Critical Review:

Does consuming dairy products, specifically milk, compared to not consuming dairy lead to mucus production in healthy individuals?

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Abstract

Many people have for many years held the belief that dairy products and specifically milk intake can cause mucus production or excessive mucus. (Lee & Dozor, 2004). Lee & Dozer (2004) have termed this belief the Milk-Mucus effect (MME). The primary objective of this critical analysis was to evaluate the literature investigating the effects of dairy products on mucus production. Critically evaluated studies included: two literature reviews, one randomized double-blinded controlled trial, two single group design case studies, and one randomized double-blind trial. Selection criteria excluded studies investigating the MME in individuals with asthma. Results suggested that consuming dairy products, specifically milk, may affect an individual's sensory perception, the release rate of stored mucus, or effect ones' mucus based on the osmotic properties or viscosity of milk. However, the consumption of dairy products does not necessarily initiate mucus production.

Introduction

Has anyone ever told you to avoid drinking milk or eating other dairy products when you have a cold or flu? What about before a big vocal performance? For many years, many people have held the belief that dairy products and specifically milk intake can increase mucus production or cause excessive mucus. This effect is often termed the Milk-Mucus Effect (MME) (Lee & Dozor, 2004). Arney and Pinnock (1993) defined the MME as a "phenomenon in which cough and/or sensations relating to the thickness of saliva or mucus are experienced in the throat for a period of up to 24 hours after the ingestion of a small volume of milk."

Despite a small body of current research suggesting that this belief is not scientifically supported, a 2004 study found that 58.5% of parents reported believing that milk increases mucus. In fact, 28% of parents reported being told this fact by a physician (Lee & Dozor, 2004).

Within voice management research, evidence has suggested that excessive mucus can cause the sensation of post-nasal drip. Everyone has a coating of mucus lining the inside of their nasopharynx as well as the rest of the pharynx. Individuals do not actively feel or perceive this coating of mucus, but it is always there. The issue arises when one starts to perceive this mucus because it becomes thicker or more excessive. Post-nasal drip can result in increased throat clearing and coughing which can cause damage to the vocal folds and may perpetuate voice problems. (Bonilha, White, Kuckhahn, Geriach, & Deliyski, 2012). Thus, if the MME is scientifically justified, a suggestion of reduced milk consumption may be acceptable. For swallowing management, resources have suggested that excessive or thicker mucus can create or contribute to swallowing difficulties (Arney & Pinnock, 1993; Penn State College of Medicine, 2020). Thus, for patients with previously compromised swallowing, the MME may result in additional difficulty swallowing. In a book written by McCool and Benditt (2018), medications and drying agents to help manage thick and excessive mucus were mentioned. This highlighted the possible management suggestions which may be utilized when working with a patient who has swallowing difficulties related to excessive or thick mucus.

Despite these possible effects on ones' voice and swallowing, the nutritional benefits of dairy, specifically milk, must also be taken into consideration. Balfour-Lynn (2019) highlighted the importance of including milk in ones' diet as a source of calcium and other vitamins. Calcium is critical, especially for children, to ensure adequate calorie intake and bone growth, as well as to reduce the risk of osteoporosis and susceptibility to bone fractures. Marangoni et al. (2018) completed a review around the importance of cow's milk as a part of a healthy balanced diet. Additionally, preliminary research suggested that consuming an appropriate amount of milk has potential protective effects against obesity, diabetes and cardiovascular disease and is beneficial across all age groups. Given the health benefits and importance of milk consumption, clinical suggestions, which involve reduction of milk or dairy intake, need to be scientifically justified.

In this analysis, the scientific evidence base for the MME will be analyzed. If there is scientific proof of the MME, there may be implications for Speech Language Pathologists (SLPs) working in the areas of dysphagia and voice management.

Objectives

The primary objective of this paper is to critically evaluate the literature investigating the effect of dairy products, specifically milk, on mucus production.

Methods

Search Strategy

Computerized databases including Google Scholar and PubMed were searched using the following terms: [(dairy) OR (milk) AND (mucus production) OR (mucus)], [(dairy) OR (milk) AND (mucus production) AND (voice)], [(dairy) OR (milk) AND (mucus production) AND (swallowing)], and [(dairy) OR (milk) AND (mucus production) NOT (asthma)]. The search was limited to articles written in English.

Selection Criteria

Studies selected for critical review were required to include healthy participants as well as a measure of mucus production, either perceptual or physical. There was one exception with a paper involving patients with symptomatic or asymptomatic inoculated Rhinovirus-2, but these patients were otherwise healthy. Studies utilizing participants with asthma were excluded as mucus hypersecretion is already a significant symptom (Lai & Rogers, 2010). As well, so conclusions could be generalized to healthy individuals. Studies providing commentary on the MME without the inclusion of mucus measures were excluded.

Data Collection

The literature search, based on the search strategy and inclusion/exclusion criteria listed above, yielded six papers included for review. These six selected papers included two literature reviews, one randomized double-blinded controlled trial, two single group design case studies, and one randomized double-blind trial.

Results

Balfour-Lynn (2019) conducted a review of perceptual and experimental studies investigating excessive mucus production associated with milk consumption. The experimental studies included in this review were available for access and reviewed in more depth later within this paper.

Balfour-Lynn (2019) included explanations as to why mucus may be perceived as "thicker" after ingesting dairy products from Vingerhoeds et al., (2005). Milk can be explained as a mixture of fat and water, formally called an emulsion. When salvia is mixed with an emulsion, it can induce extensive droplet flocculation of the emulsion, which results in the formation of clusters of emulsion that increase viscosity and volume of saliva. Thus, this could provide some explanation as to why sensory perception may be altered after consuming dairy products, specifically milk.

Balfour-Lynn (2019) included data from a study completed by Arney and Pinnock (1993), which looked at individuals' perceptions of mucus production associated with dairy products. Of 169 adults, 41% believed that consuming dairy products produced additional mucus. These individuals also described the sensations they experienced after consuming dairy which included: difficulty swallowing, and the perception of thicker saliva/mucus in the throat, nose, and mouth. Afterwards, participants were either given 300mL of cow's milk or soy milk. Immediately following milk consumption, individuals reported significantly increased symptoms of a coating/lining over the mouth, throat and/or tongue, needing to swallow a lot, and/or thicker saliva and more difficulty swallowing. This increase in symptoms was seen across groups suggesting that consuming dairy products influenced sensation but did not produce a physiological effect.

This review appeared significant as it reviewed seven articles and included 19 additional sources, however, the overarching goals were never stated. This review was divided up according to sub-questions. However, as this review provided historical, perceptual and experimental studies, their conclusion was clearly laid out. Overall, this review of studies provided compelling evidence that the texture and chemical make-up of milk can result in some individuals feeling that their saliva/mucus is thicker and that they have more difficulty with swallowing. However, there is no physiological evidence to suggest consuming dairy products, specifically milk, can lead to excessive mucus production.

Frosh, Cruz, Wellsted, and Stephens (2018) completed a prospective, randomized, double-blinded controlled study, where they compared levels of nasopharyngeal mucus secretion between individuals who consumed a dairy versus a nondairy diet. Participants included a group of 108 individuals referred to an ear, nose and throat clinic in the United Kingdom for nasopharyngeal mucus concerns.

This study was completed over 8 days. Participants were assessed, asked to eliminate dairy products from their diet, then (on day four) randomly assigned to one of two groups— a) receiving soya milk disguised as a dietary supplement or b) receiving cow's milk disguised as a dietary supplement. On days two through seven, each participant was asked to provide several ratings regarding their perception of their personal mucus secretions. The results from this study revealed that individuals who had a dairy-free diet experienced a significant reduction in the perception of their mucus levels.

Strengths of this study included the design being a prospective, randomized, double-blinded controlled trial, and having a large and representative sample size. Appropriate statistical analysis was completed. Additionally, the inclusion/exclusion criteria for the participants were very stringent. However, there are risks to the validity of the study when relying on the participants to record their daily measures accurately and honestly. Additionally, no objective measure of mucus was completed.

Overall, this study provided compelling evidence that individuals, who had previously complained of persistent nasopharyngeal mucus, experienced a significant reduction in their symptom of excessive nasopharyngeal mucus when they removed dairy products from their diet in comparison to similar individuals who were still consuming dairy products.

Moose (1948) conducted a single group design case study exploring the effects of milk consumption on mucus production. Data in this study was collected from patient medical histories. A group of 647 patients with no physical anomalies were observed over the course of three years by an ear, nose and throat (ENT) physician. Information collected included: the number of glasses of milk consumed per week, if they had bothersome mucus, as well as if they had a cold, sinus issues, sore throats, and/or allergies.

The patients were divided into three groups based on their consumption of milk (0-5 glasses per week, 6-9 glasses per week, & 10 or more glasses per week respectively.). These groups were further subdivided into those patients experiencing post-nasal drip and those without bothersome mucus. Regardless of the number of glasses of milk consumed per week, half the patients in each group reported post-nasal drip and half reported no mucus concerns. These results suggested no correlation between drinking more milk and having more mucus or post-nasal drip.

A total of 157 patients also consented to a nose and throat examination to objectively measure their quantity of mucus. Half the participants who drank 0-5 glasses of milk per week had excessive mucus (52%), and the other half did not (48%). Similar results were found for participants who drank 10 or more glasses of milk per week, exactly half the participants had excessive mucus, and the other half did not. These results indicated no observable differences in mucus production according to the level of milk consumption, suggesting that milk does not play a role in increasing mucus production or post-nasal drip.

Strengths of this study included its large sample size as well as its inclusion of both perceptual and objective measures. Weaknesses of this study included a lack of a control group or randomization in the study design. In addition, the methods were not clearly described in this study making it difficult to replicate. Due to the unclear methods, the nature of the blinding and recruitment in this study is unknown. Another flaw in the methodology was a lack of standardization over milk ingestion in terms of when the milk was ingested and how much milk was ingested. Overall, this study provided equivocal evidence to suggest that individuals who consume more milk do not have increased mucus production or post-nasal drip sensation.

Pinnock and Arney (1993) conducted a randomized double-blind trial comparing mucus production in 169 participants after drinking cow's milk (dairy) versus a soy milk placebo.

Following consumption, a Milk-Mucus (MM) questionnaire was given to participants which included 14 questions related to the presence, or lack thereof, of physical mucus symptoms. The questionnaire was completed at baseline, 5 minutes and 4 hours after consuming the 300mL drink and finally the next morning.

Of the 14 scores of the MM questionaries, 2 factors increased enough to be significant in both the milk and placebo groups: "needs to swallow a lot" and "saliva thicker than before". As the factors increased for both milk and the non-milk placebo, this suggested that the effect may be more related to the osmotic proprieties, ionic strength viscosity or colloidal properties of milk and that the MME is not necessarily tied to dairy but can also be replicated with milk-substitutes.

This study had a strong experimental design being a randomized double-blind trial with a soy milk control group. The sample size was also adequate. Some weaknesses of the study included seeking out MME believers and discussing this aspect before the study. This could possibly prime the subjects to report more of the mucus production indicators. Also, the

researchers reported that using the continuum may not have been the best option and that the symptoms being reported would have been better represented with anchor points meaning the symptom is present or absent. Overall, this study provided compelling evidence to demonstrate the perceptual presence of the MME as well as suggesting that this does not occur exclusively with milk, but with other drinks similar in viscosity and osmotic properties.

Pinnock, Graham, Mylvaganam and Douglas (1990) conducted a single group design case study investigating the relationship between milk intake and mucus production in adults challenged with Rhinovirus-2 (RV-2), or the common cold. Participants were otherwise healthy adults aged 18-35.

Participants were isolated for ten-days, during which they kept a journal of everything they ate and drank. Participants were inoculated with RV-2 on the first day and started medication as soon as symptoms appeared. Symptoms were recorded using a checklist and three-point severity rating scale. Nasal secretion weight was also measured.

Congestion symptoms were present in participants 245 out of the 510 person days of observation. Mucus weights ranged from 0g to 30.4g. Subjects ingested 1 to 11 glasses of milk each day and other dairy products ingested ranged from 0-20. After analysis, no significant correlations were found between increased milk intake, or other dairy product intake, and congestion symptoms or mucus production.

This was a single group case study, meaning there was no control group or randomization of participants. As well, the researchers highlighted that this study was cross-sectional and, thus, simultaneous and opposing association between milk intake and mucus production could occur, and thus could not be distinguished. Finally, these patients were treated for their colds as soon as symptoms were observed, and it is possible that treatment of patients effected their symptoms and mucus production. Overall, this study provided equivocal evidence suggesting no correlation between milk intake and symptoms of congestion or nasal secretion weight in healthy adults challenged with RV-2.

Sessions (2020) conducted an analysis to explore the scientific explanation associated with the debate on whether dairy products, specifically milk, increase the production of mucus and the effect it may have on ones' voice. The topics discussed included how milk acts as a minor opioid and agonist, thus, effecting mucus secretions. This article also included dietary suggestions for when dairy has impacted ones' voice.

The formation of cow's milk has two different types of protein in it: Whey and Casein. When Casein breaks down, it releases a chemical known as Beta-Casomprphine-7 (BCM-7). Once in the blood stream, BCM-7 begins to travel to the brain, crossing many neurons and passing through areas known as synaptic clefs. Within these clefs, lay tons of opioid receptors, which BCM-7 attaches to. This process results in a release of dopamine in the brain. Due to this, it was suggested that BCM-7 causes excessive mucus to be released. Sessions (2020) included data from Zoghbi et al., (2006) that showed BCM-7 caused a 169% increase of mucus production, however, much of this mucus was found within the digestive system. Thus, leading to the conclusion that the excessive mucus could not impact the voice or vocal folds.

Sessions (2020) included more recent research from Zhu (2015) that found a type of mucus cell, MUC5AC, that produces mucus in the airway from goblet cell secretion. According to Zhu (2015), these cells have a limited amount of storage. The stored mucus is released when agonists are released into the body. During release, there is a significant spike in exocytic events (EE). In this study, once an agonist was introduced, the EE/min increased to 118. After a few moments, the stored mucus in these cells were depleted, which resulted in the EE/min to drop to 2. BCM-7 acts as a partial agonist which means it could have a similar effect on these cells. Sessions (2020) further discussed how this data may explain why some people experience the MME and some don't. Specifically, if the individual drinking milk has already depleted their stored mucus, then the BCM-7 would not affect the mucus. Thus, consuming dairy may affect the release rate of mucus secretions but not the production rate.

This analysis included nine articles and 24 additional sources, and their overarching goal was to explore the scientific explanations behind the MME. This analysis also highlighted the importance of separating mucus secretion and mucus production. Specifically, mucus secretion refers to already stored mucus within ones' body that will be secreted due to the introduction of diary, whereas mucus production refers to a physiological change in the amount of mucus (Sessions, 2020). Overall, this study provides compelling evidence that the chemical make-up of dairy products, specifically milk, can have effects on mucus secretions, however, not mucus production.

Discussion

The collected findings from the analyzed studies provide suggestive evidence that consuming dairy products, specifically milk, may affect an individuals'

sensory perceptions, the release rate of stored mucus, or affect ones' mucus based on the osmotic properties or viscosity of milk. However, milk products do not necessarily lead to excess mucus production. However, within these analyzed studies there are weaknesses regarding the methods, design of the study, biased definitions of the MME, and generalization to clinical settings.

Future research considerations

Evidence shows that the MME is perceived and believed by a lot of people but, excessive mucus production cannot be physically captured in the studies completed thus far. As well, the MME is still not well understood. Researchers are unsure as to which part of the respiratory tract is affected, whether the effects are seen in the rate or volume of secretions, if there are changes in the characteristics of the mucus and if there are differences across age groups. In the future, it would be beneficial to investigate a) if the effects of the MME vary across ages, backgrounds, cultures and ethnicities, b) what standardized objective measures of mucus productions immediately prior to and following dairy consumption reveal c) if a true definition of the MME can be reached (including factors like which part of the respiratory tract is involved, mucus characteristics, etc.) and d) how the MME directly affects ones' voice and swallowing function through the utilization of videofluoroscopy, nasopharyngoscopy, and specific voice measures (i.e., jitter or shimmer).

Clinical Implications

The suggestion to reduce the intake of dairy products, specifically milk, in management plans for voice, swallowing, dietary concerns and other respiratory ailments can be found often in current research (Bonilha, et al., 2012; Arney & Pinnock, 1993; Penn State College of Medicine, 2020). Resources have highlighted the importance of dairy for child's development and avoidance of ailments such as osteoporosis and bone fractures (Balfour-Lynn, 2019). Furthermore, resources have suggested that milk can have protective factors against obesity, diabetes, and cardiovascular disease and has benefits across all individuals of different ages (Marangoni et al., 2018). Given the health benefits and importance of milk consumption, clinical suggestions, which involve reduction of milk or dairy intake, need to be scientifically justified. The need for further research on the MME is crucial to ensuring that any suggestions made, regarding altering dairy product intake, are evidence-based.

Without a true understanding of the MME and given the lack of conclusive evidence present in current research, the suggestion to reduce dairy consumption to prevent mucus production is not scientifically justified. Despite this evidence-based conclusion, clinicians will likely have many swallowing and voice clients who hold the belief that milk, and dairy consumption increases mucus production. It is important to validate the literature suggesting that some individuals perceive changes in their mucus after drinking dairy products. However, it is also important to recognize that overall, the evidence surrounding changes in mucus production as a result of dairy consumption is suggestive. The role of the clinician should be to educate and ensure his or her clients are informed regarding the current body of evidence suggesting that dairy products may not increase mucus production, but instead influence ones' sensory perception, release rate of stored mucus, or affect the mucus in their systems based on the osmotic properties or viscosity of milk. As well, indicating that further research needs to be completed in order to further understand the MME and the effect milk may have on mucus production.

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