

# Clinical lip alterations associated with chronic occupational sun exposure among beach street vendors: a cross-sectional study

## Abstract

**Objective:** To evaluate the clinical condition of the lips and identify factors associated with lip lesions among street vendors occupationally exposed to solar radiation on the beaches of São Vicente, São Paulo State, Brazil.

**Methods:** A cross-sectional observational study was conducted involving 98 street vendors working on Gonzaguinha and Itararé beaches. Participants completed a structured questionnaire containing sociodemographic, occupational, and behavioral information, followed by a clinical examination of the lips. Descriptive analyses, univariate association tests, and multivariable binary logistic regression models were performed. Statistical significance was established at  $p < 0.05$ .

**Results:** The mean age of participants was  $45.3 \pm 13.4$  years, and most were male (68.4%). Clinical lip alterations were identified in 35.7% of the sample, with lip dryness representing the most frequent finding (30.6%). Participants presenting lip lesions had significantly longer occupational exposure durations than those without lesions (177.7 vs. 102.6 months;  $p = 0.015$ ). In the final multivariable model, occupational exposure duration (OR = 1.004; 95% CI: 1.001–1.008;  $p = 0.007$ ) and self-reported White ethnicity (OR = 3.77; 95% CI: 1.44–9.89;  $p = 0.007$ ) remained independently associated with the presence of lip lesions.

**Conclusion:** Beach street vendors constitute a vulnerable population with a high frequency of clinical lip alterations associated with chronic occupational sun exposure. Longer occupational exposure duration and self-reported White ethnicity were independently associated with higher odds of lip lesions. These findings reinforce the importance of preventive strategies, photoprotection measures, regular oral examinations, and early detection programs targeting outdoor workers.

**Keywords:** lip lesions, lip cancer, ultraviolet radiation, occupational health, oral health, epidemiology

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## Introduction

Over the last decades, the global burden of lip and oral cavity cancer has increased substantially. Between 1990 and 2021, the number of prevalent and incident cases rose by 161.8% and 142.2%, respectively, reflecting the growing impact of this disease on public health worldwide. Although increases in age-standardized rates were more modest, prevalence and incidence rates still increased by 27.5% and 14.3%, respectively. Projections for 2050 estimate that more than 2.65 million individuals may be living with the disease, representing a 68.7% increase compared with 2021, while incident cases are expected to reach approximately 790,000, corresponding to an 82.6% increase. These findings underscore the importance of implementing effective prevention strategies, promoting early diagnosis, and improving treatment approaches to mitigate the future burden of this malignancy.<sup>1-3</sup>

In tropical regions such as Brazil, excessive exposure to ultraviolet (UV) radiation constitutes a major risk factor for the development of cellular atypia and lip carcinogenesis. Solar radiation predominantly affects fair-skinned individuals and is responsible for a substantial proportion of lower lip cancer cases. Occupational groups engaged in outdoor activities, including farmers, fishermen, and street vendors, are particularly vulnerable to the development of epithelial dysplasia and other lesions associated with chronic sun exposure.<sup>4-7</sup>

The early identification of clinical signs such as lip dryness, atrophy, desquamation, erythema, ulceration, and alterations of the vermilion border may facilitate the recognition of lip alterations requiring further clinical investigation and monitoring. Early detection contributes to improved prognosis while reducing the need for invasive treatments, palliative care, and the economic burden imposed on patients and healthcare systems. Common manifestations of oral cancer include persistent oral ulcers resembling aphthous lesions that fail to heal within 15 days, as well as cervical lymph node enlargement. Early-stage lesions are often asymptomatic, making diagnosis challenging in the absence of regular clinical examination. Definitive diagnosis is established through histopathological analysis of biopsy specimens, and early detection remains one of the most important determinants of treatment success and patient survival.<sup>1,8-12</sup>

Recent studies have reported a high prevalence of lip alterations among workers occupationally exposed to solar radiation along the coast of São Paulo State, particularly beach vendors. These investigations demonstrated low rates of lip photoprotection, limited awareness regarding the risks associated with solar exposure, and a high frequency of clinical findings compatible with chronic actinic damage, highlighting the urgent need for continuous prevention and early detection programs.<sup>13,14</sup> Despite the growing scientific interest in the association between occupational sun exposure and potentially malignant lip lesions, studies specifically focusing on beach vendors remain scarce.

These workers are subjected to prolonged daily exposure to ultraviolet radiation, frequently without adequate access to personal protective equipment or regular dental care.<sup>15</sup>

Given this context, the present cross-sectional study aimed to evaluate the clinical condition of the lips and identify factors associated with the occurrence of lip lesions among street vendors occupationally exposed to solar radiation on the beaches of São Vicente, located on the coast of São Paulo State, Brazil.

## Methodology

### Study design

This observational, analytical, cross-sectional study was conducted to evaluate the clinical condition of the lips and associated factors among street vendors occupationally exposed to solar radiation. The study was carried out on the beaches of Gonzaguinha and Itararé, located in the municipality of São Vicente, São Paulo State, Brazil.

### Ethical considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and the Brazilian regulations governing research involving human participants. The research protocol was reviewed and approved by the Research Ethics Committee of Santo Amaro University (UNISA) under CAAE number 67049223.2.0000.0081. All participants received detailed information regarding the study objectives and procedures and provided written informed consent prior to enrollment.

### Study population and sampling

The study population consisted of street vendors who regularly worked on the beaches of Gonzaguinha and Itararé in São Vicente during the data collection period. Data collection was performed on March 22, 2025. A total of 98 workers occupationally exposed to solar radiation were evaluated. Participants were recruited using a convenience sampling strategy.

The recruitment strategy employed convenience sampling, whereby street vendors present at the study sites on the day of the campaign were invited to participate. Although convenience sampling may introduce selection bias, efforts were made to approach all eligible individuals present during the data collection period in order to maximize sample representativeness within the context of the prevention campaign.

### Inclusion and exclusion criteria

Individuals were eligible for inclusion if they met the following criteria: Aged 18 years or older; Actively working as street vendors on the evaluated beaches; Present at the study sites during the data collection period; Willing to participate voluntarily and provide written informed consent.

Individuals were excluded if they: Were unable to understand or respond to the questionnaire; Declined participation; Failed to complete all stages of the clinical evaluation.

### Data collection

Data collection consisted of a structured interview followed by a clinical examination of the lips and perioral tissues. Initially, participants completed a standardized questionnaire designed to obtain sociodemographic, occupational, and behavioral information.

The variables investigated included sex, age, self-reported ethnicity, smoking status, alcohol consumption, combined tobacco and alco-

hol use, duration of occupational activity, occupational sun exposure, number of working days per week, daily working hours, use of lip sunscreen, use of body sunscreen, use of hats or caps, and frequency of dental visits.

### Clinical examination

Following questionnaire administration, a clinical examination of the lips was performed by a previously trained and calibrated examiner. Examiner calibration was conducted during two 90-minute sessions led by two PhD specialists in Oral Medicine and Oral Pathology. Clinical cases were reviewed and discussed to ensure diagnostic standardization and consistency.

The clinical assessment aimed to identify findings compatible with chronic actinic damage and potentially malignant disorders of the lips. The presence or absence of the following clinical alterations was recorded according to predefined diagnostic criteria established during examiner calibration and supported by the scientific literature

Lip dryness, presence of superficial fissures, surface roughness, and/or fine scaling affecting the vermilion border. Atrophy, thinning of the labial epithelium associated with reduced tissue elasticity and loss of vermilion border definition. Ulceration, loss of epithelial continuity with exposure of the underlying connective tissue, which may be symptomatic or asymptomatic. White plaques, white lesions, either flat or elevated, that could not be removed by gentle scraping and were suggestive of leukoplakia or other potentially malignant disorders. Clinically detectable lip lesion, any other visible lip alteration not classified within the categories above but considered by the examiner to warrant clinical follow-up, complementary examination, or biopsy.

All examinations were performed under appropriate illumination conditions using personal protective equipment and in accordance with biosafety standards applicable to clinical research in Dentistry.

When clinically indicated, lesions were photographed to assist diagnostic documentation and subsequent evaluation. All images were stored in a secure, restricted-access digital repository, ensuring participant confidentiality and compliance with ethical standards for research involving human subjects.

### Statistical analysis

Data were entered into an electronic database and analyzed using SPSS software (Statistical Package for the Social Sciences; IBM Corp., Armonk, NY, USA).

Initially, descriptive analyses were performed. Categorical variables were summarized using absolute and relative frequencies, whereas continuous variables were described using means, standard deviations, minimum values, and maximum values. The distribution of continuous variables was assessed using the Shapiro–Wilk test. Variables demonstrating normal distribution were analyzed using parametric methods.

Comparisons between participants with and without lip lesions were performed using Student's t-test for continuous variables. Associations between categorical variables and the presence of lip lesions were assessed using the Pearson chi-square test. To identify factors independently associated with the occurrence of lip lesions, multivariable binary logistic regression models were constructed using both the Enter and Stepwise selection methods. In the Enter model, all variables identified as potentially relevant in the univariate analyses were simultaneously included. In the Stepwise model, variables were

sequentially entered or removed according to their statistical significance, resulting in a more parsimonious final model.

The results of the logistic regression analyses were expressed as regression coefficients (B), odds ratios (ORs), and corresponding 95% confidence intervals (95% CIs). Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test, whereas explanatory power was assessed using the Nagelkerke pseudo-R<sup>2</sup> coefficient. Statistical significance was established at a 5% level (p<0.05).

Results

Characteristics of the study population

A total of 98 street vendors working on the beaches of Gonzaguinha and Itararé, located in São Vicente, São Paulo State, Brazil, were evaluated. The mean age of the participants was 45.3±13.4 years, ranging from 20 to 74 years. Males accounted for 68.4% of the sample, whereas females represented 31.6%.

Regarding self-reported ethnicity, 57.1% of participants identified as Black and 42.9% as White. Smoking was reported by 38.8% of the participants, while 43.9% reported alcohol consumption.

All participants performed occupational activities involving direct exposure to solar radiation. Most individuals (91.8%) reported working more than six hours per day and had accumulated several years of occupational exposure. Adherence to photoprotective measures was limited. Only 6.1% of participants reported regular use of lip sunscreen, whereas 43.9% used body sunscreen. Detailed sociodemographic, occupational, and behavioral characteristics are presented in Table 1.

Table 1 Sociodemographic, behavioral, and occupational characteristics of street vendors occupationally exposed to solar radiation (n = 98)

| Characteristic      | n (%) or Mean ± SD (Min–Max) |
|---------------------|------------------------------|
| Age (years)         | 45.3 ± 13.4 (20–74)          |
| Sex                 |                              |
| Male                | 67 (68.4%)                   |
| Female              | 31 (31.6%)                   |
| Ethnicity           |                              |
| Black               | 56 (57.1%)                   |
| White               | 42 (42.9%)                   |
| Smoking Status      |                              |
| Yes                 | 38 (38.8%)                   |
| No                  | 60 (61.2%)                   |
| Alcohol Consumption |                              |

| Characteristic                                | n (%) or Mean ± SD (Min–Max)                                                                                                                           |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes                                           | 43 (43.9%)                                                                                                                                             |
| No                                            | 55 (56.1%)                                                                                                                                             |
| Duration of Occupational Activity (months)    | Not specified in the original dataset; mean duration was 177.7 months among participants with lip lesions and 102.6 months among those without lesions |
| Occupational Sun Exposure Daily Working Hours | 98 (100%)                                                                                                                                              |
| > 6 hours/day                                 | 90 (91.8%)                                                                                                                                             |
| ≤ 6 hours/day                                 | 8 (8.2%)                                                                                                                                               |
| Use of Lip Sunscreen                          |                                                                                                                                                        |
| Yes                                           | 6 (6.1%)                                                                                                                                               |
| No                                            | 92 (93.9%)                                                                                                                                             |
| Use of Body Sunscreen                         |                                                                                                                                                        |
| Yes                                           | 43 (43.9%)                                                                                                                                             |
| No                                            | 55 (56.1%)                                                                                                                                             |

Lip alterations were identified in 35 participants, corresponding to 35.7% of the study population. Among the clinical findings, lip dryness was the most prevalent condition (30.6%), followed by atrophy (9.2%), ulceration (5.1%), and white plaques (5.1%). The distribution of the clinical findings is presented in Table 2.

Table 2 Prevalence of lip alterations among street vendors occupationally exposed to solar radiation (n = 98)

| Lip Alteration                               | n (%)      |
|----------------------------------------------|------------|
| Lip dryness (cheilitis sicca)                | 30 (30.6%) |
| Atrophy                                      | 9 (9.2%)   |
| Ulceration                                   | 5 (5.1%)   |
| White plaque                                 | 5 (5.1%)   |
| Total individuals presenting lip alterations | 35 (35.7%) |

Comparisons between participants with and without lip lesions revealed a statistically significant difference in occupational exposure duration. Individuals presenting lip lesions had worked in the profession for a mean of 177.7 months, compared with 102.6 months among those without lesions (p = 0.015).

No statistically significant associations were observed between lip lesions and smoking status, alcohol consumption, body sunscreen use, or lip sunscreen use in the univariate analyses. Detailed comparisons between participants with and without lip lesions are presented in Table 3.

Table 3 Comparison of age and occupational exposure time between street vendors with and without lip lesions

| Variable                            | Group          | Mean  | median | SD    | CV (%) | Minimum | maximum | range | Standard error | p-value |
|-------------------------------------|----------------|-------|--------|-------|--------|---------|---------|-------|----------------|---------|
| Occupational exposure time (months) | With lesion    | 177.7 | 108    | 156.2 | 88%    | 4       | 540     | 535   | 51.8           | 0.015   |
|                                     | Without lesion | 102.6 | 36     | 137.3 | 134%   | 1       | 720     | 719   | 33.9           |         |
| Age (years)                         | With lesion    | 49.4  | 54     | 15.6  | 32%    | 17      | 80      | 63    | 5.2            | 0.061   |
|                                     | Without lesion | 43.0  | 43     | 16.1  | 37%    | 14      | 78      | 64    | 4.0            |         |

Variables showing statistical significance in the univariate analyses were subsequently included in multivariable binary logistic regression models. Following adjustment, only occupational exposure duration and ethnicity remained independently associated with the presence of lip lesions.

White participants exhibited a significantly greater likelihood of presenting lip lesions than black participants (OR=3.77; 95% CI: 1.44–9.89; p=0.007). Furthermore, longer occupational exposure was associated with a progressive increase in the odds of developing lip lesions (OR=1.004; 95% CI: 1-1.01; p=0.007). The final multivariable logistic regression model is presented in Table 4.

**Table 4** Logistic regression analysis of factors associated with lip lesions among street vendors occupationally exposed to solar radiation

| Variable                                 | Enter method       |           |         |       |              |              | Stepwise Method |       |         |       |              |              |
|------------------------------------------|--------------------|-----------|---------|-------|--------------|--------------|-----------------|-------|---------|-------|--------------|--------------|
|                                          | Coef. (B)          | Wald      | p-value | OR    | 95% CI Lower | 95% CI Upper | Coef. (B)       | Wald  | p-value | OR    | 95% CI Lower | 95% CI Upper |
| <b>Age</b>                               | 0.020              | 1.295     | 0.255   | 1.02  | 0.99         | 1.06         |                 |       |         |       |              |              |
| <b>Duration of occupational activity</b> | 0.003              | 2.822     | 0.093   | 1.00  | 1.00         | 1.01         | 0.004           | 7.279 | 0.007   | 1.00  | 1.00         | 1.01         |
| <b>Sex</b>                               | Female             | Reference |         |       |              |              |                 |       |         |       |              |              |
|                                          | Male               | 0.192     | 0.134   | 0.715 | 1.21         | 0.43         | 3.38            |       |         |       |              |              |
| <b>Smoking status</b>                    | No                 | Reference |         |       |              |              |                 |       |         |       |              |              |
|                                          | Yes                | -0.141    | 0.027   | 0.870 | 0.87         | 0.16         | 4.70            |       |         |       |              |              |
| <b>Alcohol consumption</b>               | No                 | Reference |         |       |              |              |                 |       |         |       |              |              |
|                                          | Yes                | -0.393    | 0.299   | 0.585 | 0.67         | 0.16         | 2.76            |       |         |       |              |              |
| <b>Smoking and alcohol consumption</b>   | No                 | Reference |         |       |              |              |                 |       |         |       |              |              |
|                                          | Yes                | 0.483     | 0.178   | 0.673 | 1.62         | 0.17         | 15.27           |       |         |       |              |              |
| <b>Lip sunscreen use</b>                 | No                 | Reference |         |       |              |              |                 |       |         |       |              |              |
|                                          | Yes                | -0.067    | 0.004   | 0.948 | 0.94         | 0.12         | 7.04            |       |         |       |              |              |
| <b>Ethnicity</b>                         | Black              | Reference |         |       |              |              |                 |       |         |       |              |              |
|                                          | White              | 3.006     | 6.718   | 0.010 | 20.21        | 2.08         | 196.19          | 1.328 | 7.288   | 0.007 | 3.77         | 1.44         |
|                                          | Mixed-race (Brown) | 1.818     | 2.701   | 0.100 | 6.16         | 0.70         | 53.87           |       |         |       |              |              |

## Discussion

The present study evaluated the clinical condition of the lips and factors associated with lip lesions among street vendors occupationally exposed to solar radiation on the beaches of São Vicente, São Paulo State, Brazil. The findings revealed a high prevalence of lip alterations, affecting more than one-third of the evaluated workers. In addition, adherence to photoprotective measures was notably low, particularly regarding the use of lip sunscreen. After multivariable adjustment, occupational exposure duration and White ethnicity remained independently associated with the presence of lip lesions, reinforcing the cumulative effect of chronic ultraviolet radiation exposure on lip tissue damage and potentially malignant disorders.<sup>1,4,6,7,12-14</sup>

The prevalence of lip lesions observed in this study is consistent with findings reported in other populations occupationally exposed to solar radiation. Previous investigations involving farmers, fishermen, rural workers, and beach workers have documented high frequencies of clinical alterations compatible with chronic actinic damage. These findings support the well-established relationship between cumulative ultraviolet radiation exposure and the development of actinic cheilitis and lower lip squamous cell carcinoma.<sup>3,15</sup>

Chronic exposure to ultraviolet radiation induces molecular and cellular alterations, including DNA damage, oxidative stress, local immunosuppression, and disruption of normal epithelial repair mechanisms. Over time, these processes may contribute to epithelial dysplasia and malignant transformation, particularly in individuals exposed for prolonged periods without adequate photoprotection. One of the most concerning findings of the present study was the extremely low prevalence of lip sunscreen use. Although most participants worked under direct sunlight for extended periods, only a small proportion reported regular use of products specifically designed to protect the lips. This finding reflects both limited awareness regarding the

importance of lip photoprotection and the barriers related to product accessibility and cost.<sup>5,16</sup>

Previous studies have similarly demonstrated inadequate adoption of preventive measures among occupationally exposed populations. According to Azurdia et al.,<sup>5</sup> even among individuals considered highly aware of photosensitivity risks, the application of lip sunscreen is often insufficient to provide effective protection. Furthermore, previous studies have highlighted the absence of public health initiatives specifically targeting informal outdoor workers, a factor that may further increase vulnerability to chronic actinic damage and lip cancer.<sup>17,18</sup>

The findings indicate that, although lip sunscreen use showed statistical significance in the descriptive distribution of the sample, no significant association was observed between its use and the presence of lip lesions. The predominance of non-use among both participants with and without lesions suggests that lip photoprotection remains insufficiently adopted within this occupational group. These findings reinforce the need for educational interventions aimed at increasing awareness regarding the importance of lip photoprotection among outdoor workers.<sup>5,16,18</sup> The association between occupational exposure duration and lip lesions observed in the present study further supports the cumulative nature of ultraviolet radiation damage. Participants with longer professional activity histories were significantly more likely to present lip alterations. This finding is biologically plausible, as the carcinogenic effects of ultraviolet radiation result from repeated exposure over many years, leading to progressive accumulation of genetic and tissue damage.

The association observed between white ethnicity and the presence of lip lesions deserves particular attention. White participants were approximately four times more likely to present lip alterations than black participants. This finding is biologically plausible and consistent with previous epidemiological studies demonstrating greater



susceptibility of individuals with lower melanin concentrations to the harmful effects of ultraviolet radiation. Melanin exerts an important photoprotective function by absorbing and dissipating ultraviolet radiation, thereby reducing cellular damage induced by chronic sun exposure.<sup>19,20</sup> In Brazil, racial admixture can sometimes lead to ambiguity; however, our study observed a higher number of labial abnormalities among white individuals.

Although sex was not independently associated with lip lesions in the final multivariable model, males constituted the majority of the evaluated population. This finding is consistent with previous studies involving occupationally exposed populations, in which men generally account for a larger proportion of outdoor workers and accumulate longer periods of sun exposure throughout their working lives. Furthermore, previous investigations have reported lower adherence to preventive measures among male workers, which may contribute to an increased risk of chronic actinic damage.<sup>14,20,21</sup>

Regarding behavioral risk factors, tobacco use and alcohol consumption remain well-established contributors to oral carcinogenesis and may potentiate the malignant transformation of chronic actinic alterations affecting the lips.<sup>22,23</sup> Although no significant associations were observed in the present study, the literature consistently demonstrates that the interaction between ultraviolet radiation, tobacco exposure, and alcohol consumption promotes oxidative stress, DNA damage, and chronic inflammation, thereby contributing to a multifactorial process involved in lip carcinogenesis.<sup>24-26</sup>

From a clinical perspective, the findings are consistent with those reported by Cavalcante et al.,<sup>27</sup> and Silva et al.,<sup>28</sup> who described a high frequency of lip alterations compatible with chronic actinic damage, including dryness, fissuring, scaling, and atrophy. These alterations are often overlooked by workers because they are initially asymptomatic or perceived as minor cosmetic changes. Consequently, delays in seeking professional evaluation may hinder early diagnosis and timely intervention. Previous studies have emphasized that appropriate monitoring and management of chronic actinic lip alterations are essential to prevent progression toward more severe lesions and invasive squamous cell carcinoma.<sup>10,15,29,30</sup>

Some limitations of this study should be acknowledged. First, the cross-sectional design precludes the establishment of causal relationships between occupational sun exposure and the occurrence of lip lesions. Second, the use of convenience sampling may have introduced selection bias and may limit the generalizability of the findings to other populations of outdoor workers. Third, some variables, including smoking, alcohol consumption, and photoprotection practices, were self-reported and therefore may be subject to recall bias. Finally, the clinical findings were not confirmed by histopathological examination, and the identified alterations should therefore be interpreted as clinical lip lesions compatible with chronic actinic damage rather than definitive diagnoses of specific pathological conditions. Additionally, the relatively small sample size may have limited the statistical power to detect associations with some behavioral variables.

Limited access to information, photoprotective products, and preventive healthcare services contributes to the persistent vulnerability of outdoor workers. In this context, the recognition of chronic sun-induced lip alterations and lip cancer as preventable occupational health conditions may facilitate the implementation of more effective public health policies.<sup>1,5,13,14</sup> Educational programs specifically designed for outdoor workers should include guidance on lip photoprotection, use of wide-brimmed hats, reduction of excessive sun exposure whenever possible, and awareness of the harmful effects of tobacco and alcohol consumption. Similar recommendations have been proposed in previ-

ous studies addressing occupational exposure to ultraviolet radiation and prevention of lip cancer.<sup>13,14,22,23,31</sup>

Ultimately, the prevention of chronic actinic lip damage and lip cancer requires coordinated action involving public health authorities, healthcare professionals, employers, and workers.<sup>13-15</sup> Recognizing sun protection as an essential component of occupational health policies may contribute substantially to reducing the burden of potentially malignant lip alterations and lip cancer among vulnerable populations.

## Conclusion

The findings of this study demonstrate that beach vendors constitute a population vulnerable to the development of clinical lip alterations associated with chronic occupational exposure to solar radiation. A high prevalence of lip changes was observed, together with limited adherence to photoprotective measures. Longer occupational exposure duration and White ethnicity were independently associated with the presence of lip lesions. These findings reinforce the cumulative effect of ultraviolet radiation on lip tissues and highlight the importance of preventive strategies, oral health education, regular clinical screening, and public policies aimed at protecting outdoor workers from chronic actinic damage and lip cancer.

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None

## Conflicts of interest

The authors declare that there are no conflicts of interest.

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