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## Research Article

# Migraine Cause and Treatment

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### ABSTRACT

**Title:** Migraine Cause and Treatment

**Background:** Research shows that migraine brains have hyperactive sensory organs and multiple sensory receptor connections. Hyper activity of these organs needs extra supply of nutrition to support increased electrical activity. Today's medicines reduce or prevent the functioning of these neurons by blocking essential voltage dependent calcium or sodium channel instead of providing nutrients. We asked: if we provide support for extra electrical activity of migraineurs, would it prevent migraines without the use of medicines?

**Methods:** We reviewed published literature and conducted research over 6 months studying 650 volunteer migraineurs in a migraine-research Facebook group. Participants were screened for migraine types, answered a questionnaire on medical conditions, medicines used, and lifestyle. They were provided instructions on the use of the migraine protocol and were evaluated weekly.

**Findings:** Migraine frequency appears to be exacerbated by carbohydrate-rich and salt- and water-poor diets and may be worsened by medicines that block voltage gated calcium or sodium channels. Stopping these medicines, reducing carbohydrates and increasing saline in electrolytes appears to prevent and/or stop migraines.

**Conclusions:** H<sub>2</sub>O and Na<sup>+</sup> efflux from cells caused by glucose, electrolyte mineral (Na<sup>+</sup>, Cl<sup>-</sup>, K<sup>+</sup>) ratio may be disrupted in carbohydrate heavy diets causing migraines. Changes to diet that include increased salt intake along with reduced carbohydrate intake appears to prevent glucose induced electrolyte changes which then decreases migraine frequency. In the present study, all participants who made these dietary changes were able to eliminate migraine medications and remained migraine free.

**MeSH Headings/Keywords:** Migraine, Electrolyte, Salt deficiency, Voltage, Energy, Deficiency.

### Introduction

Chronic migraine is considered to be a disabling neurological illness [1-4] that is treated with dangerous [5] and often brain damaging [6] medicines [7,8]. While crucial experiments and findings have already been established, we found that a synthesis with an eye toward dietary factors for practical intervention was missing. Research has indicated that migraineurs excrete 50% more sodium in their urine than non-migraineurs [9]. This finding offers an important clue for the mechanism of migraine and may indicate a potential therapeutic option; namely, the possibility that sodium depletion is involved with migraine onset and persistence. The anatomy of migraine is now visible in scanners [10-14]. Depolarized regions, zones of cortical depression (CD), are unable to generate energy for action potential [16]. Healthy regions send voltage shockwave of cortical spreading depression (CSD) that is visible in scanners [16]. Deep-brain electrical stimulation in the CD regions of depression patients yields complete resolution of depression and the re-activation of the CD region [17-21]. Since CD regions are identical in scope, differing only in their location between migraine and depression patients, not surprisingly researchers found that CD regions are also responsible for migraines and therefore can be stimulated with neuronal stimulators [22]. Additionally, it is known that blood flow changes occur in the brain preceding a migraine.

Migraineurs are much more likely to have metabolic disorders than non-migraineurs [23-29] which we speculated is connected to carbohydrate disturbance of electrolytes [30]. Additionally, migraineurs have only nominal changes in voltage between states of action potential versus resting potential, indicating that a migraine brain is "always on," [31,32] supporting the theory that

migraineurs have hyper sensitive sensory organs [33,34]. Hyper sensitive sensory organs result in more receptor connections among sensory neurons [35]. Thus brains containing hyper sensitive sensory organs with multiple receptor connections would need more voltage generating nutrients to accommodate the increased frequency of action potentials. The excretion of 50% more sodium in the urine is indicative of increased sodium use by such active brains. Combined these findings suggest a potentially increased need for sodium and other electrolytes in migraineurs.

Considering that voltage for an action potential is generated by the interaction of proper ratio of sodium (Na<sup>+</sup>) and chloride (Cl<sup>-</sup>) through cell membranes and since "...serum Na<sup>+</sup> falls by 1.4 mM for every 100-mg/dL increase in glucose, due to glucose-induced H<sub>2</sub>O efflux from cells", we hypothesize that glucose disrupts fluid dynamics, modifies electrolyte balance and blood volume and initiates migraines in individuals so inclined. Research supports this hypothesis suggesting that migraineurs are sensitive to glucose. Since glucose disrupts electrolyte balance reducing Na<sup>+</sup> and H<sub>2</sub>O, this may explain the frequently found coupling of metabolic disorder with migraines, the changes in blood flow, and the lack of action potential in brain regions affected by glucose increase. Moreover, unless Na<sup>+</sup> is replaced, the energy required for action potential generation is hampered leading to regions of CD that lead to migraine pain via CSD. Consequently, migraine may be preventable by the reduction of carbohydrate consumption, the increase of H<sub>2</sub>O and Na<sup>+</sup> to stabilize electrolyte and action potential generation.

### Methods

The research we conducted was exclusively on Facebook.

Unsolicited members found the migraine research group and consented to all rules upon joining (supplement 1). They were immediately given a questionnaire (supplement 2) with three weeks to complete and return the questionnaire to the research team. Of the several thousand members, a subset of 650 volunteers responded to the questionnaire in a timely manner, followed instructions and weekly discussions and were admitted into the study. After receiving the participant responses, we provided analysis and diet modification instruction to reach “Baseline” (Supplement 3). Baseline required eliminating all sweeteners, increasing water intake as per a water calculator, eliminating all drinks other than water (1 coffee was permitted per day) and meeting the potassium and sodium maximum recommended values of the USDA<sup>1</sup>. Research participants had to find their carbohydrate threshold levels, the point at which their electrolytes were disrupted by glucose resulting in edema, extreme thirst or clear-color urination (Supplement 4). Participants used a carbohydrate consumption process that was aimed at reducing the speed of carbohydrate conversion to glucose and to slow its use (Supplement 5). A carbohydrate test protocol was undertaken once participants had mastered the dietary changes and were migraine free for 1 month. This involved consuming 2 cups of blueberries (35.79 grams net carbohydrates with 29.48 grams free sugar and only 228 mg potassium and 3 mg sodium that had little effect on electrolytes)<sup>36</sup> followed by watching symptoms (urination within 30 minutes, thirst developing within 10 minutes) signs that carbohydrates threshold levels were passed. In all participants this passed their carbohydrate threshold levels. They were instructed to take 1/8<sup>th</sup> teaspoon salt with only a sip of water after the symptoms of passed threshold appeared to prevent migraine. Participants followed all processes. No participants were turned away or left the study.

## Results

**Demographics and Participant Characteristics:** In total there were 15 male (2.3%) and 635 female (97.7%) participants. Metabolic syndromes were also found: 7 (1.1%) knew they were hypoglycemic and 4 (0.6%) had diabetes mellitus. There were 4 (0.6%) pregnant women of whom 2 had gestational hypoglycemia and 1 gestational diabetes mellitus. All migraineurs used some medicines: 340 (52.55%) participants were on preventives, such as calcium or sodium channel blockers or SSRIs, of the 340 preventive medicated members 204(60%) used both types of preventives and also abortives. Those who only used abortives 250 (38.64%) used triptans, opiates or other abortives, and 60 (9.2%) used OTC. Of the 650 migraineurs 227 (35.36%) were episodic (less than 15 migraines a month) and 423 (66.64%) chronic (15 or more migraines a month). In the chronic group, we found 9 (2%) of the members had what they called “non-stop migraines” over several months.

**Dietary Intake:** The dietary balance of the participants was as follows: 400 (61.54%) were heavy vegetable eaters (over 90% of their meals consisted only of vegetables) but also ate some meat (at least one meal consisting of meat or fish), 8 (1.2%) vegans,

88 (13.54%) vegetarians, 25 (3.85%) junk food eaters (ate only prepared and fast foods, nothing fresh), and the remaining 120 (19.85%) general well balanced eaters (their diets represented all food groups in the proportions considered ideal by the USDA). We found that 645 (99.23%) of the members drank significantly less than 8 glasses of water a day (ranging from 0 water to 6 glasses a day). Those who drank no or very little water drank soft drinks or teas instead. Blood pressure responses indicated that 10 participants (1.54%) had high systolic and diastolic blood pressure (140-178 systolic and 90 - 130 diastolic) while 640 (98.46%) participants had low blood pressure (60-117 systolic and 53-77 diastolic). All 100% of the participants ate a high amount of sweeteners (exceeding the daily recommended sugar amounts by the USDA): sugar (88%) or sugar substitutes (12%). Some of the international participants (15% of the members UK, AU and NZ) were heavy tea drinkers drinking more than two cups of regular and over two cups of herbal or decaffeinated teas per day and 6 participants (1%) were from locations with carbs heavy diets where over 90% of their diet consisted of high carbs foods like rice or noodles, and sugar (Singapore, Indonesia, Taiwan, Malaysia, Pakistan and India).

**Migraine Frequency Reduction:** Of the 650 participants, 647 (99.54%) were able to abort each individual migraine of all types within the 6-months research period and remained migraine free. 3 (0.65%) subjects had comorbid migraine-cause and were not able to prevent their migraines but were able to lessen the frequency and severity. We found the ideal sodium dose for migraine prevention to be 30% to 50% greater than the USDA 2400 mg maximum Na<sup>+</sup> based on individual dietary types (vegetarian versus not). Those who were not using any daily preventive medicines were able to overcome the cause of migraines more efficiently than those whose critical channels were blocked via reuptake inhibitors or calcium gate blockers. This group benefited most when they increased their sodium intake by 70% relative to the USDA recommended maximum. They reduce the sodium intake as they reduce their medications. The research group contained 2 participants with surgically implanted neural stimulators (under skin, over skull). Both turned their stimulators off; 1 had it surgically removed and quit all medications. Both are migraine free and are following our protocol. All migraines responded to our protocol regardless of type.

We found that the modified diet with increased water consumption, elimination of all sweeteners, a reduction of carbohydrates and management of proper potassium to sodium ratio at its maximum USDA recommended level significantly reduced migraine days for all participants. Those with episodic migraines of less than 15 migraine-days a month and not on any preventive medicines had the quickest response. They were able to eliminate their migraines within a month of beginning the protocol. A few were able to prevent all migraines within the first 2 weeks, remained migraine free for the duration of the 6-months experiment, and are still migraine free as long as they stay on the protocol.

Those with chronic migraines of over 15 migraine days per month all using preventative medicines reduced their migraines in the first month to less than 10, in the second month to 2. By the end of the 6-months period all migraineurs were able to

<sup>1</sup>In the middle of our experiment the USDA changed its recommendations from 2350 mg maximum sodium to 2400 mg and from 4700 mg potassium to 3500 mg. We followed the USDA recommendations and modified the ratio required as per baseline (Supplement 3).

prevent or abort every type of migraine under any circumstance. Eventually the participants began to reduce their preventive medications. Those on Topamax were able to reduce their medications fully in the 6-months period and have completely regained all functionality and migraine free life.

In order to more fully evaluate the role of sugar in migraine onset and sodium in migraine cessation, we encouraged each recovering migraineur to enjoy a sugary candy or dessert after they were fully migraine free. This caused a migraine in every single participant without exception. The administration of a 1/8<sup>th</sup> teaspoon salt after consuming the sweets with only a sip of water stopped the migraine within 10 minutes.

## Discussion

One of the most important processes in the brain for its own energy support is the maintenance of electrolyte with proper ionic balance of Na<sup>+</sup>, Cl<sup>-</sup>, K<sup>+</sup> and H<sub>2</sub>O. A typical healthy brain is well energized by the USDA diet guidelines for ideal Na<sup>+</sup>, Cl<sup>-</sup>, K<sup>+</sup>, and H<sub>2</sub>O ratio but these guidelines do not appear to satisfy the needs of migraineurs with hyper sensitive sensory organs and over sensitized brains. Migraineurs appear to use more energy to create additional action potentials than non-migraineurs. The maximum 3500 mg K<sup>+</sup> and 2400 mg Na<sup>+</sup> recommended by the USDA is inadequate to maintain the operation of a migraine-brain's voltage demand. Many natural and processed foods are naturally out of K<sup>+</sup> to Na<sup>+</sup> balance, causing electrolyte imbalance that trigger migraine. This imbalance can be neutralized by matching foods based on their chemical ingredients so food triggers can be offset—such as salt dipped dark chocolate (dark chocolate is high in K<sup>+</sup> but low in Na<sup>+</sup>)—now sold in grocery stores.

We also found that glucose sensitivity is prevalent among migraineurs, supporting the notion that when glucose pulls H<sub>2</sub>O and Na<sup>+</sup> from the cells it disrupts the electrolyte balance and evokes migraine. The sodium replacement plan appeared to restore proper electrolyte balance when carbohydrates were eaten, suggesting that simple dietary changes reduce migraine frequency.

We understand the bias we introduced by using only migraineurs who randomly discovered our Facebook research group; our research represents a sub group of all migraineurs. The study group was predominately women and the study design included surveys and self-reported behaviors. Both can be considered limitations to our findings. Nevertheless, the findings presented here, though limited, are promising and warrant additional research and consideration.

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## Competing and Conflicting Interests

The authors declare no competing interest

## Abbreviations

CD = cortical depression

CSD – cortical spreading depression

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