Higher prevalence of nasal polyposis among textile workers: an endoscopic based and controlled study*

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Background: There is a deficit of reliable epidemiologic studies exploring the prevalence of Chronic Rhinosinusitis with Nasal Polyps (CRSwNP). Recent data suggests that occupational dust exposure may be involved in its physiopathology.

Objectives: To compare the prevalence of nasal polyposis (NP) in a group of workers with occupational dust exposure (textile workers) and in a control group (retail store workers).

Methods: Cross-sectional study with a random sample of textile and retail store employees. Clinical data was gathered through a systematic interview, which included RhinoQOL and CAT™ questionnaires. A systematic endoscopic nasal examination was performed using a 0º rigid endoscope. Lund-Kennedy endoscopic score was determined for each participant. Statistical analysis was performed with SPSS.

Results: 316 participants were included in the study, i.e. 215 textile workers and 101 retail store workers. NP was found in 19 subjects among textile workers and none in the control group. The prevalence of NP increased by age strata and by years of dust exposition. Polypoid degeneration of the middle turbinate was more prevalent in the exposed group with Lund-Kennedy scoring also higher. RhinoQOL and CAT™ questionnaires had both significantly higher scores among textile employees. Previous medical diagnosis of atopic diseases or chronic lower airway diseases did not differ between exposed and control groups or even between subjects with and without NP.

Conclusions: These results point to an important correlation between occupational dust exposure and NP occurrence.

Key words: nasal polyps, paranasal sinus diseases, sinusitis, occupational exposure

Introduction

There is a deficit of epidemiologic studies exploring the prevalence of Chronic Rhinosinusitis with Nasal Polyps (CRSwNP), especially in European countries[(1)]. When reviewing the current literature, it becomes clear that giving an accurate estimate of CRSwNP prevalence remains speculative, mainly due to the diagnostic imprecision often used in publications, which are mostly based on symptoms questionnaires. The data obtained with such approach can be unreliable as not all patients that claim to have the disease have nasal polyps on endoscopy and asymptomatic polyps will be unaccounted for. Therefore, EPOS 2012 expert panel considers endoscopy as a prerequisite for accurate estimate of the prevalence of nasal polyposis (NP) and alerts to the need to distinguish between clinically silent NP or preclinical cases, and symptomatic NP[(1)]. In Europe, there are only two endoscopic based studies published, an in-vivo study done in Sweden which found a prevalence of 2.7%[(2)] and a cadaver study done in Portugal, by our investigation group, which found a prevalence of 5.5%[(3)].

Recent data suggests that occupational dust exposure may be involved in Chronic Rhinosinusitis (CRS) physiopathology. In 2012, Hox et al. stated that occupational exposures can be a risk

factor for the occurrence of CRS and for its recurrence or persistence[4]. Patients submitted to endoscopic sinus surgery (ESS) for CRS were inquired and a relevant occupational exposure was reported in 25% of all responding patients (N= 467). The prevalence of occupational exposures increased linearly with the number of ESS procedures needed by each patient ($p<0.001$)[4]. Our investigation group have also demonstrated, in a multivariate regression analysis, that occupational exposure to dust has a negative impact on CRSwNP postoperative outcome (N=85), with exposed patients (60% of the sample) having 38 times more chance of recurrence compared to the non-exposed group ($p=0.001$)[5]. However, both studies were retrospective analysis with their inherent limitations. In 2016, a multicenter cross-sectional study done in China was published (N=10,633) suggesting that some occupational and environmental exposures are strongly associated with CRS[6]. Nevertheless, that epidemiologic study was based on self-administered questionnaires for CRS diagnosis and occupational and environmental history; and no separation between patients with CRSwNP or patients with CRSsNP (Chronic Rhinosinusitis without Nasal Polyps) was made. Until present, there are no epidemiologic data comparing the prevalence of NP in workers with and without occupational exposure to dust.

The objective of this research was to establish the prevalence of NP in a group of workers with occupational exposure to dust (textile workers) and to compare it with its frequency among a non-exposed group (retail store workers).

Materials and methods

The study was performed according to established ethical guidelines and approval of Ethics Committee at the Health Sciences Faculty, Beira Interior University. A signed informed consent was obtained from each participant in the study.

A descriptive cross-sectional study was carried out to determine NP prevalence among two groups: textile workers (exposed group) and retail store workers (controls). This study took place in Castelo Branco District, within the Interior Centre Region of Portugal. This area is internationally known for its textile industry, mainly wool manufacturing. For the purpose of the study, a total of 357 workers were recruited, 254 textile workers and 103 controls. The sample was randomly selected using employee's numbers at the personnel database of the Factory/Retail Store. Textile workers were recruited from an industrial unit with a total workforce of 509 employees, comprising subjects from every working sector (spinning, wrapping, weaving, dyeing, finishing, quality control, storing and packing, informatics and marketing, administration, designing, woodwork). There were only included those with a minimum of one year's work. This factory manufactures mainly pure wool fabrics and wool rich or polyester/wool mixtures and, in lesser extent, cotton, linen and lycra products. The individuals for the control group were recruited from two retail stores from the same geographic area of the factory. In the control group, individuals who referred previous jobs in textile industry at any time or other jobs/hobbies with relevant dust exposures (such as construction workers, wood workers, bakers) in the last 10 years were also excluded.

Clinical data was gathered through a systematic interview to collect information on demographics, occupational history (including working sector, types of dust exposure, years of exposure, mask use), domestic or hobby dust exposures, smoking and alcoholic habits, comorbidities, previous nasal surgeries, nasal symptoms and their duration. Atopy (based on positive skin prick test or IgE antibodies in serum), lower airway disease and obstructive sleep apnea syndrome (OSAS) history were only considered positive when diagnosed by a specialist physician in each area. Subjective assessment of upper and lower airway symptoms and quality of life was obtained applying two Portuguese validated questionnaires: Rhinosinusitis Quality of life survey – Portuguese version (RhinoQOL-pv)[7] and COPD Assessment Test™ (CAT)[8]. RhinoQOL-pv scores for the symptom frequency and impact scales ranged from 1 ("never") to 5 ("always") in each question, while for the bothersomeness scale, scores ranged from 0 to 10, in accordance with the questions possible answers. We chose the CAT™ test because it consists of nonspecific questions about lung disease impacts and has already been studied not only for Chronic Obstructive Pulmonary Disease (COPD), but also Asthma and Asthma–COPD overlap syndrome (ACOS)[9].

A systematic endoscopic examination of both nasal cavities was performed by an otolaryngologist, using a 0º, 2.7 mm rigid endoscope from Karl-Storz®; decongestion with vasoconstrictor was used on an as-needed basis, especially to make middle meatus inspection easier. Nasal polyps were classified endoscopically in grade I, II or III, according to Lund criteria(10); Lund-Kennedy endoscopic score for CRS(11) was also determined for each participant. For the study purpose, cases of antrochoanal polyps, polypoid lesions with features suggestive of benign neoplasia (e.g. sinonasal papillomas) or with malignancy suspicion were excluded. All employees were observed in the doctor's office located at the company during their working shifts.

Terminology Usage Notes

CRSwNP according to EPOS 2012 is defined as a symptomatic clinical entity, not contemplating asymptomatic polyposis. So, it was decided to use "Nasal Polyposis" terminology, to include symptomatic CRSwNP and subclinical disease.

Statistical analysis

Statistical analysis was performed with Statistical Package for Social Sciences (IBM® SPSS® Statistics for Windows, Version 23.0). Textile workers and retail store workers were grouped in two independent samples and compared for multiple factors. Descrip-

Table 1. Sample demographics, comorbidities, smoking habits and occupational history (N=315).

	Exposed Group		Control Group		p value
Demographics					
Age (years ± SD; [range])	50 ± 11; [21; 67]		41 ± 10; [20; 65]		< 0.001
	n	%	n	%	
Gender: Male	92	42.3	35	34.7	0.120
Race					0.680
Caucasian	214	99.5	101	100	
African	1	0.5	0	0	
Comorbidities (n, %)					
Allergic Rhinitis	43	20.0	13	12.9	0.080
Asthma	17	7.9	11	10.9	0.252
COPD	1	0.5	0	0	0.680
Sinonasal Tumour	0	0	1	1.0	0.320
OSAS	11	5.1	0	0	0.013
Atopic Dermatitis	26	12.1	14	12.1	0.392
Salicylates Intolerance	3	1.4	1	1.0	0.617
Smoking Habits					0.832
Non-smoker	124	57.7	65	64.4	
Ex-smoker	41	19.1	8	7.9	
Smoker	50	23.3	28	27.7	
Alcoholic Habits					0.057
Non-alcoholic habits	107	49.8	60	59.4	
Light-to-moderate	97	45.1	40	39.6	
Heavy drinking	11	5.1	1	1.0	

tive statistics was used in those samples characterization. For categorical variables, Chi-Square Test (or Fisher's Exact Test/ Likelihood Ratio Test when assumptions needed for the previous test were not verified) was used to test for variable association. For continuous quantitative variables, Mann-Whitney Test was applied. Binomial test was used to compare our prevalence of NP with previous data published on the literature.
Statistical significance was accepted to correspond to a p-value of less than 0.05.

Results

A total of 316 individuals were included in the study: 215 textile workers (exposed group) and 101 retail store workers (control group). A total of 41 subjects were excluded: two retail store workers with a past working history in the textile industry; 15 textile workers with less than one year of work experience; 22 employees that were temporarily absent from work (ex. maternity leave, medical reason) and other two that refused to participate. Sample demographics, comorbidities, smoking and alcoholic habits are summarized in Table 1.
When asked about exposure to domestic fumes (ex. use of firewood/ coal) no difference was observed between groups with 12.2% of retail store employees and 13.1% of textile workers answering positively (Chi-Square Test, p=0.854). With regard to domestic animals, the non-exposed group (retail store workers) had more pets in a statistically significant way (Chi-Square Test, p=0.004).
The previous history of nasal surgery did not differ among the study groups (Table 2).
When asked about sinonasal symptoms with at least three months duration, the textile group reported significantly higher rates of hyposmia (16% vs 5%, p=0.003), headache (38% vs 22%, p=0.003), facial pressure (38% vs 24%, p=0.008), sneezing (62% vs 38%, p<0.001) and nasal pruritus (61% vs 37%, p<0.001). Snoring had also a significantly higher rate among the exposed group (54% vs 38%, p=0.005). Despite having all higher rates in the exposed group, other symptoms as nasal congestion/ blockage/obstruction, anterior and posterior rhinorrhea, and epistaxis did not differed statistically.
RhinoQOL-pv (total and by scales) and CAT™ mean scores are specified by group in Table 3.
The endoscopic findings as well as the Lund-Kennedy endoscopic score for both groups are summarized in Table 4. In nine cases (4.2%) from the exposed group and one case (1.0%) from

Table 2. History of nasal surgical procedures with absolute and relative frequencies. ESS – endoscopic sinus surgery.

Surgery	Exposed Group		Control Group		p value
	n	%	n	%	
Septoplasty	3	1.4	2	2.0	0.656
ESS	2	1.8	1	1.0	1.00
Polipectomy	0	0	0	0	-

Table 3. RhinoQOL-pv and CAT™ mean scores by group.

Questionnaire	Exposed Group	Control Group	p value
	mean± SD; [range]	mean± SD; [range]	
RhinoQOL-pv	26.31 ± 15.4 [14; 116]	21.45 ± 10.1 [14; 50]	0.005
Frequency Scale	8.25 ± 5.9 [5; 81]	7.12 ± 2.8 [5; 16]	0.011
Impact Scale	11.92 ± 5.3 [9; 37]	10.12 ± 2.6 [9; 25]	0.013
Bothersomeness Scale	6.14 ± 7.0 [0; 30]	4.21 ± 6.0 [0; 24]	0.009
CAT	2.67 ± 5.36 [0; 29]	1.37 ± 3.12 [0; 17]	0.023

Table 4. Results of endoscopic evaluation, including Lund-Kennedy score, by group.

Endoscopic Evaluation	Exposed Group		Control Group		p value
	n	%	n	%	
Nasal Polyposis	19	8.8	0	0	0.001
Antrochoanal Polyp	0	0	1	1.0	0.320
Polypoid degeneration of the middle turbinate	24	11.2	1	1.0	0.001
Septal Deviation	71	33.0	40	39.6	0.258
Lund-Kennedy score (mean± SD; [range])	3.43 ± 2.43; [0; 12]		1.76 ± 1.48; [0; 6]		<0.001

Table 5. Nasal polyps classification according to Lund criteria by group.

Grade	Exposed Group		Control Group	
	n	%	n	%
0 (no polyps)	196	91.2	101	100
I	9	4.2	0	0
II	9	2.2	0	0
III	1	0.5	0	0
Total	215	100	101	100

the control group, it was impossible to adequately inspect the middle meatus bilaterally due to severe septal deviation of the nasal cavity. In those cases, the Lund-Kennedy score and the polypoid status of the mucosa was inferred from the contralateral side.

The prevalence of septal deviation did not differ between the exposed and control groups (Table 4); also, total RhinoQOL-pv scores did not differ significantly between patients with and without nasal septum deviation (Man-Whitney Test, p=0.505).

One case of unilateral polyp was found in the control group. This patient had an history of a previous unilateral endoscopic surgery for an antrochoanal polyp (in the same side), and so it was assumed to correspond to disease recurrence.

NP was found in 19 subjects (8.8%) among the textile workers group (12 men and 7 women, ratio 1.7:1; mean age of 55 years) and none in the control group. From the 19 individuals found to have NP, only two (11%) were previously aware of the diagnosis and had been previously submitted to ESS. All cases of NP presented bilateral disease. Characterization of nasal polyps according to Lund criteria[10] is displayed on table 5.

When performing a statistical analysis stratified for age, we verified that in the subgroup of subjects with less than 45 years (N=120, 62 from exposed group and 55 from control group) the prevalence of NP was higher among the exposed ones (p=0.035, Likelihood Ratio Test), with 3 cases among them (4.8%) and none in the control group. In the subgroup of individuals with 45 or more years (N=196, 141 from exposed group and 39 from control group), the prevalence of NP was also higher in the exposed group with 16 cases among textile workers (11.3%) and no cases found in the control group (p=0.024, Fisher's Exact Test).

The prevalence of NP by age and years of dust exposition strata among textile workers is presented in Table 6. The mean time of years of textile dust exposure was 26±15 years, with a minimum of one year and a maximum of 54. Distribution of individuals with and without NP across working textile sectors is presented in Table 7. We found individuals with NP across almost every sector, apart from informatic/marketing and administration teams. Only 21 (9.8%) of textile workers referred to use occasional mask-protection during their job duties.

Concerning medication habits, 4.7% of textile workers referred regular use of nasal steroids and 9.3% of anti-histamines. Only two subjects with nasal polyps (11.7%) were using nasal steroids and were the ones with history of previous ESS.

The percentage of clinically silent NP or preclinical cases was 21% (4 cases) versus 79% (14 cases) of symptomatic NP. From the seven textile workers (3.3%) which claimed to have a previous medical diagnosis of CRSwNP, the diagnosis was confirmed in only two (being both workers with symptomatic NP). In the control group, two patients claimed also to have CRSwNP but

Table 6. Prealence of nasal polyposis by age and years of dust exposition strata among textile workers.

Age Strata	Exposed Group		Years of Exposition	Exposed Group	
	Nasal Polyposis	No Nasal Polyposis		Nasal Polyposis	No Nasal Polyposis
< 25 years	0	3	< 15 years	3	50
[25; 50[years	3	81	[15; 35[years	5	92
≥ 50 years	16	112	≥ 35 years	11	54
Fisher's Exact Test (p-value)	0.03		Fisher's Exact Test (p-value)	0.017	

Table 7. Distribution of individuals with and without NP across working sectors.

Work Sector	Exposed Group			
	Nasal Polyposis		No Nasal Polyposis	
	n	%	n	%
Spinning	2	10.5	40	20.4
Wrapping	1	5.3	15	7.7
Weaving	5	26.3	30	15.3
Dyeing	2	10.5	18	9.2
Finishing	4	21.1	54	27.6
Quality Control	1	5.3	7	3.6
Storing, Packing	2	10.5	14	7.1
Informatics, Marketing	0	0	6	3.1
Administration	0	0	8	4.1
Designing	1	5.3	3	1.5
Woodwork	1	5.3	1	0.5
TOTAL	**19**	**100**	**196**	**100**

the diagnosis was not confirmed in both of them. In total, from the 9 subjects claiming to have CRSwNP, seven (77%) had no signs of NP on endoscopic nasal evaluation, neither previous history of nasal surgery. Of the 19 individuals found to have NP, only two (11%) were previously aware of the diagnosis.

Chronic lower respiratory diseases (27 cases with asthma, i.e. 21 atopic asthma and 6 non-atopic asthma) have been previously diagnosed and treated in 9% of the total 297 individuals without polyps (total sample, exposed and not exposed) and in 10.5% of NP subjects (1 case of non-atopic asthma and 1 case of COPD) (p=0.689, Fisher's Exact Test). Among patients with clinically silent NP there were no cases of previously diagnosed chronic lower respiratory diseases. When comparing the exposed and control group for chronic lower respiratory diseases there was also no statistically significant difference (Table 1).

Concerning atopy in general, five individuals from the 19 subjects with NP (26%) reported a previous diagnosed of atopy by an immunoallergologist versus 51 in 297 individuals without NP (17%) (p=0.349, Fisher's Exact Test).

Comparing with the two published European endoscopic based studies(2,3), our prevalence of NP among textile workers was significantly higher: 8.8% versus 5.5% found in the Portuguese cadaver-study (p=0.029, Binomial Test) and 8.8% versus 2.7% found in the Swedish in-vivo study (p<0.001, Binomial Test).

Discussion

Despite all investigation on CRSwNP, there is still a deficit of information about its prevalence and risk factors. The rate of clinically silent disease that we found (21%) and the fact that the diagnosis was not confirmed in seven out of nine patients (77%) who claimed to have a previous medical diagnosis of CRSwNP, confirms the need of endoscopic based studies over the non-reliable questionnaire based ones.

Our epidemiologic study, is to our knowledge the first endoscopic based one to address whether occupational dust exposure has influence on CRSwNP prevalence. We decide to make a nasal endoscopic screening among textile workers since our previous retrospective study among patients with CRSwNP (N=85) showed that 60% of these patients were exposed to organic dust with a majority of them being textile particles[5]. All employees were observed in the doctor's office located at the company during their working shifts, allowing a truly workplace assessment of sinonasal diseases. This fact, along with the use of a control group without dust exposure represent some of the main study's strengths. Moreover, all participants were observed by the same otorhinolaryngologist specialist which reduces inter-observational biases.

Our prevalence results in the exposed group are significantly higher than the two European population-based studies, in Portugal and Sweden[2,3], which highlights the importance of occupational dust exposure as a risk factor for the occurrence of CRSwNP. This is also accentuated by the significantly higher NP rates among textile workers comparing to the control group.

The control of potential confounding variables such as domestic fumes exposures or the presence of pets at home was also important to this work. Interestingly, no difference on domestic dust exposures was observed among exposed and non-exposed group but more retail workers owned animals at their homes in a statistically significant way. This fact reinforces the role of occupational dust exposure in sinonasal inflammatory pathology detected in the textile population.

One of this study limitations is the difference in age between the

exposed and the control group. The textile industry in central Portugal is led by an ageing population and it was not possible to equalize the groups concerning this factor. However, we analyzed the groups by age strata and the difference in NP prevalence is still evident and significant. There was also a stronger female predominance in the control group, despite not being significantly different from the exposed group. These two factors, in addition to a relative small sample size might have contributed to the absence of nasal polyposis among the controls. These limitations are exceeded when comparing results of the exposed group with the prior cadaver endoscopic study done in Portugal, which had an even older population (mean age of 77 years, N=200) and a male predominance (58.5%). The prevalence results among these textile workers are significantly higher than the prevalence found in the cadaver study[3].

Another limitation is the fact that in a few cases (3.2%) it was impossible to adequately inspect the middle meatus bilaterally due to marked septal deviation. Small polyps may have also been missed in a small percentage of the sample since rigid endoscopy must be done gently and no topical anesthesia was used. These factors in combination can lead to an underestimation of NP prevalence.

In accordance to previously published studies that suggested an increase of NP prevalence with age[2,12,13], and a male predominance[1,2], we also found an higher prevalence among older strata and a male-female ratio of 1.7:1.

The prevalence of NP also rose by strata according to the number of years of textile dust exposition, suggesting that a longer occupational dust exposition increases the risk of CRSwNP occurrence. The fact that we found NP across every textile sector apart from informatic/marketing and administration teams is not surprising, since these two sectors are the least exposed ones to textile dust.

Comparing the comorbidities between volunteers from the exposed and control group (Table 1), we notice that OSAS prevalence is higher among the exposed ones. This fact can be attributed to the older age of this group since we know that the frequency of this pathology also increases with age, but also due to higher rates of sinonasal disease, as we can infer by RhinoQOL-pv results and Lund-Kennedy scores (significantly higher on the exposed group). OSAS and rhinosinusitis severity seem not to be correlated but the prevalence of OSAS in patients with chronic rhinosinusitis is high (with a recent study finding a prevalence of 65%)[14].

The fact that all rhinologic symptoms were higher among textile workers compared with the control group, and especially the statistically significant rhinosinusitis characteristic symptons like hyposmia, headache and facial pressure, are in accordance with our previously published hypothesis that occupational/work-exacerbated rhinitis may progress toward occupational/work-exacerbated rhinosinusitis and may contribute to CRSwNP development[5]. Moreover, RhinoQOL-pv, which was designed for rhinosinusitis, scored higher in a statistically significant way between the exposed and control group.

Another interesting issue is that patients reporting atopic diseases previously diagnosed by an immunoallergologist did not differ significantly between the exposed and control groups or even between CRSwNP patients and subjects without the disease. Moreover, the prevalence of atopy was 20% in the exposed group and 26% among CRSwNP patients and these values are in the range of the reported prevalence of atopy in the general population (20–30%)[15]. These findings corroborate our previous work[5] and other published studies[13], supporting the hypothesis of important non–IgE-related mechanisms on CRSwNP etiopathogenesis, including immune and non-immune ones.

We found not only a significant difference among NP prevalence between the groups (p=0.001) but also among polypoid degeneration of the middle turbinate (p=0.001) and overall inflammatory state of the nose as shown by higher Lund-Kennedy score among textile workers (p<0.001). By these findings, we can state that occupational exposure to dust is associated to general inflammatory changes of the nose and paranasal sinus.

No statistically significant difference was found on the frequency of previously diagnosed chronic lower respiratory diseases in subjects with and without NP, contrary to what was expected by recent studies on CRSwNP which found prevalences as high as 55%[5] or 72.5%[16]. The relative small number of cases with NP in our sample (only 19 cases) and the rate of subclinical and early NP stages (mainly grade I/II) may contribute to these figures.

The prevalence of previously diagnosed chronic lower respiratory diseases did not differ also between exposed and control groups. However, many epidemiologic studies assessing lower respiratory symptoms and spirometry results among textile workers and controls have been alerting to higher rates of respiratory symptoms and deterioration in spirometric parameters in the first group[17–19]. Moreover, it is clear by CAT™ score that lower respiratory symptoms are more frequent among exposed individuals, with a statistically significant difference, pointing up to a probable underdiagnosis of lower respiratory diseases among textile workers. The fact that in this study it was only considered the diagnosis of chronic lower respiratory diseases previously diagnosed by a respiratory physician can partially explain this finding, as many employees are treated by general practitioner or workplace doctor.

As this represents a problem of Public Health, these findings show the importance of employee's protective measures, such as mask use during work, and reinforces the need for legislation and control to guarantee the functioning of air dust filters and exhausting systems.

More epidemiologic investigations are needed, namely to establish the NP prevalence in other types of occupational dust

exposure. The concomitant involvement of otolaryngologists and a pneumologists on this type of studies can be helpful to clarify the association between CRSwNP and lower respiratory diseases.

Conclusion

This investigation was the first endoscopic based epidemiological study to evaluate the impact of occupational dust exposure on NP prevalence. Our results revealed a higher prevalence of NP among textile workers compared to our control group, but also comparing with previous in-vivo and cadaver endoscopic based studies done in Europe. These results point to an important correlation between occupational dust exposure and NP occurrence, justifying more research in this area. Meanwhile, Public Health policies like employee's protective measures must be reinforced.

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Authorship contribution

RVT: Study design, data collection, statistical analysis, discussion, revision. RC: Study design, discussion, revision. RF: Study design, discussion, revision. CvB: Study design, discussion, revision.

Conflict of interest

No conflicts of interest or financial disclosure to declare.

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