

# Weather and migraine: Can so many patients be wrong?

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A migraine trigger is a factor which temporarily increases the probability that a migraine headache will occur, and many individuals with migraine blame certain weather conditions for initiating at least some of their migraine attacks (1,2). Some consider weather changes to be their most important headache trigger and even go so far as to refer to themselves as ‘human barometers’. A large, recent, clinic-based study of patient perceptions has indicated that 53% of migraine patients perceive that weather triggers their headaches at least occasionally, and 11% felt that weather triggered at least two-thirds of their headache attacks (2).

The perception that weather can trigger headaches is not limited to patients with migraine; a substantial proportion of patients with tension-type headache also report weather as a headache trigger (3,4). While it might be argued that patient self-report of headache triggers from surveys based on memory of past events might be unreliable, data based on patient diaries where patients recorded the factor they felt was responsible for their headaches on a daily basis have given similar results (5). A population-based diary study in France performed in this manner indicated that 35% of migraine sufferers felt that weather had triggered at least some of their attacks. Of interest, similar to a clinic-based study (3), it was found that weather was reported as a headache trigger by a higher proportion of migraine patients as compared to patients with other headache types (35% vs 18%;  $P < 0.05$ ) (5). On the other hand, in another clinic-based survey study of relatively severely affected headache patients, 45.5% of migraine patients listed weather changes as a headache trigger, and this was not different from patients with tension-type headache (48%) (6). In patients drawn from the general population, Rasmussen (4) found, perhaps surprisingly, that a higher proportion of people with tension-type headache reported weather as a headache trigger than did individuals with migraine. Clearly, when it comes to weather, many patients including both those with migraine and those with tension-type

headache consider it to be a factor in triggering their attacks.

Yet a very sophisticated recent study by Zebenholzer et al. (7) was unable to show any major connection between weather conditions and migraine occurrence. Although some association was shown between wind speed and day-to-day change of daily sunshine duration and migraine occurrence, none of these associations remained statistically significant after correcting for multiple testing by means of a Bonferroni correction (only  $P$ -values of  $< 0.0018$  were considered significant). The conclusion of the authors was that: ‘The influence of weather factors on migraine and headache is small and questionable’.

Some previous studies which tried to identify weather factors as migraine triggers have also been negative (8,9). Others have shown at least some associations between certain weather conditions and migraine occurrence (10–15), but no consistent picture of which weather-related factors are important migraine triggers has emerged.

Can so many migraine patients be wrong? Or is there another reason why research to date has been unable to measure the apparently robust association between weather and migraine attacks that so many of our patients tell us exists? Is the problem with the patients or with the research?

Pertinent to this discussion is that a number of studies have found little correlation between whether patients think they are weather sensitive, and whether they actually are based on research results. Although Prince et al. (10) found that 50.6% of patients in their study were weather sensitive, there was no significant difference in the degree of weather sensitivity found

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between those who believed they were weather sensitive and those who did not. Similarly, in the study by Cooke et al. (11), 88% of the patients studied felt that Chinook weather influenced their headache probability, but this could only be demonstrated in the study in 39% of these patients. Although both these studies had limited power because of relatively small size, it appears that patient perceptions do not align well with research results.

Zebeholzer et al. (7) attempted to determine whether patient perceptions of weather conditions correlated with headache occurrence. They came up empty handed in terms of statistical significance, but their data did show some interesting trends. The patients perceived the presence of 'annoying wind' on 29.9% of headache-onset days compared to 22.2% of headache-free days. Similarly, they perceived a 'change of weather' on 36.1% of headache-onset days versus 18.4% of headache-free days. While one does not want to make too much of such trends, one wonders if a larger study might have shown statistical significance.

So, are our patients wrong? Personally, I don't think so. There are many reasons why research studies might have great difficulty showing statistically significant correlations between weather conditions and migraine attack occurrence. I will discuss several of these below.

1. Most migraine patients report multiple triggers. In a clinic population, the average number of triggers reported by patients was 6.7 (2) It has been estimated that there are at least 60 trigger factors in migraine (16). As most patients may have a number of different triggers for their attacks, showing a correlation between attack onset and the occurrence of one of these triggers, for example a given weather change, may be challenging and require very large numbers of patients.
2. A specific trigger may not precipitate an attack with each exposure. It would appear that many triggers do not precipitate attacks in an all-or-none fashion (17), but rather may precipitate an attack only when present at a particularly strong intensity, or when operating in conjunction with other triggers. Once again, this will make correlation of headache attack onset with the occurrence of any particular trigger difficult. Exceptions might be particularly powerful triggers and, for example, Zebeholzer et al. (7) had no difficulty showing a correlation between menstruation and migraine attack onset. Similarly, Cooke et al. (11) were able to show a correlation between the occurrence of Chinook winds, a very abrupt and powerful weather change, and migraine onset. It may be relevant that the weather conditions studies by Zebeholzer and colleagues (7) appear to have been relatively moderate. Maximum wind speed during their study period was 27.4 km/h. Cooke and co-workers (11) could only show the actual Chinook wind itself to be a trigger for headache if the wind velocity exceeded 38 km/h. Prince et al. (10) found that, of all weather conditions, the strongest correlation with migraine onset was with a function of absolute temperature and humidity. Nursall (15) also found that migraine attack frequency increased as both temperature and humidity increased. It is perhaps not surprising that the study by Zebeholzer et al. (7) was unable to show these associations, as it was carried out between the months of October and March in Austria, and the maximum air temperature appears to have been only 21.5°C.
3. The mechanisms by which weather-related factors or indeed any trigger factor precipitates migraine attacks are not understood. Therefore, it is difficult to know which of numerous weather factors to focus on. Many different atmospheric conditions have been postulated as migraine triggers. In addition to changes in temperature and humidity, barometric pressure, wind, and sunlight, sferics (low frequency low intensity electromagnetic pulses radiating from distant meteorological events and other sources) (18,19) and geomagnetic activity (20) have been postulated with some evidence to influence migraine. If in fact many of these do influence migraine onset, it might prove very difficult to show correlations with any one of them, especially as they may occur simultaneously. Changes in atmospheric ion concentrations, particularly positive ion concentrations, could be a further complicating factor. Cooke et al. (11) found wind *per se* to be a trigger factor only if the wind velocity exceeded 38 km/h, and it is at these wind velocities that positive ions begin to show their steepest rise in concentrations during the Chinook winds of southern Alberta (21). Finally, there is evidence that unknown components of Saharan dust can trigger the trigeminovascular system in animals; (22) therefore, it is possible that atmospheric contaminants like dust could be an additional weather-related migraine trigger factor. In short, the possible interactions between migraine and weather are so complex that it may be impossible to clarify them until much more is known about migraine pathophysiology.
4. A further consideration has to do with timing. Many weather changes do not happen abruptly, may occur at different times in neighbouring locations as a system moves across the landscape, and the lag time between a trigger and migraine onset is not well established and may be variable. All these factors make it difficult to establish correlations. Where

powerful weather systems do begin quite abruptly, as for example with the Chinook winds of southern Alberta, correlations have been found (11). Even this simple example, however, illustrates the complexity of weather triggers and migraine. Surprisingly, Cooke et al. (11) found that at least two different mechanisms appeared involved in the triggering of migraine attacks by Chinook weather. Seventeen patients appeared sensitive to the pre-Chinook day, while 15 patients had an increased headache probability on the day of the Chinook wind itself. Only two patients appeared sensitive to both mechanisms, and 39 patients were not sensitive to Chinook weather. Only sensitivity to the Chinook wind itself, and not pre-Chinook sensitivity, was influenced by wind velocity and patient age.

5. Migraine populations are heterogeneous, and what may be a trigger for one individual may not be a trigger for another. In patient groups, therefore, it can be difficult to show correlations between weather factors and headache, particularly when different patients may be sensitive to opposite extremes of a given factor such as barometric pressure. Patients have implicated all of high barometric pressure, low barometric pressure, falling barometric pressure, rising barometric pressure, and any change in barometric pressure. (10) In the same patient population, the analysis of diary data confirmed that indeed some patients were sensitive to weather conditions of high barometric pressure, and others were sensitive to low barometric pressure (10).

In their complaints about the weather, migraine patients are joined by patients with arthritis. In arthritis, there is also evidence that the patients are right, but that the response to weather is very individual and likely not present in all patients. A large study concluded that barometric pressure and changes in ambient temperature are independently associated with osteoarthritis knee pain severity (23). A recent study in a cohort of patients with rheumatoid arthritis concluded that weather sensitivity in arthritis was a highly individual phenomenon, and found that over half of the patients studied showed a significant association between pain levels and weather variables (24). As has been found in some of the migraine studies, patients differed in the weather variables they responded to and in which direction. A systematic review found that the hypothesis that weather changes might significantly influence pain reporting in some patients with rheumatoid arthritis could not be rejected. Although a consistent group effect of weather conditions on pain in people with rheumatoid arthritis could not be shown, there was evidence suggesting that pain in some individuals is more affected by the weather than in

others, and that patients react in different ways to the weather (25).

Migraine patients who claim to be weather sensitive are, therefore, not alone, but where does all this leave us? Perhaps it is still best to listen to our patients. Despite the careful work of Zebenholzer et al. (7), more research is needed before the question of how big a role weather factors play in migraine can be settled. In my view, this problem will not be solved by studying correlations in patient groups between migraine attacks and weather factors. It will likely be more fruitful to study individual patients over relatively prolonged periods of time, so that each patient serves as his or her own control. This approach was taken by Prince et al. (10) with promising results, but follow-up in some of their patients was short, only 2 months. Larger patient numbers with more prolonged follow-up are needed. Even with such studies, it may not be possible to unravel the complexities of the relationship between putative trigger factors and migraine completely, including weather factors, until we understand migraine pathophysiology better, or at least are able to subdivide patients with migraine into pathophysiological or genetic subcategories.

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