Concise Review

Early Childhood Caries and Dental Public Health Programmes in Hong Kong

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ABSTRACT

The objective of this study was to investigate the relationship amongst early childhood caries (ECC), economic development, and dental public health programmes in Hong Kong. We searched exhaustively qualitative and quantitative data on the oral health policy, dental service, public health strategies of caries control and epidemiologic surveys on ECC. We then performed meta-regression to explore the impact of the Human Development Index (HDI), gross domestic product (GDP) growth, water fluoridation, oral health promotion, dental school establishment, free education, and dental workforce on ECC prevalence in 5-year-olds. We found that the first government oral health survey was conducted in 1960, when Hong Kong experienced significant growth, as the HDI indicated. The survey revealed that 97% of 6- to 8-year-old children experienced ECC. Water fluoridation was implemented in 1961 at 0.7 ppm (0.9 ppm in winter) to prevent caries. The government offered free 9-year education in 1978. In 1981, the government established a dental school to improve a low dentist-to-population ratio of 1:9000. The ECC prevalence amongst 5- to 6- year-old children was reduced from 84% in 1968 to 63% in 1986. The Department of Health created an oral health education division in 1989. The ECC prevalence for 5-year-old children was further reduced to 44% in 1997. The ECC prevalence amongst 5-year-old children was stabilised at 51% both in 2001 and 2011. However in 2021, the prevalence of untreated ECC increased to 57% during the outbreak of COVID-19. Meta-regression analysis showed that ECC prevalence was not linked to GDP growth but decreased with improvements in HDI, the provision of 9-year free education, the establishment of a dental school, fluoridation of water supply, and implementation of territory-wide oral health promotion. In conclusion, better education, living conditions, and dental public health programmes have improved children's oral health in Hong Kong.

Introduction

The American Academy of Pediatric Dentistry defined early childhood caries (ECC) as the presence of tooth decay in a child younger than 6 years old.[1] ECC causes pain and infection. Untreated ECC can progress into the tooth pulp, cause local infection, and form dental abscesses. The local infection can spread systemically to cause serious illness and even death.[2] The prevalence of ECC in the US is estimated to be 6%.[3] The ECC prevalence in Europe ranged from 11% in Sweden to 36% in Greece[3]. Some countries showed even higher ECC prevalence, such as Brazil (46%) in South America and Israel in the Middle East (65%).[3] Some Asian countries, such as Cambodia (93%) and the Philippines (88%) had high ECC prevalence.[4] In Hong Kong, 51% of 5-year-olds had ECC experience, and 92% were left untreated.[5] The ECC experience in the 5-year-old Hong Kong children as measured by the mean decayed, missing, and filled teeth (dmft) value was 2.5. Untreated ECC affected 57% of 5-year-old Hong Kong children.[6]

Hong Kong is a densely populated city, with 7.4 million people living in a 1100-square-kilometre territory. Its economy and human life level underwent considerable transformations from the 1960s to 2020. Gross domestic product (GDP) is a commonly used measure of economic activity and is a good indicator to track a country's economic health. Economic growth (GDP

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growth) refers to the percentage change in real GDP. Rapid industrialisation in the 1960s and 1970s led to economic expansion, job creation, and population growth in Hong Kong. In the 1980s and 1990s, the city transitioned towards a service-based economy, with finance, tourism, trade, and professional services growth. Since 1997, Hong Kong has become a special administrative region of China and has brought new opportunities and challenges. The overall quality of life has remained high since then. The development of Hong Kong can also be measured through the Human Development Index (HDI), which summarises achievements in key dimensions of human development. The HDI of Hong Kong has consistently ranked amongst the highest in the world, reflecting improvements in education, health care, and living standards.

Amid Hong Kong's rapid economic and educational growth, the government implemented dental public health measures to enhance the population's well-being, including oral health programmes. These practices have included prevention strategies, oral health education, and the School Dental Care Service provision. The School Dental Care Service, launched in 1980, offers highly subsidised dental services to primary school students aged 6 or older.

Because preschool children younger than 6 remain underserved, their lack of organised or public dental care to the preschool children contributes to persistently high ECC prevalence. The Department of Health has implemented various oral health promotion initiatives targeting preschool children in response to this public health challenge. The number of dentists could not meet public demand, and the dentist-to-population ratio is low.[7] In 1981, the government established the first and only dental school in Hong Kong to improve the dentist-to-population ratio[8]; however, Hong Kong still faces a severe dental workforce shortage. No comprehensive historical evaluation has been conducted on the ECC status of Hong Kong children from the 1960s to 2020. Therefore, this study will review the available epidemiologic data and information on ECC prevalence in 5-year-old Hong Kong children.

Method

Data collection

We performed a literature search on various materials related to the caries status of 5-year-old children in Hong Kong. These materials included governmental oral health reports, documents of oral health policy released by the Legislative Council, oral health service reports and oral health surveys by the Department of Health, community service reports by the University of Hong Kong, and journal articles archived in the PubMed database. Qualitative and quantitative data on the oral health surveys, oral health policy, dental services, and public health strategies for ECC control in Hong Kong were collected to investigate the ECC prevalence and identify potential areas for improvement in oral health promotion initiatives in Hong Kong. The oral health reports and data were collected from the period after 1960 when children were the focus of dental public health practices.

Data analysis

A meta-regression was performed to explore the effects of HDI, GDP growth, water fluoridation, territory-wide oral health promotion by the Department of Health, the establishment of a dental school to train dentists, provision of 9-year free education, and the dental workforce (dentist-to-population ratio) on the ECC prevalence of 5-year-old children in Hong Kong.

Results

ECC in Hong Kong

The first oral health survey conducted in 1960 by the Department of Health examined 6- to 8-year-old children. The ECC experience as measured by the mean dmft in 6-to 8-year-olds was 9.2[9] (Table 1). The second and third epidemiologic surveys examined 5- to 6-year-old children after the implementation of water fluoridation in 1961. In 1968, the Department of Health conducted the second survey and found the ECC experience in mean dmft was 5.3.[10] The University of Hong Kong conducted a survey in 1986 and found that the ECC experience decreased to 3.2.[11] The subsequent 7 surveys used random cluster sampling to recruit 5-year-old children. These surveys followed the basic method of oral health survey in caries diagnosis recommended by the World Health Organization (WHO).[12] This caries assessment method diagnoses ECC at the cavitation level. The mean dmft for 5-year-old children was further reduced to 1.8 in 1997 before Hong Kong became a special administrative region of China.[13] Since 1997, when China regains its

Table 1 – Epidemiologic surveys on experience and prevalence of early childhood caries (ECC) in Hong Kong.

Year	Reporting institution (reference)	Sample size	Age (y)	ECC prevalence (%)	ECC experience (dmft)
1960	Government[9]	NA	6-8	97%	9.2
1968	Government[10]	657	5-6	84%	5.3
1986	University[11]	977	5-6	63%	3.2
1997	University[13]	367	5	44%	1.8
2001	Government[14]	3,733	5	51%	2.3
2009	University[16]	338	5	48%	2.3
2011	Government[5]	1,728	5	51%	2.5
2016	University[15]	459	5	55%	2.7
2019	University[6]	404	5	57% *	2.8*

* dt, untreated caries.

sovereignty, many children from mainland China where water was not fluoridated have immigrated to Hong Kong. In 2001, the Department of Health conducted its second oral health survey and found the mean dmft of 5-year-old children was 2.3.[14] In 2011, the third oral health survey by the Department of Health reported a slight increase in the mean dmft of 5-year-old children to 2.5.[5] A subsequent survey by the university in 2016 showed an increase in the mean dmft to 2.7.[15] Although the COVID-19 epidemic delayed the fourth oral health survey, a survey in 2019 reported the untreated ECC (dt) of the 5-year-old children was 2.8.[6]

Economic development in Hong Kong

Since the 1960s, the GDP growth rate generally increased, but several points functioned as adverse shocks, such as the financial crisis in 2008 and COVID-19 since 2020. The GDP in Hong Kong averaged USD 120 billion from 1960 until 2021, reaching an all-time high of USD 368 billion in 2021 and a record of only USD 1 billion in 1960.[17] Paralleled to its rapid economic growth in GDP, Hong Kong has significantly increased its HDI. Hong Kong's HDI score has consistently ranked amongst the highest in the world, from 0.56 in 1960[18] to 0.95 in 2019,[19] indicating a significant improvement in the city's social and economic development over the years.

Education development in Hong Kong

Before the 1960s, many children in Hong Kong had little access to education due to poverty and other social and economic factors. In 1978, the government offered free 9-year education to harmoniously redistribute knowledge and skill resources. As the population increased and more people became aware of the importance of education, the government had to expand educational opportunities to society. Through a series of measures, the proportion of the population aged 15 and older having attended secondary and higher education gradually increased from less than 6% in 1968[20] to 82% in 2019[21].

Oral health policy and dental service in Hong Kong

The government's oral health policy promotes awareness of oral hygiene and encourages proper habits for oral disease prevention. The dental service sector in Hong Kong is predominantly composed of private practice dentists. Before 1973, there were only about 440 practising dentists in Hong Kong, leading to a low dentist-to-population ratio of approximately 1:9000.[7] The government established a dental school and an accompanying dental hospital for teaching purposes in 1981. The first batch of 60 graduates entered dental practice in 1985. By 2021, the number of practising dentists in Hong Kong had increased to 2706,[22] increasing the dentist-to-population ratio to approximately 1:3000.

Water fluoridation in Hong Kong

The Water Supplies Department introduced 0.7 ppm (0.9 ppm for winter months) of fluoride into the water supply in 1961.[23] It adjusted the water fluoride level to 1.0 ppm in 1967. The fluoride level was reduced to 0.7 ppm in 1978[24] and further reduced to 0.5 ppm in 1988 because of concerns about an increased prevalence of dental fluorosis in the population (Figure 1). The annual expenditure of the Water Supplies Department in 2022 on water fluoridation is about USD 2 million. Hence, the annual cost of water fluoridation to 7.4 million Hong Kong people is USD 0.3 per person.

Oral health promotion for preschool children in Hong Kong

The Department of Health introduced the School Dental Care Service in 1980 for primary school children aged 6 and older.[25] However, this service does not cover preschool children. In 1989, the Department of Health established the Oral Health

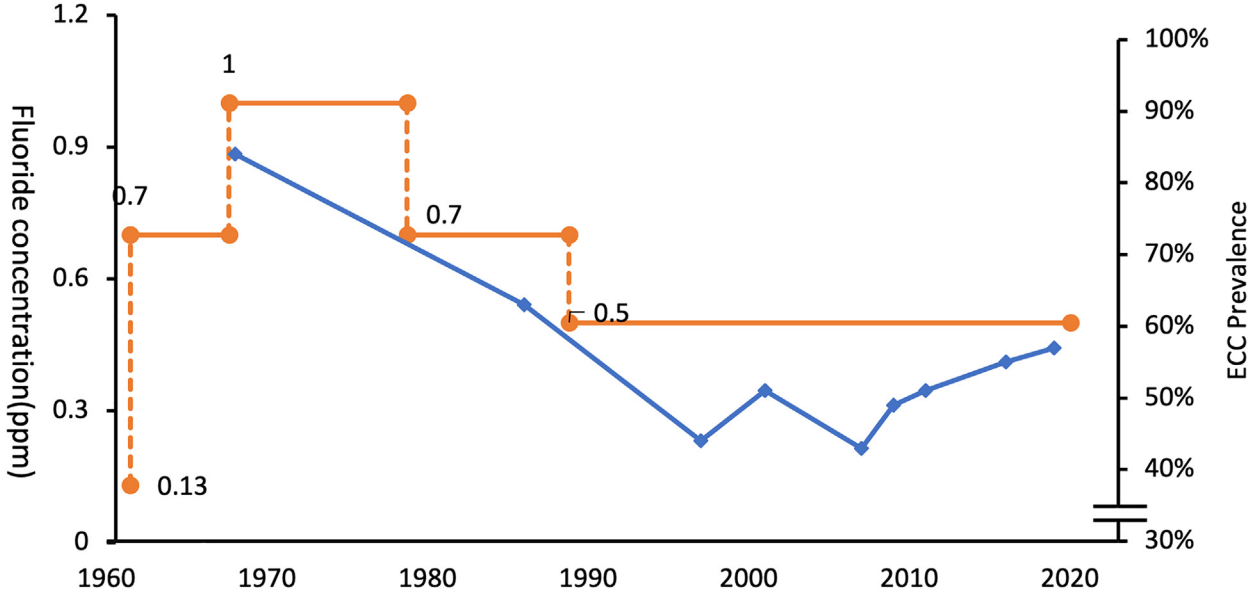

Fig. 1 – Water fluoridation and early childhood caries (ECC) prevalence from 1960 in Hong Kong.

Table 2 – Meta-regression of the studied factors on early childhood caries (ECC) preference in Hong Kong

Factor	Coefficient	95% confidence interval	*P* value
Human Development Index (HDI)	−0.743	(−1.186 , −0.301)	.001
Water fluoridation	−0.312	(−0.438, −0.186)	<.001
Territory-wide oral health promotion	−0.225	(−0.343, −0.107)	<.001
Establishment of dental school to train dentist	−0.312	(−0.438 ,−0.186)	<.001
Provision of 9-year free education	−0.312	(−0.438, −0.186)	<.001
Dental workforce (dentist-to-population ratio)	−901.808	(−1755.736 ,−47.880)	.038
Gross domestic product (GDP) growth	0.007	(−0.016, 0.029)	.568

Education Division to improve oral health awareness and promote preventive care for children and their parents. The Oral Health Education Division introduced the Brighter Smiles for the New Generations programme in 1993.[25] This large-scale programme promotes oral health awareness by educating children younger than 6 years about good oral health–related behaviour. As of March 2020, approximately two-thirds (68%) of kindergartens have joined this programme.[25]

Meta-regression of ECC prevalence

This study included 8 surveys for analysis (Table 2). Meta-regression showed a negative correlation amongst ECC prevalence, HDI (*P* = .001), and the dentist-to-population ratio (*P* = .038). Additionally, ECC prevalence decreased with improvements in the provision of 9-year free education, the establishment of a dental school (*P* < .001), the implementation of water fluoridation (*P* < .001), and territory-wide oral health promotion efforts (*P* < .001). Figure 2 shows the ECC experience and oral health–related events from 1960 in Hong Kong.

Discussion

In recent years, dentistry in Hong Kong has progressed along with economic development, and the government has implemented public health policies to enhance oral health care. However, information on the impact of these initiatives on

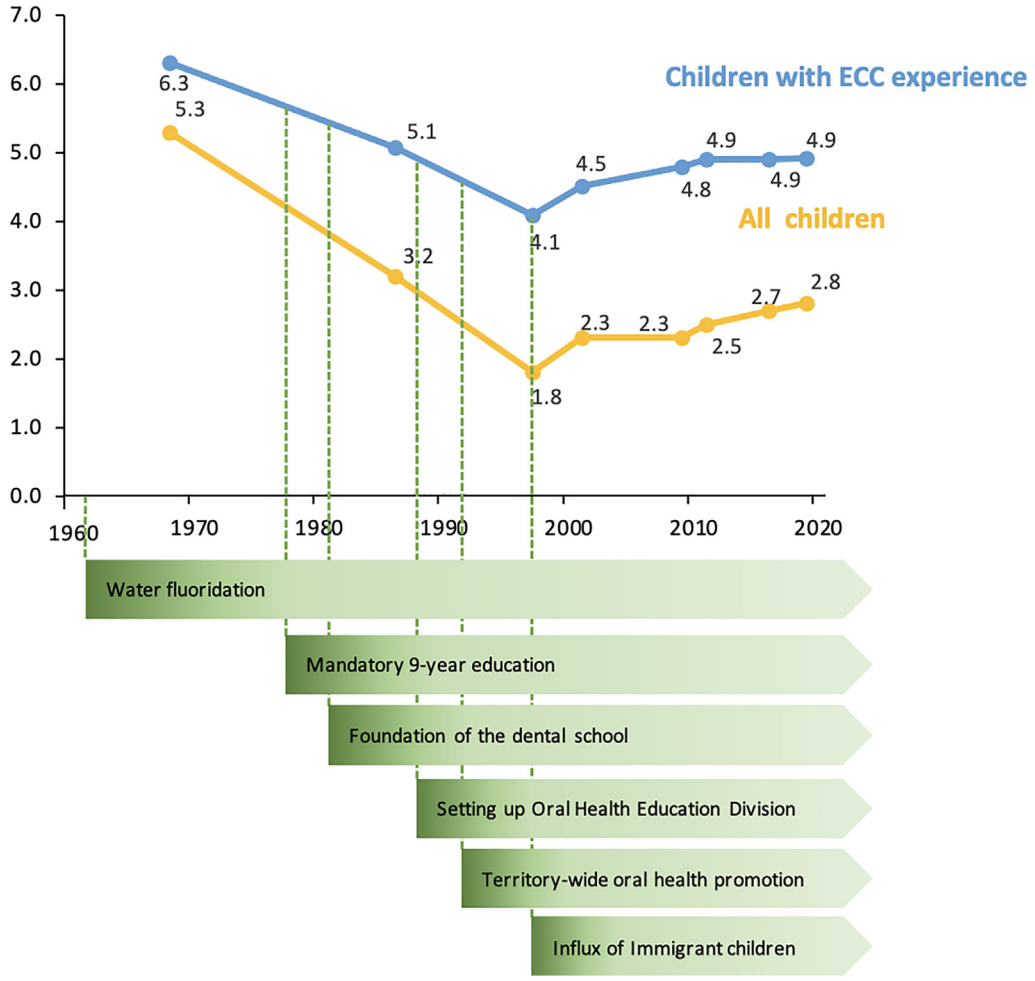

Fig. 2 – Early childhood caries (ECC) experience and oral health–related events from 1960 in Hong Kong.

the oral health of Hong Kong children is limited, partly due to restricted access to findings from earlier government reports.

Hong Kong flourished both in human and economic development in the 1960s. HDI measures human development in terms of average achievement of life expectancy, access to education, and financial situation. We found that ECC has significantly decreased with the rapid development since the 1960s in Hong Kong, and the HDI is negatively associated with ECC prevalence. Generally, economic growth is linked to rising health service costs, whilst the economic recession has the opposite effect. However, this study did not link GDP growth and ECC prevalence.

People with higher education levels are more likely to be aware of the importance of oral hygiene, the causes of dental caries, and the need for regular dental check-ups. Based on the result of meta-regression, improving overall education levels are very important in ECC control. Additionally, a study reported that increasing the share of GDP on education may reduce the caries burden in children globally.[26] People with higher education levels are more likely to engage in healthy behaviours. Parents with higher education levels are also more likely to have better access to dental care for their children due to higher income and better health insurance coverage.

Food consumption increased with the improvement in the living standard in Hong Kong. Sugar consumption also increased, and this could affect the ECC prevalence. The sugar consumption in Hong Kong has been steadily rising over the years. It exceeds the WHO's recommended upper limit for safe sugar intake.[27,28] However, we could not find relevant data on sugar consumption of children in Hong Kong. The lack of data on sugar consumption for analysis is a limitation of this review.

During the 1960s, the Department of Health developed dental public health measures to improve the population's oral health, particularly for children. The government also offered scholarships annually for Hong Kong residents to study dentistry at overseas dental schools, with recipients obliged to serve in the Department of Health after graduation. Although a few dentists started practising in Hong Kong, the workforce remained limited, leading to a dentist-to-population ratio of about 1:9000.[7] The government established a dental school in 1980 to address the shortage of dentists. However, due to the ongoing understaffing of dentists, preschool students continue to face challenges in receiving adequate and appropriate dental services for caries prevention and treatment.[29]

The WHO Health 21 set a goal for 2020 to ensure at least 80% of children aged 5 to 6 years old are caries-free.[30] The Netherlands achieved 91% of children who were caries-free in 1998.[31] The Dutch health care system is known for its universal coverage and high-quality care. Health insurance generally covers dental care for children younger than 18.[32] Moreover, the children have easy access to dental service care because of the high density of dental practices in the Netherlands. The limited dentist workforce and the high ECC prevalence affect the access, availability, and even affordability of dental services in Hong Kong.

Water fluoridation is the primary strategy for preventing dental caries in Hong Kong.[8] A Cochrane Review concluded that water fluoridation prevents dental caries with a 35% reduction in the dmft score.[33] In the United States, water fluoridation is an inexpensive and cost-effective strategy for caries prevention.[34] In the United Kingdom, a more than 50% reduction in the ECC experience of children living in the fluoridated districts of Birmingham has provided strong evidence of the fluoride effect on caries prevention.[35] Singapore was the first country to implement water fluoridation in Asia in 1958.[36] The Ministry of Health of Singapore reported decreased ECC prevalence after water fluoridation.[37] The Singapore government also promotes the use of fluoride toothpaste, which is readily available and affordable. Hong Kong in many aspects is similar to Singapore. The marked reduction in the ECC prevalence can be strong evidence of caries prevention by water fluoridation and the promotion of fluoride-toothpaste use by the Department of Health.

Some people are against water fluoridation. The opposition to water fluoridation has spread due to a better-educated populace with different political voices and a myriad of online antifluoridation materials.[38] Nevertheless, evidence from the literature does not support such links.[39,40] It is generally accepted that water fluoridation with fluoride concentration below 0.7 ppm has no significant side effects.[41] The Hong Kong government provides fluoridated water supply to all residents for caries prevention.[42] Moreover, the Department of Health promotes the use of fluoride toothpaste amongst children, which is readily available and affordable in Hong Kong.

The ECC prevalence and experience declined from the 1960s to the 1990s, but it mildly increased from 2001. When China regained its sovereignty over Hong Kong in 1997, many children from mainland China, where water was not fluoridated, immigrated to Hong Kong. Whilst relevant data on preschool children are not available, many mainland migrants came, and they constituted approximately 13% of the city's total population by 2016.[43] Additionally, eligible students living in mainland China can attend school in Hong Kong. A recent news report reported that an estimated 21,000 children in 2023 were crossing the border from the mainland to attend schools in Hong Kong.[44]

Oral health promotion can improve not only oral health but also overall health and well-being of children. However, oral health inequalities will only be reduced by implementing an effective and appropriate oral health promotion policy.[45] In Japan, the success of oral health promotion results in a marked reduction in ECC prevalence.[46] The government provides the *Maternal and Child Health Handbook*, which records the child's oral health–related information up to 6 years of age. The dentists at the health centre offer regular oral health examinations and preventive services for children older than 18 months.[46] In Hong Kong, the Department of Health launched a territory-wide oral health promotion,[47] and analysis in this study showed that it contributed to ECC reduction.

The gap in ECC experience between children with ECC and all children was getting larger after 2000 compared with the period from the 1960s to the 1990s. The latest oral health survey report by the Department of Health in 2011 found that 81% of the decayed teeth were found in 26% of the 5-year-old children, whereas 49% of the children had no ECC

experience.[5] These findings corroborated the situation in the United Kingdom.[45] There were widening inequalities in oral health amongst social classes, regions of the country, and certain ethnic minority populations.

Dental public health workers should revisit their oral health policy and focus on reducing preschool children's inequalities in oral health. Developing and implementing effective and appropriate oral health promotion policies is essential to reduce the oral health inequalities in preschool children. Children from disadvantaged and socially marginalised populations had a higher caries experience and severity.[11,13,16,48] Therefore, preventive care should target the underprivileged population. In Hong Kong, 75% of preschool children have never visited a dentist, and the prevalence of ECC increased from 38% for 3-year-olds to 55% for 5-year-olds.[49] Hence, a territory-wide outreach dental service was launched in 2019 to provide kindergarten children with a free dental examination and fluoride therapy.[50] A follow-up of a sample of kindergarten children showed that the ECC prevalence reduced from 43% in 2010 to 34% in 2019.

Conclusion

The ECC prevalence decreased with the social and economic development, the provision of mandatory education, the establishment of a dental school, the implementation of water fluoridation, and the territory-wide oral health promotion. Although the overall children's oral health has improved with better education and living conditions, there is a widening in oral health inequalities with a small portion of the child's population living with the majority of the ECC. Dental public health workers should develop effective and appropriate oral health promotion policies to reduce oral health inequalities.

Conflict of interest

None disclosed.

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Author contributions

Faith Miaomiao Zheng: drafting the article or revising it critically for important intellectual content, analysis and interpretation of data. Iliana Gehui Yan: interpretation of data. Ivy Guofang Sun: interpretation of data. Duangporn Duangthip: analysis and interpretation of data. Edward Chin Man Lo: final approval of the version to be submitted. Chun Hung Chu: the conception and design of the study, final approval of the version to be submitted, funding acquisition.

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