relevant, as demonstrated by the growing number of publications. Most of the top 50 publications and citations are from 2010 to 2020, indicating an increasing interest in the topic.

The prevention of chronic non-communicable diseases such as obesity, diabetes, and caries has become urgent due to the high prevalence of these conditions throughout the world [4,6,9,10,20]. Among the diseases associated with inadequate diet during the first 1000 days of life, dental caries usually manifest at the earliest, presenting itself as a warning sign of long-term repercussions. The relationship between added sugar and ECC is well-established in the literature, but it was not yet associated with the diet of the first 1000 days of life. There was an increase in studies on the subject in recent decades, with studies on the diet of the first two years of life highlighting the importance of avoiding added sugar early in life and its long-term repercussions. Fourteen articles have been cited more than 100 times. Articles with more than 100 citations are often considered classics [21]. Articles with many citations can signal the potential to influence other studies and generate changes in clinical management [22]. However, some studies may have a high citation rate because they received criticism or are examples of methodological errors, in addition to the temporal bias by which articles tend to accumulate

more citations over time [23]. The citation density corrects this temporal bias by revealing articles with fewer absolute citations but a large number of citations per year of publication, which may reflect emerging research topics and trends. When evaluating the 14 most cited articles by citation density, only the first, second, and third most cited articles remained in these positions. This data highlights the need to evaluate the classification by absolute citations with caution to avoid overestimating work favored by time bias and/or underestimating relevant but recent work.

The continent that had published the most among the top 50 articles was Anglo-America, which corroborates with other studies in the Dentistry area [11,13-15]. Most of the world's research centers are located in the United States, and it is also where most investment in the area is concentrated [24]. The United States continues to have a high research output; however, regarding research on the diet during the first years of life, countries such as Australia, Brazil, and England stand out. This is per other bibliometric [14,15]. Indeed, Brazil had the highest citation rate on this topic.

Of the most cited authors, 10 authored the most cited article by Victora et al., published in *The Lancet* in 2016. This literature review of 22 systematic reviews with meta-analysis examined the relationship between breastfeeding and the health of the mother and baby. This article covers essential information about mortality, growth, overweight, blood pressure, tooth decay, and malocclusion in children, with complete information on breastfeeding and its implications. It is crucial that comprehensive and relevant work on the diet during early life also highlights the impact on ECC because, in addition to being a highly prevalent condition in childhood, it is the first disease to manifest itself in the case of inadequate diets.

CA Feldens was the author with the most publications and was the second most cited author. His research output includes cohort studies and randomized clinical trials demonstrating a positive relationship between diet and ECC during the first years of life. These studies do not represent the majority of the top 50 most cited articles, even though they are necessary to assess cause and effect, which shows a gap in research on the topic. Only two clusters stand out in the ranking, the largest of which is concentrated around CA Feldens, probably due to his work attracting international researchers. This prominence also allows new researchers interested in the topic to approach groups with more extraordinary methodological experience in carrying out work in the area. There is no consensus in the literature on the best way to select the most relevant authors since the number of citations alone may underestimate the contribution of other authors who research and publish on a given topic. This information stimulates discussion about which parameter is ideal for grading the relevance of an author.

Most studies cited were cross-sectional because they have low development and execution costs, besides practically no losses to follow-up [25], being the kind of study most easily carried out. Cohort studies and RCTs are the most suitable for evaluating the cause-effect relationship between diet and ECC, and the fact that they were not the most cited highlights a gap to be explored in research on the subject. Most cross-sectional studies (53% of those included) presented a low risk of bias. Regarding cohort studies, half of them presented a low risk and half a high risk of bias. In most articles, the RCTs demonstrated a low risk of bias (40%) or some concerns (40%). The systematic reviews in the ranking all presented a critically low risk of bias. The 1000-day diet and ECC study delves into aspects that direct interests by topics. The association between ECC and diet is the most recurrent in the top 50 since it is the topic with the most publications. Dental caries is one of the most prevalent chronic diseases in childhood [26,27], and studies on its development, preventive methods, and the influence of diet are still relevant. A high number of citations highlights trends, so ECC and breastfeeding have been among the topics of most significant interest to researchers on the subject. This was the most cited topic, a consistent result, given that the primary source of nutrition for these children during the first 1000 days of life is breast milk, and there are still socio-behavioral gaps that need to be elucidated in the health-disease process. Citation rates may progressively decline as information is absorbed into updated knowledge [23]. The topic of diet and oral microbiota showed a decline in the number of publications and citations, as the microbiota's role in tooth decay has been supplanted by the role of sugar in the occurrence of this disease [8]. Specific topics are in decline because their main questions have already been clarified, and this information allows research to be directed toward points that still do not have clear and applicable answers for preventing ECC. Although diet and breastfeeding associated with ECC are topics that have grown in recent decades in citations and publications, there is a lack of studies that discuss ways to make adherence to a healthy diet easier. These studies can foster new public policies that make healthy choices the easiest.

Self-citations were used in the total count of the most cited articles because disregarding this measure disadvantages authors in a list of the most cited articles. Authors working on a particular topic or in a niche field with few studies will cite their articles. In these cases, self-citation is not necessarily a bad practice but a consequence of an author being the most significant contributor in that scientific field [28].

Although it is impossible to say that more citations mean a study has better quality, the importance of bibliometric studies is indisputable. The data allow researchers and editors to understand a topic's relevance better – in this study, the relationship between the diet during the first 1000 days of life and ECC – in the international scientific scenario. Knowledge of themes, study designs, geographic distribution, and the authors most cited by peers can help formulate policies and assist clinicians and researchers in choosing scientific evidence for their decision-making processes. Current and relevant studies on the topic may have been excluded from the ranking, and this is an inherent limitation of a classification based on the number of citations.

#### Conclusion

The most cited articles on the relationship between the diet during the first 1000 days of life and ECC are literature reviews by Brazilian authors on ECC and breastfeeding. The journal that has published the most on the topic is *Community Dentistry and Oral Epidemiology*, and CA Feldens is the most frequent author. This study has addressed aspects and gaps to assist researchers and editors regarding the relationship between the diet during the first 1000 days of life and ECC.

# Authors' Contributions

NRPR	D	https://orcid.org/0009-0006-7293-5288	Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing -	
			Original Draft and Writing - Review and Editing.	
ACSL	D	https://orcid.org/0009-0004-0338-5177	Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing -	
			Original Draft and Writing - Review and Editing.	
LFADN	Л 🝺	https://orcid.org/0000-0002-4112-1533	Conceptualization, Methodology, Writing - Original Draft and Writing - Review and Editing.	
CCBL	D	https://orcid.org/0000-0002-2977-6035	Conceptualization, Methodology, Validation, Formal Analysis, Writing - Original Draft and	
			Writing - Review and Editing.	
MDML	· (D	https://orcid.org/0000-0002-7641-6331	Conceptualization, Methodology, Writing - Original Draft and Writing - Review and Editing.	
PAMJ	D	https://orcid.org/0000-0002-1575-5364	Conceptualization, Methodology, Writing - Original Draft and Writing - Review and Editing.	
MSM	D	https://orcid.org/0000-0002-9044-9025	Conceptualization, Methodology, Validation, Formal Analysis, Writing - Original Draft,	
			Writing - Review and Editing, Supervision and Project Administration.	
All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.				

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None.

# Conflict of Interest

The authors declare no conflicts of interest.

# Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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