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Early childhood caries and related risk factors in Mongolian children

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Objectives: The aims of this study were to investigate the dental caries experience among 1-5 year-old children in the two areas of Ulaanbaatar city, and to examine the relationship of dental caries experience with socioeconomic status, eating behaviors, oral hygiene habits, dental plaque accumulation and *Mutans Streptococci* level. ***Methods:*** In 2004/2005, 670 children from the two areas were examined and a questionnaire survey was conducted. *Mutans streptococci* (*MS*) levels in the children's and mothers' dental plaque were evaluated using Dentocult® SM. ***Results:*** Dental caries prevalence (72%) and mean dmft (4.4) were very high in both areas, however, children in the central area showed higher caries severity than those in the suburban area in 3-5-year olds ($p<0.05$). Higher family income and education level of the mothers were significantly associated with children's higher caries experience. Furthermore, dental caries showed a significant positive relationship with sweets intake and a negative relationship with tooth brushing habits of the children. The children's caries experience was significantly and positively associated with modified debris index (m-DI) scores, and the *MS* levels in their own and their mothers' dental plaque. Area, sweets intake, prolonged breastfeeding, and high *MS* level in the dental plaque resulted in significant odds ratios for the development of caries. ***Conclusions:*** The prevalence of dental caries amongst 1-5 year-old children in Ulaanbaatar City, Mongolia was found to be high and was associated with socioeconomic, demographic and behavioural factors.

Key words: Early childhood caries, epidemiology, risk factor, Mongolia,

Introduction

Mongolia is a developing country, currently in an economically intensive transitional period after the democratic revolution of 1990. During this transition to a market-oriented economy, Mongolian society has faced many demographic and socioeconomic changes. This is especially evident in Ulaanbaatar, the capital city of Mongolia. Founded in 1639, this city with a population of 928,500 (from a total Mongolian population of 2,533,100) is the political and cultural centre of the country. For economic reasons, a great migration to Ulaanbaatar city began in 1990 and has not slowed down (National Statistical Office of Mongolia, 2005). The resulting urbanization and westernization of the lifestyle have changed the Mongolian diet from one traditionally dominated by milk and meat products to more cariogenic sugar-containing food and beverage products. In 2001, for example, Mongolia imported $US5.27 million sugar confectionery and it rose to $US10.67 million by 2005. Similarly, in 2001, $US4.02 million of chocolate products were imported, and by 2005 it rose to $US9.55 million (ITC-International Trade Statistics by Country and Product-Mongolia,). This change is likely to have a great, long-term impact on the general health as well as on the dental health of Mongolian people.

No national dental health survey has yet been conducted in Mongolia. There is little nationwide information related to dental health, because dental health problems are given low priority. There is also a lack of experienced dentists and a scarcity of financial support for large epidemiological surveys. The rapidly changing social background by internal migration and westernization makes investigation of the influence of social and behavioral factors on dental health, identification of the risk factors, and development of strategies to solve any detected problems extremely urgent.

Previous studies conducted in Ulaanbaatar city indicated that early childhood caries (ECC) is common, rapidly progressing, and is being inadequately treated (Oyunbat, 1993, Oyuntsetseg et al., 2004). The early implementation of preventive programs for ECC is important, when the primary teeth first erupt, as bacteria first colonize the tooth surfaces, and dental behaviors are starting to develop.

To provide basic data for planning appropriate oral-health-promotion programs for Mongolian preschool children, we investigated the current caries experience of preschool children and analyzed its relationship with socioeconomic status, dietary behaviors, oral-hygiene habits, dental plaque and *Mutans streptococci* level.

Methods

Two districts in Ulaanbaatar city were selected for the survey, one in the central area of the city and the other in the surrounding suburbs. Fluoride concentrations in the water supply were low (0.01-0.02 ppm) in both

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areas. The central area was selected as representative of an urbanized downtown area where residential and commercial regions are mixed, and most of the residents (original citizens) live in apartments or private houses. The selected suburban area is a newly developing agricultural region located on the west side of Ulaanbaatar, and most of the residents who emigrated from rural areas still live in Mongolian traditional gers (felt dwellings with stove heating and well water).

A total of 670 children aged 1-5 years (327 in the central area and 343 in the suburban area) were voluntarily enrolled in this study in 2004/2005. From those children, 1-2-year-olds were involved in the survey together with their mothers and were examined in eight family clinics (four from the central area and four from the suburban area). Three- to five-year-old children were examined in three kindergartens (two from the central area and one from the suburban area). Consent to participate in the study was obtained from mothers/caregivers.

All mothers/caregivers were interviewed on the day of the dental examination by trained dental assistants. Preliminary tests on questionnaire design, contents and English-Mongolian-English translation reliability were done before conducting the survey. Final questionnaire items included questions regarding the socioeconomic status (accommodation, family monthly income, mother's education level, occupational status), the child's feeding history, dietary behaviors and oral-hygiene habits.

Oral examinations of children and their mothers were conducted by three pre-trained and calibrated dentists. The intra-examiner Kappa scores were 0.97-0.98 for caries detection. The inter-examiner reliability scores were above 0.80. All children had a knee-to-knee dental examination (Ramos-Gomez, 2002). After assessing the plaque and sampling for MS detection, children had their teeth brushed by the examiner. Then all tooth surfaces were examined using a dental mirror (Osada, Japan). Additionally, teeth were inspected using a CPI probe if doubtful caries was found. Radiographs were not taken for caries assessments because of the young age of the subjects. Each tooth was examined and scored, based on WHO standard criteria (WHO, 1997).

The dental plaque of children was assessed by sliding a CPI probe's tip horizontally on the labial surfaces of all erupted incisors. A modified Debris Index (m-DI) of the Oral Hygiene Index (OHI) criteria by Greene and Vermillion was used to evaluate the amount of dental plaque, and the worst score of all checked incisors was recorded. Dental plaque of 1-2-year-old children (n=255) together with their mothers' dental plaque were sampled and used for *Mutans streptococci* (*MS*) detection. "Dentocult® SM" strips (Orion Diagnostica, Espoo, Finland) were used for the evaluation of *MS* level of plaque samples. The *MS* level was assessed by comparing the colony density on the test strip with the product model chart (score 0: <10,000 CFU, score 1: ≥10,000 and <100,000 CFU, score 2: 100,000-1,000,000 CFU and score 3: >1,000,000 CFU).

Chi-square tests were used to compare distributional differences of the socioeconomic and behavioral variables between the central and the suburban areas. Non-parametric Mann-Witney tests were performed to assess the differences by age of caries experience of children between the two areas. For the analysis of relationships between ECC experience and questionnaire variables non-parametric tests were also used. Spearman's correlation analysis was conducted to detect association between dmft, tooth brushing experience, m-DI score and *MS* in the plaque. Differences in the means of m-DI scores by age were evaluated using ANOVA with a Bonferroni multiple comparison test.

Logistic regression models were used to estimate the independent effect of each variable on dmft (0: dmft=0 and 1: dmft≥1) for 1-2-year olds and severity of caries (0: dmft<6 and 1: dmft≥6) for 3-5-year olds. To reduce the degree of multi-collinearity of variables a series of single and multiple linear and logistic analyses using various combinations of variables were performed. Two variables on "family income" and "mother's education level" were excluded from the final models because of strong multi-collinearity with another socioeconomic variable "area". Statistical significance was set at $p<0.05$. Data were analyzed using the Statistical Package for Social Science (SPSS 11.5 version).

This research was approved by Ethical Committee of Tokyo Medical and Dental University in Japan. The research funding was provided by Tokyo Medical and Dental University.

Results

All mothers/caregivers of 670 children (Table 1) completed the questionnaire survey. Table 2 shows that socio-economic characteristics such as family income,

Table 1. The number of children by area, age and gender

Age (years)	*Central*		*Total (%)*	*Suburban*		*Total (%)*
	Boy	*Girl*		*Boy*	*Girl*	
1	51	46	97 (29.7)	34	31	65 (18.9)
2	38	32	70 (21.4)	31	42	73 (21.3)
3	11	14	25 (7.6)	28	18	46 (13.4)
4	23	24	47 (14.4)	31	39	70 (20.4)
5	37	51	88 (26.9)	45	44	89 (25.9)
Total	160	167	327 (100)	169	174	343 (100)

Table 2. Socio-economic and behavioural differences between the two areas

Questionnaire item	*Area*				
	Central		*Suburban*		*p-value*
	%	*N*	*%*	*N*	
Family					
Low (150,000 Tugrig[a])	28	90	79	271	<0.001
High (>=150,000 Tugrig)	72	237	21	72	
Mother's education					
High school or lower	22	71	81	279	<0.001
University or higher	78	256	19	64	
Accommodation					
Apartment	100	327	0	0	<0.001
Mongolian ger	0	0	100	342	
Working mother (until 2 year old)					
Yes	75	244	52	179	<0.001
No	25	83	48	164	
Feeding practice					
Breastfeeding	66	215	80	274	<0.001
Other types of feeding	34	112	20	69	

Questionnaire item	*Area*				
	Central		*Suburban*		*p-value*
	%	*N*	*%*	*N*	
Weaning age of breastfeeding[b]					
Before 2-year old	49	48	40	63	0.107
From 2-year old and after	51	50	60	94	
Sweets intake					
Yes	78	256	68	233	0.002
No	22	71	32	110	
Sweets intake frequency					
Often	76	248	43	146	<0.001
Occasionally	24	79	57	197	
Current toothbrushing					
Yes	73	237	74	253	0.387
No	27	90	26	90	
Fluoride toothpaste[c]					
Yes	88	209	94	238	0.016
No	12	28	6	15	

a: equivalent to 135US$
b: 3-5-year old children
c: children who brush teeth

Table 3. The differences in caries experience between the two areas

Age (years)	*Area*	*n*	*Caries prevalence*	*p-value*	*Mean dmft (SD)*	*p-vale*	*Mean dt (SD)*	*p-value*	*Mean mt (SD)*	*p-value*	*Mean ft (SD)*	*p-value*
1	Central	97	32.0		1.31		1.29		0		0.04	
	Suburban	65	24.6	0.135	0.80	0.218	0.80	0.228	0		0	
	Total	162	29.0		1.12 (2.14)		1.09		0		0.02	
2	Central	70	77.1		3.73		3.59		0.17		0.07	
	Suburban	73	60.3	0.023	2.93	0.031	2.85	0.041	0.07	0.446	0.01	0.526
	Total	143	68.5		3.32		3.21		0.07		0.04	
3	Central	25	96.0		6.68		5.88		0.16		0.72	
	Suburban	46	80.4	0.068	4.00	0.001	3.87	0.060	0.09	0.262	0.04	<0.001
	Total	71	85.9		4.94		4.58 (4.10)		0.11		0.28	
4	Central	47	97.9		7.74		6.91		0.13		0.79	
	Suburban	70	90.0	0.042	5.56	0.005	5.50	0.065	0.09	0.190	0.01	<0.001
	Total	117	93.2		6.44		6.07		0.12		0.32	
5	Central	88	96.6		8.60		7.23		0.17		1.25	
	Suburban	89	94.4	0.366	6.62	0.004	6.28	0.223	0.25	0.639	0.13	<0.001
	Total	177	95.5		7.60		6.75		0.21		0.69	
Total	Central	327	73.4		5.13		4.54		0.09		0.53	
	Suburban	343	71.1	0.226	4.16	0.021	4.03	0.214	0.11	0.98	0.05	<0.001
	Total	670	72.2		4.64		4.28		0.10		0.28	

mother's education level and working status, and living environments of children were significantly different between the two areas. Breastfeeding was significantly more dominant among suburban children than those in central area. In both areas, more than half of 3-5-year-olds showed a delayed weaning age. Sweet snacks were popular in bothareas, however, children who more frequently had a sweet diet were more prevalent in the central than in the suburban area. The majority of children in both areas brushed their teeth and used fluoride toothpaste. Interestingly, the fluoride toothpaste usage rate was higher in the suburban than in the central area.

Chi-square test showed statistically significant differences for caries prevalence between the two areas which were found for 2- and 4-year-old children, while the non-parametric Mann-Witney tests found significant differences for the number of carious teeth in all ages of children except 1-year-olds. Treatment rates were very low in all children, however, the number of filled teeth was significantly higher in the central area than the suburban area for children over two years of age. As age increased, a decrease in the number of caries-free subjects and a gradual increase in the number of children with multiple carious teeth were observed. The rate of children with six or more carious teeth was 7% in 1-year-olds, 22% in 2-year-olds, 41% in 3-year-olds, 57% in 4-year-olds and 63% in 5-year-olds.

Dental plaque score 0 was observed in 13% of children, 1 in 31%, 2 in 34% and 3 in 23%. The means of m-DI scores increased with age; in 1-year-olds 0.76±0.68, in 2-year-olds 1.31±0.87, in 3-year-olds 2.08±0.75, in 4-year-olds 2.19±0.67 and in 5-year-olds 2.29±0.68. Significant differences in dental plaque scores were observed between younger and older age children. Children with higher m-DI score had higher dmft (Table 4). The Dentocult®SM showed that early *MS* infection was common among children (84% in 1-year-olds and 92% in 2-year-olds), and 92% of mothers were also *MS* positive. Significant associations were detected between children's *MS* levels and related variables. The mean number of carious teeth of the children increased with the *MS* colonization level. Children with a higher *MS* infection score had higher dmft. A significant difference was observed between *MS* scores 0 and 3 only.

Table 4. Correlation coefficients of child's and mother's MS level with m-DI score and dmft (n=255)

		Child's	
	dmft	*m-DI*	*MS*
Child's MS	0.19	0.24	---
p-value	0.002	<0.001	
Mother's MS	0.17	0.10	0.50
p-value	0.006	0.097	<0.001
Child's m-DI	0.48	---	0.24
p-value	<0.001		<0.001

As shown in Table 5, non-parametric bivariate analyses indicated that the mean dmft for 1-2 year-olds and 3-5 year-olds was significantly and strongly related with sweets-intake behaviour of the children. Children aged 3-5-years in the central area had a higher caries experience than those in the suburban area. Furthermore, high family income and mother's education level were significantly associated with a high caries experience in children of this age group.

The logistic regression analyses were performed by controlling for age and other contributing factors. Goodness-of-fit was high on both models (χ^2=5.32, p=0.723 in 1-2 year olds; and χ^2 =3.26, p= 0.917 in 3-5 year olds). Table 6 shows that in both models, the area of residence and age were significant variables. In two age groups, the children from the central area had twice, or almost twice, the risk of dental caries than those from the suburban area. Intake of sweets produced a higher risk for dental caries in the 1-2-year olds, and for children with severe dental caries (dmft≥6) in the 3-5-year olds. Moreover, children aged 1-2-years with higher *MS* levels had a higher caries risk than their counterparts. Older children with prolonged breastfeeding history showed a 1.65 times higher risk of experiencing severe caries than those who were weaned before two years of age.

Discussion

This study measured dental caries experience and its related factors in Mongolian children aged 1-5-years in the two areas of Ulaanbaatar city and provided basic data for development of appropriate oral health promotion programs for preschool children. It would be hard to generalize the current findings to all Mongolian children because this is not a representative sample of children from throughout Mongolia. However, the findings obtained in this study could be a useful indicator of the overall caries experience of young children in Mongolia.

This study showed regional differences for oral health and socioeconomic status of the two areas, although they were in the same city. The results indicated an early onset of dental caries among Mongolian children, where the caries prevalence and severity of both areas were very high and increased with age. A recent study reveals that dental disease prevalence is high in the newly developed countries where there has been a shift from traditional diets and life styles to industrial diets and lifestyles associated with urbanization (Diehnelt, 2001). The corresponding current rapid changes in the society and in the behaviors of Mongolians also could have a great impact on their dental health status. Caries prevalence was already 29% in 1-year-old children, and it increased to 69% in 2-year olds and reached almost 100% for children over three years of age. In contrast to previous studies (Oyunbat, 1993, Oyuntsetseg et al., 2004), the current study investigated caries experience of much younger aged children, as recommended by the ECC international workshop (Drury et al., 1999). Untreated decayed teeth were prevalent in both areas. This very high caries experience implies that the need for treatment is high among young children, and that urgent and early disease detection, prevention, and monitoring are necessary for the resolution of this problem in Mongolia.

Table 5. Relationships of caries experience with questionnaire items

Questionnaire items	*1-2 yr olds*				*3-5 yr olds*			
	N	*dmft*		*P-value*	*N*	*dmft*		*P-value*
		Mean	*SD*			*Mean*	*SD*	
Gender								
Boy	154	2.08	3.12	0.420	175	6.51	4.30	0.432
Girl	151	2.23	2.98		190	6.89	4.47	
Area								
Central	167	2.34	2.98	0.114	160	8.05	4.51	<0.001
Suburban	138	1.93	3.13		205	5.67	3.99	
Family monthly income								
Low	174	2.21	3.30	0.883	187	5.78	4.15	<0.001
High	131	2.07	2.69		178	7.70	4.42	
Mother's education level								
High school and lower	162	2.43	3.26	0.093	188	5.89	4.17	<0.001
University and higher	143	1.84	2.77		177	7.59	4.45	
Working mother (until 2 yr old)								
Yes	146	2.40	3.16		277	6.94	4.47	0.104
No	159	1.92	2.93	0.142	88	5.99	4.03	
Feeding practice								
Breastfeeding	228	2.22	3.19	0.812	261	6.77	4.43	0.693
Other types of feeding	77	1.95	2.59		104	6.58	4.28	
Weaning age of breastfeeding[a]								
Before 2-year old	-				62	5.55	4.02	0.323
From 2-year old or after	-				303	6.95	4.42	
Sweets intake								
Yes	227	2.40	3.18	0.006	262	7.02	4.53	0.043
No	78	1.42	2.53		103	5.94	3.92	
Current toothbrushing								
Yes	132	2.96	3.11	<0.001	358	6.75	4.38	0.094
No	173	1.53	2.86		7	4.86	4.41	
Fluoride toothpaste usage[b]								
Yes	98	3.29	3.32	0.079	349	6.72	4.36	0.274
No	34	2.03	2.22		9	7.89	5.18	

[a]: 3-5-year old children, [b]: children who brush teeth

In this study the children who were living in better housing conditions, with high income and highly educated mothers, had a higher prevalence and severity of caries experience. This could be explained by Diehnelt's findings on life-style and also by Mongolian mother's lack of oral health knowledge and concern, even though they were highly educated. Moreover, the intake and frequency of regular sweet foods such as chocolates, candies, soft drinks and starchy cookies, were higher in the central area than in the suburban area. This could be attributed to: a) central area children had easier access to sweets because of their family's higher income and location; and b) working mothers might give more sweets to their child to compensate for their absence from the home. Moreover, another caregiver (e.g., grandparents) could treat the child to sweets because the mother is absent. Our findings of an association between sweets consumption and the prevalence of dental caries are similar to those of previous work (Dini et al., 2000).

Many researchers have described a possible relationship between dental caries and children's feeding experience and weaning habits (Sarwar, 2002, Vachirarojpisan et al., 2004, Williams and Hargreaves, 1990). In this study, 3-5-year olds who had prolonged breast-feeding showed a significantly higher caries experience than those who had not.

Children's oral hygiene level in the present sample was not satisfactory, even though 73% of mothers responded that the child brushed their teeth and that almost all of them used fluoride toothpaste. The study showed a significant difference in the fluoride toothpaste usage rate between the two areas. An unexpectedly higher toothpaste

Table 6. Logistic regression models of caries and high caries risk children by age groups

Independent variables	*1-2 year old children (0:dmft<1, 1:dmft≥1)*					*3-5 year old children (0:dmft<6, 1:dmftt≥6)*				
	n	*Odds Ratio*	*95% C.I. for OR*		*P-value*	*n*	*Odds Ratio*	*95% C.I. for OR*		*P-value*
			Lower	*Upper*				*Lower*	*Upper*	
Age (years)										
1	156	reference				-				
2	99	5.22	2.51	10.85	<0.001	-				
3	-					68	reference			
4	-					113	2.13	1.13	4.01	0.020
5	-					166	2.60	1.41	4.76	0.002
Gender										
Boy	131	reference				170	reference			
Girl	124	0.96	0.54	1.72	0.900	177	1.17	0.75	1.83	0.494
Area										
Suburban	107	reference				202	reference			
Central	148	2.01	1.07	3.78	0.030	145	1.94	1.18	3.18	0.009
Working mother (until 2 yr old)										
Yes	144	reference				85	reference			
No	111	0.81	0.44	1.50	0.507	262	1.18	0.68	2.04	0.558
Feeding practice										
Breastfeeding	186	reference				255	reference			
Other types of feeding	69	0.89	0.46	1.72	0.722	92	0.85	0.51	1.43	0.546
Weaning age of breastfeeding										
Before 2-year old	-					169	reference			
From 2-year old or after	-					178	1.65	1.04	2.62	0.034
Sweets intake										
No	54	reference				99	reference			
Yes	201	2.17	1.04	4.56	0.040	248	1.70	1.04	2.80	0.036
Current toothbrushing										
Yes	94	reference				340	reference			
No	161	0.46	0.19	1.09	0.079	7	1.26	0.15	10.56	0.854
Fluoride toothpaste usage										
Yes	64	reference				331	reference			
No	191	1.61	0.60	4.32	0.345	16	0.86	0.20	3.61	0.834
Child's MS level										
0	33	reference								
1	58	2.20	0.74	6.52	0.154	-				
2	60	4.91	1.64	14.73	0.005	-				
3	104	3.40	1.22	9.50	0.019	-				

usage rate among suburban children could be explained by the distributional difference of very young children in the two areas (Table 1). The percentage of children aged 1-2-year olds, who usually do tooth brushing without toothpaste, was higher in the central (51.1%) rather than in the suburban area (40.2%).

The negative association between plaque accumulation and tooth brushing habits of these young children suggests that their oral hygiene was not optimal and probably irregular. Surprisingly in the bivariate analysis, children who did brush their teeth had more carious teeth in younger age children. Possibly their tooth brushing was unsupervised and performed incorrectly, or their brushing habits were started after their parents had detected several carious teeth in their child's mouth. The low level of oral-hygiene knowledge and a corresponding mother's acceptance of poor or irregular tooth brushing by the children could confound the relationship between caries experience of children and reported information on oral-hygiene habits. It could be also explained by the high sweet intake overwhelming the tooth brushing of children. However, there was no significant relationship between oral hygiene habits with caries risk of children of both age groups in logistic regression models.

Mutans streptococci in the oral cavity is strongly associated with high levels of dental decay. In the present study, *MS* infection was more prevalent and detected in children at a younger age than seen in previous investigations (Milgrom et al., 2000, Pienihäkkinen and Jokela, 2002). The children's m-DI score was significantly correlated with the *MS* colonization level and caries experience. Additionally, the mean caries experience was strongly associated with the *MS* level. A similar result to Tanner et al., (2003) was found in the current study where a child's *MS* level was significantly related with their mother's *MS* level. In the multivariate analysis, children with high *MS* levels in dental plaque showed a significantly higher risk of caries. Thus, an improvement of oral-hygiene knowledge, oral-health behaviours, and a decrease in the microbes' level in plaque of children and mothers both would be beneficial.

In this study, many preschool children had multiple carious teeth, their rate of dental treatment was low and they had very few filled teeth**.** This could be related to the low appreciation by parents and dental providers of the benefits of preventive dentistry. Children are not taken for dental treatment until dental caries becomes a serious problem. This low rate of dental caries treatment in Mongolian preschool children confirms that new oral health development strategies for preschool children should be implemented based on preventive measurements to improve not only early caries prevention but also early diagnosis and arresting of ECC. Further work is also needed to determine and improve the country's health system which would impact on dentists' ability to deliver preventive and restorative care for children (Pine et al., 2004).

Multivariate analysis revealed that the significant factors related to the development of dental caries of preschool children were residence area, sweets intake, prolonged breastfeeding, and the presence of *MS* in the dental plaque. The enhancement of mothers' oral-health knowledge, skills, and behavior are considered to be the most effective strategy for the prevention of early childhood caries because mothers are the primary promoters of oral hygiene practices and they are the most influential persons in the dietary habits and food choices of infants, toddlers and children (Rossow et al., 1990).

This study found higher and earlier caries occurrence of the children in Ulaanbaatar city, especially in its central area, which was related to high intake of sweets, poor oral hygiene and *MS* in dental plaque. Since the socioeconomic conditions have been rapidly changing in Mongolia, prompt and appropriate prevention programs should be implemented. Furthermore, the educational programs about ECC prevention targeting pregnant women and mothers with young offspring would be effective to prevent ECC.

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