

Fall 2018

Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding Xylitol in Clinical Practice

Agatha Stavnesli
Eastern Washington University

Follow this and additional works at: <https://dc.ewu.edu/theses>



Part of the [Dentistry Commons](#)

Recommended Citation

Stavnesli, Agatha, "Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding Xylitol in Clinical Practice" (2018). *EWU Masters Thesis Collection*. 540.
<https://dc.ewu.edu/theses/540>

This Thesis is brought to you for free and open access by the Student Research and Creative Works at EWU Digital Commons. It has been accepted for inclusion in EWU Masters Thesis Collection by an authorized administrator of EWU Digital Commons. For more information, please contact jotto@ewu.edu.

Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding Xylitol in
Clinical Practice

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Science

in

Dental Hygiene

in the

College of Graduate Studies

Eastern Washington University

by

Agatha Stavnesli, RDH, BS

Fall 2018

Major Professor:
Merri Jones, RDH, MSDH

THESIS OF Agatha Stavnesli APPROVED BY

_____ DATE _____
Merri Jones, RDH, MSDH, GRADUATE STUDY COMMITTEE

_____ DATE _____
Ann O'Kelley Wetmore, RDH, BSDH, MSDH, GRADUATE STUDY
COMMITTEE

_____ DATE _____
Sabine Thomas, ND, GRADUATE STUDY COMMITTEE

MASTER'S THESIS

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Eastern Washington University, I agree that the JFK Library shall make copies freely available for inspection. I further agree that copying of this project in whole or in part is allowable only for scholarly purposes. It is understood, however, that any copying or publication of this thesis for commercial purposes, or for financial gain, shall not be allowed without my written permission.

Signature 

Date November 30, 2018

Human Subjects Approvals



EASTERN WASHINGTON UNIVERSITY

Office of Grant & Research Development
210 Showalter Hall, Cheney, WA 99004-2444
509-359-6567

start something **big**

TO: Agatha C. Stavnesli, Department of Dental Hygiene

FROM: Ruth A. Galn, ^{RG} Human Protections Administrator

DATE: April 23, 2018

SUBJECT: Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice (HS-5527)

With the amendments provided on April 23, 2018, human subjects protocol HS-5527 entitled "Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice" has been approved as an exemption from federal regulations under CFR Title 45, Part 46.101(b) (1-6).

A signed and approved copy of your application is attached.

Student research qualifying for an exempt IRB review is valid for a period of one year. If subsequent to initial approval, the research protocol requires minor changes, the Office of Grant and Research Development should be notified of those changes. Any major departure from the original proposal must be reviewed through a Change of Protocol application submitted to the IRB before the protocol may be altered. Please refer to HS-5527 on future correspondence as appropriate as we file everything under this number.

Cc: HS-5527 file
Prof. Merri Jones, RPI
Prof. Ann Wetmore, Dept. Chair
Graduate Office

Abstract

Purpose: The intent of this study was to assess naturopathic physicians' knowledge, attitudes, and practices regarding the use of xylitol clinical practice.

Methods: This study utilized a convenience sample of naturopathic physicians (NPs) ($N=325$) through an online survey via SurveyMonkey®.

Results: The majority of NPs were knowledgeable of the medical and dental uses of xylitol (84%; $n = 53$ and 95%; $n = 60$, respectively). Ninety percent ($n=57$) viewed the current demand for naturopathic medicine as increasing. The medical literature was the highest ranked source of information on xylitol (45%; $n = 28$) with clinical practice guidelines being reported as the level of evidence required for adoption of xylitol. There is a significant correlation ($p = 0.015$) between NPs awareness of medical dental uses and having used xylitol as a preventive agent. There was also a significant correlation ($p = 0.002$) and relationship between strongly agreeing xylitol is useful in preventing dental caries and having used xylitol. Participants responded they would be highly likely to use xylitol, based on the American Academy of Pediatric Dentistry (AAPD) guidelines, to prevent dental caries and having used it as a preventive agent.

Conclusion: The majority of naturopathic physicians surveyed are aware of the use of xylitol in clinical practice as an evidence-based approach to preventing dental caries.

Subsequently, approximately one-half of those surveyed utilize xylitol in clinical practice. Further investigation of opportunities for educational interventions and collaboration between naturopathic and dental professionals is of value considering the current trend toward complementary and alternative therapies.

Acknowledgements

I would first like to thank my thesis chair, Professor Merri Jones, RDH, MSDH, of the Dental Hygiene program at Eastern Washington University. Professor Jones was always available whenever I ran into a trouble spot or had a question about my research or writing. She consistently allowed this paper to be my own work and steered me in the right direction whenever she thought I needed it.

I would also like to thank Professor Ann O'Kelley Wetmore, RDH, BSDH, MSDH, at Eastern Washington University and Sabine Thomas, ND, for their support of this thesis, and I am gratefully indebted to their very valuable comments on this thesis.

My sincerest gratitude to Robert May, ND, Executive Director of Washington Association of Naturopathic Physicians for his input and support. Without his backing of this research study, the survey could not have been successfully conducted.

I would like to acknowledge and thank Boyd Foster for his expertise in statistical analysis. Without his passionate participation and input, the results of this study could not have been successfully reported.

Finally, I must express my very profound gratitude to my parents for always believing in my ability to achieve success in whatever I set out to do and to my boyfriend for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Table of Contents

Abstract	v
Acknowledgements	vii
List of Figures	x
List of Tables	xi
Introduction/Literature Review	1
Introduction to the Research Question	1
Statement of the Problem	2
Overview of Research	4
Summary	19
Methodology	21
Research Methods or Design	21
Procedures	21
Human Subjects Protection/Informed Consent	21
Sample Source/Plan, Size, Description of Setting	22
Variables	22
Instruments (reliability/validity)	22
Equipment	22
Steps to Implementation	23
Summary	23
Results	25
Description of Sample	25
Statistical Analysis	28
Discussion	40
Summary of Major Findings	40
Discussion	40
Limitations	46
Recommendations/Suggestions for Additional Research	47
References	49

Appendices..... 57

Curriculum Vitae..... 67

List of Figures

Figures

Figure 1: Additional studies.....	7
Figure 2: Primary practice or specialization	27
Figure 3: NP’s perceptions as to why patients may seek naturopathic medicine.....	28
Figure 4: Reported sources of information regarding xylitol	29
Figure 5: NPs reported use of xylitol as a preventive agent	30
Figure 6: Attitudes regarding usefulness of Naturopathic medicine in dental caries prevention	30
Figure 7: Products recommended for dental caries prevention.....	31
Figure 8: Xylitol is useful in preventing dental caries.....	31
Figure 9: Based on AAPD guidelines, likelihood of using xylitol in dental caries prevention	32
Figure 10: Interest in xylitol as a preventive agent	33
Figure 11: Levels of evidence in making clinical judgements.....	34
Figure 12: Continued research on xylitol as a caries preventive agent is important.....	34
Figure 13: Interest in a continuing education course on xylitol.....	35
Figure 14: New model of care.....	42
Figure 15: Oral healthcare professional roles and opportunities.....	44
Figure 16: Continuum of care	46

List of Tables

Tables

Table 1: Demographic Characteristics	26
Table 2: Pearson Correlations. Significant correlations: Having used xylitol as a preventive agent.....	36
Table 3: Pearson Chi-Square Test. Significant relationships: Are you aware of medical uses for xylitol related to: Number of years in practice	37
Table 4: Pearson Chi-Square Test. Significant relationships: Is Having used xylitol as a preventive agent significantly related to: Medical/dental uses, side effects, usefulness of naturopathic medicine in preventing dental caries, usefulness in preventing dental caries, likelihood of using xylitol per AAPD guidelines.....	38

Introduction/Literature Review

Introduction to the Research Question

Oral diseases continue to be of major health concern worldwide and across the lifespan. Specifically, dental caries represents a transmittable and preventable oral disease with the potential to notably impact an individual's health. Oral health is integral to overall health and general well-being and relates to the quality of life beyond the orofacial complex (U.S. Surgeon General, 2000). Since the first water fluoridation trials in 1945, progress has been made in reducing the prevalence of dental caries. Water fluoridation is the number one preventive measure for dental caries and is one of the greatest achievements in public health in preventing dental decay. However, xylitol is a naturally occurring substance used as a natural sweetener and has been studied extensively for application as an anti-caries agent due to its antimicrobial properties.

Western or allopathic medicine recognizes the oral systemic link and uses a systems approach to the prevention of disease by rigorously testing the safety and efficacy of medicines, diagnostic, and therapeutic treatments (Milburn, 2004). Traditional treatment modalities used to prevent dental decay and promote oral health include the use of chemotherapeutic agents such as fluoride, other re-mineralizing agents, and antimicrobials, including xylitol. In a holistic manner, the naturopathic community recognizes the oral systemic link and uses diverse approaches in complementary and alternative interventions together with conventional treatment to promote oral and overall health (Barnes, Bloom, & Nahin, 2008).

Complementary and alternative medicine (CAM) is defined as "a group of diverse medical and health care systems, practices, and products that are not presently considered

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

to be part of conventional medicine” (National Center for Complementary and Integrative Health [NCCIH], 2004, ¶ 1). In the past 20 years, the use of CAM therapies has increased significantly in the U. S. population (Spector, Kummet, & Holmes, 2013).

Complementary and alternative medicine therapies include, but are not limited to:

homeopathy, naturopathy, megavitamin therapy, chiropractic/massage therapy, acupuncture, ayurvedic medicine, and herbal medicines. Spector et al. (2012)

summarized that most patients reported using CAM in conjunction with traditional

Western medicine rather than abandoning traditional medicine all together. Due to this

increase in CAM usage it is important that the dental professional understands these

therapies and their implications on patients’ oral and systemic health. Spector et al.

(2013) concluded from an exploratory survey of U.S. dental schools only 22 of 60 dental

schools responded to inquiries about CAM therapy inclusion in their curricula. Twelve

of the 22 schools who responded indicated they did not have a formal CAM course.

These results indicate recognition of CAM use within U.S. dental schools but the need for widespread CAM instruction is warranted.

Statement of Problem

While there are numerous studies examining the use of xylitol as a CAM therapy in the dental setting (Spector et al., 2013), little is known about the utilization of xylitol, and/or its acceptance and use in oral health among naturopathic practitioners.

Naturopathic medicine is a distinct primary health care profession, emphasizing prevention, treatment, and optimal health through modern and traditional, scientific, and empirical methods. Naturopathic physicians (NP) are a diverse group of practitioners who graduate from a four-year nationally accredited naturopathic medical graduate

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

school with training in conventional biomedical sciences, diagnosis, and treatment, as well as natural therapeutics in combination with the latest advances in science (Bastyr University, 2018). Currently there are 20 states, the District of Columbia, and the U. S. territories of Puerto Rico and Virgin Islands that license or certify NPs (American Association of Naturopathic Physicians [AANP], 2018). Naturopathic physicians work to identify underlying causes of illness and emphasize the prevention of disease by assessing risk factors, heredity and susceptibility to disease and help facilitate and promote patient-centered care through individualized appropriate interventions to restore and maintain optimal health. Naturopathic physicians treat all medical conditions and work as primary care providers and as part of an integrated healthcare team in providing both individual and family health care (adults as well as children and infants) (AANP, 2018). Restoration of health through prevention, not treating pathology, is the primary objective of naturopathic medicine. However, when a specific pathology must be addressed, NPs employ minimally invasive therapies and natural substances to restore health (AANP, 2018).

The purpose of this study was to gain insight into naturopathic physicians' knowledge, attitudes, and practices regarding the use of xylitol as a CAM therapy in clinical practice. Thus, this study included the following research questions: What is naturopathic physicians' knowledge of xylitol as an anti-caries agent? What are naturopathic physicians' attitudes toward use of xylitol as an anti-caries agent? Is xylitol recommended as part of CAM practice and if so, how?

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Overview of Research

The adoption of CAM therapies is growing in the U. S. according to the 2007 U.S. National Health Interview Survey (NHIS). Approximately 4 out of 10 adults (38.3%) used some form of CAM within the past year (Barnes, Bloom & Nahin, 2008, p. 4). Milburn (2004) summarized from a 1998 Eisenberg, et al. study 16% of overall CAM use was in relaxation techniques, 12% in herbal medicine, and 11% in massage and chiropractic therapies. Annual visits from 1990 to 1997 grew from 470 million to 629 million, far exceeding the 386 million visits to U.S. primary-care physicians that year (Eisenberg et al., 1998). Because of this increase, there is growing appreciation and acknowledgement among health care professionals regarding the public's use and interest of CAM in obtaining and maintaining optimal oral health (Milburn, 2004).

Unfortunately, many patients, about 70%, do not communicate to their conventional practitioners about their alternative therapy modalities (Eisenberg et al., 1998; Eisenberg et al., 1993). Notably, neither CAM nor traditional practitioners may be well informed about one another's therapeutic approach; therefore, this lack of communication may inhibit practitioners in providing optimal care and may lead to redundancy in treatment or even worse, development of a dangerous interaction (Milburn, 2004).

Defining Xylitol

Xylitol is a 5-carbon pentitol naturally occurring sugar alcohol. It resembles the sweetness of sugar but does not breakdown to create acids. Xylitol's mode of action inhibits bacterial growth, which promotes a reduced risk of plaque accumulation resulting in lower levels of acid. *Streptococcus mutans* (*S. mutans*) is the most common bacteria responsible for dental caries; therefore, a reduction in the amounts of *S. mutans* would

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

result in diminished caries risk. Xylitol inhibits the process of glycolysis in *S. mutans* resulting in interference with growth and metabolism of these microorganisms (Silva, Pereira, Machado, & Buzalaf, 2009). *S. mutans* have a “sticky” outer layer allowing adherence on to tooth surfaces and xylitol reduces the adherence of *S. mutans* on tooth surfaces (Peldyak & Makinen, 2002).

In 1969, Finnish researchers found consumption of xylitol led to a decrease in dental plaque production that resulted in substantial caries reduction (Makinen, 2010). Unlike sugar, xylitol is non-fermentable by most bacteria and this lack of fermentation results in diminished bacterial growth and eventual death of bacterial cells. Xylitol also has alkaline promoting properties that help to decrease the acidic environment bacteria need for caries formation. Due to xylitol's non-acidogenicity, a stabilizing effect occurs on the salivary Calcium-phosphate system and xylitol consumption is associated with increased plaque calcium levels.

Background on Xylitol Use

Xylitol was first introduced in the United States fifty-plus years ago, when it was first used as a food additive (Milgrom et al., 2006). It was used as a sugar substitute for diabetic diets and has only been recognized as a dental therapeutic agent within the last ten years (Milgrom et al., 2006). Research on xylitol as a therapeutic agent is in its infancy. Only 22 years have lapsed since the U.S. introduced xylitol as a possible anti-caries agent compared to fluoride's 70 years of use.

Research over the course of the past 40 years strongly suggests xylitol positively improves caries prevention due to its anti-cariogenic effects and studies on the efficacy of xylitol (Makinen et al., 1995; Zhan et al., 2012) have shown xylitol to be an effective

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

anti-caries and cariostatic agent (Makinen et al., 1995; Peldyak & Makinen, 2002; Scheie & Fejerskov, 1998). Xylitol has been known to science since the early nineteenth century (Peldyak & Makinen, 2002), but during the early 1970's xylitol gained recognition in the dental field as an anti-cariogenic agent through a Finnish study known as the Turku Sugar study (Scheinin, Mäkinen, & Ylitalo, 1976). The landmark Turku Sugar studies propelled and led to important developments in the use of xylitol as an anti-caries agent (Scheinin et al., 1976). The Turku Sugar study looked at differences in caries rate among various sugars and investigated the use of xylitol as an alternative prevention agent and tested its effectiveness in caries reduction. The trial substituted fructose and xylitol for sucrose for a two-year period and included 35 subjects in the sucrose group, 38 in the fructose group, and 52 in the xylitol group. Results indicated an impressive reduction in dental caries with a mean increment of decayed, missed and filled tooth surfaces of 7.2 in the sucrose group, 3.8 in the fructose group, and 0.0 in the xylitol group; concluding that xylitol possesses non- and anti-cariogenic properties (Scheinin et al., 1976).

Adoption of xylitol as an anti-caries preventative agent has been very slow in the United States, although it is widely used in many other countries. In the United States, the Army Dental Command's Health Promotion Program has created the *Look for Xylitol First* initiative to educate dental professionals about the benefits of xylitol (Richter & Chaffin, 2004). Dental hygiene professional associations in Arizona, Hawaii, and Kentucky have endorsed xylitol since 2008 (Clark, 2014). California began endorsing xylitol in 2010 and dental hygiene associations in Texas, Wisconsin, Florida, Pennsylvania, Nebraska, Nevada, New York, and Maine have all made efforts to advocate the use of xylitol since August 2010 (Clark, 2014). In Finland, xylitol gums are

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

recommended by public health centers as an important caries-prevention program (Peldyak & Makinen, 2002). The Finland Dental Association endorsed xylitol in 1988 and subsequent endorsements were made in 1989 by the Swedish Dental Association and 1990 for Britain (Clark, 2014). The slow adoption and lack of information could be the reason why xylitol use has not been widespread in the U.S. Although xylitol has gained attention in both the medical and dental realm there is still limited awareness on its positive effects, although there have been numerous studies researching the efficacy of xylitol, therefore it has not been adopted into practice (P. Milgrom, Rothen, & L. Milgrom, 2006).

Chewing Gum	Compressed Tablet, Lozenges and Candies	Other
<ul style="list-style-type: none"> ï Makinen et al., 1995 ï Burt, 2006 ï Peldyak and Makinen, 2002 ï Hujoel et al., 1999 ï Scheie and Fejerskov, 1998 ï Silva, Pereira, Machado, and Buzalaf, 2009 ï Biria, Malekafzali, and Kamel, 2009 ï Scheie, Fejerskov, and Danielsen, 1998 ï Rethman et al., 2011 ï Campus et al., 2013 	<ul style="list-style-type: none"> ï Pickett, 2012 ï Lenkkeri, Pienihakkinen, Hurme, and Alanen, 2012 ï Bader et al., 2013 ï Silva, Pereira, Machado, and Buzalaf, 2009 	<p>Treating Otitis Media:</p> <ul style="list-style-type: none"> ï Danhauer, Johnson, Rotan, Snelson, and Stockwell, 2010 ï Kontiokari, Uhari, Koskela, and Niemela, 1996 <p>Upper Respiratory Infections:</p> <ul style="list-style-type: none"> ï Kontiokari, Uhari, and Koskela, 1995 <p>Reducing S. Mutans Transmission:</p> <ul style="list-style-type: none"> ï Marrs, Trumbley, and Malik, 2011 ï Burt, 2006 ï Peldyak and Makinen, 2002 <p>Dental Caries Preventive Treatment Modalities:</p> <ul style="list-style-type: none"> ï Adams, Hyde, and Gansky, 2009

Figure 1. Additional studies

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Delivery Methods

The effectiveness and success of xylitol is dependent on the delivery mechanism. Use of products must be easy and readily available to promote patient compliance. Delivery of xylitol comes in different forms such as: xylitol-containing chewing gum, mints, energy bars and foods, nasal sprays, and oral hygiene products such as mouth rinse, toothpaste, gels, wipes and floss (AAPD, 2011). The most utilized is chewing gum, although delivery of xylitol is highly recommended through lozenges or candies for individuals who are not able to chew gum or have other contraindications. Makinen et al., 1995 performed a 40-month double-blind cohort study of all 4th grade pupils ($N=1,277$) of Belize City, Belize to evaluate the effects of six different chewing gums and their usage on caries rates. The researchers found xylitol-containing gums were associated with a significant reduction of caries compared with sucrose gum ($p < .0001$) and sorbitol gum ($p < .05$). The caries onset risk in the xylitol stick gum and xylitol pellet gum were 48-44% and 41-27% respectively compared to the “No gum” control group.

Dental caries is a common transmittable disease affecting individuals throughout life with early childhood caries (ECC) affecting 6 out of 10 children in the United States by age 5 (U.S. Surgeon General, 2000). For this reason, xylitol studies have focused on early childhood caries (ECC) prevention. Early childhood caries susceptibility can be diminished by using xylitol to reduce *S. mutans* transmission from mother to child (Marrs, Trumbley, & Malik, 2011). Studies in Finland and Sweden concluded mothers who regularly chewed xylitol-sweetened gum resulted in lower *S. mutans* levels in both mother and child (Burt, 2006). Peldyak and Makinen (2002) concluded in their review

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

that mothers who used xylitol gum during and after pregnancy were more likely to have children who were 70% less likely to develop caries by the age of five. In a critical review of long-term clinical caries studies published on xylitol's efficacy, Scheie and Fejerskov (1998) concluded that although many of the studies were flawed, the studies did provide positive results in xylitol's ability to reduce caries. Mickenautsch and Yengopal (2012) conducted a quantitative systematic review of clinical trials looking at the anticariogenic effects of xylitol versus fluoride. In their literature search they found ($N=1199$) articles of which they excluded ($N=1187$) articles due to duplication or irrelevance. From the remaining articles only six articles and their quantitative clinical evidence regarding the caries-preventive effects of xylitol were reviewed. In four of the six articles, results showed that xylitol used in conjunction with fluoride containing products increased anti-cariogenic effects. Studies using fluoride with xylitol and fluoride alone found xylitol had a contributory effect beyond, just fluoride use (Kandelman, Bär, & Hefti, 1988; Sintes, Elías-Boneta, Stewart, Volpe, & Lovett, 2002; Sintes et al., 1995; Scheinin et al., 1985).

In 2009, Adams, Hyde, and Gansky conducted a study on Hispanic parental/caregivers' ($N=211$) acceptability and preference in preventive treatment modalities among Hispanic children from two Head Start and Early Head Start Centers. The ECC preventive agents included: fluoride varnish, brushing with a fluoride containing dentifrice, xylitol in food, xylitol in gum, and chlorhexidine. Researchers collected data through personal interviews and calculated results using a nonparametric Friedman rank test. All five preventive agents were highly acceptable with a mean ranging from 4.6 (xylitol in food) to 4.9 (chlorhexidine). Researchers concluded

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

(Friedman chi-square test = 23.4, $p < 0.001$) fluoride varnish (52%) and tooth brushing (48%) were the most commonly recognized and preferred treatment and chlorhexidine was preferred over xylitol in gum and foods ($p < 0.001$). Percentage of participants having heard of fluoride varnish was 60 % and only 1 % had heard of xylitol (Friedman chi-square = 317.6, $p < 0.001$). Analyzing the data, researchers concluded xylitol, due to its relatively new introduction to caries prevention, was not chosen as a treatment option due to unfamiliarity. This study supports the benefits of increased awareness of xylitol.

Hujoel et al. (1999) found in a two-year habitual gum-chewing study of participants ($N=288$), long-term dental caries preventive effects of xylitol even after 5 years. Children were given gums sweetened with xylitol, sorbitol, or xylitol/sorbitol mixtures and were compared to a control group with “no-gum”. Sorbitol gums had no significant long-term effect ($p < 0.18$) compared with the no-gum group. Xylitol gum reduced the caries risk by 59% ($p < 0.0034$) and xylitol/sorbitol gum had a reduction of 44% ($p < 0.02$). Long-term caries risk reduction associated with xylitol was dependent on teeth eruption. Teeth that erupted after one year of gum-chewing had a long-term caries risk reduction of 93% ($p < 0.0054$) and eruption after the two-year trial resulted in an 88% ($p < 0.0004$) reduction. Teeth that erupted before gum-chewing started had no significant long-term prevention ($p < 0.30$). This study concluded that xylitol gum-chewing should be started at least one year before permanent teeth erupt to benefit in caries-preventive effects.

In a literature review of the most important clinical studies on xylitol for caries prevention Peldyak and Makinen (2002) also recommend xylitol consumption to begin one year prior to tooth eruption, primary and permanent, to gain maximum benefits

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

initially and long-term. Although studies have proven and disproven efficacy, barriers may attribute to the slow adoption of xylitol use in dentistry. The original Turku Sugar study was followed by the Turku Chewing Gum Study done in the early 1970's that comprised randomly divided voluntary dental and medical students ($N=102$). The study compared xylitol containing chewing gum and chewing gum containing sucrose over a 12-month period. Results indicated a therapeutic effect of xylitol containing chewing gum and cariogenic effects from chewing gum containing sucrose (Scheie & Fejerskov, 1998). Silva et al. (2009) found in their review of literature the decrease in acidogenicity of dental biofilm, *S. mutans*, and prevention of new dental caries results from an increase of salivary flow when chewing gum. This increase in salivary flow contributes to buffering effects of the acidic oral environment and promotes re-mineralization.

In a cross-over, single blinded, in situ study done by Biria, Malekafzali, and Kamel (2009), fifteen 20-30 years of age healthy volunteers ($N=15$) participated. Chewing a natural substance such as mastic gum and xylitol-containing gum both resulted in a statistically significant decrease ($p=0.018$) in demineralization of dental lesions. The average decrease in demineralization in the mastic gum group was 6.02% and 8.86% in the xylitol containing chewing gum group. Results from this study indicated re-mineralization associated with increased salivary flow. Xylitol's ability to maintain supersaturated levels of calcium in saliva aids in enamel re-mineralization (Makinen, 2010). Scheie, Fejerskov, and Danielsen (1998) found in their randomized, double-blind study involving healthy students ($N=30$) who had more than 4 filled teeth, ranging in ages from 18-28 years old, with no clinical signs of active dental caries saw no significant reduction of plaque biofilm and acidogenicity by chewing xylitol- or

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

xylitol/sorbitol-sweetened chewing gum. Scheie et al. examined whether xylitol would have better effects on individuals with higher amounts of *S. mutans*. Regardless of dental caries prevalence, all dentulous patients may benefit from mechanical plaque removal with the added benefits of xylitol's non-cariogenic saliva stimulation (Peldyak & Makinen, 2002).

Based on a comprehensive review of literature, Rethman et al. (2011), concluded from available evidence that non-fluoride agents may provide an adjunctive benefit to individuals who are at higher risk of experiencing caries; therefore, recommends sucrose-free chewing gum or xylitol lozenges for caries prevention. A two-year double-blind randomized, placebo-controlled clinical study involving high-risk caries subjects ($N=204$) by Campus et al. (2013) supports findings that xylitol is beneficial to high-caries risk individuals. Results from this two-year randomized clinical study concluded that participants in the xylitol group ($N=74$), chewing two xylitol containing gum pellets for five minutes, five times a day saw a statistically significant difference ($p<0.01$) in plaque acidogenicity and caries incidence and after six months of xylitol exposure, subjects in the xylitol group did not experience any new carious lesions when examined during a two-year follow up (Campus, et al., 2013).

An alternative to chewing gum, compressed tablet, lozenges, and candies can be made entirely of xylitol (Peldyak & Makinen, 2002). This therapeutic delivery method allows xylitol to stay in constant contact with the teeth, delivering optimal levels. A systematic review of 66 studies, 51 randomized and 15 non-randomized, evaluated the efficacy of various non-fluoride caries preventive agents where 4 studies evaluated xylitol in candy, lozenges, tablets, and syrup (Pickett, 2012). One study found

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

participants who sucked on xylitol containing tablets three times a day for 10 minutes versus participants who used no lozenges resulted in a statistically significant response favoring xylitol use (Pickett, 2012). In contrast, Lenkkeri, Pienihakkinen, Hurme, and Alanen (2012) found in a four year, double-blinded, cluster-randomized, controlled trial involving participants ($N=496$) using lozenges as the delivery method of xylitol and erythritol, used in combination with maltitol, resulted in no significant difference clinically ($p=0.726$) between control ($N=101$) and four different study groups: xylitol 1 year ($N=96$), xylitol 2 year ($N=99$), erythritol 1 year ($N=99$), and erythritol 2 year ($N=101$), for additional caries-preventive effects. Researchers concluded these results may be due to natural fluoridation and low-caries incidence as contributing factors. An additional 33-month, multicenter, placebo controlled, double-blind, randomized controlled study involving participants ($N=681$) conducted by Bader et al. (2013) also showed xylitol lozenges did not statistically decrease ($p=0.20$) caries risk in adults who were exposed to fluoridated water, fluoride containing dentifrices, and regular dental care. Silva et al. (2009) reviewed and analyzed literature regarding xylitol and its use in caries prevention, mechanism of action and frequency of use. They concluded individuals who would benefit from intensive xylitol treatment via lozenges are children, patients with high *S. mutans* levels and high caries lesions, physically and mentally handicapped subjects, elderly, orthodontic patients, and teenagers. Other methods of xylitol delivery include toothpaste, alcohol free mouth rinses, thick syrups for customized trays, oral moisturizers, and saliva substitutes for xerostomia patients.

Additional use of xylitol has been studied in the treatment and prevention of otitis media, common ear infection, (Danhauer, Johnson, Rotan, Snelson, & Stockwell, 2010;

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Kontiokari, Uhari, Koskela, & Niemela, 1996) and as an additive in nasal sprays for upper respiratory infections (Kontiokari, Uhari, & Koskela, 1995). Danhauer et al. (2010) conducted a randomized national postal survey of pediatricians in the U.S. to evaluate knowledge and opinions about xylitol use in the treatment of acute otitis media. The questionnaire response was 22% (98 useable/506 mailed). Only about half of the participants were aware of medical uses of xylitol although none have used it with patients and only had heard about its use in chewing gum in preventing acute otitis media. Participants were unsure of xylitol's effectiveness and/or dosages but would be inclined to use it if evidence supported it. Kontiokari et al. (1996) conducted a double-blind randomized trial of day care aged children ($N=306$) where during the two-month trial researchers had each child chew either xylitol or sucrose (control) chewing gum. The study concluded significantly less antimicrobial medication was used to treat acute otitis media among those receiving xylitol (18.5%) versus those receiving sucrose (28.9%). A 10.4% difference ($p=0.032$) between these two groups seems to indicate xylitol has a preventive effect against acute otitis media. Kontiokari et al., 1995 tested the effects of xylitol in inhibiting *S. pneumoniae* growth and hypothesized that xylitol could affect the growth of bacteria in the nasopharyngeal flora responsible for middle ear and respiratory infections. The study showed test medium containing 1 or 5% (wt./vol) of xylitol versus xylitol-free medium resulted in 35 and 72% inhibition respectively of *S. pneumoniae* growth at 2 hours of incubation and 39 and 51% inhibition respectively at 6 hours. A statistically significant difference was found at 14-24 h of incubation ($p< 0.001$ to 0.04) during the logarithmic phase of growth between the two groups. At 24 hours there was no significant difference between the 1% xylitol group and control ($p=0.68$) but the difference between the 5%

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

xylitol group and control remained statistically significant ($p=0.001$ to 0.02). As a result, researchers concluded if xylitol reduces the growth of *S. pneumoniae* in the nasopharynx then it could also reduce the carriage of it and prevent upper respiratory infections.

Dosage Recommendations

Xylitol was approved by the U.S. Food and Drug Administration (FDA) in 1963, as a food additive (AAPD, 2011). Since the 1970s, xylitol has been added to consumer goods as an alternative sweetener in small amounts (Milgrom et al., 2006). In the U. S, consumers are exposed to products that do not deliver therapeutic amounts of xylitol. Companies are not required by law to disclose the amounts of xylitol incorporated into their products, therefore it is difficult to determine if the amounts are simply marketing strategies or have definite value in anti-caries claims. Peldyak and Makinen (2002) stated that “when used properly, very little xylitol is needed for dental benefits” (p.281). In other studies, there have been conflicting and confusing conclusions as to effective doses. Bader et al. (2013) studied xylitol lozenges and used the high end of the typical dosages to ensure effectiveness, but due to the undetermined threshold of daily consumption, effectiveness is still in question. This study resulted in no significant effect of decreased caries incidence. Scheie and Fejerskov (1998) suggests the lack of preventative effects of xylitol may be a result from low daily doses in their present study compared to doses used in previous studies, like the original Turku sugar study. Lenkkeri et al. (2012) summarized a dose of approximately 6-10g of xylitol, at least three times a day, is required to obtain a caries-preventive effect. Alanen, Isokangas, and Gutman (2000) identified a daily dose of 5g of xylitol effective in caries reduction. Discrepancies in dosages warrant continued studies on xylitol and its efficacy for future recommendations.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Guideline on Xylitol Use in Caries Prevention

Studies have indicated that timing, consistency, amounts, and frequency all play a role in the effectiveness of xylitol. The Council on Clinical Affairs (CCA), working together with the American Academy of Pediatric Dentistry (AAPD), developed guidelines and adopted a policy on the use of xylitol in 2006, with revisions made in 2010; however, professional awareness of these guidelines is undetermined (AAPD, 2011). The AAPD recognizes the benefit of caries prevention strategies involving natural sweeteners, namely xylitol, in promoting oral health in infant(s), children, and adolescent(s) (AAPD, 2011). In 2011, the AAPD developed and published guideline on the use of xylitol. The guideline is “intended to assist oral health care professionals make informed decisions about the use of xylitol-based products in caries prevention” (AAPD 2011, p. 175). This guideline focuses on infants, children, adolescents, and individuals with special health care needs, with moderate to high caries-risk (AAPD, 2011). The dosing frequency should be no less than two times a day and the amount not to exceed eight grams per day no matter the age appropriate delivery method (AAPD, 2011).

Chewing gum is the main method of delivery, but children under the age of four should not use gum, lozenges, or candies as it poses a choking hazard. Given these hazards, formulating a xylitol-containing product via compounding pharmacy may be ideal to ensure products meet the dosage recommendations and aid in compliance. In a review Murthykumar (2013) addressed the impact of milk incorporated with xylitol on dental caries. The purpose of the literature review was to examine taste acceptability of xylitol added to milk and found milk with xylitol was well accepted by children and this addition of xylitol lead to the lack in fermentation of *S. mutans*. This leads to an increase

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

in oral pH resulting in potential anti-caries effects and possible re-mineralization due to xylitol's calcium binding properties. A randomized control study of syrup containing xylitol resulted in highly effective preventative benefits in early childhood caries therefore xylitol is recommended for children with high rates of disease by two years of age (Milgrom, Ly, & Rothen, 2009). Other products such as pacifiers with pouches for xylitol placement and toothpastes are available, but not here in the United States, yet. This may be because dosage recommendations are still being determined. It is recommended that dental professionals adjust doses based on reassessment of caries-risk once every six months (AAPD, 2011).

Barriers to Use of Xylitol

Most products available to consumers have trace amounts of xylitol and often those amounts are unknown. These products are targeted towards candy/gum consumers and not for dental related consumption or professionals (Milgrom et al., 2006). One xylitol containing chewing gum was offered through Henry Schein called XyliFresh. It is the first commercial xylitol chewing gum made with 100% xylitol and was developed and launched almost simultaneously in Finland and the U. S. in 1975 (Global Sweet, 2017). Although Henry Schein is no longer a distributor of this product in the U. S. XyliFresh is still sold and consumed in the Netherlands. The Nordic confectionary company Cloetta paved the way for xylitol use in chewing gum and Cloetta products are sold in more than 50 markets worldwide (Cloetta, 2017). Scheie and Fejerskov (1998) reported the annual cost of using XyliFresh Professional would be \$350-400 per child (p.275). Other researchers say this cost would be equivalent to the cost of restorations that would be avoided. Unfortunately, xylitol costs 5-6 times more per kilogram than

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

sorbitol and most common over-the-counter dental product sweeteners (CariFree, 2015) and the increased demand for xylitol containing products, available for dental consumers, is surpassing the supply of xylitol (Milgrom et al., 2006). To deliver adequate amounts of xylitol, dental products must contain at least 10% to have therapeutic effects. There are several xylitol containing gums and mints available in the U. S. market providing potential dental caries preventive effects, but these markets rapidly change, and new products frequently appear (Milgrom et al., 2006). The costs range from approximately \$0.62-\$2.25 per 10 pieces of gum/mints/candies (Milgrom et al., 2006). The recommendation for consistent use to maintain effectiveness can become financially cumbersome. Low-income families, individuals who are of low socioeconomic status (SES), and those who cannot afford dental care, cannot get assistance from government-based insurance programs to cover the cost of xylitol products (Milgrom et al., 2006). These are the individuals who would benefit from xylitol products the most.

Although finances may hinder compliance of xylitol use, the frequency of xylitol use also influences compliance. The recommended five times a day, three to five minutes of gum chewing might not be feasible for long durations. Even with lozenges and candies, patient compliance continues to be an issue. With the elevated amounts of xylitol consumption, sensitive individuals may experience gastrointestinal side effects such as gas, bloating, and osmotic diarrhea. Because xylitol and its associated enzymes are produced in the human body daily, these symptoms are only temporary, as most individuals adjust their dosages and build up a tolerance quickly (Peldyak & Makinen, 2002). Attrition due to side effects and lack of compliance was a factor in many studies.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

These biases may impact internal validity of study finding. For individuals to gain the benefits of xylitol, ease of use and more affordable products need to become available.

Other barriers to the use of xylitol include lack of public, dental, and medical awareness on the therapeutic effects of xylitol. Although education is the most important form of obtaining knowledge, many dental/medical communities utilize diffusion principles when deciding to use new products or ideas. Therefore, there is a need for future studies, as well as continuing education courses about xylitol and its anti-cariogenic potential. For delivery of the latest and greatest advancements in therapy to the public, professionals must be better informed.

Summary

Dental communities recommend xylitol use as an adjunctive therapeutic agent and have recommended it to be used in conjunction with proper oral hygiene regimens along with fluoride use for caries prevention. Although the advantages and benefits of xylitol are still not concise, studies have concluded that xylitol's mechanism of action is influential in promoting overall oral health. Since the 1990's, xylitol has gained more recognition through numerous clinical studies; unfortunately, the data is still conflicting on whether xylitol is anti-cariogenic in nature. Numerous studies have shown that this underutilized sugar-substitute promotes non-fermentation, thus decreasing acidogenicity in the oral environment. Bacteria (e.g., *S. mutans*) cannot metabolize xylitol, which reduces bacterial colonization and adherence to teeth and salivary stimulation creates a natural buffering mechanism to neutralize pH. Xylitol's calcium binding properties aid in the re-mineralization of incipient carious teeth. These positive effects are the

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

motivating factors that have researchers studying xylitol. Further studies will be required, to determine the claims of xylitol's efficacy against caries prevention.

As concerns grow over high dental and health care costs and poor health outcomes in the United States, the integration of dental and health care professionals from a broad range of disciplines must collaborate to emphasize prevention and help spread the message about the positive effect xylitol has on oral and overall health. By addressing and treating the root causes of disease rather than its symptoms the need for repeated, expensive, and sometimes ineffective treatment is eliminated. Naturopathic medicine offers CAM therapies and use plant-based medicines (botanicals) along with lifestyle changes to improve many aspects of a patient's health (AANP, 2018) and because xylitol is a naturally occurring sugar alcohol with antimicrobial properties and is not manufactured in a laboratory or artificial, licensed naturopathic physicians have a central role to play in these efforts. An understanding of its acceptance and use in naturopathic medicine could serve to further identify its use as a preventive adjunct therapy among the naturopathic medical community. However, there is little known of the attitudes, knowledge, and use of xylitol regarding prevention of dental decay.

To better understand the many uses of xylitol and to promote its usage in dental caries prevention, dental professionals must develop partnerships with other health professions to deliver optimal patient-centered oral health care. In collaborating with naturopathic physicians, oral healthcare professionals can better understand how one CAM profession of primary care providers utilizes xylitol and become better informed about each other's therapeutic approaches. Sharing scientific information and

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

developments of recommended usage of xylitol can promote its use and possibly develop new and improved recommendations for obtaining optimal dental and oral health.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Methodology

Research Methods or Design

This study employed a descriptive exploratory design to examine naturopathic physicians' attitudes, knowledge, and practices regarding the use of xylitol as a CAM therapeutic approach in clinical practice. The survey data was generated and collected using SurveyMonkey®. The web-based survey method was utilized for delivery of the survey/questionnaire. Rationale for selecting the online format is twofold: Ease of completion in a timely and cost-effective manner and secondly, facilitating the efficient use of time for data collection.

Procedures

Human subject(s) protection/informed consent. This study was approved by the Eastern Washington University (EWU) institutional review board (IRB). The study met the criteria for a Certificate of Exemption under Category 1 (survey or interview). The study posed minimal risk to participants and participation is voluntary. After IRB approval, a pre-notice letter (see *Appendix A*) was sent to potential participants via email by Robert May, N.D., Executive Director of the Washington Association of Naturopathic Physicians (WANP). Robert May served to relay study information and participation requests to participant email addresses and introduced participants of the study to better prepare them in recognizing the email recruitment letter, and thus less likely to delete the message. One week following the pre-notice letter, a recruitment letter/consent statement (see *Appendix B*) was sent to participants including a link to the SurveyMonkey® website. Potential respondents were informed that participation is voluntary and that

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

confidentiality as well as anonymity is assured throughout the research process; findings will be available to participants upon completion of all phases of the research study.

Only the principal investigator (PI) and graduate faculty thesis chair have access to the data. The SurveyMonkey® settings are selected as “anonymous responses,” thus insuring anonymity upon all data exports from SurveyMonkey®. All data exported from SurveyMonkey® is kept in a password-protected computer only accessible by the PI.

Sample source, plan, sample size, description of setting. The sampling frame and inclusion criteria used in this study is composed of naturopathic physicians who are members of the WANP ($N=325$). Non-probability sampling method was used to recruit a convenience sample of practicing naturopathic physicians at the time of the study. Participants were recruited through the WANP listserv®.

Variables. The descriptive study design utilized research questions, rather than a hypothesis to gather outcomes on the variable(s) of study

Instruments. The instrument consisted of a 22-item survey/questionnaire. Items 1-5 of the survey gathered demographic information relevant to naturopathic physicians regarding years of practice, current practice standing and location, practice setting, and area of study and specialization. Items 6-18 in the second section addressed naturopathic physicians' knowledge and perceptions regarding xylitol as a preventive agent and their use of xylitol with patients in their practice. Items 19-22 inquired about participants' interest and opinion on whether a continuing education course on xylitol as a preventive agent would be of benefit (see *Appendix D*).

Equipment. The survey instrument in the form of an online, electronic survey/questionnaire was utilized to collect data using SurveyMonkey®. Computer

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

software program used in this study included IBM SPSS® version 2.5 to analyze the data.

Steps to implementation. Approval of this study was obtained from the Eastern Washington University (EWU) Institutional Review Board (IRB) prior to implementing this study. Confidentiality and ethical procedures were upheld by the PI and all participants remained anonymous apart from the PI. On behalf of the PI, a pre-notice letter was sent one week prior to implementation of the study to potential participants via email by Robert May N.D., Executive Director of WANP (see *Appendix A*). One week post pre-notice letter, a recruitment letter was sent to participants including a link to the SurveyMonkey® website (see *Appendix B*). Follow up reminders were sent in 2-week intervals through week eight of the study at which time the study was concluded (see *Appendix E*).

Upon completing the survey, participants were entered in to a drawing for a \$50 cash gift card as an incentive to participate. To be eligible for the gift card, participants were given the opportunity to go to a separate link at the end of the survey to provide their e-mail address. If participants chose to provide their e-mail address and participate in the drawing, the PI only knew who participated in the survey not the responses. The e-mail addresses did not correlate to the data. Participant's e-mail addresses were entered in to a list randomizer program to select the winning participant who was contacted via e-mail. All information was kept confidential on the PI's password protected computer.

Summary

This descriptive exploratory study assessed naturopathic physicians' attitudes, knowledge and practices regarding the use of xylitol for oral and overall health. This

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

quantitative evaluation assisted in determining if xylitol use improves oral health and enhances collaborative efforts to deliver useful and practical applications primarily in caries prevention. Results of this study are discussed in the next section.

Results

Description of Sample

A nonprobability convenience sample of NPs were recruited through the WANP member listserv ($N = 325$). This study was conducted via SurveyMonkey®. From the 325 members of WANP, sixty-three ($N = 63$; 20%) members participated in this survey. Participants varied in years of experience, practice settings, area of specialization, practice standing and location.

Demographic characteristics. Of the 63 respondents, 22.22% ($n = 14$) have been practicing for less than five years, 23.81% ($n = 15$) for five to ten years and 53.97% ($n = 34$) for more than ten years. Ninety-five percent of respondents ($n = 60$) reported as actively practicing. Geographic areas of practice varied from 13% rurally, 17% inner city, 24% from suburban areas, and 46% urban. Most participants reported private practice as the primary work setting ($n = 49$; 77.78%) (Table 1).

Table 1

Demographic Characteristics

Characteristic	Percentage of Sample ($N=63$)
Number of Years of Practice	
Few than 5 yrs.	22.22% ($n=14$)
5-10 years	23.81% ($n=15$)
Over 10 years	53.97% ($n=34$)
Practice Status	
Actively practicing	95.24% ($n=60$)

 NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Non-active	4.76% (<i>n</i> =3)
------------	----------------------

Geographic Area of Practice

Inner city	17.46% (<i>n</i> =11)
------------	------------------------

Urban	46.03% (<i>n</i> =29)
-------	------------------------

Suburban	23.81% (<i>n</i> =15)
----------	------------------------

Rural	12.70% (<i>n</i> =8)
-------	-----------------------

Primary Work Setting

Private practice	77.78% (<i>n</i> =49)
------------------	------------------------

Federally qualified health center	1.59% (<i>n</i> =1)
-----------------------------------	----------------------

(FQHC)

Interprofessional group practice	17.46% (<i>n</i> =11)
----------------------------------	------------------------

Other	3.17% (<i>n</i> =2)
-------	----------------------

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Primary areas of practice or specialization(s) varied from pediatrics, endocrinology, gastroenterology, nutrition; to family practice (Figure 2).

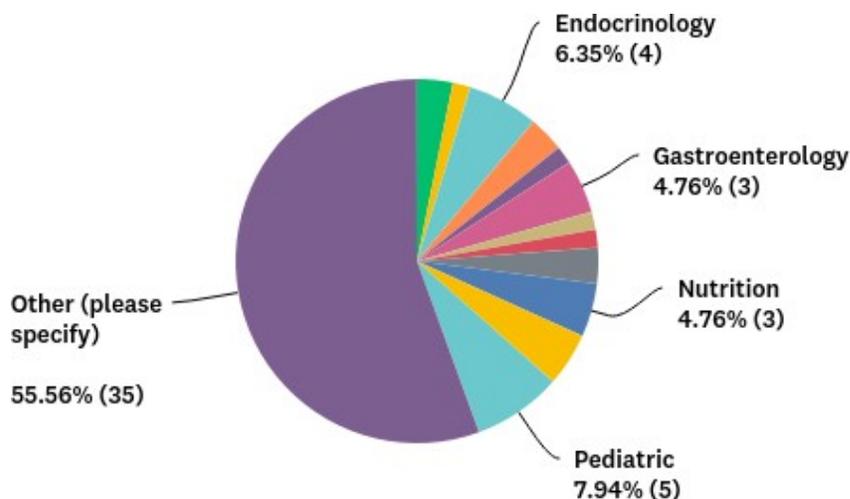


Figure 2. Primary practice or specialization

Perceived demand for naturopathic medicine. When asked to determine the population's current demand for naturopathic medicine as perceived by the NP, 90% ($n = 57$) reported demand as increasing, while 8% ($n = 5$) felt the demand was stable; only 2% ($n = 1$) felt demand for naturopathic medicine was decreasing.

Perceived reasons for seeking naturopathic medicine. When asked how NPs perceive the reasons why patients may seek naturopathic medicine, 93.65% ($n = 59$) responded by selecting that patients felt treatment with conventional medicine has not been effective. This was followed by patients desire for a holistic approach to their health care (90.48%; $n = 57$) (Figure 3).

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

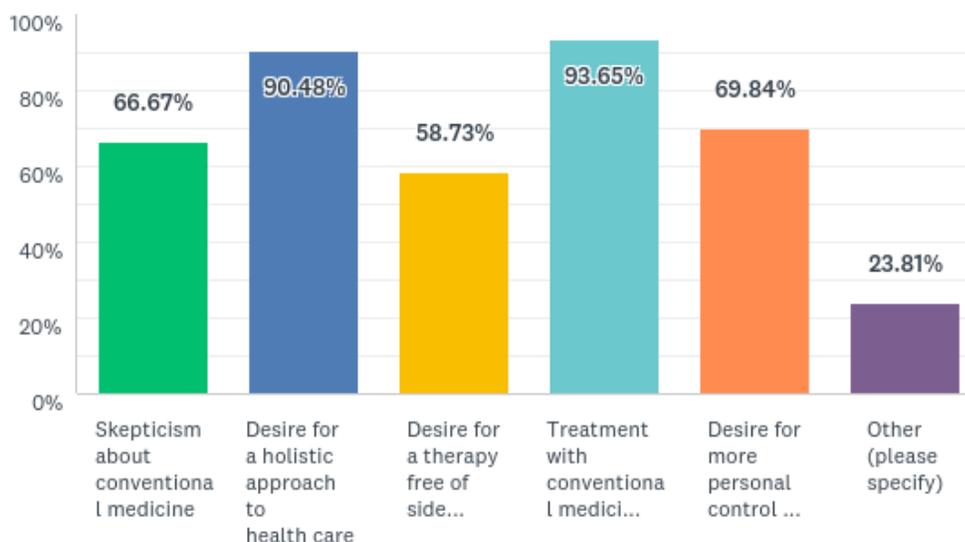


Figure 3. NP's perceptions as to why patients may seek naturopathic medicine.

Twenty three percent of participants ($n = 15$) selected "other" and listed reasons such as:

- ï Personalized care
- ï Seeking integrative health care
- ï More face to face time during visits than conventional models allows
- ï More economical option
- ï Has worked in the past
- ï Desire to not use drugs

Statistical Analysis

Quantitative data was collected using a 22-item survey/questionnaire and was analyzed using descriptive and inferential statistics. Software used in statistical analysis included SurveyMonkey® exported to IBM SPSS®. Items 1-5 of the survey inquired on demographic information relevant to naturopathic physicians regarding years of practice, current practice standing and location, practice setting, and area of specialization. Items 6-18 related to naturopathic physicians' knowledge and perceptions regarding xylitol as a preventive agent and their use of xylitol with patients in their practice. Items 19-22 inquired on participants' interest and opinion on whether a continuing education course on xylitol as a preventive agent would be of benefit.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Knowledge and Perceptions Regarding Xylitol

Medical/dental uses for xylitol. When asked “Are you aware of medical and dental uses for xylitol?” 84% of respondents ($n = 53$) indicated knowledge of medical uses of xylitol and 95% ($n = 60$) for dental use. Sixteen percent were unaware of medical uses and 5% were unaware of xylitol uses in dental related therapeutics.

Source of information on xylitol. When asked “Which of the following best describes your source of information regarding xylitol?” 44.44% ($n = 28$) indicated “medical literature” as their main source followed by “popular press” ($n = 16$; 25%), and “other” ($n = 8$; 12%) (Figure 4). Sources in “other” included both professional sources and delivery methods. Specified “other sources” included: dentists, Delta dental training, other healthcare providers, information delivered through in-service presentations, dental continuing education, and medical literature mentioned at conferences.

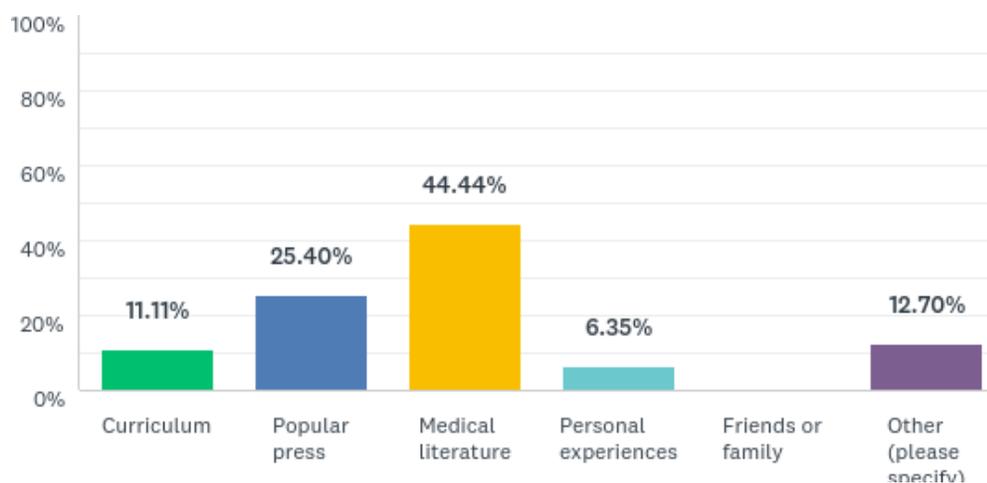


Figure 4. Reported sources of information regarding xylitol.

Xylitol Use and Practice of Xylitol

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Use of xylitol. Fifty-three percent of participants reported having used xylitol as a preventive agent ($n = 33$) in treating dental caries, preventing otitis media ($n = 9$; 14%), and treating xerostomia ($n = 7$; 11%). Thirty-eight percent of the participants ($n = 24$) specified other uses related to disease prevention and treatment addressing various acute and chronic conditions, including: inflammation and infection of the oral cavity, common ear nose and throat ailments; prevention of diabetes/weight control, as a sugar substitute, oral health (halitosis, gingivitis, and dental caries prevention) and as an adjunctive for nasal lavage and detox in narrowly selected cases (Figure 5).

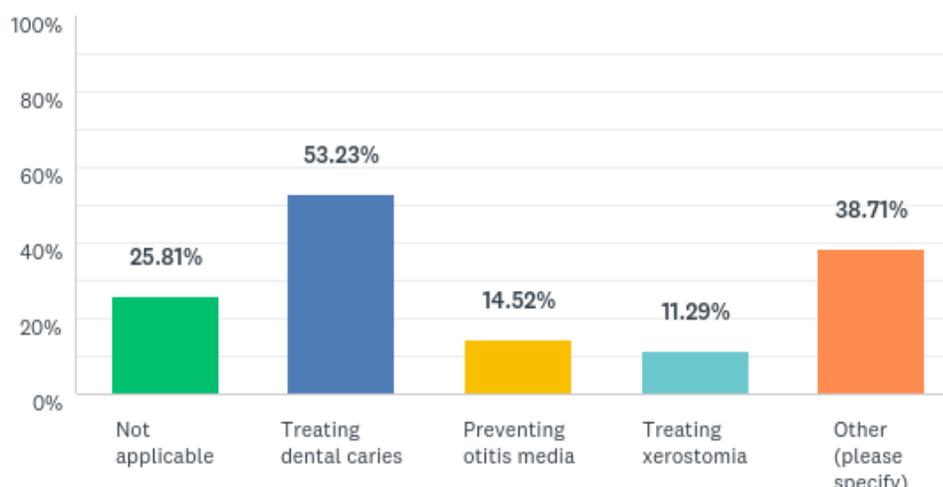


Figure 5. NPs reported use of xylitol as a preventive agent.

Attitudes Toward Xylitol

Caries prevention. Majority of participants agreed that naturopathic medicine is useful in the prevention of dental caries ($n = 34$; 54.84%) (Figure 6)

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

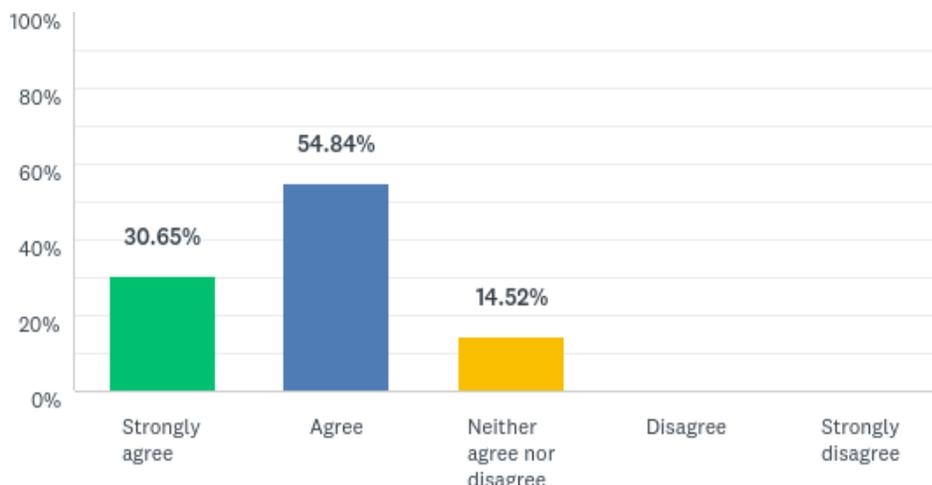


Figure 6. Attitudes regarding usefulness of Naturopathic medicine in dental caries prevention.

When asked what products participants have recommended for dental caries prevention 66.13% ($n = 41$) answered xylitol (Figure 7).

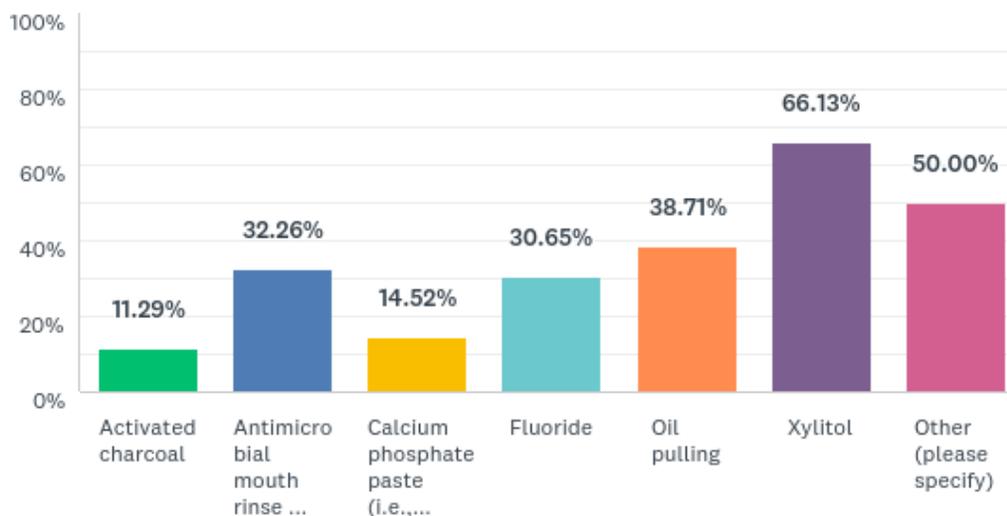


Figure 7. Products recommended for dental caries prevention.

More than half of the participants ($n = 37$; 58.73%) were aware of xylitol's side effects and the remaining 41.27% ($n = 26$) were not. Participants feel xylitol is useful in

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

preventing dental caries (61.29%; $n = 38$) (Figure 7); however, when asked if participants were aware of the AAPD guidelines, 80.95% ($n = 51$) indicated they were not.

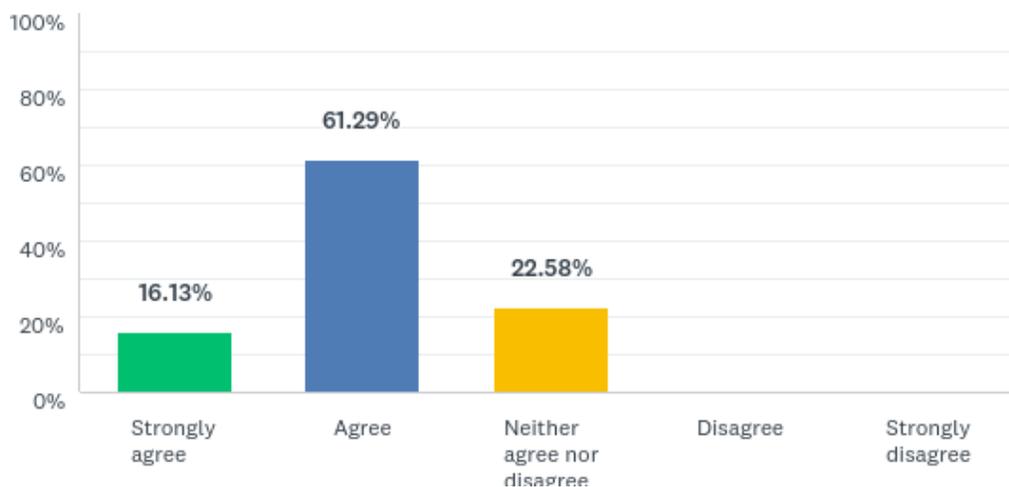


Figure 8. Xylitol is useful in preventing dental caries.

After learning what these AAPD guidelines are 36.51% ($n = 23$) (Figure 9) of the participants felt very likely to use xylitol in the prevention of dental caries.

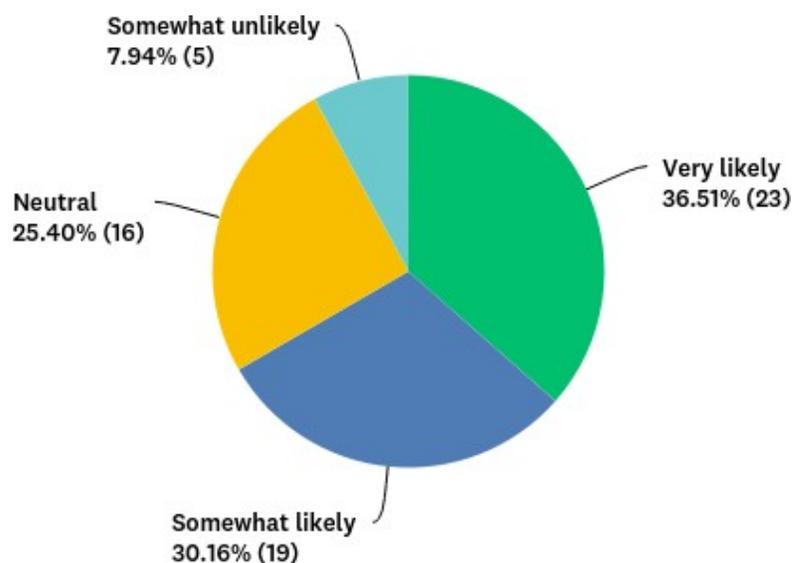


Figure 9. Based on AAPD guidelines, likelihood of using xylitol in dental caries prevention.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Over half of the participants ($n = 50$; 79.36%) indicated having an interest in xylitol as a preventive agent (Figure 10).

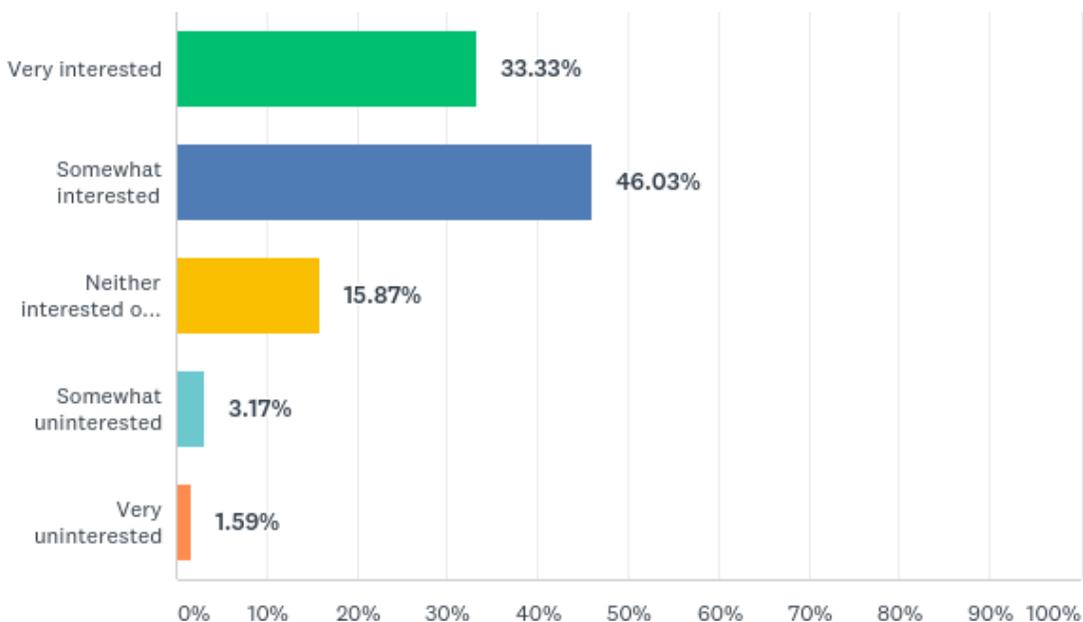


Figure 10. Interest in xylitol as a preventive agent.

Levels of evidence, interest and research on xylitol. Seventy-three percent of NPs ($n = 46$) indicated they use clinical practice guidelines to make clinical judgement(s) (Figure 11) and over half of the participants ($n = 33$; 52.38%) feel continued research on xylitol as a caries preventive agent is important (Figure 12).

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

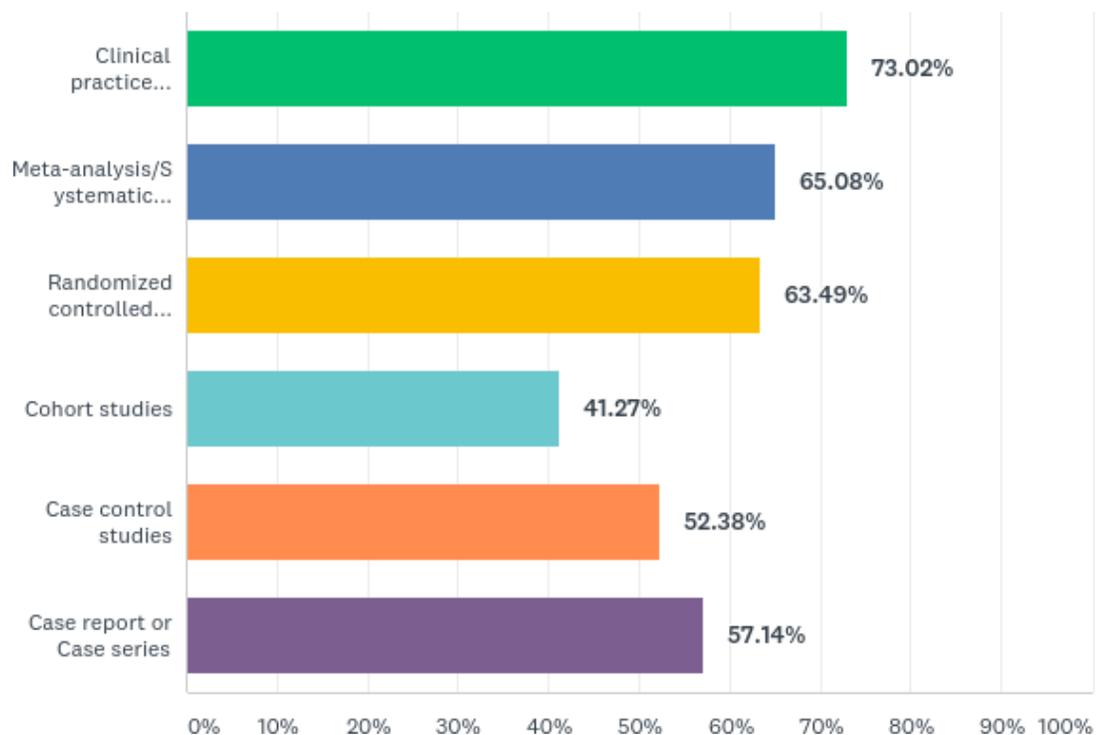


Figure 11. Levels of evidence in making clinical judgements.

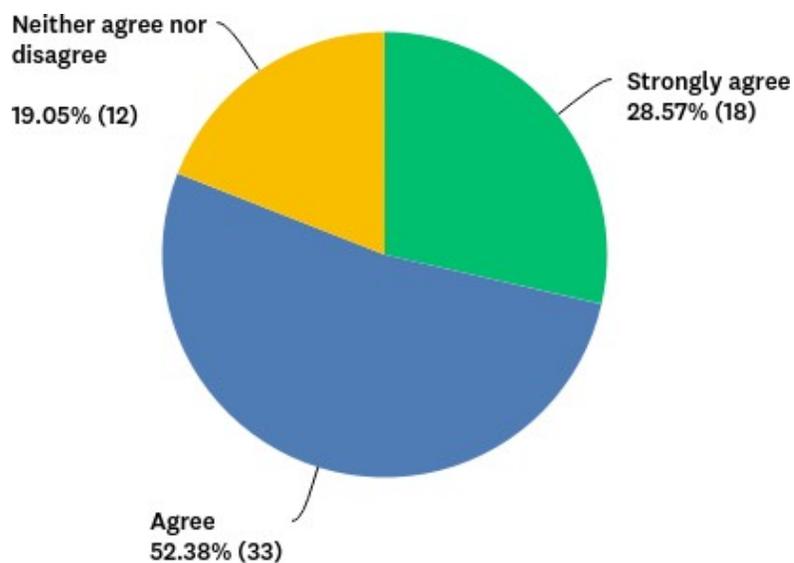


Figure 12. Continued research on xylitol as a caries preventive agent is important

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

When asked if a continuing education course was made available on xylitol as a dental caries preventive agent 61.9% ($n = 39$) indicated they would be interested (Figure 13).

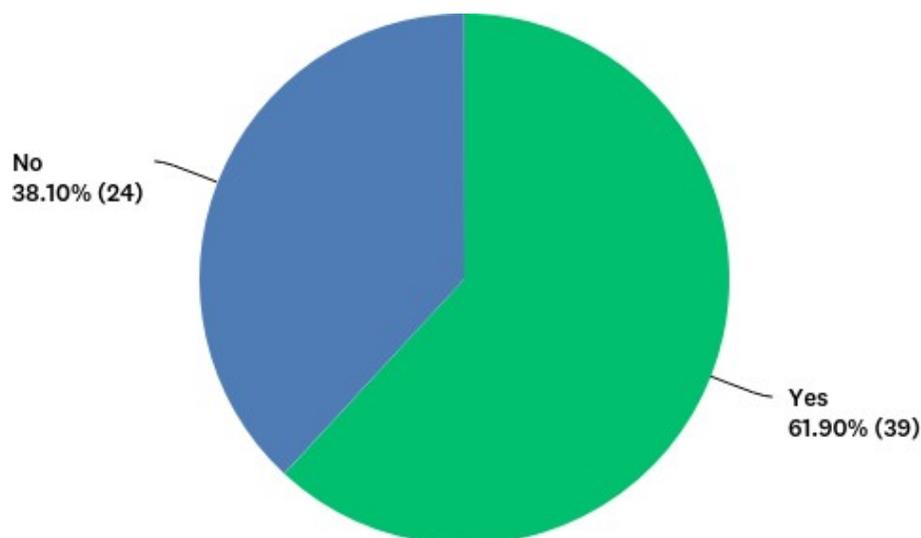


Figure 13. Interest in a continuing education course on xylitol.

Correlations

Pearson correlation statistics were conducted to determine the relationship between certain data sets. A significant correlation was discovered connecting awareness of medical uses of xylitol and having used xylitol as a preventive agent ($r = .320$; $p = .001$). Significant correlation was also seen in awareness of dental uses and having used xylitol ($r = .305$; $p = .015$) and those participants who agreed in the usefulness of xylitol in caries prevention also resulted in a significant correlation with awareness of its dental uses ($r = .341$; $p = .007$) as well as in having used xylitol ($r = .421$; $p = .001$). NPs awareness of the side effects of xylitol use also showed significant correlation to having used xylitol ($r = .253$; $p = .045$). Participants who agreed naturopathic medicine is useful

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

in preventing caries also significantly correlated with having used xylitol ($r = .287$; $p = .024$). Finally, the likelihood of NPs using xylitol as a preventive agent significantly correlated with having used xylitol ($r = .412$; $p = .04$) (Table 2).

Table 2

Pearson Correlations

Significant correlations: Having used xylitol as a preventive agent		
	Correlation Coefficient	Significance
	<i>r</i> statistic	<i>p</i> value
Being aware of medical uses	0.32	0.001*
Being aware of side effects of xylitol	0.253	0.045*
Being aware of dental uses	0.305	0.015*
Agreement that naturopathic medicine is useful in preventing dental caries	0.287	0.024*
Agreement that xylitol is useful in preventing dental caries	0.421	0.001*
Likelihood of using xylitol as a preventive agent	0.412	0.04*
Significant correlation: Awareness of xylitol's dental uses		
Agreement that xylitol is useful in preventing dental caries	0.341	0.007*

Note. Significance * $p \leq .05$

Demographic characteristics, perceived demand for naturopathic medicine or reasons for seeking naturopathic medicine, source of information regarding xylitol, levels of evidence, interest and research on xylitol had no significant correlation in NPs having used xylitol as a preventive agent or in the awareness of xylitol's dental uses.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

To look closer at significant correlations, the Pearson Chi-Square coefficient was performed to analyze correlations within significant variables and the use of xylitol.

Results showed there was no significant relationship ($p = 0.414$) between the number of years of practice and awareness of medical uses for xylitol (Table 3).

Table 3

Pearson Chi-Square Test

Significant relationships: Are you aware of medical uses for xylitol related to:			
	Pearson Chi- Square Value	df	Asymptotic significance (2-sided) <i>p</i> value
Number of years in practice	1.765	2	0.414*

Note. Significance * $p \leq .05$

However, there was a significant relationship in awareness of the medical ($p = 0.011$) and dental ($p = 0.015$) uses of xylitol and having used xylitol (Table 4). Results show there is no significant relationship ($p = 0.117$) regarding the awareness of the side effects of xylitol use and having used xylitol as a preventive agent (Table 4). There was also no significant relationship ($p = 0.062$) between NPs belief that naturopathic medicine is useful in the prevention of dental caries and having used xylitol (Table 4). The belief that xylitol is useful in preventing dental caries and having used xylitol as a preventive agent was found to have a significant relationship ($p = 0.002$) (Table 4). Chi-Square test also showed a significant relationship ($p = 0.010$) between how likely NPs would be to use xylitol in the prevention of dental caries, based on the AAPD guidelines and having used xylitol as a preventive agent (Table 4).

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Table 4

Pearson Chi-Square Test

Significant relationships: Is having used xylitol as a preventive agent significantly related to:			
	Pearson Chi- Square Value	df	Asymptotic significance (2-sided) <i>p</i> value
Being aware of medical uses? (yes or no)	6.436	1	0.011*
Being aware of dental uses? (yes or no)	5.870	1	0.015*
Being aware of the side effects? (yes or no)	2.458	1	0.117*
Naturopathic medicine is useful in the prevention of dental caries? (strongly agree, agree, neither agree nor disagree)	5.552	2	0.062*
Xylitol is useful in preventing dental caries? (strongly agree, agree, neither agree nor disagree)	12.329	2	0.002*
Based on the AAPD guidelines, how likely are you to use xylitol in the prevention of dental caries? (very likely, somewhat likely, neutral, somewhat unlikely)	11.403	3	0.010*

Note. Significance * $p \leq .05$

There was a significant relationship ($p = 0.011$) between participants responding “yes” to awareness of medical uses and having used xylitol, with 72% ($n = 38$) of those responding “yes” to having used xylitol while only 28% ($n = 15$) of those who were not aware of xylitol’s medical uses reporting having used xylitol. A significant relationship ($p = 0.015$) was also seen between participants responding “yes” to awareness of dental uses and having used xylitol, with 68% ($n = 41$) of participants responding “yes” to having used xylitol as compared to 32% ($n = 19$) who were not aware of dental uses and reporting having used xylitol. As for awareness of side effects of xylitol there was no

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

significant relationship ($p = 0.117$) between responding “yes” to being aware of the side effects and having used xylitol, with 73% ($n = 27$) responding “yes” to having used xylitol versus 27% ($n = 10$) of participants who were not aware of the side effects reporting having used xylitol. No significant relationship ($p = 0.062$) was found between members saying they “strongly agree”, “agree” or were “neutral” to naturopathic medicine being useful in the prevention of dental caries and having used xylitol. The results showed 79% ($n = 15$) of participants responding “yes” to having used xylitol as compared to 21% ($n = 4$) of members who did not “strongly agree” naturopathic medicine was useful in dental caries prevention having used xylitol as a preventive agent. The usefulness of xylitol in preventing dental caries was found to be significantly related to having used xylitol ($p = 0.002$), with 90% ($n = 9$) of those responding “yes” to having used xylitol while 10% ($n = 1$) of participants who did not “strongly agree” that xylitol was useful in preventing dental caries reporting having used xylitol. Lastly, a significant relationship ($p = 0.010$) was found between the likelihood of using xylitol in the prevention of dental caries per the AAPD guidelines and having used xylitol, with 83% ($n = 19$) responding “yes” to having used xylitol as compared to 17% ($n = 4$) reporting they were “not very likely” to use xylitol in the prevention of dentals caries based on the AAPD guidelines reporting having used xylitol.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Discussion

Summary of Major Findings

This study utilized a convenience sample in recruiting participants from the WANP association. Participants ranged in years of experience from less than five years to more than ten years and 95% of participants ($n = 60$) reported as actively practicing. The predominant location of practice is in urban areas and private practice as their primary work setting. Results of this study indicated, although informative, no correlation between demographic data and awareness and use of xylitol. However, data analysis suggests several significant correlations between awareness of medical/dental uses, agreement that xylitol is useful in preventing dental caries, likelihood of using xylitol as a preventive agent and having used xylitol. Most importantly, it appears that informed NPs are more inclined to use, prescribe or recommend the use of xylitol for dental caries prevention.

Discussion

The results of this study confirm the need for more education regarding xylitol and its uses as a preventive agent. The findings in this study serve as a starting point to better prepare for planning future oral-health promotion programs, interventions, and educational opportunities. To further discern the outcomes of this study, each research question will be addressed in this section.

Question 1: Is xylitol recommended as part of CAM practice and if so, how?

Findings of this study provide insight into NPs use of xylitol as a preventive agent in caries prevention. Given most participants (53%), reported using xylitol in practice suggests a call for greater examination of interprofessional opportunities. These findings

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

further confirm the use of xylitol as a preventive agent in CAM therapies (Danahauer et al., 2010; Kontiokari et al., 1995) and in the treatment of xerostomia (Su et al., 2011).

Currently, complementary and alternative therapies are gaining popularity among the general population. Annual visits to CAM providers from 1990 to 1997 grew from 470 million to 629 million, far exceeding the 386 million visits to U.S. primary-care physicians that year (Eisenberg et al., 1998). Because of this increase, there is growing appreciation and acknowledgement among health care professionals regarding the public's use and interest of CAM in obtaining and maintaining optimal oral health (Milburn, 2004).

When asked why might patients seek naturopathic medical care, *ineffective treatment with conventional medicine* and the *desire for a holistic approach*, were the most frequently selected responses. These findings corroborate those of Milburn (2004) which identified similar reasons for patients utilizing CAM therapies. These responses should be of interest to dental professionals, as they provide insight into patient preferences to treatment modalities. Given the trend of increasing utilization of CAM therapies (Milburn, 2004), the need to understand how these therapies effect both oral and overall health becomes even more important. The opportunity for interprofessional collaboration is reciprocal in nature; whereby the dental professional must be knowledgeable of CAM therapies and thus providing evidence-based patient education as well as insure the NP is fully prepared with the evidence-base of xylitol as a preventive agent. The dental professional is well prepared to engage in professional dialogue with the naturopathic provider in the promotion of xylitol as well as other evidence-based therapies. These findings prompt further conversation strategies to promote xylitol by

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

collaborating with health care professionals in integrating oral health into overall health by exploring ways to meld conventional, traditional, and innovative therapies to create new models of care (Satcher, 2000; Milburn, 2004) (Figure 14).

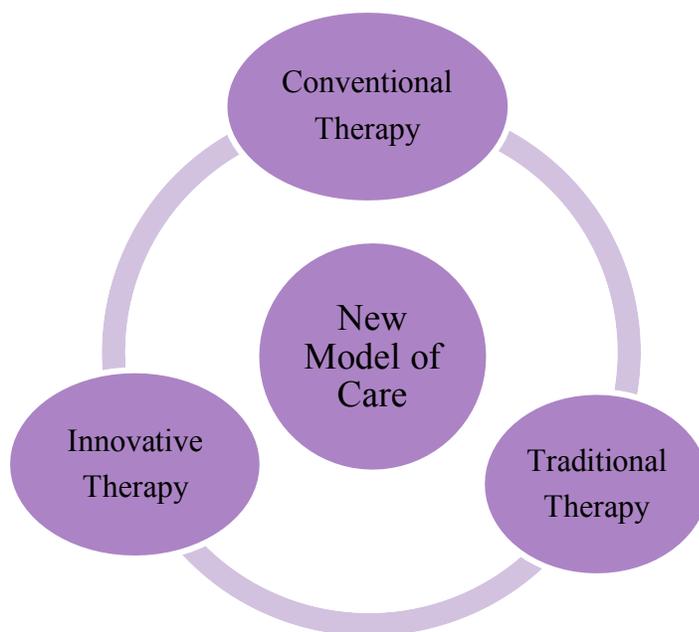


Figure 14. New model of care.

Question 2: What is naturopathic physicians' knowledge of xylitol as an anti-caries agent? The results indicate there is a relationship between NPs attitudes and knowledge regarding xylitol; therefore, one can presume that informed individuals are more likely to prescribe or recommend xylitol in practice. Although 95% ($n = 53$) of those NPs participating are aware of xylitol's dental uses only 53% ($n = 33$) use xylitol in clinical practice as a preventive agent in treating dental caries.

Participants indicated the highest level of evidence, clinical practice guidelines, as the level of evidence needed to make clinical judgements. Medical literature was the most commonly reported source (44%; $n = 28$), followed by popular press (25%; $n = 16$) and curriculum (11%; $n=7$). It is important to note that sources of information on xylitol,

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

and that xylitol products are readily available via medical literature as well as popular press. This is explained using Rogers' diffusion of innovations theory to explain how new ideas, practices, or products are disseminated through society (Mason, 2010). In hindsight, this question may lack face validity, as it is not clear as to whether the question implies actively seeking the source or simply reading about it passively, in either medical literature or in popular press. Furthermore, this unintended finding provides insight into future communication between NPs and dental professionals, as well as future means of disseminating content on xylitol.

Participants indicated they recommended other evidence-based products for dental caries prevention. Products selected were all evidence-based and included: xylitol (66%; $n = 41$), antimicrobial rinses (31%; $n = 19$), and fluoride (31%; $n = 20$). These responses should be of interest to dental professionals in that health care professionals use scientific principles to determine appropriate treatment modalities, the next logical step for researchers/clinicians is to disseminate information and promote studies on xylitol's oral and overall health benefits by publishing findings in various medical and dental journals to ensure multidisciplinary cohesiveness (Figure 15).

It is evident that more than a cursory introduction to CAM and xylitol is needed to promote knowledge/awareness and propel its use as a preventive agent although integration may be incremental. The findings in this study demonstrates the need for more education. As health care models change, interprofessional education (IPE) programs or integration of oral health and CAM within dental and medical curriculum could potentially strengthen multidisciplinary collaboration, communication and understanding of therapeutic approaches, as well as increase scientific knowledge in

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

support of CAM/xylytol as an ideal adjunctive agent in preventing caries (Figure 15).

Spector et al. (2013) concluded from an exploratory survey of U.S. dental schools, 12 of the 22 schools who responded indicated they did not have a formal CAM course. These results indicate recognition of CAM use within U.S. dental schools but the need for widespread CAM instruction is warranted.

Anecdotally, regarding importance of this study, one participant provided their perspective on how they felt dental hygienists need to *“keep fighting for a nationwide independent practice law due to the role they assume as the leading oral healthcare expert for managing the oral microbiome, which in turn helps guide patients to improve oral and metabolic health.”* Theoretically, NPs and oral healthcare professionals can partner and endeavor on eradicating the silent global epidemic of tooth decay, that could lead to better health and social outcomes (Figure 15).



Figure 15. Oral healthcare professional roles and opportunities.

Question 3: What are naturopathic physicians' attitudes toward use of xylitol as an anti-caries agent? The NP respondents, 66.13% ($n = 41$), recommended xylitol as a dental caries preventive agent and 55% ($n = 35$) of these participants feel

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

xylitol is useful in preventing dental caries, however 80.95% ($n = 51$) were unaware of the recommended AAPD guidelines for xylitol use. The AAPD (2011) developed guidelines on xylitol use in caries prevention to assist oral health care professionals in making informed decisions regarding xylitol use. This research study found the likelihood of using xylitol as an anti-caries preventive agent is related to knowledge; therefore, efforts are needed to encourage increased awareness of these guidelines through education. After sharing the AAPD guidelines, over half of the participants (79.36%; $n = 50$) indicated interest in xylitol as a preventive agent. It is evident xylitol is well known to the naturpopathic community and is used, but as an anti-caries preventive agent, guidelines are not utilized due to the lack of awareness of these guidelines. This finding validates the need for a continuing education course on AAPD dosage guidelines as indicated by 62% ($n = 39$) of respondent's interest in further education. Utilizing best practices is imperative for delivery of optimal intraoral clinical care (Pickett, 2012). Furthermore, there is an expectation that clinicians remain current and aware in use of new evidence-based therapies (Pickett, 2012). Therefore, both dental and medical professional teams, utilizing traditional and CAM therapeutic approaches, and taking into consideration patients' desires, beliefs, wants, and expectations may result in delivery of the highest quality patient-centered oral health care and ensure the best possible patient outcomes (Figure 16).

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

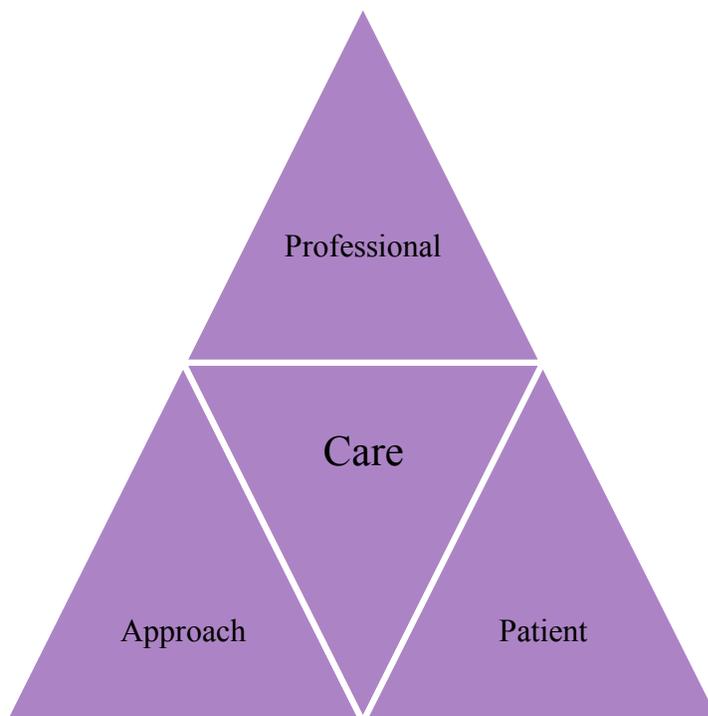


Figure 16. Continuum of care

Limitations

Based on this study alone, it appears the demographic characteristics such as the number of years in practice, practice status, geographic area of practice and work setting have no bearing on NPs awareness or use of xylitol. Data was collected using a one-time survey of a small convenience sample of WANP members and contact was limited to correspondence through an email listserv.

The fact that only sixty-three ($N = 63$; 20%) WANP members responded to this survey may have led to difficulty in finding statistically significant relationships from the data. Due to the nonprobability convenience sample, the findings of this study cannot be generalized beyond the population of Washington State NPs. The lack of awareness of xylitol's uses and therapeutic benefits could have played a role in the survey not having a

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

high priority in the respondents' busy schedules; thus yielding a lower than anticipated response rate.

Recommendations/Suggestions for Future Research

This study is the first to explore NP's attitudes, knowledge, and practices regarding the use of xylitol in clinical practice. Recommendations for future research include the delivery and evaluation of educational interventions, that may be delivered through in-service sessions and/or providing continued education training at conferences or via scientific publications in the arena of CAM regarding the use of xylitol as a preventive agent and guidelines as an anti-caries preventive agent.

Conclusion

Discovering and understanding the attitudes, knowledge, and practices of NPs and xylitol use is essential, as NDs are advocates of CAM therapies. As primary health care professionals, NPs have the unique opportunity to converse with patients seeking CAM regarding the benefits of xylitol use and oral health. Results from this study concludes that NDs are knowledgeable of xylitol and use it as a preventive agent but the study substantiates the need for educational venues to inform NPs of the AAPD guidelines for xylitol use as an anti-caries preventive agent. Oral healthcare professionals, through IPE, can strengthen multidisciplinary collaboration, communication and understanding of therapeutic approaches, as well as increase scientific knowledge in support of xylitol as an ideal adjunctive agent in preventing caries and promoting oral and overall health.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

References

- American Association of Naturopathic Physicians. (2018). Naturopathic Medicine FAQs: A Service for Consumers. Retrieved from <https://www.naturopathic.org/natfaqs>
- Adams, S. H., Hyde, S., Gansky, S. A. (2009). Caregiver acceptability and preferences for early childhood caries preventive treatments for Hispanic children. *Journal of Public Health Dentistry*, 69(4), 217-224. doi:10.1111/j.1752-7325.2009.00125.x
- Alanen, P., Isokangas, P., & Gutman, K. (2000). Xylitol candies in caries prevention: results of a field study in Estonian children. *Community Dentistry and Oral Epidemiology*, 28(3), 218-224.
- American Academy of Pediatric Dentistry. (2011). Guideline on xylitol use in caries prevention. *American Academy of Pediatric Dentistry Reference Manual*, 35(6), 171-174.
- Bader, J. D., Vollmer, W. M., Shugars, D. A., Gilbert, G. H., Amaechi, B. T., Brown, J. P., ... Leo, M. C. (2013). Results from the xylitol for adult caries trial (X-ACT). *Journal of the American Dental Association*, 144(1), 21-30.
- Barnes, P. M., Bloom, B., & Nahin, R. L. (2008). Complementary and alternative medicine use among adults and children: United States, 2007. *National Health Statistics Reports*, 12, 1-23.
- Bastyr University. (2018). What is Naturopathic Medicine? Retrieved from <https://bastyr.edu/academics/naturopathic-medicine/about-naturopathic-medicine>

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Biria, M., Malekafzali, B., & Kamel, V. (2009). Comparison of the effect of xylitol gum and mastic-chewing on the remineralization rate of caries-like lesions. *Journal of Dentistry, Tehran University of Medical Sciences*, 6(1), 6-10.

Burt, B. A. (2006). The use of sorbitol- and xylitol-sweetened chewing gum in caries control. *Journal of the American Dental Association*, 137(2), 190-196.

Campus, G., Cagetti, M. G., Sale, S., Petruzzi, M., Solinas, G., Strohmenger, L., & Lingstrom, P. (2013). Six months of high-dose xylitol in high-risk caries subjects - a 2-year randomized, clinical trial. *Clinical Oral Investigations*, 17(3), 785-791. doi:10.1007/s00784-012-0774-5

CariFree. (2015). Xylitol. Retrieved from <http://carifree.com/patient/learn/protective-factors/xylitol.html>

Centers for Disease Control and Prevention. (2014). Oral and dental health. Retrieved from <http://www.cdc.gov/nchs/fastats/dental.htm>

Clark, S. (2014). Wonders of xylitol. Retrieved from <http://www.rdhmag.com/articles/print/volume-31/issue-4/features/wonders-of-xylitol.html>

Cloetta. (2017). Cloetta in brief. Retrieved from <https://www.cloetta.com/en/about-cloetta/>

Danhauer, J. L., Johnson, C. E., Rotan, S. N., Snelson, T. A., & Stockwell, J. S. (2010). National survey of pediatricians' opinions about and practices for acute otitis media and xylitol use. *Journal of the American Academy of Audiology*, 21(5), 329-46.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Eisenberg, D. M., Davis, R. B., Ettner, S. L., Appel, S., Wilkey, S., Van Rompay, M., &

Kessler, R. C. (1998). Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. *Journal of the American Medical Association*, 280(18), 1569-1575. doi:10.1001/jama.280.18.1569

Eisenberg, D. M., Kessler, R. C., Foster, C., Norlock, F. E., Calkins, D. R., Delbanco, T.

D. (1993). Unconventional medicine in the United States prevalence, costs, and patterns of use. *New England Journal of Medicine*, 3(28), 246-252. doi: 10.1056/NEJM199301283280406

Global Sweet. (2017). "The future of sweet". The Original Birch Xylitol Company.

Retrieved from

<https://www.globalsweet.com/merchant2/merchant.mvc?Screen=XYHI>

Hujoel, P. P., Makinen, K. K., Bennett, C. A., Isotupa, K. P., Isokangas, P. J., Allen, P., &

Makinen, P. L. (1999). The optimum time to initiate habitual xylitol gum-chewing for obtaining long-term caries prevention. *Journal of Dental Research*, 78(3), 797-803.

Kandelman, D., Bär, A., & Hefti, A. (1988). Collaborative WHO xylitol field study in

French Polynesia I. Baseline prevalence and 32-month caries increment. *Caries Research*, 22(1), 55-62. doi: 10.1159/000261084

Kontiokari, T., Uhari, M., & Koskela, M. (1995). Effect of xylitol on growth of

nasopharyngeal bacteria in vitro. *Antimicrobial Agents and Chemotherapy*, 39(8), 1820-1823.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

- Kontiokari, T., Uhari, M., Koskela, M., & Niemela, M. (1996). Xylitol in preventing acute otitis media. *Pediatric Research*, 39, suppl. 4, 176.
doi:10.1203/00006450-199604001-01062
- Lenkkeri, A., M., Pienihakkinen, K., Hurme, S., & Alanen, P. (2012). The caries-preventive effect of xylitol/maltitol and erythritol/maltitol lozenges: Results of a double-blinded, cluster-randomized clinical trial in an area of natural fluoridation. *International Journal of Paediatric Dentistry*, 22(3), 180-190.
doi:10.1111/j.1365- 263X.2011.01182.x
- Marrs, J., Trumbley, S., & Malik, G. (2011). Early childhood caries: Determining the risk factors and assessing the prevention strategies for nursing intervention. *Pediatric Nursing*, 37(1), 9-15.
- Makinen, K. K. (2010). Sugar alcohols, caries incidence, and remineralization of caries lesions: A literature review. *International Journal of Dentistry*, 2010, 1-23. doi: 10.1155/2010/981072
- Makinen, K.K., Bennett, C.A., Hujoel, P.P, Isokangas, P.J., Isotupa, K.P., Pape, H.R., Jr., & Makinen, P.L. (1995). Xylitol chewing gums and caries rates: A 40-month cohort study. *Journal of Dental Research*, 74(12), 1904-1913.
- Mason, J. (2010). Concepts in dental public health (2nd ed.). Baltimore, MD: Lippincott, Williams, & Wilkins.
- Mickenausch, S. & Yengopal, V.(2012). Anticariogenic effect of xylitol versus fluoride – a quantitative systematic review of clinical trials. *International Dental Journal*, 62(1), 6-20. doi:10.1111/j.1875-595X.2011.00086.x

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Milburn, M. P. (2004). Understanding the convergence of complementary, alternative & conventional care. Retrieved from

<https://www.med.unc.edu/phyrehab/pim/files/Convergence.text.pdf>

Milgrom, P., Rothen, M., & Milgrom, L. (2006). Developing public health interventions with xylitol for the US and US-Associated Territories and States. *Finnish Dental Journal*, 13, suppl. 1, 28-37.

Milgrom, P., Ly, K. A., Tut, O. K., Mancl, L., Roberts, M. C., Briand, K., & Gancio, M. J. (2009). Xylitol pediatric topical oral syrup to prevent dental caries: a double blind, randomized clinical trial of efficacy. *Archives of Pediatrics and Adolescent Medicine*, 163(7), 601-607. doi:10.1001/archpediatrics.2009.77

Murthykumar, K. (2013). The impact of milk with xylitol on dental caries – A review. *Journal of Pharmaceutical Sciences and Research*, 5(9), 178-180.

National Institutes of Health, National Center for Complementary and Alternative Medicine. (2008). What is complementary and alternative medicine? Retrieved from <http://nccam.nih.gov/health/whatiscom/>

National Center for Complementary and Integrative Health. (2004). More than one-third of U.S. adults use complementary and alternative medicine. Retrieved from <https://nccih.nih.gov/news/2004/052704.htm>

Peldyak, J., & Makinen, K. K. (2002). Xylitol for caries prevention. *Journal of Dental Hygiene*, 76(4), 276-285.

Pickett, F. A. (2012). Clinical practice recommendations for non-fluoride anti-caries products: review and summary. *Canadian Journal of Dental Hygiene*, 46(3), 167-171.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Rethman, M. P., Beltan-Aguilar, E. D., Billings, R. J., Burne, R. A., Clark, M., Donly, K.

J., ... Meyer, D. M. (2011). Nonfluoride caries-preventive agents. Executive summary of evidence-based clinical recommendations. *Journal of the American Dental Association*, *142*(9), 1065-1071.

Richter, P., & Chaffin, J. (2004). Army's "look for xylitol first" program. *The Dental Assistant*, *73*(2), 38-40.

Satcher, D. S. (2000). Surgeon general's report on oral health. *Public Health Reports*, *115*, 489-490.

Scheie, A. A., & Fejerskov, O. B. (1998). Xylitol in caries prevention: what is the evidence for clinical efficacy? *Oral Diseases*, *4*(4), 268-278.

Scheie, A. A., Fejerskov, O., & Danielsen, B. (1998). The effects of xylitol-containing chewing gums on dental plaque and acidogenic potential. *Journal of Dental Research*, *77*(7), 1547-1552. doi:10.1177/00220345980770071001

Scheinin, A., Mäkinen, K.K., & Ylitalo, K. (1976). Turku sugar studies. V. Final report on the effect of sucrose, fructose and xylitol diets on the caries incidence in man. *Acta Odontologica Scandinavica*, *34*(4), 179-216.

Scheinin, A., Bánóczy, J., Szöke, J., Esztári, I., Pienihäkkinen, K., Scheinin, U., ... Hadas, E. (1985). Collaborative WHO xylitol field studies in Hungary I. Three-year caries activity in institutionalized children. *Acta Odontologica Scandinavica*, *43*(6), 327-347. doi: 10.3109/00016358509046517

Silva, T. C., Pereira, A. F. F., Machado, M. A. A. M., & Buzalaf, M. A. R. (2009). The use of xylitol as a strategy for prevention of dental caries. *Journal of Dental Science*, *24*(2), 205-212.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

- Sintes, J.L., Elías-Boneta, A., Stewart, B., Volpe, A.R., & Lovett, J. (2002). Anticaries efficacy of a sodium monofluorophosphate dentifrice containing xylitol in a dicalcium phosphate dihydrate base. A 30-month caries clinical study in Costa Rica. *American Journal of Dentistry*, 15(4), 215-9.
- Sintes, J.L., Escalante, C., Stewart, B., McCool, J.J., Garcia, L., Volpe, A.R., & Triol, C. (1995). Enhanced anticaries efficacy of a 0.243% sodium fluoride/10% xylitol/silica dentifrice: 3-year clinical results. *American Journal of Dentistry*, 8(5):231-5.
- Spector, M.L., Fischer, M., Dawson, D.V., Holmes, D.C., Kummet, C., Nisly, N. L., Y Baker, K. A. (2012). Complementary and alternative medicine usage by patients of a dental school clinic. *Special Care Dentistry*, 32(5), 1770183. doi: 10.1111/j.1754-4505.2012.00273.x
- Spector, M.L., Kummet, C.M., & Holmes, D.C. (2013). Complementary and alternative medicine in predoctoral dental curricula: An exploratory survey of U.S. dental schools. *Journal of Dental Education*, 77(12), 1610-1615.
- Su, N., Marek, C. L., Ching, V., & Grushka, M. (2011). Caries prevention for patients with dry mouth. *Journal of the Canadian Dental Association*, 77(b85), 1-8.
- Uhari, M., Tapiainen, T., & Kontiokari, T. (2000). Xylitol in preventing acute otitis media. *Vaccine*, 19, suppl. 1, S144-147.
- U.S. Surgeon General. (2000). Oral health in America: A report of the surgeon general. Retrieved from <https://profiles.nlm.nih.gov/ps/retrieve/ResourceMetadata/NNBBJT/>

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Xylitol.org. (2015). Xylitol, probiotics, & GI effects. Retrieved from

<http://xylitol.org/xylitol-video-presentations/xylitol-probiotics-gi-effects>

Zhan, L., Cheng, J., Chang, P., Ngo, M., DenBesten, P.K., Hoover, C.I., & Featherstone, J.D.B. (2012). Effects of xylitol wipes on cariogenic bacteria and caries in young children. *Journal of Dental Research Clinical Research Supplement*, 91(1), 85-90.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Appendix A

Pre-Notice Letter

Washington Association of Naturopathic Physicians Member:

Please allow me to introduce myself. My name is Agatha Stavnesli and I am a registered dental hygienist living in Washington State. I am a student currently enrolled in the Eastern Washington University Dental Hygiene Master's Degree program and I am conducting a research project to satisfy my degree requirements.

One week from now, you will receive an e-mail inviting you to participate in a study titled: Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice. The purpose of this study is to assess naturopathic physicians' attitudes, knowledge and practices regarding the use of xylitol for oral and overall health. Data collected will be used to determine if xylitol use improves the oral health and enhances collaborative efforts to deliver useful and practical applications primarily in caries prevention. The study includes a one-time survey that will take approximately 10 minutes of your time.

Sincerely,

Agatha Stavnesli, RDH, BS

EWU MSDH student

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Appendix B

Recruitment Letter/Consent Statement

Washington Association of Naturopathic Physicians Member:

You are being asked to participate in a study titled: Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice. The purpose of this study is to assess naturopathic physicians' attitudes, knowledge and practices regarding the use of xylitol for oral and overall health. Data collected will be used to determine if xylitol use improves the oral health and enhances collaborative efforts to deliver useful and practical applications primarily in caries prevention.

You are being asked to participate in this study because you are a current member of the Washington Association of Naturopathic Physicians.

This project has been approved by the Eastern Washington University Institutional Review Board. Participation in this study is anonymous, and only the primary investigator and key personnel for this study will have access to data collected.

If you wish to participate, you will be asked to:

Complete a one-time online survey with questions including:

- i years of practice, current practice standing and location, practice setting, and area of study and specialization
- ii knowledge and perceptions regarding xylitol as a preventive agent and use of xylitol with patients in clinical practice

This survey can be accessed at:

<https://www.surveymonkey.com/r/2VKXYFC>

By completing the survey your consent to participate in this study is implied. You should not expect to directly benefit from participating in this research; however, findings will be available to participants upon completion of all phases of the research study. Participating in this study involves no more than minimal risk. Please know that your participation in this study is completely voluntary and that your responses are anonymous as they do not require you to disclose any identifying information. Also, you may skip any questions that you are not comfortable answering and you may opt out of the survey at any time.

You are under no obligation to participate. However, **as an incentive for participation, there will be a drawing for one participant to win a \$50 gift card.** To be eligible for the gift card, you will have the opportunity to go to a separate link at the end of the survey to provide your e-mail address. If you choose to provide your e-mail address and participate in the drawing, I will only know that you participated in the survey not how you responded to it. The e-mail addresses will not correlate to the data.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

All information will be kept confidential or anonymous on my password protected computer.

If you have any questions or concerns please contact Agatha Stavnesli RDH, Principal Investigator, at aggiecs73@eagles.ewu.edu or (253) 381-7239.

Thank you for your time, participation, and contribution of information to help increase awareness and acceptance of xylitol's many uses, specifically in oral health.

Sincerely,

Agatha Stavnesli, RDH, BS, MSDH(c)
Principal Investigator
Tel: (253) 381-7239
aggiecs73@eagles.ewu.edu

Merri Jones, RDH, MSDH
Responsible Project Investigator
Dental Hygiene Department
Eastern Washington University
310 N Riverpoint Blvd
Spokane, WA 99202
merri.jones@ewu.edu

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact Ruth Galm, Human Protection Administrator, 509-359-7971, rgalm@ewu.edu.

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Appendix C

Participant Consent Form

Title: Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice

Principal Investigator

Agatha Stavnesli, RDH, BS
Graduate Student
Dental Hygiene Department
Eastern Washington University
310 N Riverpoint Blvd
Spokane, WA 99202
aggiecs73@eagles.ewu.edu

Responsible Project Investigator

Merri Jones, RDH, MSDH
Assistant Professor
Dental Hygiene Department
Eastern Washington University
310 N Riverpoint Blvd Box E
Spokane, WA 99202
merri.jones@ewu.edu

Purpose

The purpose of this study is to assess naturopathic physicians' attitudes, knowledge and practices regarding the use of xylitol in clinical practice. Additionally, the study will satisfy the Principal Investigator's requirements for a master's degree of science in Dental Hygiene at Eastern Washington University.

Data collected will be used to determine if xylitol use improves the oral health and enhances collaborative efforts to deliver useful and practical applications primarily in caries prevention.

Procedures

A recruitment letter will be sent to you including a link to the SurveyMonkey® website. Participation is voluntary and confidentiality as well as anonymity will be assured throughout the research process. The survey will take approximately 10 minutes and its intended use is to assess naturopathic physicians' attitudes, knowledge and practices regarding the use of xylitol for oral and overall health.

If you wish to participate, you will be asked to:

Complete a one-time online survey with questions including:

- i years of practice, current practice standing and location, practice setting, and area of study and specialization
- ii knowledge and perceptions regarding xylitol as a preventive agent and use of xylitol with patients in clinical practice

By completing the survey your consent to participate in this study is implied. Return your completed survey via SurveyMonkey®. You are under no obligation to participate. However, as an incentive for participation, there will be a drawing for one participant to win a \$50 gift card. To be eligible for the gift card, you will have the opportunity to go to

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

a separate link at the end of the survey to provide your e-mail address. If you choose to provide your e-mail address and participate in the drawing, I will only know that you participated in the survey not how you responded to it. The e-mail addresses will not correlate to the data. All information will be kept confidential or anonymous on my password protected computer.

Benefits

You should not expect to directly benefit from participating in this research; however, findings will be available to participants upon completion of all phases of the research study.

Risks

Participating in this study involves no more than minimal risk.

Participation and Withdrawal

Your participation in this study is voluntary and you may opt out at any time without offering a reason. You may skip any questions you are not comfortable answering. If you decide to participate, you are free to withdraw your consent and discontinue your participation at any time without consequences.

Privacy and Confidentiality

This is an anonymous study and only the principal investigator (PI) and graduate faculty thesis chair will have access to data collected. Upon completion, all data exported from SurveyMonkey® will be kept in a password-protected computer only accessible by the PI.

If you have any questions or concerns regarding the study or data collected at any time, you may reach the Principal Investigator, Agatha Stavnesli, at 253-381-7239 or by email aggiecs73@eagles.ewu.edu

Signature of Principal Investigator

Date

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact Ruth Galm, Human Protection Administrator, 509-359-7971, rgalm@ewu.edu

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Appendix DNaturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice
Questionnaire

1. Number of years in practice:
 - Less than 5 years
 - 5 – 10 years
 - More than 10 years

2. Are you actively practicing currently?
 - Yes
 - No

3. What is your geographic area of practice?
 - Not applicable
 - Inner City
 - Urban
 - Suburban
 - Rural

4. What is your primary work setting?
 - Private practice
 - Federally Qualified Health Center
 - Interprofessional group practice
 - Other (please describe) _____

5. What is your main area of practice or specialization?
 - Acupuncture & East Asian Medicine
 - Ayurvedic Sciences
 - Counseling & Health Psychology
 - Endocrinology
 - Environmental Medicine
 - Exercise Science & Wellness
 - Gastroenterology
 - Generative Medicine
 - Herbal Sciences
 - Homeopathy
 - Midwifery
 - Nutrition
 - Oncology
 - Pediatric
 - Public Health
 - Other (please describe) _____

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

6. I view the current population demand for naturopathic medicine as:

- Increasing
- Decreasing
- Stable

7. In your opinion, why might patients seek naturopathic medical care? (Select all that apply)

- Skepticism about conventional medicine
- Desire for a holistic approach to health care
- Desire for a therapy free of side effects
- Treatment with conventional medicine has not been effective
- Desire for more personal control in health care decisions
- Other (please describe) _____

8. Are you aware of medical uses for xylitol?

- Yes
- No

9. Are you aware of dental uses for xylitol?

- Yes
- No

10. Which of the following best describes your source of information regarding xylitol?

- Curriculum
- Popular press
- Medical literature
- Personal experiences
- Friends or family
- Other (please describe) _____

11. Have you used xylitol as a preventive agent?

- Yes
- No

12. If so, in what circumstances have you used xylitol as a preventive agent? (Select all that apply)

- Not applicable
- Treating dental caries
- Preventing otitis media
- Treating xerostomia
- Other (please specify) _____

13. Are you aware of the side effects of xylitol?

- Yes
- No

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

14. Naturopathic medicine is useful in the prevention of dental caries.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

15. What products have you recommended for dental caries prevention? (Select all that apply)

- Fluoride
- Antimicrobial mouth rinse (i.e., Peridex)
- Calcium phosphate paste (i.e., MI paste)
- Oil pulling
- Activated charcoal
- Xylitol
- Other (please specify) _____

16. Xylitol is useful in preventing dental caries.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly Disagree

17. Are you aware of the American Academy of Pediatric Dentistry (AAPD) guidelines on xylitol use in caries prevention? (Dosing frequency should be no less than two times a day and the amount not to exceed eight grams per day).

- Yes
- No

18. Based on the AAPD guidelines, how likely are you to use xylitol in the prevention of dental caries?

- Very likely
- Somewhat likely
- Neutral
- Somewhat unlikely
- Very unlikely

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

19. What levels of evidence do you require in making clinical judgments? (Select all that apply)

- Clinical practice guidelines
- Meta-analysis/Systematic reviews
- Randomized controlled trial
- Cohort studies
- Case control studies
- Case report or Case series

20. What is your level of interest in xylitol as a preventive agent?

- Very interested
- Somewhat interested
- Neither interested or uninterested
- Somewhat uninterested
- Very uninterested

21. Continued research on xylitol as a caries preventive agent is important.

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

22. If made available, would you be interested in a continuing education course on xylitol as a dental caries preventive agent?

- Yes
- No

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Appendix E

Participation Follow-up Letter

Washington Association of Naturopathic Physicians Member:

This is a reminder for participation in a study titled: Naturopathic Physicians' Attitudes, Knowledge, and Practices Regarding the Use of Xylitol in Clinical Practice.

This survey can be accessed at:

<https://www.surveymonkey.com/r/2VKXYFC>

Your participation and contribution to this study is greatly appreciated and will help to better understand the current attitudes, knowledge and practices naturopathic physicians have of xylitol use for oral and overall health. As a thank you for participating, you will be entered in to a drawing for a \$50 cash gift card upon completion of the survey.

Questions regarding this survey can be directed to Agatha Stavnesli at aggiecs73@eagles.ewu.edu or (253) 381-7239.

Again, thank you for your time,

Agatha Stavnesli, RDH, BS, MSDH(c)
Tel: (253) 381-7239
aggiecs73@eagles.ewu.edu

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Curriculum Vitae**Agatha Stavnesli, RDH, BS, MSDH**

Tacoma, WA 98422

(253) 381-7239

Email: aggiacs73@yahoo.com

Citizenship: United States of America

GRADUATE EDUCATION:

September 2013 – December 2018	M.S.D.H.	Master of Science in Dental Hygiene Eastern Washington University Cheney, Washington
--------------------------------	----------	--

UNDERGRADUATE EDUCATION:

2002	A.A.S.	Associate of Applied Science in Dental Hygiene Lake Washington Technical College Kirkland, Washington
1997	B.S.	Bachelor of Science in Biology Western Washington University Bellingham, Washington
1991	Diploma	Spanaway Lake High School Spanaway, Washington

ACADEMIC RESPONSIBILITIES:

October 2014		Lake Washington Institute of Technology Department of Dental Hygiene DHYG 112 - Dental Hygiene Practice I – Extra/Intra – oral lecture
--------------	--	--

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

January – March 2015	Lake Washington Institute of Technology Department of Dental Hygiene DHYG 139 – Pathology I Co-instructor
January – March 2015	Lake Washington Institute of Technology Department of Dental Hygiene DHYG 122 - Dental Hygiene Practice II Adjunct Clinical Instructor
September 2015 - Present	Lake Washington Institute of Technology DHYG 252, 322, 332, 342, 412, 422, 432 Adjunct Clinical Instructor
September 2016 – Present	Lake Washington Institute of Technology DHYG 256 Dental Imaging Radiology Lab Instructor
January 2017 – Present	Lake Washington Institute of Technology DHYG 326 Radiographic Interpretation Radiology Lab Instructor
January 2017 – Present	Lake Washington Institute of Technology DHYG 324 Ethics and Jurisprudence Didactic Instructor
April 2018 – Present	Lake Washington Institute of Technology DHYG 331 Research II Didactic Instructor

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

September 2018 – Present	Lake Washington Institute of Technology DHYG 248 Research I Didactic Instructor
July 2018 – Present	Lake Washington Institute of Technology DHYG 341 Professional Practicum Didactic Instructor
September 2018 – Present	Seattle Central College DHY 256 Dental Imaging Radiology Lab Instructor
January 2019 – Present	Seattle Central College Full Time Instructor

PROFESSIONAL EXPERIENCES:

January 2018 – Present	Clinical Dental Hygienist Part-time Pam Butterfield, DDS Kent, Washington
December 2012 – Present	Clinical Dental Hygienist Part-time Issaquah Family Dentistry Frank Sciabica/Anna Lisin, DDS Issaquah, Washington
September 2012 – March 2014	Clinical Dental Hygienist Part-time Josephine Lee, DDS Federal Way, Washington
October 2005 – September 2008	Clinical Dental Hygienist Part-time Dennis Hopkins, DDS Milton, Washington
January 2003 – April 2016	Clinical Dental Hygienist Kim/Ryan Anardi, DDS

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

Auburn, Washington

July 2002 – Present

Clinical Dental Hygienist
Temporary/Substitute
Dental Connections
Placement Agency
Seattle/Tacoma, Washington

July 2002 – February 2003

Clinical Dental Hygienist
Part-time
Sidney Gallegos, DDS
Federal Way, Washington

December 1997 – January 2002

Clinical Dental Assistant
Sidney Gallegos, DDS
Federal Way, Washington**PROFESSIONAL LICENSURE:**

2002 – Present

Washington State Dental
Hygiene
Washington Board of Dental
Examiner**CERTIFICATIONS:**

2002 – Present

Washington Registered
Dental
Hygienist with Expanded
Functions including local
anesthesia, restorative
packing
and carving, and nitrous
oxide/oxygen sedation.**PROFESSIONAL ORGANIZATIONS:**September 2000 – 2005,
September 2013 – PresentAmerican Dental Hygienists'
Association (ADHA)

September 2000 – 2005,

Washington State Dental

NATUROPATHIC PHYSICIANS' USE OF XYLITOL

September 2013 – Present

Hygienists' Association
(WSDHA)

September 2013 – Present

American Dental Education
Association (ADEA)**COMMUNITY SERVICE:**

October 2002

Washington State Dental
Hygienists' Association

(WSDHA)

Volunteer Tooth Fairy at
Factoria Mall

May 2014

Dental Hygiene Educational
Presentation
Auburn Youth Resources
(AYR)
Arcadia House**Honors and Awards:**

January 2001 – June 2002

Phi Theta Kappa
International
Honor Society
Lake Washington Technical
College

February 2002

Beta Iota Tau chapter of Phi
Theta Kappa International
Honor Society
Lake Washington Technical
College