Mealtime Hydration's Impact on Digestion

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Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.

Abstract

Understanding how mealtime hydration impacts on digestion is crucial for optimizing nutritional strategies. Water, the elixir of life, plays a multifaceted role in human health. Beyond serving as a solvent and transport medium, its influence on digestion and gastric emptying remains elusive.

While traditional practices cautioned against concurrent beverage and food consumption, new questions arise: do specific water intake timings and temperatures hold merit? Despite the wealth of research conducted thus far, clarity on this subject continues to evade us. Notably, some studies revealed that meals' temperature and composition impact gastric emptying, highlighting the interplay among temperature, texture, and digestion. However, when caloric content and total volume are matched, gastric emptying times may be similar regardless of compositional differences or initial state.

Key insights are summarized, highlighting research gaps and avenues for future investigations on optimal hydration at mealtimes, considering temperature nuances. This review serves as a springboard for further research, guiding nutritionists and other health professionals in devising optimal strategies for their patients' gastric health.

Keywords: water; mealtime; hydration; temperature; digestion; gastric emptying.

Introduction

The seemingly innocuous act of drinking water at mealtimes harbors a surprising degree of controversy. Despite common practices and ingrained beliefs, our understanding of its direct effects on digestion remains fragmented. This review delves into the intricate interplay between water intake and gastric physiology.

Mechanoreceptors, chemoreceptors, and thermoreceptors in the upper gastrointestinal (GI) tract orchestrate a complex symphony of food processing.

While traditional wisdom and some studies caution against simultaneous food and beverage intake[1][2], others propose distinct health benefits associated with specific water intake timings throughout the day[3][4]. However, a critical evaluation reveals a plethora of controversies.

Contemporary studies shed light on the intriguing impact of meal temperature on gastric emptying[5][6]. Furthermore, the structural composition of food[5][7], adds another layer of nuance, highlighting the multifaceted interactions among water timing, volume, temperature, and gastric dynamics.

This emerging knowledge landscape underscores the need for a comprehensive understanding of how hydration at mealtimes directly impacts digestion in both healthy individuals and those with GI pathologies. Such evidence-based guidelines are crucial for refining existing recommendations and optimizing nutritional practices. By navigating existing research, identifying gaps, and meticulously unraveling the interplay between these factors and gastric physiology, I aim to redefine the narrative on this seemingly simple yet highly nuanced aspect of our daily lives.

Search Strategy:

The search strategy targeted literature concerning the impact of water intake during mealtimes on digestion. PubMed, Scopus, ScienceDirect, and Google Scholar were searched up to 09/02/2024. Search terms included "water," "hydration," "mealtime," "during meal," and "digestion," with no date restrictions to ensure inclusivity. Only English language articles were considered, supplemented by two references from Persian and Arabic sources related to Persian Traditional Medicine. Screening criteria included relevance to the topic, regardless of study design. Thirty-three articles were initially found, with 17 ultimately pertinent. Despite efforts to be comprehensive, limitations include potential language bias and the possibility of missing relevant articles not indexed in the selected databases.

Gastric Physiology and Water Intake:

Water, the ubiquitous molecule of life, plays a myriad of roles within the human body, transcending its simple designation as a nutrient. It serves as a structural scaffold, a solvent for countless reactions, and a critical medium for cellular transport and waste removal. Its influence extends beyond cellular function, contributing to thermoregulation through its impressive heat capacity and acting as a lubricant and shock absorber in various bodily systems[8]. Furthermore, it weakens

molecular bonds, facilitating ion movement and participating in hydrolytic reactions essential for macronutrient breakdown, including proteins, carbohydrates, and lipids.[8]. Yet, despite its well-established physiological importance, the intricacies of water intake remain largely unexplored.

The digestive tract responds to food ingestion with a meticulously orchestrated dance, encompassing the cephalic, gastric, and postprandial phases. Each phase presents a unique set of challenges and opportunities for nutrient assimilation. During the cephalic phase, the anticipation of food triggers preparatory processes such as salivary amylase secretion, while the gastric phase focuses on accommodation, acid secretion, and initial food breakdown. The tightly regulated choreography of gastric emptying is orchestrated by a symphony of hormonal and neural signals emanating from the duodenum in response to nutrient presence[9].

Different Perspectives:

Opposing viewpoints exist on how hydration at mealtimes affects digestion. Some emphasize the potential disruption caused by diluted stomach contents [1][2], while others promote mindful water intake at mealtimes[10][11]. According to Traditional Persian Medicine (TPM), esteemed figures such as Avicenna and Razi postulate that excessive water consumption may weaken the gastrointestinal (GI) tract, heightening the risk of organ diseases. Adherence to their specific drinking guidelines, considering factors such as timing, constitution, and activity levels, is advised for optimal health. Water or water-rich foods are discouraged shortly before or at mealtimes, except for individuals with high metabolic rates and pronounced thirst sensitivity due to a warm constitution[12][13]. Avicenna cautions against drinking water during or after intense activities and advises delaying consumption upon waking. Optimal hydration should coincide with genuine thirst. Lukewarm or warm water may harm the GI tract, so prioritize cool water intake without excessive chilling. Sip water slowly for proper GI system preparation and utilization. Extend the interval between meals and water intake for better health[12].

In the contemporary literature, concrete evidence regarding the relationship between water intake timing and digestion remains elusive. A study explored traditional approaches to manage flatulence as a prevalent GI issue. This study highlighted some dietary modifications, such as avoiding beverage consumption during and directly after meals, and delaying the intake of beverages, vegetables, and fruits by 1-1.5 hours post-meal, to mitigate flatulence[1]. These strategies are also recommended for managing meteorism [2].

Many other studies have examined divergent aspects of hydration at mealtimes. For instance, their investigations focused on how eating and water intake affect satiety and hunger[10][11]. The first study suggested that alternating between food and water intake might increase energy consumption by reducing the development of Sensory-Specific Satiety (SSS)[10]. The second one showed that while water influenced feelings of satiety and hunger at mealtimes, these effects did not persist afterward. This funding suggested that subjective feelings of satiety and hunger may change independently of calorie intake at mealtime[11].

Temperature Dynamics:

Intriguingly, research has revealed that meal temperature plays a significant role in gastric emptying, with hot meals notably accelerating the process[5][6]. Additionally, the distinction between liquid and solid meals[5][7]highlights the complexity of digestive responses, with distinct patterns observed in gastric, pancreatic, and biliary functions.

Several scientists examined the influence of meal temperature on gastric emptying[14]. They suggested that meals at 37°C, regardless of consistency, could induce more profound relaxation of gastric muscles than colder counterparts, potentially delaying initial emptying. Other studies highlighted the impact of temperature on the regular propagation of gastric peristaltic waves, essential for emptying force[15]. Consequently, there is speculation that a reduction in temperature may decelerate gastric emptying. Another possible mechanism through which meal temperature influences gastric emptying is the thermal stimulation of thermoreceptors in the gastrointestinal tract[16]. In Yuko Mishima et al.'s 2009 study, gastric emptying notably sped up within 30 minutes after consuming a hot liquid meal. While the hot solid meal test showed a tendency for accelerated emptying, without statistical significance[7].

Solid or Liquid:

In a crossover investigation, researchers examined the gastric emptying kinetics of various liquid and solid foods with equal volumes. They suggested that when caloric content and total volume are matched, gastric emptying times may be similar regardless of compositional differences or initial state. This finding underscores two principles: firstly, that within a fixed food volume, caloric load is a critical determinant of gastric emptying; and secondly, that the energy content, not volume, may primarily regulate gastric emptying rates[17].

Discussion

The historical perspective on water intake, as elucidated by Avicenna, underscores concern regarding excessive water consumption and its potential adverse effects on gastrointestinal health. Although the definition of "excessive" remains ambiguous, contemporary medicine acknowledges the rare but significant condition of hyperhydration, where electrolyte balance is disrupted by overconsumption of water, though typically not observed in healthy individuals. Avicenna's caution against water or water-rich foods at mealtimes prompts consideration of gastric emptying dynamics, yet evidence-based studies suggest that when energy content and total volume are equated, gastric emptying rates remain consistent regardless of food composition or original state.

For healthy individuals, the emphasis on food composition rather than water intake at mealtimes emerges as pivotal in dictating gastric emptying duration. However, in contexts such as flatulence management, caution is warranted regarding water consumption during or immediately after meals, as it may exacerbate discomfort. Conversely, investigations into weight management underscore the potential of hydration at mealtimes to modulate satiety and reduce overall food consumption.

Controversies surrounding food temperature further complicate the discourse, with some studies proposing that meals at body temperature could promote gastric muscle relaxation, potentially delaying gastric emptying, while others highlight the

role of temperature in facilitating gastric peristalsis. Notably, the temperature of ingested water at mealtimes emerges as a factor influencing food temperature, with colder water potentially decelerating gastric emptying.

Ultimately, while further research is warranted to elucidate the precise impact of water intake on digestion, current evidence suggests that water at ambient temperature may represent an optimal choice at mealtime to mitigate potential disruptions to gastric emptying kinetics.

Conclusion

This thorough review meticulously explores the depths of current knowledge, unveiling critical gaps in research concerning water consumption at mealtimes and its intricate effects on gastric physiology. Integrating historical insights with contemporary scientific understanding enhances our appreciation of the complexities surrounding dietary habits and their implications for gastrointestinal health.

Future research endeavors should focus on delineating specific guidelines that account for individual variations in health status, addressing the intricate interplay between water consumption, temperature, and gastric physiology. These recommendations serve to refine existing practices and guide individuals seeking to enhance their digestive well-being.

Statements and Declarations

Competing Interests

The author has no competing interests to declare that are relevant to the content of this article.

Funding

The author did not receive support from any organization for the submitted work.

Author Contributions

The author, N.A., conceived the idea for the article, conducted the literature review, and drafted and critically revised the entire manuscript. The author, N.A., approved the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. [a, b, c] *Larijani B, Esfahani MM, Moghimi M, Shams Ardakani MR, Keshavarz M, Kordafshari G, Nazem E, Hasani*

Ranjbar S, Mohammadi Kenari H, Zargaran A. Prevention and Treatment of Flatulence From a Traditional Persian Medicine Perspective. Iran Red Crescent Med J.2016. 18:e23664. 10.5812/ircmj.23664.

2. [a, b, c] *Zhang L, Sizar O HK. Meteorism, on Treasure Island (FL): StatPearls Publishing.2024. https://www.ncbi.nlm.nih.gov/books/NBK430851/. Accessed 2024*
3. [^] *Vieux F, Maillot M, Rehm CD, Barrios P, Drewnowski A. The Timing of Water and Beverage Consumption During the Day Among Children and Adults in the United States: Analyses of NHANES 2011-2016 Data. Nutrients.2019. 11. 10.3390/nu11112707.*
4. [^] *Salari-Moghaddam A, Aslani N, Saneei P, Keshteli AH, Daneshpajouhnejad P, Esmaillzadeh A, Adibi P. Water intake and intra-meal fluid consumption in relation to general and abdominal obesity of Iranian adults. Nutr J.2020. 19:39. 10.1186/s12937-020-00551-x.*
5. [a, b, c, d] *Mishima Y, Amano Y, Takahashi Y, Mishima Y, Moriyama N, Miyake T, Ishimura N, Ishihara S, Kinoshita Y. Gastric emptying of liquid and solid meals at various temperatures. Journal of Gastroenterology.2009. 44:412-418. 10.1007/s00535-009-0022-1.*
6. [a, b] *Remes-Troche JM. "Too Hot" Or "Too Cold": Effects of Meal Temperature on Gastric Function. Digestive Diseases and Sciences.2013. 58:2439-2440. 10.1007/s10620-013-2789-4.*
7. [a, b, c] *Fisher RS, Malmud LS, Bandini P, Rock E. Gastric emptying of a physiologic mixed solid-liquid meal. Clin Nucl Med.1982. 7:215-21. 10.1097/00003072-198205000-00005.*
8. [a, b] *Jéquier E, Constant F. Water as an essential nutrient: the physiological basis of hydration. European Journal of Clinical Nutrition.2010. 64:115-123. 10.1038/ejcn.2009.111.*
9. [^] *Farré R, Tack J. Food and symptom generation in functional gastrointestinal disorders: physiological aspects. Am J Gastroenterol.2013. 108:698-706. 10.1038/ajg.2013.24.*
10. [a, b, c] *Cunningham PM, Roe LS, Keller KL, Rolls BJ. Switching between bites of food and sips of water is related to food intake across meals varying in portion size. Appetite.2023. 182. 10.1016/j.appet.2022.106443.*
11. [a, b, c] *Lappalainen R, Mennen L, Van Weert L, Mykkanen H. Drinking water with a meal: A simple method of coping with feelings of hunger, satiety and desire to eat. European Journal of Clinical Nutrition.1993. 47:815-819.*
12. [a, b] *H A. Al Qanun Fi Al-Tibb (Persian), vol 4. Soroush Press, Tehran.1988*
13. [^] *MZ R. Al-Havi Fi Al-Tibb (Arabic), vol 2. Dar Al Kotob Al-islmiyah.2000*
14. [^] *Minami H, McCallum RW. The physiology and pathophysiology of gastric emptying in humans. Gastroenterology.1984. 86:1592-610.*
15. [^] *Sanders KM. A case for interstitial cells of Cajal as pacemakers and mediators of neurotransmission in the gastrointestinal tract. Gastroenterology.1996. 111:492-515. 10.1053/gast.1996.v111.pm8690216.*
16. [^] *Rawson RO, Quick KP. Localization of intra-abdominal thermoreceptors in the ewe. J Physiol.1972. 222:665-7. 10.1113/jphysiol.1972.sp009820.*
17. [^] *Okabe T, Terashima H, Sakamoto A. A comparison of gastric emptying of soluble solid meals and clear fluids matched for volume and energy content: a pilot crossover study. Anaesthesia.2017. 72:1344-1350. 10.1111/anae.14026.*