• FULL-LENGTH ARTICLES •

Prevalence of Gingivitis in a Group of 35- to 70-Year-Olds Residing in Puerto Rico

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Objective: Gingivitis, an inflammation of the gingival tissues, typically progresses to periodontitis. The objective of this study is to estimate the prevalence of gingivitis in 35- to 70-year-olds residing in San Juan, Puerto Rico, and assess the differences in gingivitis distribution between age and gender groups.

Methods: A cross-sectional epidemiological study was conducted with a sample of patients from a private practice and patients/employees of the Puerto Rico Medical Center. Participants completed a medical history questionnaire and received soft/hard tissue and gingival assessments based on a modified Löe–Silness index. Descriptive statistics were employed to estimate the overall gingivitis prevalence, severity (mild, moderate, severe), and mean gingival index (GI). Bleeding on probing (BOP) prevalence and the mean percentage of BOP sites were calculated by gender and age. Multinomial logistic regression was used to evaluate the associations between age, gender, and severity in 3 categories; multivariate logistic regression was used for having ≥40% sites with BOP (vs. having <40% sites with BOP as reference). Odds ratios were also estimated.

Results: All 300 participants (52% women; 48% men) had gingivitis. The mean GI was 1.38. Moderate gingivitis was detected in 83% of the participants, mild in 7.3%, and severe in 9.3%. BOP was observed in 99% of the subjects (mean % BOP sites = 34%). After adjusting for age, men had significantly higher odds of moderate ($\widehat{OR}$ = 4.66) and severe gingivitis ($\widehat{OR}$ =10.06), compared to women, as well as 1.76 times higher odds of having 40% or more sites with BOP.

Conclusion: Gingivitis was observed in all participants. Men had significantly higher GI, compared to women. The prevalence of gingivitis was higher in Puerto Rico than in the US. [*P R Health Sci J 2017;36:140-145*]

Key words: Prevalence, Gingivitis, Adults, Bleeding on probing, Puerto Rico

Dental plaque–induced gingivitis is an inflammation of the gingival tissues that is characterized by changes in gingival color and texture and the tendency for the gums to bleed when probed (1). Bacterial plaque on teeth is considered to be the main etiological factor in gingivitis. If unattended, gingivitis can lead to tissue attachment loss, periodontitis, and, eventually, tooth loss (2). Moreover, there is strong evidence of an association between periodontal disease (PD) and general health (3). Epidemiological and clinical studies have reported that the prevalence of adult gingivitis in the US exceeds 50% (4,5).

Bleeding on probing (BOP) is a reliable clinical sign of gingival inflammation (6). According to a 1985–86 US survey, 47% of men and 39% of women, 18 to 64 years of age, presented at least 1 BOP site (7). The mean number of bleeding sites in this previous survey was higher for older men (7). While earlier epidemiologic surveys focused on gingivitis, the simplest form of PD, more recent surveys have concentrated on periodontitis, a more advanced form of PD. Recently, it was reported that periodontitis affects 46% of the adults in

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the US. This prevalence is higher in men and even higher in those who are smokers, less educated, below the poverty level, and Hispanic (8).

According to the Hispanic Community Health Study/Study of Latino Communities (2008–2011), 45- to 54-year-old Puerto Rican men had the highest prevalence (33.9%) of severe periodontitis compared to other Hispanic/Latino groups in the US (9). Data from the NHANES (1982–1984) also revealed that Puerto Ricans had the worst oral hygiene among Hispanic groups in the US, as evidenced by their having higher mean debris index and calculus scores (8).

Preliminary results of an island-wide study revealed that the prevalence of gingivitis, a precursor of PD, in 12-year-olds exceeded 85% (10). A study conducted in San Juan, Puerto Rico (PR), showed that 44.5% of the individuals 70 years of age and older had moderate to severe periodontitis (11), more than twice that observed for Puerto Ricans residing on the US mainland (12).

There are no published studies in the peer-reviewed literature that have assessed the prevalence of gingivitis in adults residing on the island. Because of the reported associations between PD and systemic health, it is important to determine the burden of adult gingivitis in this population. The purpose of this cross-sectional study was to make a preliminary estimate of the prevalence of clinical gingivitis in a group of 35- to 70-year-olds residing in the metropolitan area of San Juan, PR, prior to designing a subsequent island-wide study of this age group. Additionally, the differences in gingivitis distribution between age and gender groups in this population were evaluated.

Methods

Study and Sample design

The Medical Sciences Campus Institutional Review Board of the University of Puerto Rico approved the protocol of this cross-sectional epidemiological pilot study to make a preliminary estimate of prevalence of clinical gingivitis in a group of 35- to 70-year-olds residing in the metropolitan area of San Juan, PR, prior to the carrying out of an island-wide study of gingivitis prevalence in this age group. Patients seeking treatment at a private practice in Trujillo Alto and patients and employees of the Puerto Rico Medical Center in San Juan were selected as subjects in a convenience sample of 300 participants.

To be included in this study, prospective subjects who expressed an interest in participating had to be healthy adults (ASA I) or have only mild systemic disease (ASA II) (13) and be residents of the San Juan metropolitan area in PR, from 35 to 70 years of age, with at least 20 permanent natural teeth (excluding third molars). Prospective subjects with signs of moderate to advanced PD, who were taking anticoagulant medication or antibiotic prophylaxis, or who were pregnant or lactating were excluded from the study. All the prospective participants screened complied with the study's inclusion criteria.

Training and Diagnostic auditing

Prior to the study, 3 examiners were trained in the use of a modified Löe–Silness index by a periodontist (FL) and an experienced reference examiner (AEB); 30 subjects were examined (not included in the main study). In addition, during the study period, each examiner conducted 30 oral exams (10% of the total exams) in the presence of the reference examiner. Examiner agreement was reached by consensus in both instances.

Clinical exam

Subjects complying with the inclusion criteria signed an informed consent form and completed a socio-demographic and a medical history questionnaire. Then all participants were examined and a soft/hard tissue assessment and gingival evaluation were made, which was then shared with the participants. Subjects were referred for treatment when required.

The degree of gingival inflammation was scored at 6 sites (disto-, mid-, and mesio-buccal; disto-, mid-, and mesio-lingual) for each tooth using a modified Löe–Silness Gingival Index (14), as adapted from Talbott, Mandel, and Chilton (1), as follows:

0 = Absence of inflammation;

1 = Mild inflammation – slight change in color and little change in texture;

2 = Moderate inflammation – moderate glazing, redness, edema, and hypertrophy; and tendency to bleed upon probing;

3 = Severe inflammation – marked redness, hypertrophy, and a tendency to bleed spontaneously.

To assess gingival bleeding, a Hu-Friedy PCPUNC-126 periodontal probe was inserted not more than 2 mm into the gingival sulcus starting just distal to the midpoint of the buccal surface, and then the probe was gently moved toward the mesial interproximal area, avoiding contact with the tooth surface.

Statistical analysis

A gingival index (GI) was calculated by summing the scores from all the sites and dividing by the total number of sites scored for each individual. To estimate the prevalence of gingivitis, we defined "a case of gingivitis" as being an individual with, at minimum, mild inflammation in at least 1 of the scored sites (15). The severity of the disease was assessed as follows: a mean GI score above 0 but less than or equal to 1.0 was classified as mild inflammation; a score greater than 1.0 but less than or equal to 2.0 was classified as moderate inflammation, and a score greater than 2.0 was classified as severe inflammation. The presence of BOP was established if the modified Löe–Silness score was at 2.0 or 3.0 in at least 1 site; the percentage of sites with BOP was also calculated.

Categorical variables (gender, age group, prevalence and severity of gingivitis, and prevalence of BOP) were summarized in terms of percentages. Mean and standard deviation, as well as median and interquartile range (Q1–Q3), were calculated for continuous variables, such as gingival index and percentage of bleeding sites.

A chi-square test or Fisher's exact test was employed to evaluate gender and age differences in the distribution of categorical outcomes, as appropriate. Normality of distribution of continuous outcomes (GI and percentage of bleeding sites) within age and gender groups was evaluated using Shapiro–Wilk tests.

Since normality was rejected for both outcomes, we used the Mann–Whitney test for gender comparisons and the Kruskal–Wallis test for differences between age groups. To evaluate the associations between age and gender (as predictors) and gingivitis severity (in 3 categories) as the outcome, multinomial logistic regression analysis was conducted, using the mild gingivitis category as the reference group. Ordinal logistic regression models were also considered; however, the assumption of proportional odds was not met (according to the Brant test results). Estimated odds ratios (ÔR) and 95% confidence intervals (CIs) were reported. The percentage of sites with BOP was categorized as being 40% or greater or as less than 40%; logistic regression was used to evaluate differences by age group and gender; odds ratios and 95% CIs were reported. Interactions between age and gender for both multivariate regression analyses were tested using the likelihood-ratio test. All analyses were performed using STATA statistical software, version 13.1 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP). An alpha level of 0.05 was considered statistically significant.

Results

A total of 330 prospective participants were screened; 300 met the inclusion criteria, entered the study, and were stratified by age and gender. Seventy-three percent (n = 220) of these subjects were patients at the Puerto Rico Medical Center, while the remaining 27% (n = 80) were patients at a private dental practice in the San Juan metropolitan area of PR. Figure 1 displays the CONSORT (Consolidated Standards of Reporting Trials) flow diagram. The average age of the study participants was 49 years (±10.35), and 52% of the participants were women.

Gingivitis prevalence and severity

All participants presented with gingivitis; most of the participants (83%) had moderate
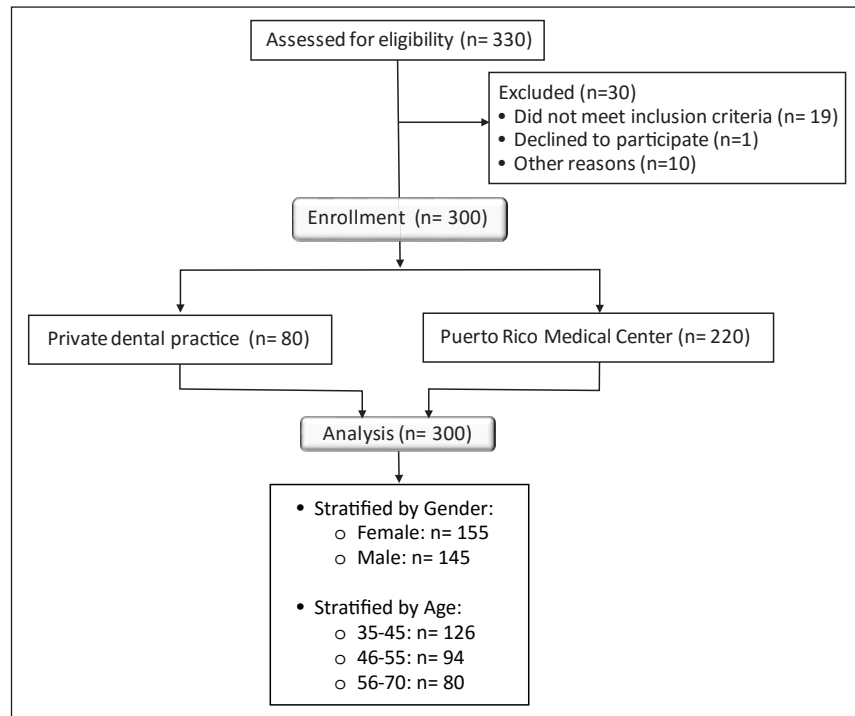

Figure 1. CONSORT Flow Diagram

gingivitis, while 9.3% had severe gingivitis and 7.3% had a milder form of this condition (Table 1). Men were more likely to have severe gingivitis (13%) than women were (5.8%); these differences were statistically significant (chi-square p-value of 0.002). Younger participants (35 to 45 years old) appeared to have slightly higher average GI scores (mean GI: 1.40; median: 1.3) than did older participants (Table 2); however, age differences were not statistically significant (Kruskal–Wallis

Table 1. Prevalence of gingivitis by severity in a group of 35- to 70-year-olds residing in Puerto Rico, in all, by gender, and by age group[1]

| | | Mild Gingivitis (GI = 0.1–1.0) | | Moderate Gingivitis (GI = 1.1–2.0) | | Severe Gingivitis (GI = 2.1–3) | |
	N	n	%	n	%	n	%
In all	300	22	7.30	250	83.00	28	9.30
By gender*							
Women	155	18	12.00	128	83.00	9	5.80
Men	145	4	2.80	122	84.00	19	13.00
By age group							
35–45 y	126	12	9.52	100	79.37	14	11.11
46–55 y	94	7	7.45	80	85.11	7	7.45
56–70 y	80	3	3.75	70	87.50	7	8.75
In women by age group[2]							
35–45 y	59	9	15.25	47	79.66	3	5.08
46–55 y	50	7	14.00	42	84.00	1	2.00
56–70 y	46	2	4.35	39	84.78	5	10.87
In men by age group[2]							
35–45 y	67	3	4.48	53	79.10	11	16.42
46–55 y	44	0	0	38	86.36	6	13.64
56–70 y	34	1	2.94	31	91.18	2	5.88

[1]p-values were obtained from chi-square tests unless otherwise indicated; [2]Fisher's exact test was used for these comparisons; *p<0.05

Table 2. Descriptive statistics for gingival index scores in a group of 35- to 70-year-olds residing in Puerto Rico, in all, by gender, and by age group[1]

Age Group	All			Women			Men		
	N	Mean±SD	Median (Q1–Q3)	N	Mean±SD	Median (Q1–Q3)	N	Mean±SD	Median (Q1–Q3)
35–45** years	126	1.40±0.41	1.30 (1.14–1.55)	59	1.27±0.34	1.25 (1.06–1.37)	67	1.51±0.44	1.37 (1.18–1.85)
46–55* years	94	1.34±0.39	1.23 (1.09–1.52)	50	1.26±0.32	1.16 (1.07–1.45)	44	1.43±0.43	1.27 (1.13–1.57)
56–70 years	80	1.38±0.41	1.24 (1.12–1.53)	46	1.39±0.43	1.26 (1.11–1.60)	34	1.37±0.38	1.21 (1.12–1.53)
All**	300	1.38±0.40	1.26 (1.12–1.53)	155	1.30±0.36	1.22 (1.08–1.43)	145	1.45±0.43	1.33 (1.16–1.60)

[1]p-values for the differences between gender groups were obtained using the Mann–Whitney test; *Gender comparison was statistically significant, with p<0.05; **Gender comparison was significant, with p<001.

test p-value>0.05; not presented in the table). When the group was stratified by gender, male participants had higher GI scores than women did (mean: 1.45 vs. 1.30; median: 1.33 vs. 1.22; Mann–Whitney p-value = 0.001). In the youngest and the midmost age groups, gender differences were significant when stratified by age (p = 0.001 and p = 0.044 for 35- to 45- and 46- to 55-year-olds, respectively).

In multivariate analysis, after adjusting for age, men had significantly higher odds of both moderate ($\hat{OR}$ = 4.66; 95% CI: 1.52–14.27) and severe gingivitis ($\hat{OR}$ = 10.06; 95% CI: 2.61–38.82) than did women (Table 3). There were no statistically significant differences between age groups after adjusting for gender. After adjusting for the main effects, there were no statistically significant interactions between age and gender groups, as evaluated by the global likelihood-ratio test (p = 0.08).

Bleeding on probing

About 99% of all participants had BOP at at 1 or more sites (Table 4), with the prevalence being similar in men (99%) and women (99%) (Fisher's exact test p = 0.612). The percentage of BOP sites, however, was higher in men—with a median of 31% (Table 5)—than it was in women (23%) (Mann–Whitney p-value = 0.018). The highest extent of BOP was observed in the youngest group (35- to 45-year-olds) men, with the median percentage of BOP being 39%, which was significantly different from that of the women in the same age group (median = 24%; p = 0.003). In multivariate analysis, after adjusting for age group, men had 1.76 times higher odds of having 40% or more sites with BOP (95% CI: 1.07–2.87) than women did (Table 6); interactions between age and gender were not statistically significant.

Table 3. Estimated odds ratios and 95% confidence intervals (CIs) for moderate and severe gingivitis, according to age and gender[1]

	Severe Gingivitis $\hat{OR}$ (95% CI)	Moderate Gingivitis $\hat{OR}$ (95% CI)	Mild Gingivitis (ref.)
Gender			
Male	10.06 (2.61–38.82)**	4.66 (1.52–14.27)*	1.0
Women (ref.)	1.0	1.0	1.0
Age group			
56–70 years	2.57 (0.26–12.60)	3.28 (0.88–12.25)	1.0
46–55 years	0.98 (0.35–3.72)	1.50 (0.55–4.05)	1.0
35–45 years (ref.)	1.0	1.0	1.0

[1]Estimates were obtained from multivariate multinomial regression models, with gender, and 3 age groups as predictors; Using the mild gingivitis group as the reference category for the outcome. *p<0.05; **p = 0.001

Table 4. Prevalence of bleeding on probing[1] in a group of 35- to 70-year-olds residing in Puerto Rico, in all, by gender, and by age group[2]

Age group	All (N = 300)		Women (N = 155)		Men (N = 145)	
	N	%	N	%	N	%
35–45	124	98%	58	98%	66	99%
46–55	94	100%	50	100%	44	100%
56–70	79	99%	46	100%	33	97%
All	297	99%	154	99%	143	99%

[1]Bleeding on probing was based on the Löe–Silness Gingival Index categories 2 and 3 in at least one site; [2]Fisher's exact test was used to obtain p-values for the differences between men and women, in all and by age group; all comparisons were statistically not significant (p>0.05).

Discussion

This cross-sectional epidemiological study provides a preliminary estimate of the prevalence of clinical gingivitis in a group of 35- to 70-year-olds residing in the metropolitan area of San Juan, PR. This estimate will be essential to the design and carrying out of a future island-wide study of this age group. All participants in this study presented clinical gingivitis, and the overall mean GI was higher in men than in women.

Previous studies have demonstrated that PD in patients aged 65 and older is highly prevalent in Puerto Ricans living on the island (12) and in those living on the US mainland (13). The prevalence of gingivitis, the mildest form of PD, in this group of adult Puerto Ricans is double that reported in the US for the same age group (4,5). A high prevalence of gingivitis has also been observed in 12-year-old Puerto Ricans (11).

The mean GI of the adult Puerto Rican in this pilot study is higher than that reported in large multi-site studies in the US (5) and China (16). However, it is lower than that reported in Saudi Arabia (17). Cultural differences may be responsible for these variations.

Table 5. Percentage of sites with bleeding on probing[1], in all participants, by gender, and by age group

Age group	All			Women			Men		
	N	Mean±SD (95% CI)	Median (Q1–Q3)	N	Mean±SD (95% CI)	Median (Q1–Q3)	N	Mean±SD (95% CI)	Median (Q1–Q3)
35–45*	126	36±27 (31–41)	29 (26–52)	59	28±23 (22–34)	24 (9.0–38)	67	42±28 (36–49)	39 (20–70)
46–55	94	33±26 (27–38)	23 (14–48)	50	30±24 (23–36)	18 (13–45)	44	36±29 (27–45)	27 (15–54)
56–70	80	32±27 (26–38)	24 (13–47)	46	34±29 (25–42)	26 (13–46)	34	30±24 (22–39)	21 (11–47)
All*	300	34±26 (31–37)	26 (14–48)	155	34±25 (26–34)	23 (13–43)	145	38±28 (33–42)	31 (16–54)

[1]Bleeding on probing was based on the Löe–Silness Gingival Index categories 2 and 3; [2]p-values for the differences between men and women were obtained using the Mann–Whitney test; *p<0.05

Table 6. Estimated odds ratios (95% confidence intervals) for percentage of sites with bleeding on probing (≥40% vs. <40%), according to age group and gender

	ÔR (95% CI)
Gender	
Male	1.76 (1.07–2.87)*
Women (ref.)	1.0
Age group	
56–70	1.06 (0.58–1.94)
46–55	1.01 (0.57–1.79)
35–45 (ref.)	1.0

*p<0.05

Regarding gender, the results of this study are in agreement with those of other studies that report higher prevalences of gingivitis in men (5,16–18) but diverge from other investigations that report either a higher prevalence in women (19) or no gender differences at all (16). Although gender-genetic differences are important factors in the etiology of PD, other factors, such as knowledge, attitudes (less positive outlook toward oral health, etc.), and lifestyle (oral care, dental-visit behavior, etc.), may play major roles in the development of PD in men (20,21).

Previous US data (22) show that the prevalence of BOP in US adults is substantially lower than it is in Puerto Rican adults. In addition, while the predilection for BOP is higher in US men than it is in US women, no such gender predilection was revealed by our study.

Few studies have included the percentage BOP-sites parameter when reporting gingivitis; however, the Joint EU/USA Periodontal Epidemiology Working Group has recently proposed that, in addition to reporting the overall BOP, the percentage of BOP sites be included in the standards for reporting gingivitis (23). The percentage of BOP sites observed in this investigation is higher than that reported in Germany (24). Moreover, a cohort of periodontally diseased patients in Italy was also observed to have a lower percentage of BOP sites (25). Considering gender, the mean percentage of BOP sites was higher in men compared to women, but this difference was not statistically significant. This finding agrees with that of a previous study by Chrysanthakopoulos, which also reported a slightly higher percentage of BOP sites in men compared to women (26).

In women, the highest percentage of BOP sites was observed in those who were from 56 to 70 years of age, and this could be explained by an association between a post-menopausal decrease in estrogen levels and gingival inflammation (27). In men, the highest percentage of BOP sites was detected in the youngest participants, and the factors responsible for this association deserve further investigation; however, the presence of greater numbers of teeth in younger adults may have contributed to this fact, since a significant association between tooth loss and age has been previously reported in Puerto Ricans in the US (10).

The results of the present study cannot be extrapolated to the general population since some of the participants in this pilot study were health-related workers who potentially had increased knowledge/awareness of oral hygiene practices. Therefore, the findings from this convenience sample may have been underestimated and so not generalizable to the 30-70 year-olds residing in San Juan. This may be considered a study limitation.

The findings of the present study suggest that gingivitis is a substantial oral health problem in PR. If uncontrolled, gingivitis has the potential to cause alveolar bone loss leading to periodontitis and could harmfully affect overall health. It is, therefore, important to confirm and document the severity of gingivitis by conducting an island-wide study (using a representative sample) with the twin purposes of 1) establishing risk factors at multiple levels and 2) establishing and implementing public health primary and secondary prevention strategies. The high prevalence of gingivitis in PR, not only in this adult population but also in children (verified by a recent study in children), confirms the need to implement these preventive strategies at an early age. In addition, it is necessary to investigate risk factors associated with gingivitis, including lack of knowledge, oral health behaviors, and access to dental care.

Conclusion

Clinical gingivitis was observed in all the study participants. The overall mean GI was higher in men than in women. Nearly one-third of the subjects presented BOP, and approximately one-third of the sites examined were affected. The prevalence of gingivitis found by this study is higher than the prevalence reported in the US.

Resumen

Objetivo: La gingivitis, una inflamación de los tejidos gingivales, típicamente progresa a periodontitis. El propósito de este estudio es estimar la prevalencia de gingivitis en residentes de 35-70 años de San Juan, Puerto Rico y evaluar diferencias en su distribución por edad y género. Métodos: Estudio epidemiológico de corte transversal utilizando pacientes de una práctica privada, y pacientes/empleados del Centro Médico de PR. Los sujetos completaron un cuestionario de historial médico, recibieron evaluaciones de tejidos blandos/duros y gingivales utilizando un Índice de Löe–Silness modificado. Se utilizaron estadísticas descriptivas para estimar la prevalencia de gingivitis (leve, moderada y severa) y el índice gingival (IG) promedio. Se calculó la prevalencia de sangrado al sondaje (SAS) y el porcentaje de sitios con SaS por género y edad. Se utilizó regresión logística multinomial para evaluar las asociaciones entre edad, sexo y severidad en 3 categorías; se usó una regresión logística multivariable presentando ≥40% con SAS (vs. tener <40% sitios con SaS como referencia). Resultados: 300 participantes (52% mujeres y 48% hombres) presentaron gingivitis. El IG promedio fue 1.38. Se detectó gingivitis moderada en 83% de los participantes, leve (7.3%) y severa (9.3%). SAS se observó en 99% de los sujetos (34% de sitios). Los hombres presentaron una probabilidad más alta de gingivitis moderada (4.66) y severa (10.06), en comparación con mujeres, así como 1,76 veces mayor posibilidad de tener ≥ 40% o más sitios con SaS. Conclusión: La presencia de gingivitis se observó en todos los participantes. El IG es mayor en hombres que en mujeres. La prevalencia de la gingivitis fue más alta que en EE.UU.

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