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Exploring socioeconomic disparities in self-reported oral health among adolescents in California

Claire Telford, PhD; Ian Coulter, PhD; Liam Murray, MRCP, MD

The existence of a social gradient in health is well documented,^{1,2} as is the fact that this relationship extends to oral health.³ In a systematic review, Reisine and Psoter⁴ demonstrated an inverse relationship between socioeconomic status (SES) and the prevalence of caries among adolescents. This is of concern because most children have all of their permanent teeth (excluding third molars) by age 13 years, and incipient decay is reversible only with rigorous fluoride treatment; otherwise, caries in secondary dentition is considered irreversible and the tooth must be restored.⁵

Oral health problems during adolescence can cause a loss of school days and can lead to problems with self-confidence and social functioning.^{6,7} Poulton and colleagues⁸ found that children who grew up in families of lower SES were at greater risk of developing periodontal disease as adults and were likely to have more caries than were those who grew up in families of higher SES. To rectify these inequalities, the underlying causes need to be identified and, where possible, changed.

Researchers have conducted studies to explain the social gradient in oral health. Perera and Ekanayake⁹ conducted a study of 15-year-olds in Sri Lanka and found that increased use of dental services

Background. Socioeconomic factors are associated with disparities in oral health among adolescents; however, the underlying reasons are not clear. The authors conducted a study to determine if known indicators of oral health can explain such disparities.

Methods. The authors examined data from a 2007 California Health Interview Survey of adolescents. The outcome of interest was self-reported condition of the teeth; covariates were socioeconomic status (SES) (that is, family poverty level and parental education) and a range of other variables representing health-influencing behaviors, dental care and other social factors. The authors conducted analyses by using logistic regression to explain disparities in self-reported condition of the teeth associated with SES.

Results. The authors found that socioeconomic disparities decreased substantially after they added all potential explanatory variables to the model, leaving poverty level as the only variable associated with differences in the self-reported condition of the teeth. Adolescents living below the federal poverty guidelines were more likely to report that the condition of their teeth was fair or poor than were adolescents who were least poor (odds ratio = 1.58; 95 percent confidence interval, 1.04-2.41). In multivariate analyses, further oral health disparities existed in relation to behaviors that influence health, social environment and dental care.

Conclusions. The results of this study showed that a number of factors decreased, but did not eliminate, the observed relationship between SES and oral health in Californian adolescents. Most of these explanatory factors are modifiable, indicating that socioeconomic differences associated with oral health among adolescents may be amenable to change.

Practice implications. By promoting a healthy lifestyle (including healthy diet, exercise and regular dental attendance) and conveying to patients in languages other than English how to maintain oral health, dentists may be able to ameliorate the effects of socioeconomic disparities in oral health.

Key Words. Adolescents; oral health; health disparities; epidemiologic factors; self-reported oral health; socioeconomic status. *JADA* 2011;142(1):70-78.

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and toothbrushing had little effect on the observed social gradient in self-reported oral health. In a study conducted among American adults, Sabhan and colleagues¹⁰ found that after accounting for potential confounders (age, sex, ethnicity, dental insurance), the following health-related behaviors failed to fully account for socioeconomic disparities in oral health: smoking, consumption of fresh fruits and vegetables and oral hygiene. Investigators in other studies of adults have found that dental attendance attenuates the relationship between SES and oral health.^{11,12} However, research is lacking into the underlying reasons for socioeconomic disparities in oral health among adolescents. The purpose of this study was to determine if known indicators of oral health, as identified in a conceptual multilevel model of oral health developed by Fisher-Owens and colleagues,¹³ explain socioeconomic disparities associated with self-reported oral health among adolescents.

METHODS

Data source. The California Health Interview Survey (CHIS) is a population-based random-digit-dial telephone survey of California's population conducted every two years. CHIS reports the survey findings from all age groups regarding health status, health conditions, health-related behaviors, health insurance, access to health care services and other health-related issues. Westat, a research organization in Rockville, Md., collected the data under a contract with the University of California, Los Angeles Center for Health Policy Research between July 2007 and March 2008. For this study, we used the 2007 adolescent data set.¹⁴

Sampling strategy. CHIS uses a multistage sample design. First, the survey administrators divided the state into 44 geographic sampling strata. Second, within each stratum, they selected households through random-digit dial, and within each household, they randomly selected one adult (18 years or older) respondent. In addition, in households in which adolescents (aged 12-17 years) lived, the interviewers randomly selected one adolescent for an interview.

To produce population estimates from the CHIS data, we applied weights to the sample data to compensate for the probability of selection. We applied the weights to the analyses in this study regarding population percentage estimates (Table 1¹⁴). Investigators in a recent study found both the CHIS sample and response rate to be representative of the population of California.¹⁵

Fisher-Owens model. The model developed

by Fisher-Owens and colleagues¹³ provides an analytic framework for examining the determinants of oral health in childhood. According to these authors,¹³ the model may be tailored to explain different measures of oral health (for example, esthetics, dental disease, functionality and pain/infection). Within this model, oral health is seen as arising from genetic factors, biological factors, the social environment, the physical environment, health behaviors and dental and medical care.¹³ The model reflects the authors' recognition of the complex interplay of causal factors. We applied an adapted version of this model to available data on self-reported oral health within the CHIS. Although the model is multilevel (that is, determinants of oral health include influences at the level of the child, the family and the community), we had access to data only at the level of the child. Therefore, testing was of a classic nature in which we considered one level of data only.

Description of variables. The outcome variable for this study was self-reported condition of the teeth. The survey asked respondents, "How would you describe the condition of your teeth: excellent, very good, good, fair, poor?" We grouped their responses into two categories for the purpose of analysis: excellent/very good/good versus fair/poor. Two common measures of SES—household poverty level (indicated by the federal poverty guidelines¹⁶ [FPG]) and the responding adult's highest educational attainment—are used in the CHIS. CHIS categorized household poverty into four groups: 300 percent FPG and above, 200 to 299 percent FPG, 100 to 199 percent FPG and 0 to 99 percent FPG. We categorized the responding adult's highest educational attainment into one of three groups: graduate school or doctorate; some college or bachelor's degree; 12th grade/high school diploma or lower. Throughout this article, we use "poverty level" and "education" to indicate household poverty level and the responding adult's highest educational attainment, respectively.

We chose potential explanatory variables to reflect the components of the model developed by Fisher-Owens and colleagues.¹³ Investigators¹⁷⁻²⁹ have demonstrated associations between the chosen variables (Box, ¹³ page 74) and oral health. Some variables could be listed under several headings.

ABBREVIATION KEY. BMI: Body mass index. CHIS: California Health Interview Survey. FPG: Federal poverty guidelines. SES: Socioeconomic status.

TABLE 1
Variables influencing self-reported condition of teeth among
adolescents surveyed in CHIS*: results of multivariate analysis.

VARIABLE	PERCENTAGE OF RESPONDENTS (N = 3,582)	ODDS RATIO (95 PERCENT CI) [†]
Condition of Teeth (Dependent Variable)		
Excellent/very good/good	89.1	Not applicable
Fair/poor	10.9	Not applicable
Socioeconomic		
Poverty level		1.00
300% FPG [‡] and above	47.9	1.01 (0.67-1.50)
200%-299% FPG	13.6	0.99 (0.66-1.47)
100%-199% FPG	18.9	1.58 (1.04-2.41) [§]
0%-99% FPG	19.6	
Responding parent's highest educational attainment		1.00
Graduate school/doctorate	12.5	0.89 (0.59-1.36)
Some college/bachelor's degree	47.7	1.13 (0.71-1.82)
12th grade/high school diploma or lower	39.8	
Age in Years		1.00
12	13.9	0.93 (0.59-1.46)
13	16.9	0.91 (0.58-1.44)
14	18.3	1.09 (0.69-1.72)
15	15.9	1.11 (0.71-1.74)
16	17.0	1.13 (0.72-1.77)
17	18.0	
Sex		1.00
Female	49.0	0.91 (0.70-1.18)
Male	51.0	
Interview Language		1.00
English	90.7	2.66 (1.60-4.41) [‡]
Spanish	8.5	0.29 (0.06-1.44)
Other	0.8	
Country of Birth		1.00
United States	87.6	1.00 (0.58-1.74)
Mexico	6.2	1.50 (0.68-3.30)
Asia or Pacific Islands	4.0	0.28 (0.06-1.22)
Other	2.2	
Language Spoken at Home		1.00
English	55.9	1.20 (0.78-1.84)
English and Spanish	29.8	1.32 (0.71-2.44)
English and other	7.4	1.55 (0.78-3.11)
Spanish	4.0	2.38 (1.04-5.45) [§]
Other	2.8	
Father's Citizenship Status		1.00
U.S.-born citizen	56.1	0.72 (0.46-1.13)
Naturalized citizen	22.3	0.70 (0.43-1.15)
Non-citizen	21.6	
Mother's Citizenship Status		1.00
U.S.-born citizen	59.5	1.21 (0.78-1.89)
Naturalized citizen	17.3	1.08 (0.67-1.76)
Non-citizen	23.2	

* CHIS: California Health Interview Survey. Source: 2007 California Health Interview Survey.¹⁴

[†] CI: Confidence Interval.

[‡] FPG: Federal poverty guidelines.

[§] P < .05.

[¶] P < .001.

[#] P < .01.

TABLE 1 (CONTINUED)

VARIABLE	PERCENTAGE OF RESPONDENTS (N = 3,582)	ODDS RATIO (95 PERCENT CI) [†]
Parent's Marital Status		
Married	62.0	1.00
Never married but live with each other	3.6	0.75 (0.37-1.54)
Separated/divorced/dead/other	25.9	0.87 (0.63-1.20)
Never married, not living with each other	8.5	1.26 (0.80-2.00)
Health-Influencing Behaviors		
Body mass index		
Normal weight	68.4	1.00
Underweight	4.1	0.93 (0.45-1.90)
At risk of being overweight	14.4	2.54 (1.83-3.53) [†]
Overweight	13.1	5.60 (4.10-7.65) [†]
No. of times fast food consumed in previous week		
0	23.4	1.00
1	31.0	1.17 (0.84-1.64)
2	21.4	0.75 (0.50-1.13)
3 or more	24.3	1.18 (0.82-1.70)
Fruit and vegetable consumption		
At least five per day	20.3	1.00
Fewer than five per day	79.7	1.17 (0.84-1.64)
No. of sodas/sweetened drinks consumed on previous day		
0	42.6	1.00
1	31.8	0.88 (0.64-1.20)
2-3	22.6	1.35 (0.97-1.88)
4 or more	3.1	1.18 (0.82-1.70)
Physical activity (times per week)		
0-1	16.6	1.00
2-4	43.0	0.60 (0.44-0.82) [†]
5-7	40.4	0.55 (0.38-0.78) [†]
Member of sports team in previous 12 months (adolescent)		
Yes	51.8	1.00
No	48.2	1.99 (1.51-2.61) [†]
Last Dental Visit		
Less than six months previously	69.6	1.00
Six months to one year previously	18.5	1.61 (1.18-2.19) [†]
One to two years previously	6.3	1.07 (0.64-1.79)
More than two years previously	4.3	1.77 (1.03-3.04) [†]
Have never visited a dentist	1.3	2.31 (0.94-5.66)
Could Not Afford Dental Care in Previous 12 Months		
No	94.8	1.00
Yes	5.2	1.31 (0.80-2.13)
Has Dental Insurance		
Yes	75.8	1.00
No	24.2	1.01 (0.75-1.36)

Genetics and biology. Because the condition and appearance of teeth are known to vary with age, including during adolescence, we included age in the logistic regression models.¹⁷ Ferraro and Vieira¹⁸ reported higher rates of caries in female participants, suggesting a genetic contribution to oral health.

Social environment. Family composition is

known to affect oral health, as associations have been found between single-parent or reconstituted households and increased childhood caries.¹⁹ Therefore, we included the parents' marital status to capture this association. Because culture also is known to affect oral health, we included in the models citizenship status (of the adolescent, mother and father),

BOX

Proposed determinants of oral health, according to a conceptual model.*

GENETICS AND BIOLOGY	
■	Age
■	Sex
SOCIAL ENVIRONMENT	
■	Interview language
■	Country of birth
■	Years in United States
■	Citizenship status
■	Responding adult's highest educational attainment
■	Language spoken at home
■	Citizenship and immigration status of father
■	Citizenship and immigration status of mother
■	Household poverty level
■	Parents' marital status
HEALTH-INFLUENCING BEHAVIORS	
■	Body mass index
■	Number of times fast food consumed during previous week
■	Fruit and vegetable consumption
■	Number of sodas/sweetened drinks consumed the previous day
■	Number of days in week that adolescent was physically active for one hour or more
■	Member of sports team in previous 12 months
DENTAL CARE	
■	Time since last dental visit
■	Could not afford dental care in previous 12 months
■	Reason for last dental visit
■	Has dental insurance

* Source: Fisher, Owens and colleagues.¹⁸

country of birth, years lived in the United States and interview language.²⁰ Language spoken at home is indicative of immigrants' acculturation into society; hence, we included the language spoken at home in this analysis.

Health-influencing behaviors. Tooth

decay stems from a diet high in sugar.²¹ Several variables used within this analysis—fast food consumption, soda consumption and low intake of fruits and vegetables—are signs of an unhealthy diet. We included body mass index (BMI) because an increase in BMI has been linked with more decayed, missing and filled teeth^{22,23} and periodontitis,²⁴ perhaps because obesity and caries have common determinants—diets high in sugar and fat.²⁵ Al-Zahrani and colleagues²⁶ and Merchant and colleagues²⁷ reported a reduced risk of developing periodontitis among people who were physically active. Because positive effects of exercise on the body, such as reduced inflammation, are thought to explain in part this reduced risk, we included physical activity and sports team membership in our analyses.

Dental care. Use of dental care services, particularly those of a preventive nature, have a positive effect on oral health.^{28,29} Consequently, we included several variables that incorporated the frequency and availability of dental care services for the adolescent: time since last dental visit, reason for last dental visit, affordability of dental care and whether or not the adolescent had dental insurance coverage.

Data analyses. We performed analyses of the data by using statistical software (STATA 9.0, StataCorp, College Station, Texas). We used logistic regression (data not shown) to examine individually the variables thought to influence the condition of the teeth (Box). All variables except age and sex were significant ($P < .05$) in bivariate analyses (data not shown). However, to avoid omitted variable bias, we examined all variables further for inclusion in the multivariate model in an attempt to explain socioeconomic disparities in oral health.

Before developing a multivariate model, we tested the variables for multicollinearity. Three variables—citizenship status, years lived in the United States and reason for last dental visit—showed signs of collinearity and were dropped from the multivariate analyses. We then constructed five regression models by using logistic regression as follows (Table 2). Model 1 contained only poverty and education as the independent variables and self-reported condition of the teeth as the dependent variable. Next, we added genetics and biology, social environment, health-influencing behaviors and dental care factors progressively in models 2 through 5, respectively. The results of model 5 are shown in Table 1.

RESULTS

CHIS included data for 3,638 adolescents, a 44.1 percent response rate. However, we excluded 56 adolescents owing to incomplete or missing household information, resulting in a final sample size of 3,582. After we accounted for the weighting, the sample consisted of 51 percent males and 49 percent females. A majority of adolescents (88 percent) were born in the United States, 6 percent were born in Mexico and 6 percent were born in other countries. The CHIS interviewers conducted most of the interviews (91 percent) in English.

Logistic regression models. As Table 2 shows, model 1 confirms the disparities in self-reported condition of the teeth related to socioeconomic factors; respondents in the two groups with the highest poverty (that is, 0 to 99 percent FPG and 100 to 199 percent FPG) and those

TABLE 2

Relationship between self-reported condition of teeth* and SES,[†] with additional covariates: results of logistic regressions.[‡]

MODEL	POVERTY LEVEL	ODDS RATIO (95 PERCENT CI) [§]	PARENT'S EDUCATION [¶]	ODDS RATIO (95 PERCENT CI)
1	300% FPG* and above	1.00	Graduate school/doctorate	1.00
	200%-299% FPG	1.36 (0.94-1.98)	Some college/ bachelor's degree	1.04 (0.70-1.55)
	100%-199% FPG	1.66 (1.18-2.34)**	12th grade/high school diploma or lower	1.74 (1.11-2.63)**
2	0%-99% FPG	2.96 (2.11-4.16) ^{††}		
	300% FPG and above	1.00	Graduate school/doctorate	1.00
	200%-299% FPG	1.36 (0.93-1.97)	Some college/ bachelor's degree	1.03 (0.69-1.54)
3	100%-199% FPG	1.68 (1.19-2.38)**	12th grade/high school diploma or lower	1.70 (1.10-2.61)**
	0%-99% FPG	3.02 (2.15-4.26) ^{††}		
	300% FPG and above	1.00	Graduate school/ doctorate	1.00
4	200%-299% FPG	1.30 (0.89-1.90)	Some college/ bachelor's degree	1.04 (0.70-1.56)
	100%-199% FPG	1.36 (0.93-1.98)	12th grade/high school diploma or lower	1.51 (0.96-2.36)
	0%-99% FPG	2.26 (1.52-3.37) ^{††}		
5	300% FPG and above	1.00	Graduate school/doctorate	1.00
	200%-299% FPG	1.01 (0.67-1.50)	Some college/ bachelor's degree	0.89 (0.59-1.36)
	100%-199% FPG	0.99 (0.66-1.47)	12th grade/high school diploma or lower	1.13 (0.71-1.82)
0%-99% FPG	1.58 (1.04-2.41) ^{††}			

* Excellently/very good/good versus fair/poor.

† SES: Socioeconomic status.

‡ Survey of Adolescents (N = 3,582) in 2007 California Health Interview Survey.¹⁴

§ Model 1: Poverty level and education as covariates. Model 2: Poverty level, education, age and sex as covariates. Model 3: Same as model 2, with interview language, country of birth, language spoken at home, citizenship status of mother, citizenship status of father and parental marital status as covariates. Model 4: Same as model 3, with body mass index, fast food consumption, soda consumption, fruit and vegetable consumption, physical activity in previous week (number of times) and sports team membership as covariates.

¶ Model 5: Same as model 4, with time since last dental visit, dental insurance and could not afford dental care as covariates.

§ CI: Confidence interval.

FPG: Federal poverty guidelines.

** $P < .01$.

†† $P < .001$.

‡‡ $P < .05$.

whose parent had the lowest education (that is, 12th grade/high school diploma or lower) had an increased likelihood of having reported a fair/poor condition of their teeth. This relationship continues in model 2 with the addition of age and sex. Throughout the remaining models, only respondents living below the FPG were likely to report that their teeth were in fair/poor condition; however, the odds ratio decreased from 2.96 in model 1, when we did not adjust for other factors, to 1.58 in model 5, when we

adjusted for all other factors. **Social environment.** A number of factors showed significance in the final model (Table 1). Within social environment, being interviewed in Spanish increased the likelihood of having reported a fair/poor condition of the teeth. Adolescents who spoke a language at home other than English or Spanish were more likely than were other adolescents to report that their teeth were in fair/poor condition.

Health-influencing behaviors. Several

behaviors were associated with the condition of respondents' teeth. Those who were overweight or at risk of being overweight were more likely to report that their teeth were in fair/poor condition compared with adolescents of normal weight. In addition, those participating in a physical activity two to four or five to seven times per week were increasingly less likely to report that their teeth were in fair/poor condition than were adolescents who were least physically active. Adolescents who had not been on a sports team in the preceding 12 months were significantly more likely to report that their teeth were in fair/poor condition than were those who reported having been on a sports team.

Dental care factors. Among dental care factors, the respondent's last dental visit remained associated with this study's measure of oral health in multivariate models. Those who had last visited a dentist more than two years previously or had visited a dentist six months to one year previously had an increased likelihood of reporting that their teeth were in fair/poor condition in comparison with that in adolescents who had visited a dentist within the previous six months.

DISCUSSION

In this study we set out to determine if the relationship between SES and self-reported oral health in adolescents is explained by factors known to influence oral health. We found that adjusting for genetics and biology, health-influencing behaviors, dental care and other aspects of the social environment partially, but not fully, accounted for socioeconomic disparities in oral health, which is consistent with the results of previous studies in adults.^{10,11} Although we conducted this study using self-reported data from adolescents in California, and some factors explored here, such as eligibility for dental insurance, vary according to state, approximately one in eight adolescents in the United States lives in California.³⁰

Health-influencing behaviors that remained significant in the final multivariate model included BMI, physical activity and sports team membership. Adolescents who were overweight or at risk of being overweight reported oral health poorer than that reported by those of normal weight. The common determinant, a diet high in sugar and fat, likely explains the observed relationship between weight and the condition of teeth.²⁵ Self-reported oral health was better among those who were physically active and those who were on a sports team.

Exercise may prevent periodontitis,^{26,27} but this disease is an uncommon cause of poor oral health in adolescents, and this association may reflect a generally healthy lifestyle or better oral hygiene.³¹

Dental attendance also remained significant in the final model. Adolescents who had last visited a dentist six months to one year previously or more than two years previously were more likely to report that their teeth were in fair/poor condition than were those who had visited a dentist within the preceding six months. Regular dental attendance is important because it affords dentists the opportunity to prevent and treat caries at an early stage; therefore, it must be encouraged, among adolescents.

It is clear from this data set that unhealthy lifestyles, which potentially are modifiable, contribute to socioeconomic differences in oral health. Educating the adolescent population (for example, in schools or dental clinics) about the effect of lifestyle choices, such as a healthy diet and regular dental attendance, on oral health may bring about behavioral change.

Another way of tackling these unhealthy lifestyle choices is via national policy initiatives that are designed to deal with the causes of poor oral health and hence result in implementation of a prevention-focused strategy.³² With respect to improving oral health, heavier taxation of caries-inducing foodstuffs may be an acceptable and effective approach.³² This may decrease the affordability of such health-damaging foods, thus making healthier foods relatively less expensive.

The study results showed disparities in oral health according to interview language and language spoken at home. In particular, adolescents interviewed in Spanish reported poorer oral health. Although low dental care utilization rates have been identified among Hispanics,³³ our study findings show that among respondents interviewed in Spanish, poorer self-reported oral health was due to something other than access to dental services. It may be that non-English-speaking adolescents and their parents have not received adequate information about maintaining oral health. This may be amenable to change via appropriate dissemination of information in languages other than English. One approach could be through an increase in the number of bilingual dental staff members, while another could be the implementation of a public health initiative whereby relevant information is distributed outside the dental clinic, both orally in schools and through written documentation distributed within

appropriate geographic areas. Within California, Spanish probably is the primary targeted language, but this may differ in other states. With increasing immigration to the United States, it is important that this issue be

addressed to prevent widening health disparities and declines in overall population health.

The results of this study provide insight into some of the underlying factors associated with socioeconomic disparities in oral health.

Addressing such factors may attenuate these disparities. However, after adjusting for all factors, we found that adolescents living in greatest poverty still were more likely to report having fair/poor oral health than were other adolescents. To fully explain oral health disparities, researchers need to conduct further investigations.

The CHIS was not established primarily to explore factors that influence oral health; therefore, some key data, such as those pertaining to fluoridation and oral hygiene, were absent. Fluoridation of community water supplies is known to have a positive effect on oral health,³⁴ and some California residents receive fluoridation in their water supply while others do not.³⁵ Despite this limitation, a substantial proportion of the socioeconomic disparity in oral health reported in this study was explained by the available data. It is possible that the disparities may have been explained entirely had data on fluoridation and oral hygiene been available.

Study limitation. The measure of oral health among adolescents in the CHIS survey was self-reported condition of the teeth. A number of studies³⁶⁻³⁹ have found an association between perceived oral health and a patient's clinically assessed oral health. Brynswick and Nikias³⁷ found this association in adolescents. Pittiphat and colleagues⁴⁰ found that the validity of self-reported oral health was good for identifying the number of remaining teeth and restorations and endodontic therapy, but it was less useful for assessing undiagnosed dental caries and periodontal disease. This finding indicates that self-reported oral health reflects dental treatment that has been performed, but it may not be an accurate reflection of undiagnosed dental disease. Readers should keep this in mind when interpreting the findings of our study.

Furthermore, the study was cross-sectional and health disparities may be better investigated by using a life course approach in which oral health and its determinants are tracked across time, which requires longitudinal data.⁴¹

CONCLUSION

The results of this study show that a number of factors described in the model of oral health developed by Fisher-Owens and colleagues¹³ attenuated, but did not fully eliminate, an observed relationship between SES and oral health among Californian adolescents. Health-influencing behaviors, dental care and some social environmental factors are modifiable, indicating that socioeconomic differences associated with adolescents' oral health may be amenable to change. ■

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