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Female Hormonal Medications and Risk Indicators of Periodontitis: Insights from the NHANES

By

Sowmya Natarajan

A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Public Health in the Department of Community and Public Health

Idaho State University

Spring 2022

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Sowmya Natarajan find it satisfactory and recommend that it be accepted.

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Sowmya Natarajan
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RE: Study Number IRB-FY2022-43: Relationship between estrogen and progesterone and gum disease based on NHANES data analysis

Dear Sowmya Natarajan:

Thank you for your responses to a previous review of the study listed above. I agree that this study qualifies as exempt from review under the following guideline: Category 4. Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

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(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

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Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

NCHS Research Ethics Review Board (ERB) Approval*

Survey Name/Date	NCHS IRB/ERB Protocol Number or Description
NHANES 2021-2022	Protocol #2021-05
NHANES 2019-2020	Protocol #2018-01
NHANES 2017-2018	Protocol #2018-01 (Effective beginning October 26, 2017)
	Continuation of Protocol #2011-17 (Effective through October 26, 2017)
NHANES 2015-2016	Continuation of Protocol #2011-17
NHANES 2013-2014	Continuation of Protocol #2011-17
NHANES 2011-2012	Protocol #2011-17
NHANES 2009-2010	Continuation of Protocol #2005-06
NHANES 2007-2008	Continuation of Protocol #2005-06
NHANES 2005-2006	Protocol #2005-06
NHANES 1999-2004	Protocol #98-12
NHANES III	Institutional Review Board (IRB) approval and documented consent was obtained from participants
NHANES II	Underwent internal human subjects review, but IRB approval using current standards was not obtained.
NHANES I	Underwent internal human subjects review, but IRB approval using current standards was not obtained.
NHES	Underwent internal human subjects review, but IRB approval using current standards was not obtained.

* In 2003, the NHANES Institutional Review Board (IRB) changed its name to the NCHS Research Ethics Review Board (ERB).

Acknowledgments

I express my sincere thanks to my committee for their unconditional support and encouragement: Dr. Irene van Woerden, Dr. Ryan Lindsay, and Ms. Leciel Bono. Thank you for this opportunity and invaluable wisdom in guiding my efforts.

Without the support of my wonderful husband, Shyam, and our little girl Samyuktha, it would have been impossible for me to finish this thesis. Thanks to my parents and in-laws, who have constantly kept me in their prayers throughout my MPH journey. Finally, a special thanks to my friends and colleagues for their love, affection, and motivation to keep me going.

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List of abbreviations

AAP	American Academy of Periodontology
CDC	Centers for Disease Control and Prevention
FHM	Female hormone Medication
GCF	Gingival Crevicular Fluid
HP	Healthy People
NHANES	National Health and Nutrition Examination Survey
NIDCR	National Institutes of Dental and Craniofacial Research
OHQ	Oral Health Questionnaire
RHQ	Reproductive Health Questionnaire
SMQ	Smoking- Cigarette Questionnaire

Female Hormonal Medications and Risk Indicators of Periodontitis: Insights from the NHANES

Thesis Abstract- Idaho State University (2022)

Changing hormone levels in women caused by medication for birth control and hormonal therapy are risk factors for periodontal disease. Periodontitis is an advanced stage of periodontal disease that may have detrimental systemic health consequences. This study examines the association between Female Hormone Medication (FHM: birth control pills and hormonal medications prescribed for other therapeutic purposes) usage and the risk of periodontitis in women aged 30-44 years.

A repeated cross-section analysis was completed using National Health and Nutrition Examination Survey (N=1783). Chi-Square tests and binomial logistic regression were used to determine if FHM were significant predictors of periodontitis risk while controlling for demographics and smoking status. The dental visit status of participants was examined to understand the association

Female Hormone Medications were not significant predictors of the risk of periodontitis. Dental visit status, perception of dental health, smoking status, and demographics were significant factors predicting the odds of periodontitis risk.

Keywords: Periodontitis, Periodontal disease, female hormone medications, oral health, NHANES

Chapter 1: Introduction

1.1 Background

The health of the mouth is an integral part of general health and reflects systemic health and well-being. The most common oral diseases are tooth decay and periodontal disease (gum disease; CDC, 2022). Periodontal disease impacts women's oral health in a variety of ways through puberty, pregnancy, menstruation, menopause, and post-menopause (AAP, 2022a). The AAP states hormonal changes and the use of oral contraceptives as risk factors that may contribute to periodontal disease (AAP, 2022a). Birth control pills, or contraceptives, are the therapeutic analogs of the naturally synthesized female hormones estrogen and progesterone. According to data from the National Survey of Family Growth (NSFG), between 2017-2019, about 14% of all women in the United States, aged 15-49 years were currently using contraceptive pills (CDC, 2020b). Data for pill use by age group revealed that 10.9% of women aged 30-39 years and 6.5% of women aged 40-49 reported as pill users between 2017-2019 (CDC, 2020b). Given the large number of women who use these medications, it is critical to monitor and investigate the potential adverse oral health outcomes on women caused by the hormones: progesterone and estrogen. These hormones are prescribed for therapeutic purposes other than contraception, such as the treatment of conditions such as menstrual disorders, fibroids, or endometriosis, to name a few.

1.2 Periodontal Diseases

Periodontal disease is the pathologic process affecting the periodontal tissues or the tissues surrounding the teeth (hard and soft) (AAP, 2022b). Gingivitis and periodontitis are the two conditions most often referred to as periodontal diseases (AAP, 2022c). A healthy

periodontium is clinically characterized by the absence of bleeding on probing, absence of erythema and edema (redness and swelling) of the gums, and absence of attachment loss and bone loss (Chapple et al., 2018). Risk factors for periodontal disease include poor oral hygiene, smoking, diabetes, stress, heredity factors, crooked teeth, underlying immuno-deficiencies, fillings that have become defective, taking medications that cause a dry mouth, ill-fitting crowns and bridges, and female hormonal changes - such as with pregnancy or the use of oral contraceptives (AAP, 2022a).

Gingivitis is characterized by inflammation of the gingiva (gums). Gingivitis is a prevalent, reversible condition that may progress to periodontitis in susceptible individuals (Eke et al.,2020). Periodontitis is a chronic condition indicating an advanced stage of periodontal disease. Periodontitis is the inflammation of the tissues surrounding the tooth (AAP, 2022c). Periodontitis results in clinical attachment loss, alveolar bone loss (alveolar bone is the part of the jawbone that supports the teeth), and periodontal pocketing (AAP, 2022c). Red, swollen, or tender gums; bleeding while brushing, flossing, or eating hard foods; receding gums; teeth that are loose or separating; tooth loss, and persistent bad breath are all symptoms of periodontitis (AAP, 2022c). Periodontitis is a major public health problem in the United States because of its high prevalence and its effect on overall health (CDC, 2020a). Research is demonstrating the bidirectional effects between periodontitis and systemic health conditions especially type 2 diabetes mellitus and cardiovascular disease (U.S. Department of Health and Human Services, 2021). In the United States, 42% of all adults and 35% of women 30 years or older had periodontitis (Eke et al., 2020). Good oral hygiene habits and having regular professional prophylactic care can slow down or prevent mild periodontal disease (CDC, 2020a).

1.3 Problem Statement:

The AAP states that changing hormone levels from contraceptive pills and hormone usage cause gingivitis - clinically visible as swollen and irritated gingiva (AAP, 2022a). Research shows that women's use of hormonal contraceptives during their reproductive phase of life has been considered to influence periodontal disease progression and may increase the risk of periodontitis (Brusca et al., 2010, Soory M., 2000, Castro et al., 2021) and studies showed that women using current low dose oral contraceptives had more extensive gingivitis than non-users (Moeintaghavi et al., 2010), (Brusca et al., 2010). Therefore, women who use FHM are susceptible to advanced periodontal diseases like periodontitis.

The bi-directional link between systemic conditions, such as diabetes and cardiovascular diseases, and periodontitis has been well demonstrated. (Liccardo et al., 2019, Seymour, 2009, Genco & Borgnakke, 2020, Sanz et al., 2020). Research demonstrated that patients with periodontitis had more than double the risk of cardioembolic and thrombotic stroke compared to patients with good periodontal health (Sanz et al., 2020). However, despite a good understanding of the consequences of periodontitis on overall health, there is limited evidence and high levels of ambiguity in determining if there is an association between the use of current low dose FHM for contraception or other therapeutic purposes as a risk factor for periodontitis. There is a need to gain clarity on this association to identify women who may be susceptible to an advanced stage of periodontal disease and be informed of potential risks, benefits, and concerns.

1.4 Research Purpose

The purpose of this study is to describe the risk indicators of periodontitis among women who reported using female hormone medication (FHM) prescribed for contraception or therapeutic purposes other than contraception.

1.5 Specific Aims

1. Perform a repeated cross-sectional analysis on four cycles of the National Health and Nutrition Examination Survey (NHANES) data (2011-2018) to examine the association between female hormone medication prescribed for birth control and other therapeutic reasons and the risk of periodontitis in women aged 30-44 years.
2. Compare the prevalence of risk indicators of periodontitis among the participants who used FHM (birth control pills and other forms of female hormones) with those who did not use such medication.

1.6 Hypothesis

It is hypothesized that among users of FHM there will be a significantly higher prevalence of the risk indicators of periodontitis and higher odds of participants reporting the risk indicators of periodontitis compared to non-users of such medications.

1.7 Significance of the study

The risk of periodontitis is higher among elderly adults and socioeconomically disadvantaged individuals (Eke et al., 2020). Addressing potential risk factors for periodontitis is expected to be beneficial to improve the health of an aging population like that of the United States. By 2035, it is projected that there will be more older adults (65+ years) than youth and more dentate older adults than there were a decade or a couple of decades ago (NIDCR, 2019). According to the recent trends in the estimation of periodontitis, more than half of the sub-population of older adults with teeth showed clinical signs of periodontitis (Eke et al., 2020). One of the objectives of the oral health goals of the HP 2030 is to reduce the proportion of adults aged 45 years and over with moderate and severe periodontitis (U.S. Department of Health and Human Services, n.d). It is necessary to prevent or reduce the increase of new cases of

periodontitis to make progress in the HP2030 oral health goals. The insights gained from the study will likely be beneficial in providing an integrated preventive approach to improve health outcomes for women aged 30-44 years and help them with healthy aging.

A study investigating the destructive effects of a commonly used contraceptive progestin on the periodontal tissues showed that the ill effects are more pronounced in women of lower socioeconomic status and those facing existing health disparities than those who did not face such disparities (Taichman et al., 2012). Oral diseases could worsen when multiple vulnerabilities are present in the same subject. FHM usage for contraception or other therapeutic purposes is a poorly understood risk factor for periodontitis. Understanding this association will be helpful to identify the population of women during their reproductive years who may be at risk for periodontitis due to the use of FHM.

Chapter 2: Literature Review

2.1 Classification of Gingivitis and Periodontitis

The consensus report from the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions classified gingivitis caused by puberty, menstrual cycle, and sex steroids (key pharmacological components of birth control pills and hormonal medications) under non-plaque induced gingivitis or gingivitis mediated by systemic factors (Chapple et al., 2018).

The prevalence of periodontitis is estimated following the classification based on the rate of disease progression. Based on the rate of progression, periodontitis is categorized as slow, moderate, and rapidly progressing periodontitis (Tonetti et al., 2018). The severity of periodontitis is linked to the immune status of individuals; environmental and behavioral factors are modifiable risk factors for the disease. (Page & Kornman, 1997).

2.2 Female Hormones and Birth Control Pills

Estrogen and progesterone are the two predominant female hormones, and they play vital roles in the various stages of the female life cycle by regulating a spectrum of processes and changes through puberty, pregnancy, and menopause (Merck Manual, 2019). The hormones produced in the ovaries need to coexist in a well-balanced state to effectively execute their functions (Merck Manual, 2019). Variations in the levels of these hormones adversely affect the tissues of the oral cavity (Brusca et al., 2010, Prasanna et al., 2018, Markou et al., 2009, Soory.M, 2000). Female hormone-based contraceptive pills were first introduced in May 1950 and have since then evolved drastically in terms of their popularity and pharmacology. Currently prescribed combination pills and progestins have lower dosages of active ingredients and more focused pharmacological actions (Liao & Dollin, 2012).

Birth control pills or contraceptives pills are prescription medications primarily used for the prevention of pregnancy. Other therapeutic uses include but are not limited to the treatment of menstrual-related disorders, fibroids, and endometriosis (Merck Manual, 2019). Contraceptives mimic a state of pregnancy and prevent ovulation (Soory. M, 2000). Birth control pills can be obtained through primary care clinics funded by health insurance (Private & Medicaid). However, even people without health insurance coverage can obtain a prescription for family planning services by visiting Federally Qualified Health Centers (FQHCs) or Planned Parenthood clinics at minimum costs (KFF, 2019). Additionally, some web-based portals and interfaces could help obtain a prescription for birth control pills for nominal costs by providing some brief health information (The New York Times, 2016).

Currently, there are three types of contraceptive pills or patch formulations prescribed in the USA, a combination of estrogen and progesterone (combined pill), a progesterone-only formulation, and an extended-release or continuous use combination of estrogen and progesterone (Kaiser Family Foundation {KFF}, 2019). They are available in different dosages, different brand names, and can be administered as injections, patches, and creams apart from the oral route of administration. A combined Pill consists of estrogen and progestin (KFF, 2019).

2.3 Biological Plausibility

The primary etiologic factors of periodontal diseases are periodontal pathogens (bacteria), which reside in the oral cavity and alter the susceptibility of the host immune system to infections. Inflammation is a characteristic feature and a very early symptom of periodontitis (Muñoz-Carrillo et al., 2019). Periodontal disease progression is the combined effect of the inflammatory process and the immune response of the host (Cekici et al,.2014). An exaggerated inflammatory response observed in the gingiva of women using oral contraceptives is due to the

vascular changes caused by the female sex hormones (Brusca et al., 2010). This is reflected by the presence of an increased gingival crevicular fluid (GCF) flow rate in women who used oral contraceptives (Sooriyamoorthy & Gower, 1989). Oral tissues, in comparison to other tissues of the body, are more prone to the effects of circulating female hormones from blood and saliva (Sooriyamoorthy & Gower, 1989). The female hormones estrogen and progesterone, which circulate in the blood, raise the levels of inflammatory mediators (Brusca et al., 2010, Markou et al., 2009). Female hormones alter cytokine production (Brusca et al., 2010, Markou et al., 2009). Estrogen and progesterone affect the microcirculatory system by causing swelling of endothelial cells and pericytes of the venules. They promote the adherence of granulocytes and platelets to vessel walls, disrupt perivascular mast cells, and enhance vascular permeability and vascular proliferation (Markou et al., 2009). Estrogen, when administered alone or in combination with progesterone, has been found to increase the levels of plasma cortisol. Chronically elevated cortisol levels suppress the immune system (Deasy & Vogel, 1976). Progesterone stimulates the production of inflammatory mediators (prostaglandin E2) and enhances the accumulation of polymorphonuclear lymphocytes in the gingival sulcus (Markou et al., 2009). Polymorphonuclear lymphocytes are a type of immune cell that are released during infections and allergies. Elevated levels of estrogen and progesterone levels in the blood due to intake of oral contraceptives have been shown to reduce the immune response to plaque, thereby, furthering periodontal disease progression (Soory.M., 2000).

Women taking oral contraceptives have demonstrated increased colonization of the prevotella species (predominant periodontal pathogen causing periodontitis) of bacteria, making them more susceptible to periodontal diseases, especially if they have untreated or preexisting gingivitis (Saini et al., 2010).

2.4 Background research

There is a high level of ambiguity in the results of several studies that have attempted to understand the adverse effects of female hormonal medication usage as risk factors for periodontal disease. An article based on an analysis of data from the NHANES by Taichman et al. (2005) concluded that the analysis failed to validate the theory that earlier high or current low-dose oral contraceptives use is associated with increased levels of gingivitis or periodontitis. This study suggested a reexamination of the perceived association between contraceptive use and periodontal disease (Taichman & Eklund, 2005). In 2012, an article by Philips. M. Preshaw concluded that modern formulations of oral contraceptives have lower doses of estrogen and progesterone compared to their predecessors, thereby having much lower unwarranted side effects and hence should not be viewed as a risk factor for periodontal disease (Preshaw, 2013). However, several studies view these medications as a potential risk factor for periodontal disease progression. Mullaly et al. (2007) conducted a comprehensive periodontal exam on current pill users and those who do not take contraceptive medication. Mullaly et al. used three clinical parameters for measuring periodontal disease and concluded that current pill (hormones estrogen and progesterone) users had poor periodontal health. Current pill users had higher associated mean probing depth compared to non-users (3.3 mm versus 2.7 mm; $P = 0.006$) and more severe attachment loss (2.6 mm versus 1.7 mm; $P = 0.015$) and more sites with bleeding on probing (44.0% versus 31.1%; $P = 0.017$) (Mullally et al., 2007).

Another study concluded that contraceptive usage seems to increase the risk of periodontitis among women aged 19-40 years (Brusca et al., 2010). Brusca et al. (2010) indicated that compared to those who do not use contraceptives, those who do use contraceptives show a higher prevalence of certain species like Prevotella intermedia, Porphyromonas gingivalis, and

A. actinomycetemcomitans. These gram-negative bacteria participate in the pathology and progression to severe periodontitis.

Brusca et al., isolated certain strains of Candida (yeast) species from the periodontal pockets of participants and found that some Candida species could survive in the conditions created by oral contraceptive pill usage even after three years of contraception use. Among the strains that survived post oral contraceptive usage are C. Albicans, C. parapsilosis, C. glabarata, C. krusei, C. tropicalis (Brusca et al., 2010). C. parapsilosis is a significant fungal species that causes sepsis and wound tissue infections in the immunocompromised (Leal et al, 2014). C. krusei is a multidrug-resistant opportunistic fungus (Pfaller et al., 2008).

The duration of contraceptive usage is also known to affect periodontal disease progression. Researchers found that there was more severe periodontal disease progression indicated by attachment loss in women who used female hormone-based contraception for a longer duration of about 2-4 years compared to those who used them for a duration of less than two years (Tilakaratne et al, 2007). A longitudinal study, investigating the clinical parameters of periodontal disease conducted to assess the effect of oral contraceptives on periodontal health revealed mean higher Community Periodontal Index (CPI) scores; a score used to assess the severity of periodontal disease for oral contraceptive users (Prachi et al., 2019). Among healthy, non-smoking women aged 18 or older, oral contraceptive users had higher mean CPI scores and a statistically significant association between the duration of oral contraceptive use and loss of attachment compared to those who did not use oral contraceptives. Periodontal pockets measuring 4-5 mm; indicative of periodontitis was found in participants who used oral contraceptives for 36 months (Prachi et al., 2019). A meta-analysis of studies done in 2021 aimed to investigate the evidence supporting the impact of hormonal contraceptives on

periodontal health found low-level evidence associating the clinical parameters of periodontitis and hormonal contraceptive usage and suggested further reexamination to be able to adopt clear preventive protocols for users of contraceptives (Castro et al., 2021).

Bone loss (destruction of jawbones surrounding the teeth) is an important clinical sign of periodontitis. Low bone mineral density puts women at risk for osteoporosis which aggravates periodontal disease progression (Ayed et al, 2019). Women under the age of 45 years who are at risk of premature menopause are at increased risk for osteoporosis (Soory.M, 2000). The use of medroxyprogesterone acetate, a common progestin used for injection contraception, has been associated with lower bone mineral density in women aged 18-40 years (Quintino-Moro et al., 2019).

Chapter 3: Methodology

3.1 NHANES

The NHANES is administered by the NCHS, which is the nation's principal health statistics agency. The use of NHANES data to assess prevalence and risk factors for major diseases has been in existence since 1960. The nationally representative survey has surveyed over 190,000 people and has been a great tool that influences public health at community and policy levels (CDC, 2017). Each survey cycle in the NHANES is a combination of two consecutive years. NHANES uses a multi-stage probability sampling and different data sets to be combined using respondent sequence numbers, allowing the analysis of multiple variables relatable to the general US population. This study used data from three different NHANES questionnaires to arrive at the study sample.

3.1.1 NHANES For Periodontal Surveillance

Before collecting data using the self-reported measures for surveillance of periodontitis, the NHANES periodontal surveillance used the golden standard periodontal exam protocol examination, which consisted of collecting clinical examination data from six standard sites per tooth for all the teeth except the third molars (Eke et al, 2020). This was a time-consuming and expensive process to gather data. Self-reported measures were developed and validated to come up with a cost-efficient and accurate method of data collection for surveillance of periodontitis (Eke et al, 2020). The efforts to use potential self-reported measures for surveillance of periodontitis in adult populations began in 2006 by the CDC and the AAP (Eke et al, 2020). The CDC and the AAP initiative have identified eight self-reported measures (see Table 1) that are promising for the surveillance of periodontal disease in adults (Eke et al., 2020). These measures were evaluated for their usefulness and diagnostic accuracy in the Australian National Adult Oral

Health Survey (Slade, 2007). A study conducted to evaluate these measures in a sample of adults in Brazil has claimed that these measures are a good strategy to estimate the prevalence of periodontitis in adults (Cyrino et al., 2011). The measures were pilot field-tested in one National Health and Nutrition Examination Survey stand before being incorporated into the full NHANES (Eke et al, 2020). These self-reported measures, which have been validated and assessed, are now used as proxies for survey-based surveillance in place of actual clinically assessed periodontal disease for state and county level surveillance in the United States (Eke et al., 2020). Table 1shows the list of measures identified as proxies for surveillance of periodontitis. The measures identified were all independently associated with periodontitis except the use of a mouthwash which was correlated with the evidence of bone loss (Eke et al., 2020). Questions in the OHQ of the NHANES administered in cycles 7-10 had collected data on five of these eight measures. This study used four of the eight measures to understand the risk indicators of periodontitis among women who used female hormone-based medications. Measures 1- 4 from table 1 were the four measures chosen for this study and are discussed in detail in the measures section (section 3.3).

Table 1

Self-report measures for surveillance of periodontitis, Reference (Eke et al., 2020)

Item Verbatim	Response options
1. Do you think you might have gum disease?	Yes/no/refused/don't know
2. Overall, how would you rate the health of your teeth and gums?	Excellent/very good/good/ fair/poor/refused/don't know
3. Have you ever had treatment for gum disease such as scaling and root planing, sometimes called "deep cleaning"?	Yes/no/refused/don't know
4.Have you ever been told by a dental professional that you lost bone around your teeth?	Yes/no/refused/don't know
5. Have you ever had any teeth become loose on their own, without an injury?	Yes/no/refused/don't know
6.During the past 3 months, have you noticed a tooth that doesn't look right?	Yes/no/refused/don't know
7.Aside from brushing your teeth with a toothbrush, in the last 7 days, how many times did you use mouthwash or other dental rinse product that you use to treat dental disease or dental problems?	Number of days/ refused
Aside from brushing your teeth with a toothbrush, in the last 7 days, how many times did you use dental floss or any other device to clean between your teeth?	Number of days/ refused

3.2 Data extraction and Sampling strategy

Data from the OHQ and the RHQ for the years 2011-2018 (cycles 7,8,9,10) of NHANES were combined for the cross-sectional analysis. The NHANES survey protocols for the surveillance of periodontitis dictate that participants aged 30-79 years are eligible to be included for periodontal exams and surveillance surveys as participants under 30 years are less likely to be diagnosed with periodontitis (Eke et al., 2020). The available data for females who use birth control includes those aged 15-49. The pregnancy status of participants gained from the RHQ data set was used as an exclusionary criterion. The questions on current pregnancy status were administered only to participants aged 20-44 years. After excluding pregnant women, a sample

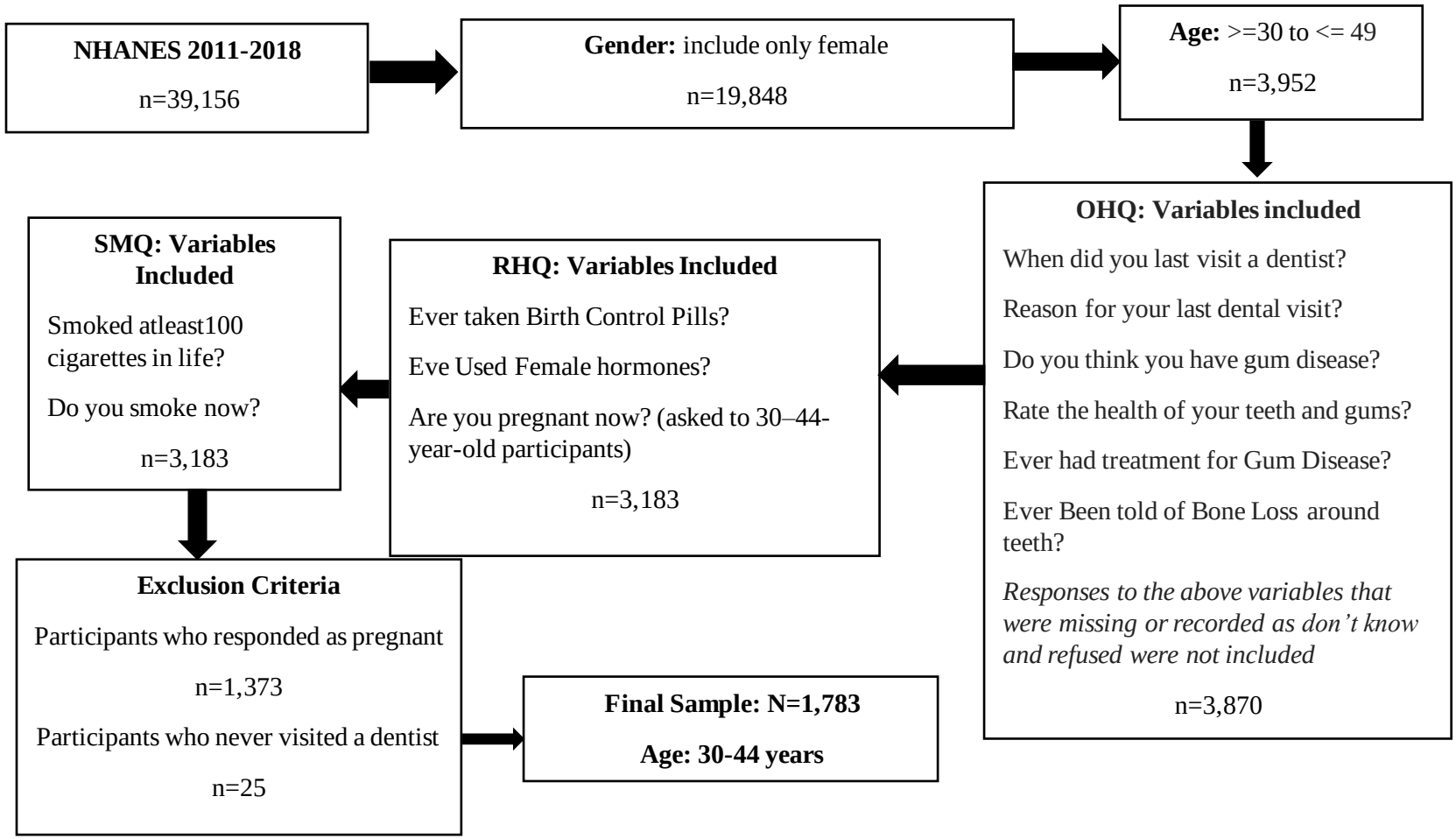
(n=1808) of female participants, who used birth control pills or female hormones for purposes other than birth control, aged 30-44 years was obtained.

3.2.1 Missing observations

Observations with refused and do not know status were filtered out from all the variables and an additional 25 participants from the never visited a dentist level of the variable last dental visit status were removed because they were less than 30 observations in a category. A final sample of (N=1783) participants was obtained. Please refer to Figure 1 for a visual representation of the sampling strategy.

Figure 1

Visualization of Sampling Strategy used for the study



3.2.2 Measures

Risk indicators of periodontitis

The oral health questionnaire section provides personal interview data on oral health topics. For the statistical analysis, the self-report measures from the OHQ defined as risk indicators of periodontitis that were examined as response variables are a) Do you think you might have Gum disease? (Suspected Periodontal Disease). The survey question format asked for this measure investigates the signs of both gingivitis and periodontitis in the respondent. b) Ever had treatment for gum disease such as scaling and root planing, sometimes called "deep cleaning"? c) Ever been told by a dental professional that you lost bone around your teeth? The survey question asked for the two measures (b and c) stated above to investigate the signs of periodontitis in the respondent. All the above-stated measures had dichotomous responses and were used as such for analysis. The measure "Overall, how would you rate the health of your teeth and gums?" (Dental Health Status) was used as a predictor for estimating the risk of periodontitis in the sample. The response categories in this measure were dichotomized. The measure, Last Dental Visit Status was recategorized into four categories based on the distribution of the responses: In the last 1 year; 2 to 5 years ago; more than 5 years ago; never visited a dentist. The level never visited a dentist had 25 observations which were excluded from the sample as the level had less than 30 observations. The measure Reason for last dental visit was recategorized into two categories: went in for a check-up, examination, or cleaning and other (reasons for visit other than an exam or cleaning). Please refer to Table 2 for the regrouping criteria used in the study.

Female Hormone Medication Use

The measures from the RHQ that were used as exposure variables to collectively define FHM usage are a) Ever used Birth Control Pills (Birth Control Pill Use) b) Ever Used Female Hormones for a reason other than birth control? (Other Female Hormone Use). Information on the smoking status of these participants were included in the analysis and this information was obtained from the NHANES SMQ.

Demographic variables

Age, race/ethnicity, and education were the demographic variables used for the analysis. The participants were regrouped into 3 age groups: 30-35 years, 36-40 years, and 40-44 years. Race/ethnicity variable had the levels: Non- Hispanic White, Mexican American, Other Hispanic, Non- Hispanic Black, other races. Education variable had the levels College Graduate or Above, Some college, High School/GED, less than high school. Please refer to Table 2 for the regrouping criteria used in the study.

Table 2

NHANES Variables and Regrouping Criteria

NHANES Variables and Regrouping Criteria			
NHANES Variable	**Question Asked**	**Response Options**	**Regrouping criteria for analysis**
Last Dental Visit Status	About how long has it been since last visited a dentist? Include all types of dentists, such as orthodontists, oral surgeons, and all other dental specialists, as well as dental hygienists.	6 months or less	In The Last 1 year
When did you last visit a dentist?		More than 6 months, but not more than 1 year ago	
		More than 1 year, but not more than 2 years ago	1-4 Years Ago
		More than 2 years, but not more than 3 years ago	
		More than 3 years, but not more than 5 years ago	
		More than 5 years ago	More than 5 years ago
		Never Visited a dentist	Never visited a dentist
Main reason for last dental visit	What was the main reason for your last visited the dentist?	Went in on own for check-up, examination, or cleaning	Went in for check-up, examination, or cleaning
		Was called in by the dentist for check-up, examination, or cleaning	

		Something was wrong, bothering or hurting	Other
		Went for treatment of a condition that dentist discovered at earlier checkup or examination	
		Other	
Suspected Gum Disease	Gum Disease is a common problem with the mouth. People with Gum Disease might have swollen gums, receding gums, sore or infected gums or loose teeth. Do you think you might have Gum Disease?	Yes	Levels retained without regrouping
Do you think you might have Gum Disease? (Periodontal disease – gingivitis and periodontitis)		No	
Dental Health Status	Overall, how would you rate the health of your teeth and gums?	Excellent	Good
Rate the health of your teeth and gums		Very Good	
		Good	
		Fair	Poor
		Poor	
Ever had treatment for Gum Disease	Ever had treatment for Gum Disease such as scaling and root planing, sometimes called "deep cleaning"?	Yes	Levels retained without regrouping
		No	
Ever been told of Bone loss around teeth	Have you ever been told by a dental	Yes	Levels retained without regrouping

	professional that lost bone around teeth?	No	
Ever taken birth control pills?	Have you Ever Taken Birth Control Pills?	Yes	Levels retained without regrouping
		No	
Ever use female hormones?	ever used female hormones such as estrogen and progesterone? Please include any forms of female hormones, such as pills, cream, patch, and injectables, but do not include birth control methods or use for infertility.	Yes	Levels retained without regrouping
		No	
Smoking Status			
Smoked at least 100 cigarettes in life	These questions are about cigarette smoking and other tobacco use. {Have you/Has SP} smoked at least 100 cigarettes in {your/his/her} entire life?	Yes	Smokers (Current or prior based on response to "Do you smoke cigarettes now?)
		No	Nonsmokers
Do you now smoke cigarettes	Do you now smoke cigarettes?	Not at all	Prior smokers (if they responded "Yes" to the previous question in this table, and “not at all” to this question)

		Everyday	Current smokers
		Somedays	Current smokers

Chapter 4: Statistical Analysis and Results

The statistical analysis for this study was done using the statistical software JAMOVI. Data from NHANES was extracted using R. A significance level of 0.05 was used as the criteria for a significant association. Univariate analysis was used to understand the sample characteristics and the prevalence of the risk indicators of periodontitis. The variables used in the study are categorical or dichotomous in nature and Chi square tests of association and binomial logistic regression was used for the analyses. Chi square tests of association were done to examine the associations between female hormonal medication use and self-reported measures of periodontitis, demographic variables, the last dental visit status and the main reason for their last dental visit. Binomial Logistic regression was used to predict the three self-reported risk indicators of periodontitis ("Suspected Periodontal Disease", "Ever had treatment for Gum disease" and "Ever been told of Bone loss around teeth") by birth Control Pill Use, other female hormone Use, last dental visit status, smoking status, and dental health status after controlling for the demographic variables of age, race/ethnicity, education, and survey cycle. The measure Ever been Informed of bone loss by a dental professional was added to the model predicting the odds of being treated for gum disease as bone loss is a major symptom of periodontitis.

4.1 Results

A total of 1783 participants (30-44 years) were included in the analysis. The median age of the participants was 37 years. The participants were 31.6% Non-Hispanic White, 23.6% Non-Hispanic Black, 17.6% Mexican American, 10.2% Other Hispanic and 17.2% women from other races. About 73% of the participants in the sample reported using birth control pills, and 3.4% of participants reported using female hormones for purposes except birth control or infertility.

Approximately sixty percent (58.3%) participants in the sample had their latest dental visit in the previous year and 88.8% of all the participants went for an exam or oral prophylaxis during their last dental visit. Sixty-five percent of the participants reported good oral health status. The prevalence of the three defined risk indicators of periodontitis {Suspected periodontal disease (gingivitis and periodontitis), Ever had Treatment for Gum disease (periodontitis), and Ever Been Informed of Bone Loss by a Dental Professional (periodontitis)} were lower among participants who used female hormonal medication than those who did not use them. Around seventeen percent (17.4%) of participants suspected they had periodontal disease Less than twenty-five percent (22.7%) reported receiving treatment for gum disease and less than ten percent (8.6%) said they were informed of bone loss by a dental professional. Please refer to Table 3 for the results of the analysis.

The only significant association with birth control pill usage at the bivariate level was observed with the variable Dental Health Status (P=0.003). No significant association was observed between Dental Health Status and other forms of female hormone use *(*P=0.576). There were also no significant associations found between the three defined self-report risk indicators of periodontitis {Suspected periodontal disease (gingivitis and periodontitis), Ever had Treatment for Gum disease (periodontitis) and Ever Been Informed of Bone Loss by a Dental Professional (periodontitis)}and birth control pill or other forms of female hormonal usage. As expected, all the three measures defined as the risk predictors of periodontitis: "Suspected Gum Disease", "Ever had treatment for Gum Disease" and "Ever been told of Bone loss around teeth" were significantly associated with age at the bivariate level (P=0.007, P<0.001, P<0.001 respectively). The variables "Suspected periodontal Disease" and "Ever had treatment for Gum disease?" were significantly associated with Education level (P=0.017, P=0.01 respectively). Twenty percent

(20%) of participants using birth control pills reported as current smokers. Chi square tests showed a significant association observed between smoking and birth control pill usage (P= 0.005) but not with female hormonal medication used for purposes other than birth control (P=0.171). The measure "Ever had treatment for Gum disease?" was also significantly associated with race/ethnicity (P<0.001). Please refer to Table 3 for the results of the univariate and bivariate analysis.

Table 3

Univariate and Bivariate analyses between Female Hormone-Based Medication Use, Demographics, Dental Visit Status, the Periodontitis Surveillance Measures and Smoking status of participants 30-44 years; NHANES 2011-2018 (N=1783)

Variables	Included N= 1783		Birth Control Pill Users			Other Female Hormone Users		
	Total	% of total	Yes	No		Yes	No	
Age (years)					p=0.391			**p=0.049**
30-35	642	36.0	460 (35.4)	182 (37.5)		26 (42.6)	616 (35.8)	
36-40	611	34.3	457 (35.2)	154 (31.8)		12 (19.7)	599 (34.8)	
41-44	530	29.7	381 (29.4)	149 (30.7)		23 (37.7)	507 (29.4)	
Race/ethnicity					**P<0.001**			**P=0.001**
Non-Hispanic White	564	31.6	491 (37.8)	73 (15.1)		34 (55.7)	530 (30.8)	
Non-Hispanic Black	420	23.6	319 (24.6)	101 (20.8)		9 (14.8)	411 (23.9)	
Mexican American	314	17.6	206 (15.9)	108 (22.3)		9 (14.8)	305 (17.7)	
Other Hispanic	181	10.2	114 (8.8)	67 (13.8)		2 (3.3)	179 (10.4)	
Other	304	17.0	168 (12.9)	136 (28.0)		7 (11.5)	297 (17.2)	
Education					**P<0.001**			p=0.237
College Graduate or Above	503	28.2	390 (30.0)	113 (23.3)		18 (29.5)	485 (28.2)	
Some college	636	35.7	502 (38.7)	134 (27.6)		28 (45.9)	608 (35.3)	
High School/GED	315	17.7	216 (16.6)	99 (20.4)		7 (11.5)	308 (17.9)	
Less than high school	329	64.3	502 (38.7)	134 (27.6)		28 (45.9)	608 (35.3)	
Smoking status					**P=0.005**			p=0.171
Current smoker	346	19.4	261 (20.1)	85 (17.5)		14 (23)	332 (19.3)	
Prior smoker	232	13.0	186 (14.3)	46 (9.5)		12 (19.7)	220 (12.8)	
Nonsmoker	1205	67.6	851 (65.6)	354 (73.0)		35 (57.4)	1170 (67.9)	
Last Dental Visit Status					p=0.401			p=0.954

In the last 1 year	1040	58.3	769 (59.2)	271 (55.9)		36 (59.0)	1004 (58.3)	
1-4 years ago	546	30.6	391 (30.1)	155 (32.0)		19 (31.1)	527 (30.6)	
More than 5 years ago	197	11.0	138 (10.6)	59 (12.2)		6 (9.8)	191 (11.1)	
Main Reason for Last Dental Visit					p=0.987			p=0.273
Went in for exam or cleaning	1583	88.8	1153 (88.8)	430 (88.7)		51 (83.6)	1532 (89)	
Other reasons	200	11.2	145 (11.2)	55 (11.3)		10 (16.4)	190 (11.0)	
Dental Health Status					**p=0.003**			
Good	1153	64.7	867 (66.8)	286 (59)		42 (68.9)	1111 (64.5)	p=0.576
Poor	630	35.3	431 (33.2)	199 (41.0)		19 (31.1)	611 (35.5)	
Suspected Periodontal Disease (Gingivitis and Periodontitis)					p=0.684			p=0.962
Yes	311	17.4	223 (17.2)	88 (18.1)		10 (16.4)	301 (17.5)	
No	1472	82.6	1075 (82.8)	397 (81.9)		51 (83.6)	1421 (82.5)	
Ever had treatment for Gum Disease (Periodontitis)					p=0.334			p=0.833
Yes	404	22.7	286 (22.0)	118 (24.3)		15 (24.6)	389 (22.6)	
No	1379	77.3	1012 (78.0)	367 (75.7)		46 (75.4)	1333 (77.4)	
Ever been told of Bone loss around teeth (Periodontitis)					p=0.354			p=1.000
Yes	153	8.6	106 (8.2)	47 (9.7)		5 (8.2)	148 (8.6)	
No	1630	91.4	1192 (91.8)	438 (90.3)		56 (91.8)	1574 (91.4)	

At the multivariate level, birth control pill usage and female hormone use were not significant predictors for the self-reported risk indicators of periodontitis {Suspected periodontal disease (gingivitis and periodontitis), Ever had Treatment for Gum disease (periodontitis) and Ever Been Informed of Bone Loss by a Dental Professional (periodontitis)}. As expected, the variables age, race/ethnicity, and smoking status, were significant predictors. Compared to participants who were 30 to 35 years, those who were older had significantly higher odds of suspecting periodontal disease: 36 to 40 years old (P= 0.036, OR= 1.41) and 40-44 years old (P<0.001, OR= 1.77). The results were similar in predicting the odds of participants being treated for periodontitis or for participants being informed of bone loss from a dental professional. The greater the age group in years, the higher the odds were of periodontal disease and periodontitis risk from the model predictions. Current smokers had significantly higher odds of self-reported periodontal disease in comparison to non- smokers (P<0.001, OR=1.84) and significant higher odds of being informed of bone loss compared to nonsmokers (P=0.007, OR=1.83). In comparison, prior smoking was not a significant predictor of being informed of bone loss (P=0.660, OR=1.13), but prior smokers had significant higher odds of being treated for gum disease compared to non-smokers (P=0.003, OR=1.70). Race/ethnicity was a significant predictor of participants being treated for gum disease but not for suspected periodontal disease and being informed of bone loss. Participants who were not Non-Hispanic Whites significantly higher odds of being treated for gum disease compared to participants who identified as Non-Hispanic White; Non-Hispanic Black (P=*0.001*, OR= 1.80), Mexican American (P< .001, OR= 2.87), other Hispanic (P< .001, OR= 2.70), other races (P=0.006, OR= 1.75). These results confirm the current literature on the prevalence of periodontitis based on the socio-demographic variables.

For the sociodemographic variable Education, the model results were unlike the general population. Participants with a lower level of education, such as those who had high school level education had significantly lower odds of Self-reporting periodontal disease compared to those who had college level education *(P*= 0.001, *OR*=0.41). At the multivariate level Education was not a significant predictor for the risk factor measures "Ever had Treatment for Gum disease (periodontitis)" and "Ever Been Informed of Bone Loss by a Dental Professional (periodontitis)". The measure Dental Health Status of participants was a significant predictor of all the defined risk indicators of periodontitis. Those who reported as having poor oral health had highly significant odds of reporting periodontal disease in comparison to their peers who reported good oral health status (*P*<0.001, *OR*=7.60). Similarly, participants who reported as having poor oral health had significant higher odds of being treated for gum disease (periodontitis) in comparison to their peers who reported good oral health status (*P*=0.001, *OR*=1.54) and participants reporting poor oral health status had significant higher odds of being informed of bone loss in comparison to their peers who reported good oral health status (*P*<0.001, *OR*=4.59). Last, Dental Visit Status was also a significant predictor of periodontitis risk. Those who had their last dental visit more than five years ago had significant higher odds of Suspecting Periodontal Disease in comparison to those who had visited a dentist the previous year (*P*= 0.027, *OR*=1.57). Those who had their last dental visit more than five years ago had significant lower odds of being treated for gum disease and being informed of bone loss in comparison to those who had visited a dentist the previous year (*P* <0.001, *OR*=0.29), (P<0.001, *OR*= 0.18). Survey year was not a significant predictor of the risk indicators of periodontitis. Please refer to Table 4 for results of the logistic regression models.

Table 4

Results of Logistic Regression predicting the odds of participants suspecting periodontal disease, being treated for gum disease, and being informed of bone loss around teeth for participants 30-44 years; NHANES 2011-2018 (N=1783)

	Suspecting Periodontal Disease (Gingivitis and Periodontitis)			**Being treated for Gum Disease (Periodontitis)**			**Being informed of Bone Loss around teeth (Periodontitis)**		
Statistic	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Intercept	0.06	(0.02, 0.14)	**< .001**	0.10	(0.06, 0.17)	**< .001**	0.03	(0.02, 0.07)	**< .001**
Predictors									
Age (years)									
30-35	(Ref)			(Ref)			(Ref)		
36-40	1.41	(1.02, 1.98)	**0.036**	1.43	(1.07, 1.92)	**0.016**	1.9	(1.20, 3.02)	**0.006**
41-44	1.77	(1.27, 2.47)	**< .001**	1.51	(1.12, 2.04)	**0.007**	2.28	(1.45, 3.59)	**< .001**
Race ethnicity									
Non Hispanic White	(Ref)			(Ref)			(Ref)		
Non Hispanic Black	0.76	(0.52, 1.10)	0.152	1.80	(1.26, 2.56)	**0.001**	1.34	(0.84, 2.16)	0.218
Mexican American	0.79	(0.51, 1.20)	0.272	2.87	(1.95, 4.23)	**< .001**	1.17	(0.67, 2.05)	0.579
Other Hispanic	0.77	(0.46, 1.29)	0.324	2.70	(1.75, 4.16)	**< .001**	1.01	(0.52, 1.97)	0.964
Other	0.97	(0.63, 1.50)	0.885	1.75	(1.18, 2.61)	**0.006**	0.76	(0.41, 1.42)	0.391
Education									

College Graduate or Above	(Ref)			(Ref)			(Ref)		
Some college	0.78	(0.53, 1.14)	0.198	1.05	(0.77, 1.45)	0.742	0.87	(0.54, 1.44)	0.603
High School/GED	0.46	(0.29, 0.74)	**0.001**	0.70	(0.47, 1.06)	0.09	0.59	(0.32, 1.11)	0.102
Less than high school	0.64	(0.40, 1.03)	0.062	1.02	(0.69, 1.52)	0.905	0.96	(0.53, 1.73)	0.896
Smoking Status									
Non Smoker	(Ref)			(Ref)			(Ref)		
Current Smoker	1.84	(1.31, 2.59)	**< .001**	0.90	(0.64, 1.28)	0.565	1.83	(1.18, 2.84)	**0.007**
Prior Smoker	1.33	(0.88, 1.99)	0.172	1.70	(1.20, 2.41)	**0.003**	1.13	(0.65, 1.95)	0.66
Survey Cycle									
7	(Ref)			(Ref)			(Ref)		
8	1.00	(0.69, 1.46)	0.963	1.13	(0.79, 1.59)	0.484	0.95	(0.56, 1.61)	0.861
9	1.03	(0.69, 1.53)	0.831	1.14	(0.81, 1.62)	0.448	1.28	(0.77, 2.15)	0.333
10	0.78	(0.52, 1.16)	0.247	0.85	(0.60, 1.22)	0.388	1.24	(0.75, 2.09)	0.399
Birth Control Pill Use									
No	(Ref)			(Ref)			(Ref)		
Yes	1.00	(0.74, 1.38)	0.963	1.00	(0.76, 1.32)	0.974	0.90	(0.61, 1.35)	0.631
Other Female Hormone Use									
No	(Ref)			(Ref)			(Ref)		
Yes	0.91	(0.43, 1.95)	0.824	1.33	(0.7, 2.54)	0.384	0.96	(0.36, 2.57)	0.931
Dental Health Status									

Good	(Ref)			(Ref)			(Ref)		
Poor	7.60	(5.73, 10.64)	**< .001**	1.54	(1.18, 2.02)	**0.001**	4.59	(3.10, 6.81)	**< .001**
Last Dental Visit									
In the last 1 year	(Ref)			(Ref)			(Ref)		
1-4 years ago	0.94	(0.69, 1.28)	0.697	0.85	(0.65, 1.11)	0.236	0.42	(0.28, 0.64)	**< .001**
More than 5 years ago	1.57	(1.05, 2.35)	**0.027**	0.29	(0.17, 0.49)	**< .001**	0.18	(0.08, 0.41)	**< .001**
Being Informed of Bone Loss around teeth									
No				(Ref)					
Yes				4.51	(3.12, 6.54)	**< .001**			

Chapter 5: Discussion

The purpose of this study was to examine the association between FHM prescribed for birth control and other therapeutic reasons as risk factors of periodontitis. The data for this study used the self-reported periodontitis surveillance measures from a nationally representative dataset. Birth control pills and female hormone use were not statistically significant predictors of the risk indicators of periodontitis in this study. The prevalence of the risk indicators of periodontitis was lower in the group of participants who used female hormone-based medications compared to those who did not use such medication

Introspecting the clinical usefulness of Self-report Measures for Surveillance of Periodontitis

The measures used to understand the risk of periodontitis in this study were self-report measures chosen with evidence-based information obtained from the literature. Evidence-based literature state these measures as validated and useful for the use of survey-based surveillance of periodontitis in place of intensive clinical examinations (Eke et al., 2020) at state and county levels. The nationally representative data used in this research was gathered through surveys. Clinical indicators like probing depth and clinical attachment loss remain the gold standards for measuring the severity and progression of periodontal disease among oral health professionals, but they are resource-intensive methods (Eke et al., 2020).

To the best of our knowledge, there is limited evidence from existing literature on the clinical usefulness of these measures for the surveillance of periodontitis. One recent study by Wiener et al., (2018) investigated the validity and clinical usefulness of these self-reported measures by determining the concordance of these measures with the clinically recommended need for oral healthcare. The authors of the study concluded that the measure "Dental Health Status" had the highest concordance at 65.4% and performed well as a promising self-report

surveillance measure. The variable Suspected Periodontal Disease asked in NHANES as "Do you think you have Gum disease" had a clinical concordance rate of 55.6% in the above-referenced study by Weiner et al., (2018). Meaning, that more people who reported poor oral health self-perception were more likely to have a clinical determination of needing immediate care. The overall concordance of these measures was also more likely among females compared to males (Wiener et al., 2018). In this study, the measure on Dental Health Status: "overall self-reported oral health" was a significant factor in predicting the other three defined risk indicators ("Do you think you have Gum disease?", "Ever had treatment for Gum disease" and "Ever been told of Bone loss by a dental professional"). Thus, based on existing data on validation of these self-report measures, we can anticipate that the overall perception of oral health or the measure "Dental Health Status" is a significant predictor of the risk of periodontitis among FHM users aged 30-44 years.

Self-report measures used as proxies for clinical measures must be consistently validated in several subpopulations as perceptions could vary with changing sociodemographic attributes and to account for any changes in perception reported over time. However, despite the varying perceptions with different populations, evidence from existing literature state that the mean rates of progression of periodontitis are similar across all populations observed globally (Tonetti et al., 2018). The trends of periodontitis in this sample mirrored the general population for the sociodemographic risk factors of periodontitis like Age and Race/Ethnicity. However, this was not the case for the sociodemographic variable Education. Our model predicted that those with lower levels of education were less likely to suspect that they had periodontal disease. This contrasts with the general trends of periodontitis in observing higher prevalence among those with lower educational levels (Eke et al,2020). This finding possibly arises due to a lack of

sufficient oral health literacy among those with a lower level of education. Education was not significantly associated with the variables "Ever had treated for Gum disease" and "Ever been told of Bone loss". A positive (Yes) response to these two measures would be reported only after a participant visits a dental professional. Hence, these two measures may likely serve as more reliable measures for periodontitis surveillance. We recommend future research gather more evidence to determine the clinical concordance of these self-report measures to enhance their use as valuable screening tools in capturing the need for clinical prophylactic care. Demonstrating the clinical usefulness of these measures would make the data gathered more reliable to estimate the prevalence of periodontitis for reaching the targeted HP2030 goals by reducing the burden on existing resources. periodontitis.

Oral health perception of participants who used female hormone-based medication

We observed that a majority of participants in this study; approximately 70% of participants reported a self-perception of having good oral health. More than 80% of these women cited the reason for their latest dental visit as going into the dental office for an exam or cleaning. Only about 20% of the participants cited visiting the dentist for pain or other reasons like treatment of existing dental conditions, and only 1% of these medication users reported never having visited a dentist. A perception of good oral health may be related to good oral care seeking behavior. It will be beneficial to further understand oral health perception through behavioral research. Given the fact that the burden of oral diseases increases with age, this may serve as a protective health behavior for these women as they advance in age. The Consensus Statement on Future Directions for the Behavioral and Social Sciences in Oral Health published in January 2022 has stated that behavioral sciences are critical to understanding oral health and understanding the multilevel socio-demographic factors that affect oral health (McNeil et

al,.2022). The statement encourages the use of dissemination and implementation (D&I) research to reduce oral health inequities, as well as to inform public health and policy approaches for improved dental care delivery, oral health programs in both clinical and community settings. We recommend, future research understand the perceptions of oral health across this population to appreciate protective behaviors that improve oral health.

In general, women exhibit more positive attitudes about oral health and demonstrate better oral health behaviors like brushing and flossing compared to men (Lipsky et al, 2021). But it is unclear whether this perception of good oral health is uniform across all age groups of adult females. Perception and behaviors may vary with several factors like culture, race/ethnicity, education, and availability of health coverage. We recommend future research gather data from female hormone-based medication users aged 15-29 years to see if there is a similar perceptions of oral health status as found in the older age group of FHM users. The age group of females 15-29 years is likely to consist of more individuals such as college students who may not have insurance for dental coverage. A study investigating dental health status and behaviors of college students found that nearly a third of college students had unmet dental needs (Basch et al, 2019). There might be probable differentiating factors in the oral health perception and oral care-seeking behavior of younger and older females**.**

Limitations of the study

The analysis did not account for the NHANES weighting variables. Poor oral hygiene is one of the major risk factors of periodontitis (CDC, 2020). However, this study did not control for the oral hygiene habits of the participants. NHANES collects data on toothbrushing habits only in participants 3-19 years of age. While data on flossing was available for the examined sample, we did not include it in our study. This is because periodontal pockets >3mm are

indicative of periodontitis and flossing does not help in such situations (Tonetti et al., 2018). Next, the data available from NHANES did not yield a sample size sufficient for an analysis to understand the effects of progesterone only or estrogen only medication. Duration of birth control pills and female hormone usage were not identifiable either. We analyzed a population of females who reported contraceptive usage anytime in their life span. The biological plausibility of the relationship mentions female hormone levels in circulation causing physiological changes in the gingiva and resulting in an exacerbated inflammatory response are documented in the literature (Brusca et al., 2010, Markou et al., 2009, Mullaly et al. 2007). This is a possible confounding factor that might have affected the results.

Further, the study did not include females in the age group of 15-29 years who used female hormonal medications due to lack of data. The population of females who are prescribed the synthetic alternatives and analogs of natural female sex hormones range between 15-49 years (CDC, 2020), but measures for surveillance of periodontal disease and periodontitis from NHANES do not collect data from patients below 30 years (Eke et al, 2020). Given the fact that the prevalence of periodontitis increases with age, collecting data from individuals 30 years or older could be prudent usage of available resources. However, this becomes a disadvantage in terms of understanding the potential oral risks on younger women. Evidence shows that the risk of periodontitis (Demonstrated by loss of attachment >3mm) increases with the duration of the use of hormonal-based contraceptive medication (Prachi et al., 2019). Collecting primary data and using longitudinal study designs or prospective cohort studies will be ideal compared to studying the association from secondary cross-sectional data. Such studies might yield more conclusive and reliable results. These data collection methods will also be free of the inherent information bias that affects data gathered using self-report measures.

Chapter 6: Conclusion

The results of this study did not show an association between female hormone-based medication use and the risk of periodontitis. However, based on the existing data the self-perception of dental health status was significant in predicting the risk of periodontitis in this population. It is encouraging to see many participants in this age group (30-44 years) report good oral health status. This information can be utilized to understand and promote oral health and overall health outcomes across the life span of females.

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