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# Survey and analysis of sleep status among community-dwelling elderly diabetics: A cross-sectional study in Shanghai, China

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**Abstract:** Sleep is crucial to maintaining physiological stability and exhibits a bidirectional relationship with metabolic health. This study used random sampling to investigate sleep status and factors influencing it among 585 community-dwelling elderly diabetics (age ≥ 60 years) in Shanghai (April–August 2025). Data were collected through a self-designed general questionnaire, the Athens Insomnia Scale (AIS), and clinical biochemical tests. Univariate analysis and binary logistic regression were used to identify influencing factors. Results indicated a median AIS score of 4.0 (3.0, 6.0), with 26.84% of patients (157/585) experiencing sleep problems. Univariate analysis revealed significant correlations between sleep quality and sex, level of education, glycated hemoglobin (HbA1c), fasting blood glucose (FBG), urine leukocytes, urine specific gravity, hypertension, the number of comorbidities, and diabetic peripheral neuropathy ($p < 0.05$ for all). Binary logistic regression analysis identified that being female (OR = 1.778, 95% CI: 1.115–2.836, $p = 0.016$), having a college degree or above (OR = 2.820, 95% CI: 1.305–6.092, $p = 0.008$), elevated glycated hemoglobin (OR = 1.460, 95% CI: 1.221–1.745, $p < 0.001$), elevated fasting blood glucose (OR = 1.490, 95% CI: 1.327–1.673, $p < 0.001$), and diabetic peripheral neuropathy (OR = 1.713, 95% CI: 1.046–2.804, $p = 0.032$) were independent risk factors for sleep disorders. Implementing individualized, multidimensional management for these high-risk populations is crucial to enhancing the overall effectiveness of diabetes prevention and control.

***Keywords*****:** elderly, diabetes mellitus, sleep quality, insomnia, influencing factors

## 1. Introduction

As aging progresses, by 2023 China' s population age ≥ 60 years accounted for 20.83% (over 290 million) of the total population (*1*), and 30.2% of these elderly have diabetes (*2*), making China the global leader in the number of elderly diabetics (*3*). Health management is critical for chronic disease control. Sleep, a key factor in maintaining physiological stability, has a bidirectional regulatory association with metabolic health (*4*). The prevalence of sleep disorders in the elderly ranges from 9.67% to 81.1% (*5*), and diabetics often have more severe sleep issues — potentially tied to more nocturia, pain, thermal discomfort, and habitual snoring (*6*). In elderly diabetics, sleep disorders correlate with lower insulin sensitivity, poorer glucose metabolism, and higher risks of cardiovascular/neurodegenerative diseases, cognitive impairment, and all-cause mortality (*7*).

The 2022 consensus by the American Diabetes Association (ADA) and European Association for the Study of Diabetes (EASD) emphasized sleep health as central to diabetes lifestyle management (*8*). While existing studies have examined elderly diabetics' sleep, findings are inconsistent, with limited targeted data on communities in Shanghai. Additionally, few studies have addressed insomnia-related risk factors in this group, and domestic research largely summarizes specific clinical issues.

Thus, the current study seeks to ascertain sleep disorder prevalence and factors influencing it in this population, providing guidance for improved prevention and development of clinical care strategies.

## 2. Patients and Methods

### 2.1. Study population and sampling method

Using completely randomized sampling, elderly diabetics who underwent health examinations at the Sijing Town Community Healthcare Center in Songjiang District, Shanghai, between April and August 2025 were selected as study subjects.

Inclusion criteria: *i*) Age ≥ 60 years; *ii*) Diagnosed with diabetes meeting the 1999 WHO diagnostic criteria for diabetes; *iii*) Permanent residence in this community for ≥ 6 months; *iv*) Being conscious, free of mental illness or cognitive impairment, and capable of communication; *v*) Voluntarily participating in the study and signing an informed consent form. Exclusion criteria: Use of sleep-related medications.

This study used sleep disorder prevalence as the outcome measure. Referencing prior research results of $P = 0.46$ (*9*), with a two-tailed $\alpha = 0.05$, $Z_{1-\alpha/2} = 1.96$, $d = 0.1p$, the sample size formula $N = Z^2_{1-\alpha/2} P(1-P) / d^2$ yielded a minimum sample size of 451 patients. Considering questionnaire response rates, the final plan included 480 patients. A total of 598 questionnaires were distributed, with 585 valid responses received, resulting in a response rate of 97.83% (Figure 1).

This study was approved by this hospital's Ethics Review Committee (2023K081) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

2.2. Survey content and research tools

2.2.1. General information questionnaire

The questionnaire was independently designed by the research team based on a literature review and clinical practice. The survey content encompasses three dimensions: *i*) Demographic and sociological characteristics: sex, age, and level of education; *ii*) Clinical diabetes data: duration of disease, family history, comorbidities, and diabetic complications; and *iii*) Health-related behaviors: smoking history, drinking history, and exercise habits.

2.2.2. Athens Insomnia Scale

The Athens Insomnia Scale (AIS), developed by the Ohio State University College of Medicine (*10*), was used to assess patients' sleep quality. This 8-item scale measures difficulty falling asleep, nighttime awakenings, early morning awakenings, insufficient total sleep time, poor sleep quality, daytime fatigue, daytime functional impairment, and daytime sleepiness. Each item is scored

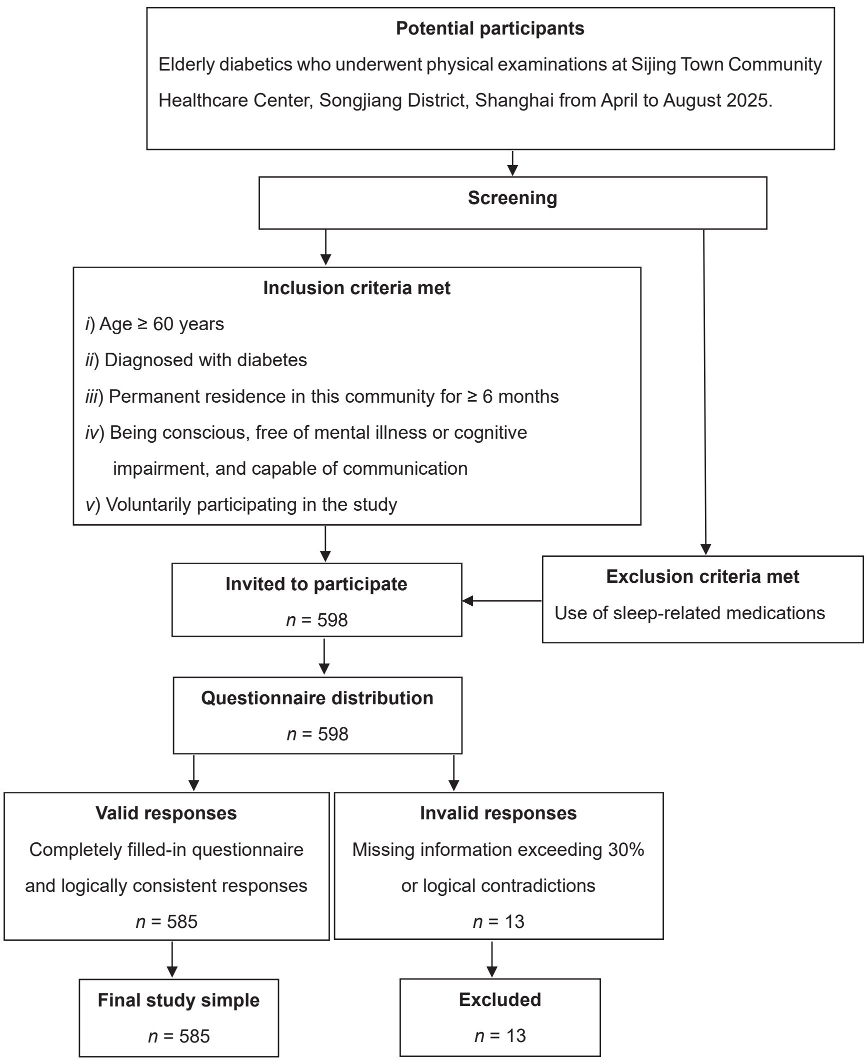


**Figure 1. Participant flow diagram.**

from 0 to 3 points (0 = no problem, 3 = severe problem), yielding a total score ranging from 0 to 24 points. Sleep quality status is categorized into four levels based on total score: no clinical insomnia (0–5 points), mild insomnia (6–9 points), moderate insomnia (10–15 points), and severe insomnia (≥ 16 points). The scale demonstrates good reliability and validity, with a Cronbach's α of 0.83.

2.2.3. Clinical and biochemical indicator testing

All indicator tests were conducted on the survey day by a professional medical team from the community health service center, including measuring height, weight, and blood pressure; calculating BMI; collecting blood after a 10-hour fast to measure glycated hemoglobin (HbA1c), fasting blood glucose (FBG), triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C); and collecting 24-hour urine specimens for measurement of urinary leukocytes, protein, glucose, ketones, pH, and specific gravity.

2.3. Method of data collection

Data were collected between April and June 2025 by a uniformly trained team (3 endocrinologists and 5 diabetes-specialized nurses) in three steps: *i*) On-site questionnaire survey: Patients were informed of study details face-to-face; after consent was obtained, and standardized guidance was provided to aid in completion; *ii*) Measurement of clinical indicators: Relevant indices were measured in designated rooms; *iii*) Quality control: On-site questionnaire checks ensured missing/inconsistent entries were verified and supplemented promptly.

2.4. Statistical methods

All data were entered into two databases and cross-checked by two operators to ensure accuracy. Data analysis was performed using the statistical software SPSS 31.0. Count data are expressed as patients (%). Comparisons were made using the chi-square $\chi^2$ test or Fisher's exact probability test. For continuous data, normality and homogeneity of variance were first assessed. Data following a normal distribution were expressed as $\bar{\mathbf{x}} \pm \mathbf{s}$, and intergroup differences were compared using the independent samples *t*-test. Non-normally distributed data were expressed as M (P25, P75) and compared using the Mann-Whitney *U* test. Binary logistic regression analysis was performed to examine factors influencing sleep quality. $P < 0.05$ was considered statistically significant.

## 3. Results and Discussion

3.1. Sleep status among community-dwelling elderly diabetics

Among 585 community-dwelling elderly diabetics, the median AIS score was 4.0 (3.0, 6.0). Using an AIS score > 6 as the cutoff, 157 elderly individuals (26.84%) had poor sleep quality. Of these, 118 (20.17%) had mild insomnia, 36 (6.15%) had moderate insomnia, and 3 (0.51%) had severe insomnia. The most prevalent problems with sleep quality according to the 8 items of the AIS were nocturnal awakenings (68.20%), followed by difficulty falling asleep (57.30%), early morning awakening (42.0%), daytime fatigue (40.10%), insufficient total sleep time (28.0%), poor sleep quality (26.8%), daytime functional impairment (25.5%), and daytime sleepiness (23.6%).

3.2. Univariate analysis of factors affecting sleep quality in elderly diabetics

Patients were divided into two groups: the good sleep quality group (AIS < 6 points) and the poor sleep quality group (AIS ≥ 6 points). Univariate analysis identified 9 factors significantly associated with sleep quality ($p < 0.05$), including sex, level of education, glycated hemoglobin, fasting blood glucose, history of hypertension, number of comorbidities, diabetic peripheral neuropathy, urinary leukocytes, and urine specific gravity (Table 1).

3.3. Multivariate analysis of factors affecting sleep quality in elderly diabetics

With "poor sleep quality (Yes = 1, No = 0)" serving as the dependent variable and the 9 statistically significant factors from univariate analysis serving as independent variables, multivariate logistic regression analysis was performed to control for confounding effects. Results indicated that sex, level of education, glycated hemoglobin, fasting blood glucose, and diabetic neuropathy were independent risk factors affecting sleep quality ($p < 0.05$) (Table 2). Results of multicollinearity testing indicated that among the 5 factors included, the tolerance values ranged from 0.952 to 0.990, and the variance inflation factors (VIFs) ranged from 1.010 to 1.051, indicating the absence of multicollinearity.

3.4. Sleep disorders in elderly diabetics: Prevalence, risk factors, and implications for community management

This study found that the prevalence of sleep disorders among community-dwelling elderly diabetics was 26.84%. This is comparable to the 30.0% reported in the 2019–2020 national survey of 12,369 urban/rural community residents age ≥ 60 years (*11*) but is significantly higher than the 19% in the general adult population (*12*), indicating that elderly diabetics remain a high-risk group for sleep disorders. The most prevalent problem was nighttime awakenings (57.3%), followed by difficulty falling asleep and early morning awakening,

**Table 1. Univariate analysis of factors affecting sleep quality in elderly diabetics**

| Characteristics | Good sleep quality group ($n$ = 428) | Poor sleep quality group ($n$ = 157) | $t/\chi^2$/Z | $p$ |
|---|---|---|---|---|
| Sex (%) | | | 11.257 | < 0.001 |
| Male | 236 (55.14) | 62 (39.49) | | |
| Female | 192 (44.86) | 95 (60.51) | | |
| Age (years), (%) | | | -0.324 | 0.746 |
| 60–69 | 189 (44.16) | 66 (42.04) | | |
| 70–79 | 206 (48.13) | 80 (50.96) | | |
| ≥ 80 | 33 (7.71) | 11 (7.01) | | |
| BMI (kg/m$^2$), (%) | | | -1.185 | 0.236 |
| < 18.5 | 7 (1.64) | 7 (4.46) | | |
| 18.5–23.9 | 167 (39.02) | 64 (40.76) | | |
| 24.0–27.9 | 193 (45.09) | 66 (42.04) | | |
| ≥ 28.0 | 61 (14.25) | 20 (12.74) | | |
| Level of education (%) | | | -2.677 | 0.007 |
| Primary school or below | 137 (32.01) | 34 (21.66) | | |
| Junior high school | 143 (33.41) | 55 (35.03) | | |
| Senior high school | 111 (25.93) | 46 (29.30) | | |
| College degree or above | 37 (8.64) | 22 (14.01) | | |
| Disease duration (years), M ($P_{25}$, $P_{75}$) | 8 (4, 15) | 10 (3,15) | -0.356 | 0.722 |
| Smoking history (%) | 88 (20.56) | 22 (14.01) | 3.226 | 0.072 |
| Drinking history (%) | 90 (21.03) | 24 (15.29) | 2.413 | 0.120 |
| Depression (%) | 1 (0.23) | 2 (1.27) | 2.436 | 0.119 |
| Anxiety (%) | 18 (4.21) | 8 (5.10) | 0.214 | 0.643 |
| Hypertension (%) | 260 (60.75) | 111 (70.70) | 4.905 | 0.027 |
| Coronary heart disease (%) | 62 (14.49) | 31 (19.75) | 2.376 | 0.123 |
| Hyperlipidemia (%) | 116 (27.10) | 49 (31.21) | 0.957 | 0.328 |
| History of stroke (%) | 43 (10.05) | 20 (12.74) | 0.866 | 0.352 |
| COPD (%) | 8 (1.87) | 4 (2.55) | 0.263 | 0.608 |
| Number of comorbidities (patients, %) | | | -2.118 | 0.034 |
| 0–1 | 297 (69.39) | 94 (59.87) | | |
| 2 | 93 (21.73) | 45 (28.66) | | |
| ≥ 3 | 38 (8.88) | 18 (11.46) | | |
| Diabetic complications (%) | | | | |
| Retinopathy | 247 (57.71) | 88 (56.05) | 0.129 | 0.719 |
| Neuropathy | 83 (19.39) | 44 (28.03) | 5.037 | 0.025 |
| Vascular disease | 82 (19.16) | 24 (15.29) | 1.161 | 0.281 |
| Diabetic foot | 7 (1.64) | 1 (0.62) | 0.849 | 0.357 |
| Exercise habits (days/week), (%) | | | -1.117 | 0.264 |
| < 1 | 92 (21.50) | 27 (17.20) | | |
| 1–3 | 27 (6.31) | 25 (15.92) | | |
| 4–6 | 19 (4.44) | 11 (7.01) | | |
| 7 | 290 (67.76) | 94 (59.87) | | |
| Glycated hemoglobin (%), M ($P_{25}$, $P_{75}$) | 6.60 (6.00, 7.30) | 7.00 (6.35, 8.70) | -7.884 | < 0.001 |
| Fasting blood glucose (mmol/L), M ($P_{25}$, $P_{75}$) | 7.18 (6.25, 8.09) | 8.61 (7.10,10.77) | -4.718 | < 0.001 |
| TG | 1.43 (1.02,1.99) | 1.40 (1.05, 2.05) | -0.155 | 0.877 |
| TC | 4.82 (4.09,5.70) | 4.80 (4.20, 5.39) | -0.355 | 0.723 |
| HDL-C | 1.35 (1.13,1.56) | 1.32 (1.13, 1.59) | -0.132 | 0.895 |
| LDL-C | 2.93 ± 1.04 | 2.90 ± 0.93 | -1.203 | 0.229 |
| Urine leukocytes (%) | | | -2.479 | 0.013 |
| Negative (-) | 324 (75.70) | 104 (66.24) | | |
| Weakly positive (±) | 37 (8.64) | 13 (8.28) | | |
| Positive (+-++++) | 67 (15.65) | 40 (25.48) | | |
| Urine protein (%) | | | -0.645 | 0.519 |
| Negative (-) | 345 (80.61) | 131 (83.44) | | |
| Weakly positive (±) | 41 (9.60) | 9 (5.73) | | |
| Positive (+-++++) | 42 (9.81) | 17 (10.83) | | |
| Urine glucose (%) | | | -0.323 | 0.747 |
| Negative (-) | 283 (66.12) | 107 (68.15) | | |
| Weakly positive (±) | 11 (25.70) | 1 (0.64) | | |
| Positive (+-++++) | 134 (31.31) | 49 (31.21) | | |
| Urine ketone bodies (%) | | | -0.638 | 0.523 |
| Negative (-) | 403 (94.16) | 150 (95.54) | | |
| Weakly positive (±) | 7 (1.64) | 1 (0.64) | | |
| Positive (+-++++) | 17 (3.97) | 6 (3.82) | | |
| Urine pH value, M ($P_{25}$, $P_{75}$) | 5.0 (5.0, 5.50) | 5.0 (5.0, 5.50) | -1.203 | 0.229 |
| Urine specific gravity, M ($P_{25}$, $P_{75}$) | 1.02 (1.01, 1.03) | 1.02 (1.02, 1.03) | -2.603 | 0.009 |

Count data are expressed as patients (%). *Abbreviations:* BMI, body mass index; COPD, chronic obstructive pulmonary disease; TG, triglycerides; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

**Table 2. Multivariate analysis of factors affecting sleep quality in elderly diabetics**

| Risk factors | *β* | SE | Wald $\chi 2$ | *p* | OR | 95% CI |
|---|---|---|---|---|---|---|
| Constant | -35.226 | 15.427 | 5.214 | 0.022 | — | — |
| Sex (female) | 0.576 | 0.238 | 5.846 | 0.016 | 1.778 | 1.115–2.836 |
| Level of education (college degree or above) | 1.037 | 0.393 | 6.956 | 0.008 | 2.820 | 1.305–6.092 |
| Glycated hemoglobin | 0.378 | 0.091 | 17.212 | < 0.001 | 1.460 | 1.221–1.745 |
| Fasting blood glucose | 0.399 | 0.059 | 45.584 | < 0.001 | 1.490 | 1.327–1.673 |
| Diabetic neuropathy | 0.538 | 0.252 | 4.578 | 0.032 | 1.713 | 1.046–2.804 |

*Independent variable coding*: Sex: Male = 1, Female = 2; Level of education: Primary school or below = 1, Junior high school = 2, Senior high school = 3, College degree or above = 4; Concurrent diabetic neuropathy: Yes = 1, No = 0.

which is consistent with the findings of Wang *et al.* (*13*). The current study found that sleep disorders are closely associated with multiple independent risk factors, which are specified below.

This study identified being female (OR = 1.778, $p = 0.016$) as an independent factor associated with a higher risk of a sleep disorder. The higher prevalence in elderly women aligns with the findings of Lu *et al.* (*14*) and is possibly linked to a postmenopausal decline in estrogen. An estrogen deficiency is associated with reduced nocturnal melatonin secretion, circadian rhythm disruption, and synergistic interactions with insulin resistance (*15-17*). Additionally, elderly women with diabetes may face greater emotional fluctuations, physical symptoms, and family burdens, which correlate with higher AIS scores (*18*). This finding overcomes the limitation of existing studies that focus only on physiological mechanisms, suggesting that medical personnel should enhance the management of elderly female patients from multiple perspectives – such as conducting regular quarterly screenings and organizing "female mutual aid groups."

A higher level of education (college or above) (OR = 2.820, $p = 0.008$) correlating with elevated risk echoes prior studies (*19*). While better-educated patients have greater awareness of diabetes-sleep comorbidity, this may lead to excessive worry about glycemic control and prognosis, which is associated with prolonged mental tension, increased nocturnal sympathetic activity, and shallower sleep (*20*). Post-retirement social role shifts (from active to static) may also trigger emotional dysregulation linked to sleep disorders. This conclusion contradicts the finding of some studies that "the higher the level of education, the better the sleep quality." Level of education may be associated with factors such as regional economic conditions and lifestyle, and it also fills the research gap regarding sleep risks among highly educated elderly diabetics in economically developed cities. In clinical practice, health education can be conducted through themed lectures to promote the self-management of diseases among elderly patients.

Elevated glycated hemoglobin (OR = 1.460, $p < 0.001$) and poor fasting blood glucose control (OR = 1.490, $p < 0.001$) were independently associated with sleep disorders. Chronic hyperglycemia is linked to advanced glycation end product (AGE) deposition in cerebral microvessels, which correlates with cerebral hypoperfusion and sleep regulatory center impairment (*21*); it also correlates with skin itching and nocturia, directly disrupting sleep continuity (*22*). Conversely, sleep disorders may act as a stressor correlating with neuroendocrine dysregulation (*e.g.*, delayed growth hormone secretion and heightened cortisol response), forming a bidirectional association with blood glucose control - consistent with the findings of Wu *et al.* (*23*) regarding sleep disturbances and the dawn phenomenon. This indicates that well-controlled blood glucose remains the crux of disease management for elderly diabetics, as it can delay the progression of pathological changes at the source.

Elderly diabetics with peripheral neuropathy had a 1.713-fold higher risk of sleep disorders ($p = 0.032$), which is consistent with studies reporting 41.9–96.79% poor sleep quality in neuropathic patients (*24-26*). This may correlate with neuropathic pain (affecting 25% of neuropathic patients), which is more pronounced at night and directly linked to sleep disruption (*27*); a bidirectional association between frequent awakenings and increased pain sensitivity may also exist (*28*). Additionally, restless leg syndrome-like symptoms and autonomic nervous system impairment (abnormal sweating and temperature regulation) may further disrupt sleep (*22,29*). This indicates that community medical personnel may need to conduct routine specialized screening for peripheral neuropathy among elderly diabetics, with a focus on those who have sleep disorders, and implement linked interventions for sleep and neuropathy to improve treatment outcomes.

Univariate analysis indicated that both positive urine leukocytes ($p < 0.05$) and abnormal urine specific gravity ($p < 0.05$) were associated with sleep quality; although neither indicator was included in the multivariate model, the aforementioned findings provide a new perspective for exploring the comorbidity mechanism between diabetes and sleep disorders, which can be further verified through prospective studies in the future.

### 3.5. Strengths and limitations of this study

The innovations of this study are: *i*) providing region-specific data on sleep status among community-dwelling elderly diabetics in Shanghai, offering a direct reference for regional prevention; *ii*) analyzing sleep disorder mechanisms from a multidimensional perspective, establishing theoretical foundations for formulating integrated intervention strategies. Limitations include: *i*) as a cross-sectional study, it only identifies associations rather than definitive causal relationships; *ii*) sleep assessment relied on 1-month self-reported recall, which may introduce recall bias. Future large-scale prospective studies are warranted to validate these findings and clarify causal relationships.

## 4. Conclusion

This study found that the prevalence of sleep disorders among elderly diabetics in communities in Shanghai is not negligible. In the future, the rate of screening for and intervention with respect to relevant risk factors needs to be increased to improve the effectiveness of comprehensive management. Additionally, prospective studies could be conducted to further verify the relevant mechanisms.

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