Swimming and nasal symptoms: pool and sea water exposure

Original Article

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Abstract

Chronic rhinosinusitis is associated with a significant prevalence and affects the quality of life of many people. The aquatic environment, specifically seawater and chlorinated pool water, has an impact on this disease. This study investigates the effect of swimming in these two types of water on the onset or worsening the symptoms of this condition.
A cross-sectional study on a sample population of 55 swimmers was performed, a questionnaire on symptoms was given and measurements of nasal flowmetry were taken before and after swimming, to objectively access the effects of water exposure.
The results in the participant samples indicate that in chlorinated pool water, there wasn´t an aggravation of sinunasal symptoms, whereas in seawater, an improvement was observed, and this effect was more relevant on participants with chronic nasal symptoms. This effect was confirmed when analyzing flowmeter results.
This study shows that swimming in chlorinated pool water, even when having sinunasal disease, the water exposure does not trigger or worsen symptoms. It also shows that swimming in sea water had a significant positive effect on our sample population, mainly on those with prior nasal symptoms

Keywords: chronic rhinosinusitis; swimming; seawater; pool water

Introduction

Rhinosinusitis is an inflammation of the nasal and sinusal mucosa, causing symptoms such as nasal obstruction, rhinorrhea, facial pain and /or hyposmia, among others [1], and having a significant impact on the quality of life of affected individuals[1]. Over the years, we have noticed a significant increase in its prevalence[2], being currently 26,1% of the general population in Portugal[3].

Allergic rhinitis is one form of nasal mucosal inflammation, being mediated by IgE, and so shares most symptoms of rhinosinusitis[4], and is even pointed as a predisposing factor for chronic rhinosinusitis[1]. It is known here that physical agents such as cold air, dry air, hypotonic water, some odors, and mechanical trauma can trigger inflammation in the hyper-reactive nasal cavity[5]. The mechanisms of this phenomenon of nonspecific stimulation are poorly understood but reflect the domiciliation of mast cells and eosinophils, among other populations, in the nasal mucosa, with a greater propensity for an immediate response, largely benefiting from continuous topical corticosteroid treatment[5].

Thus, chlorinated water more frequently causes neutrophilic inflammation of the nasal mucosa due to the irritative effect of chlorine components.[6] On the other hand, saltwater appears to reduce rhinitis symptoms[7]. However, many of the existing studies refer to the use of saline solutions rather than specifically to seawater, which is not only hypertonic but also contains various substances and microorganisms in suspension.

These irritative effects are documented in athletes and sports practitioners in chlorinated water[8], with very little information and study on individuals who practice water sports in a non-competitive manner, and therefore less frequently per week. Also, to our knowledge, there is no such study on seawater swimmers. This study aims to investigate the impact of exposure to different types of water on the worsening of chronic nasal disease complaints to promote recommendations accordingly.

Methods

Our study hypothesis was that swimming may aggravate chronic rhinosinusitis symptoms. Our secondary hypothesis was that swimming in sea water would be less harmful (due to known beneficial effects).

A descriptive cross-section study design was chosen to evaluate whether swimmers with chronic sinus symptoms would have these aggravated by exposing to water when swimming. We used two groups of participants, one exposed to pool water, chlorinated with standard salt electrolyser (pH at 7.4, Chl. at 1,5 ppm, 28°C) and another to sea water (free water swimming) in September (average temperature 17,5°C). In both groups a control group was established, that was also exposed to water but had no previous sinus symptoms.

There is no study in the literature establishing the expected difference and so sample size was determined by the objective to establish this value. Recruitment was done by opportunity, expecting to recruit 30 participants per group to expect normal distribution.

All the groups would be exposed during at least 45 minutes of swimming, and not more than one hour for the testing. All the subjects were tested during September or October (to ensure same weather conditions, same exposure to allergens, same possible exposure to respiratory infectious agents.

Hospital Ethics Committee approval was obtained before the study begun (Hospital Cuf Descobertas, 253/25), and that all the study is in accordance with the Declaration of Helsinki of the World Medical Association (October 2024). Also, all efforts were made to ensure data privacy and participants' anonymity, in complete confidentiality and in accordance with data protection regulations.

Participants were recruited from groups participating in swimming events, whether in a pool or in the sea, and were invited to participate by opportunity. Inclusion criteria were immediate participation on a swimming event (training or competition) for at least 45 minutes, regular participation on swimming events for a maximum of 2 days per week (to allow safe interval and nasal mucosal return to a non-affected state). Exclusion criteria were participation in a clinical trial at the time of evaluation; younger than 18 years old; only recreational swimming with no training; chronic topical steroid treatment or vasoconstrictor abuse (for these would hamper potential inflammatory effect of water exposure).

A pre-exposure questionnaire was filled by participants to collect sociodemographic and clinical data and to characterize the exposure to different types of water, associated symptoms, and their frequency; and recording of nasal pathology, treatments, regimens, and adherence, and finally to register basal nasal complaints and symptoms. A peak nasal inspiratory flowmeter (PNIF) was obtained to access after exposure symptoms, using the In-Check portable inspiratory flow meter (Clement Clarke International® Ltd) was then used to access basal nasal patency. After exposure, a new questionnaire was filled and a PNIF testing was repeated, not more than 30 minutes after exposure.

After training (not more than 30 minutes), a new questionnaire was filled, for what type of water was the exposure, any nasal symptoms, how intense was the training, whether water entered the nose.

PNIF was tested immediately before and immediately after training, and prior to the measurements each participant received detailed guidance on the correct use of the device. The mask was positioned horizontally, fitting tightly to the face to cover both the mouth and nose. Participants were instructed to inhale maximally through the nose, keeping the mouth completely closed. The maneuver was repeated three times, with the highest value being considered. All measurements were performed at rest.

The variables studied were sex, age, previous nasal surgery, diagnosed nasal-sinus disease, regular medication, swimming in chlorinated pool water, swimming in sea water, sinu-nasal symptoms after swimming, delay for symptoms to worsen after training, medication after training, workouts per week.

Data analysis was performed using SPSS 29.0.2.0®, using descriptive statistics, contingency tables, chi-square tests and the t test to compare means. For those in which the hypothesis of normality was rejected, the alternative Mann-Whitney test was used. A significance level of 0.05 was considered for all hypothesis tests.

Results

A total of 61 participants were recruited, from which 6 were excluded because of chronic steroid treatment. From the remaining 55 participants, 73% were males, and age distribution mode was on the 45-54 years old (36%). All were regular swimming athletes.

Testing was done during a regular training session, with one group of 26 participants swimming in chlorinated pool water (group A), and 29 in sea water (group B).

About half the participants had previous chronic nasal symptoms (44% in group A, 48% in group B, not different between groups p=0,064). Reported symptoms are shown in table 1. Ten participants present chronic rhinosinusitis full criteria according to Epos (1), 6 in group A and 4 in B. Three had nasal itching and frequent sneezing, suggesting allergic rhinitis.

Table 1
Participants' reported chronic nasal symptoms (at least 12 weeks).

Nasal obstruction	14
Rhinorrhea	12
Nasal pruritus	8
Face pain	6
Hyposmia	6
Sneezing	5

A subgroup of 8 patients had previous nasal surgery (septoplasty and/or ethmoid surgery). The distribution was statistically even between test groups (p=0,377) and nasal symptoms after swimming was not different on these participants in each group (group A p=0,377; degrees of freedom= 1; and group B p = 3,461, d.f. =2). After swimming exposure, 23% of group A participants (swimming pool) and 21% of group B had nasal complaints. However, when comparing participants with previous chronic nasal symptoms on each group, we find that for group A both participants with and without previous complaints equally worsened their symptoms (p = 0,366).

Table 2
Participants' reported nasal symptoms after exposure

	Nasal symptoms after swimming		
	With	Without	
Group A (swimming pool)	6	20	
with prior symptoms	3	6	p = 0,366
without prior symptoms	3	14	
Group B (sea swimming)	6	23	
with prior symptoms	6	10	p=0,020
without prior symptoms	0	13	

Participants were asked whether during the test exposure they felt water specially penetrating nasal cavity (during turns for example) to access an eventual greater exposure to water. We had 29 participants with such exposure (16 group A, 13 group B), and of these, 7 had symptoms (4 group A, 3 group B), versus 5 on the 26 participants (2 group A, 3 group B). No statistical difference was found here too.
On the opposite direction, we wanted to evaluate if adrenergic load from exercise might oppose the inflammatory effect of exposing to water, and so swimmers were asked to grade their effort as mild to very intense. All rated their session as moderate, intense or verry intense, and we found no difference in complaints after exercise when comparing these groups.
Beyond having subjective measures, we aimed to objectively measure exposure impact on nasal function, using PNIF. We compared PNIF test values before and after exposure using Mann-Whitney for two dependent samples. We observe that on participants referring nasal symptoms after swimming, the median is higher after training (75 L/min) than before (70 L/min), however with no statistical significance (U=-1,281; p>0,05).
The same lack of difference was found when comparing participants with prior nasal symptoms, with before median of 90 L/min, to median after of 100 L/min (U=-2,766; p>0,05).
Regarding the remaining participants, the ones without nasal symptoms, we also found no difference. Using t test for two dependent samples we compared means before (M=93; sd=41) and after training (M=100; sd=53), finding no significance (t=-1,048; p>0,05).
To understand whether the type of water made any difference, using Mann-Whitney, we found no significance on this difference when swimming in pool water (Mdn before=70; Mdn after=80; U=-1,254; p>0,05). On the contrary, and in line with symptoms evaluations, when accessing sea water exposure, we found a statistical difference (Mdn before=120; Mdn after=140; U=-2,224; p<0,05). When further evaluating this group, separating participants with chronic nasal symptoms, we observe that these were the ones that benefited the most, with statistically significant benefice (M before 116 ± 47; M after 136 ± 5;- t=2,344 p=0,033), that was not observed on the participants with no prior complaints.
As to effort grading, no statistical difference was found when analyzing flowmetry results.

Discussion

We wanted to better document the water effect on nasal mucosa on regular swimmers, especially regarding swimming in sea water. On the one hand, irritant effect is well documented before[9] and attributed to volatile chlorine derivatives[6], but on the other, sea water has long been associated with healing properties to the diseased nasal mucosa[10].
Having found in our sample population that

PNIF measures were significantly improved only on sea water, and that this was especially true on participants with prior sinusitis, reinforces, in our mind, the notion that sea water as a positive effect on nasal inflamed mucosa. Salt water appears to reduce rhinitis symptoms[11], however, most existing studies refer to the use of saline solutions and not specifically to sea water. Several studies on the use of diluted seawater have documented that after exposure to seawater, there is a reduction in edema in the submucosal tissue and clearing of excess liquid in the nasal lumen, namely mucus[12].

On the opposite sense, having found no difference on pool swimmers could be used to question previous findings. This lesser positive effect must be read knowing that chlorinated pool water most often causes neutrophilic inflammation of the nasal mucosa due to the irritating effect of chlorine components[6]. However, we know that exercise is a potent nasal vasoconstrictor, comparable to topical decongestants[13], and in our participants' swimming effort was considerable and for at least 45 minutes. So, we must forcefully deduct a significant adrenergic effect that most likely has hampered most inflammatory symptoms, vis a vis nasal obstruction, mainly.

According to current literature, practicing sports in an aquatic environment increases the prevalence of rhinitis, due to its irritating effects on the nasal mucosa[8]. However, these data come from studies carried out on high performance athletes and in chlorinated water, with limited information on individuals who practice water sports non-competitively and, therefore, less times a week, or in sea water. And this gives even more relevance to our findings. Regardless of not finding a statistical difference on the median values for PNIF measurements, we know that a difference of 20 l/min is clinically significant[14], and this difference was obtained by the majority of swimmers regardless of the subgroup we were analyzing, allowing a simple conclusion that swimming benefits in general and a priori nasal function. However, we must consider here that this comes from the combined effects of water exposure and exercise, and is more evident when swimming on sea water, especially on diseased nasal mucosa.

Using a flowmeter to document objective nasal patency, and comparing values before and after exposure, and evaluating these results along the symptoms evaluations, confers our results robustness and replicability. Peak nasal inspiratory flowmeter has been validated and is currently used as a standard measure on field studies such as this one[15], for its results bear strong correlation with the gold standard rhinomanometry, and is portable and inexpensive, being therefore the ideal tool to work on these settings as the beach or the pool. It has a known limitation of not allowing evaluation of each nostril separately. However, this should not be regarded as a limitation in our study, for the effect we were measuring (nasal obstruction after water exposure) is expected on both nostrils simultaneously, because of the nature of the exposure itself.

In addition to the studied variables, we considered an intervention using a nasal protector or nose clip, which would even better characterize the role of the water in the nasal cavity, thus constituting a control group. However, we have no universal device that confidently seals the nasal cavity in a sure way to reproducibly ensure an objective result. And also, on these participants' level of performance, nasal clips are not well tolerated and are associated with poorer performance. We therefore opted not to include this tool.

The study includes 55 participants, as initially planned for statistical study. A further study with more participants may allow for a further subsampling of our population, in other to better understand the role of other factors as gender or medication, for example.

Conclusions

The results in the participant samples indicate that in chlorinated pool water, there wasn´t an aggravation of sinunasal symptoms, whereas in seawater, an improvement was observed, and this effect was more relevant on participants with chronic nasal symptoms. This effect was confirmed when analyzing flowmeter results. Also, even if not significant statistically, an improvement of nasal function of more than 20L/min was obtained on most of our participants, therefore above the consensual threshold of clinical benefice.

This study shows therefore that when swimming in pool water, even with sinunasal disease, water exposure does not trigger or worsen symptoms. And swimming in sea water had a significant positive effect on our sample population, mainly on those with prior nasal symptoms.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

Privacy policy, informed consent and Ethics Committee Authorization

The authors declare that they have written consent for the use of photographs of patients in this article.

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Availability of scientific data

There are no datasets available, publicly related to this work.

Statement on the Use of Generative AI and AI-Assisted Technologies in the Writing Process

No generative AI or AI-assisted technologies were used at any stage of the project.

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