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PHYSICAL ACTIVITY AND PERIODONTAL DISEASE IN ADULTS

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Dedication

The road to my master's degree has been long, and at times, seemed unattainable. However, most of my journey has been enjoyable and has only increased my appetite to continue learning. The completion of my master's and especially this thesis was not possible without the help and support of many individuals. First off, I would like to thank my supervisor, Dr Steven Johnson, for his guidance and support throughout my thesis journey. To my co-supervisors, Dr Haider Al-Waeli and Dr Gina Martin, thank you for always giving good advice and helping me progress with my work. I also would not have been successful without my family and friends, especially my amazing parents and brother. This piece of my education would not have been possible without their encouragement and belief in me to achieve my dreams. I love you! And to my partner, Mark, thank you for always lending an ear and a shoulder to cry on when balancing it all was overwhelming. I love you too and I can't wait to have some free time to go on adventures together!

Abstract

Physical activity has been shown to improve many chronic inflammatory conditions. Periodontal disease is a chronic inflammatory condition that affects the oral tissues. This study will explore whether there is a relationship between physical activity and periodontal disease in adults using the 2017 American Academy of Periodontology Classification System. 25 adults diagnosed with periodontal disease subjectively reported their physical activity using the Godin-Leisure Time Index and wore a FitBit fitness tracker to measure their daily step count as an objective measure for one week. Periodontal disease was measured using the American Academy of Periodontology Classification System to determine the stage and grade of periodontitis. Linear regression found that there was no relationship between physical activity, using moderate to vigorous physical activity levels and average daily walking steps, and periodontitis. This study was inconclusive, and a larger sample size would be beneficial in determining if there was a relationship between physical activity and periodontal disease.

Key words: periodontal disease, oral health, systemic health, physical activity, inflammation

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IPAQ = international physical activity questionnaire

MVPA = moderate to vigorous physical activity

BMI = body mass index

PA = physical activity

Chapter 1. Introduction

Periodontal disease is an umbrella term used to describe preventable, major, multifactorial inflammatory conditions affecting the oral tissues, including gingivitis and periodontitis. Gingivitis is localized, reversible, early-stage periodontal disease characterized by bleeding gums and localized inflammation (Kinane et al., 2017). Untreated gingivitis can progress to the next stage of periodontal disease, termed periodontitis, that can cause irreversible damage to the attachment structures in the oral cavity (Liccardo et al., 2019). This tissue destruction can lead to tooth mobility and tooth loss as well as other health implications such as trouble with mastication, speaking and reduced self-esteem (Lang & Bartold, 2018; Chandy et al., 2017). Periodontitis is diagnosed following the American Academy of Periodontology Classification System looking at several criteria including, but not limited to, missing teeth and periodontal pocket depths. Patients are given a stage, ranging from 1 to 4, in increasing severity of periodontitis based on the extent of damage to the oral tissues (American Academy of Periodontology, 2017). In addition to a stage, patients are also given a grade, of either A, B or C, depending on the rate of progression of their disease. Grading is based on factors that may put an individual at a higher risk of continued deterioration of the disease, such as smoking and diabetes (AAP, 2017).

Background

Periodontal disease is a public health threat affecting 20-50% of the population worldwide (Nazir, 2017). In Canada, it is estimated that 70% of the population are affected by periodontal disease at some point throughout their life (Bournais & Dowsett, 2019). Significant economic effects can also be attributed to periodontal disease as so many individuals will be

affected by this condition in their lifetime (Canadian Dental Association, 2017). Risk factors in developing this disease can include environmental stressors, certain lifestyle habits, genetics, preexisting health conditions and local oral conditions (Nazir, 2017; Lang & Bartold, 2018). Older age increases the risk and severity of periodontal disease due to the natural degradation of the oral tissues as well as the prolonged exposure to environmental risk factors (Tadjoedin, 2017). This disease has also been observed more frequently in men than women indicating a gender correlation (Ioannidou, 2017). A lower socioeconomic status also puts a person at risk for developing periodontal disease as there has been found to be an inverse relationship between the severity of the disease compared to individual income and education levels (Kumari et al., 2021).

The inflammation that occurs in periodontal disease can have systemic implications as the bacteria can destroy the structures surrounding the tooth, escape into the bloodstream and travel throughout the body (Liccardo et al., 2019). The inflammation will then cause an immune response and consequently increase inflammatory markers within the body. Chronic conditions, such as cardiovascular disease and diabetes, are found to be linked with the systemic inflammation that occurs in periodontal disease (Hedge & Awan, 2019).

Treatments for periodontal disease range from non-surgical to surgical options depending on the severity of the case. Non-surgical options can include improving homecare practices, reducing environmental risk factors and instrumentation by dental health professionals (Salzer et al., 2020; Suvan et al., 2020). Surgical options for treatment of periodontal disease can include flap surgery or guided tissue/bone regeneration (Sanz-Sanchez et al., 2020; Gojkov-Vukelic et al., 2017). Both procedures aim to remove bacteria, gain attachment, reduce inflammation, and improve the health of the oral tissues (Sanz-Sanchez et al., 2020).

Physical activity has been shown to benefit many chronic inflammatory diseases including cardiovascular disease and obesity. Being physically active reduces the systemic inflammatory markers that are associated with these inflammatory conditions. The benefits of physical activity span further than just reducing inflammation as it is also beneficial in improving lung capacity, brain function, heart health and fat reduction (Ferreira et al., 2019).

Statement of the Problem

Periodontal disease is an oral condition that affects many of the population throughout their lifetime therefore reviewing alternative treatment measures will help to gain a better understanding of additional treatment options that could be used in the future.

Purpose

The purpose of this research is to investigate the relationship between physical activity, using moderate to vigorous physical activity levels through self-reported PA questionnaires and walking using FitBit fitness trackers, and periodontal disease, using the 2017 American Academy of Periodontology Classification System.

Research Question

This study seeks to answer the following research question: What is the relationship between physical activity and periodontal status in adults?

Key Terms

Periodontal Disease

Periodontal disease, also called gum disease, is an umbrella term used to describe both gingivitis and periodontitis (AAP, 2023).

Gingivitis.

Gingivitis is the reversible form of periodontal disease characterized by localized inflammation of the gum tissues. It is the least severe form of this disease and is not typically associated with any form of pain (AAP, 2023).

Periodontitis.

Periodontitis is defined as a chronic inflammatory disease that affects the bone and periodontium, the attachment structures of the teeth, in the oral cavity. This disease happens when bacteria in dental plaque triggers an inflammatory immune response that leads to irreversible damage of the bone and supporting attachments structures of teeth (Hedge & Awan, 2019). The diagnosis of periodontitis uses the American Academy of Periodontology Classification System and is a combination of a stage and a grade (AAP, 2017). The stages of periodontitis ranges from 1 to 4, increasing in severity. The stage of periodontitis is given based on the clinical attachment loss (CAL) or radiographic bone loss (RBL), tooth loss due to periodontitis, the complexity (i.e., the type of bone loss (vertical versus horizontal), furcation involvement and probing depths) and the extent of the disease (i.e., localized versus generalized) (AAP, 2017). Periodontitis is then given a grade of A, B or C which is based on the risk factors for the rate of disease progression, such as smoking and diabetes, response to treatment and potential impacts to health due to the disease (AAP, 2017). Grade A is considered to be a slow progression of the disease whereas grade C is the quickest rate of progression (AAP, 2017).

Periodontal pocket.

As periodontal disease progresses, the gum tissue separates from the teeth due to the presence of bacteria and the corresponding inflammatory response. This separation of gum

tissues creates a periodontal pocket which will continue to increase as more bone and attachment loss occurs (AAP, 2023).

Dental Probe.

A tool used in dentistry to measure the extent of bone and attachment loss around a tooth. It measures in millimeters (Sinclair, 2021).

Clinical Attachment Loss (CAL).

Clinical attachment loss is used to evaluate the amount of support that has been lost due to periodontitis around a tooth. It is measured with a dental probe which measures from the cemento-enamel junction (CEJ) to the base of the periodontal pocket (Farook et al., 2020).

Probing Depths.

A method used to assess the health of gum tissues and one of the components used to diagnose periodontal disease. As periodontal disease progresses, the probing depths will increase (AAP, 2023).

Radiographic Bone Loss (RBL).

Another method to determine the amount of bone loss associated with periodontitis. This method uses radiographic images to evaluate the amount and type of bone loss (horizontal versus vertical bone loss) (Farook et al., 2020; AAP, 2023).

Furcation.

A furcation is an anatomical part of multi-rooted teeth (i.e., the premolar and molar teeth) and is where the tooth and root connect. As periodontal disease progresses, furcations can become involved as bone loss progresses; this is called a furcation defect (Colgate, 2023).

Physical Activity.

Physical activity is defined by the American College of Sports Medicine (n.d.) as "any bodily movement produced by the contraction of skeletal muscles that results in a substantial increase in caloric requirements over resting energy expenditure."

Moderate to Vigorous Physical Activity (MVPA).

Moderate to vigorous physical activity is defined as a disturbance to the homeostasis of the body and is related to the intensity at which an individual is physically active. Moderate intensity can have minimal disturbance to homeostasis and can be maintained for a longer period of time (i.e., fast walking or raking leaves) (MacIntosh et al., 2021). Vigorous intensity creates more disturbance to homeostasis and can be maintained with increasing aerobic metabolism through increases to intensity (i.e., running or shoveling snow). There are a variety of ways to monitor the intensity of physical activity such as the talk test or heart rate monitors. It is recommended that individuals get 150 minutes of MVPA per week for optimal health benefits (MacIntosh et al., 2021).

Exercise

Is defined as a "type of physical activity that is planned, structured and uses repetitive bodily movements to improve and/or maintain one or more components of physical fitness" (American College of Sports Medicine, n.d.). It is important to note that the terms physical activity and exercise are often used interchangeably however they are not the same (ACSM, n.d.).

Body Mass Index (BMI)

Body mass index is a measure used to calculate an individual's body fat based on height and weight. The formula is BMI= body weight (kg)/height (m^2) (National Heart, Lung and Blood Institute, n.d.).

Chapter 2. Literature Review of Physical Activity and Periodontal Disease in Adults

Introduction

Historically, physical activity has been positively associated with many chronic and health-related inflammatory conditions, such as diabetes and obesity (Lamster & Pagan, 2017; Wernicke et al., 2021). Periodontal disease is an inflammatory oral condition that has the potential to have a systemic effect if the periodontal pathogens escape the oral cavity and travel throughout the body (Hedge & Awan, 2019; Liccardo et al., 2019). Given that physical activity has helped to reduce inflammatory markers in other conditions, it is important to understand the relationship between physical activity and periodontal disease (Han et al., 2019).

Literature Review

A literature review was performed examining the current studies related to the area of physical activity and periodontal disease and identifying gaps in the literature where more research would be beneficial. Pubmed, Google Scholar and the Athabasca University Library database were all searched for the purpose of this literature review.

Concept One

Physical activity has been shown to improve many aspects of health such as cognition, lung function, heart health and a reduction in fat (Ferreira et al., 2019). It also has been proven to positively affect the inflammatory markers present in chronic diseases, including the reduction of

reactive protein often associated with periodontal disease (Ferreira et al., 2019). Among a sample of participants with periodontitis, Han et al (2019) completed a cross sectional study of 9728 Korean adults 19 years old and older to determine if there was a relationship between regular walking and periodontitis. Walking was assessed using a Korean version of the validated International Physical Activity Questionnaire (IPAQ) and periodontitis was diagnosed using the Community Periodontal Index (CPI) developed by the World Health Organization (Han et al., 2019). Socio-demographic characteristics, oral health practices, general and oral health status as well as lifestyle behaviours were all analyzed using multivariable logistic regression analysis (Han et al., 2019). Han et al. (2019) found that the prevalence of periodontitis increased as age increased as the mean age of individuals with periodontitis was 54.3 years old compared to 42.4 years old in the non-periodontitis group. Gender was also a factor with 58% of the participants being men in the periodontitis group compared to 45.5% in the non-periodontitis group. Participants who were more educated and had a higher income were less affected by periodontitis than those less educated and who made less money (Han et al., 2019). Current and past smokers were notably higher in the periodontitis group compared to the non-periodontitis group (54% versus 37.9% respectively). Furthermore, there was a significant relationship found with those who walked having lower incidence of periodontitis compared to those who were sedentary. In all models participants who walked regularly had significantly lower incidence of periodontitis (Han et al., 2019).

A systematic review by Ferreira et al. (2019) examined a sample of participants to establish the relationship between physical activity and the prevalence of periodontal disease. For this review, a total of seven studies were considered including one case control study, one cohort, and five cross sectional studies. The age range of the participants in these studies was

between 30-50 years old. The oral health variables that were reported were number teeth missing, periodontal pocket depth, clinical attachment loss (CAL), loss of attachment (LA), radiographic analysis, and periodontal and plaque index (Ferreira et al., 2019). In all studies, the level of physical activity (frequency and intensity) was self-reported and based on responses from the International Physical Activity Questionnaire (IPAQ). Data examined included self-reported data on walking, jogging, running, cycling, aerobics, hiking, dancing, swimming, calisthenics, yard work and lifting weights (Ferreira et al., 2019). Overall, being physically active was associated with a reduction in the prevalence of periodontal disease with one study reporting an overall reduction of 16% versus those who were not physically active. Additionally, it was noted that among former smokers, periodontal disease prevalence was 74% lower in physically active compared to those who were not active. This lower prevalence could possibly be attributed to a reduction in inflammatory cytokines, namely C-reactive protein, whose presence would otherwise worsen periodontal disease (Ferreira et al., 2019).

Concept Two

There has been an established link between chronic, systemic conditions and periodontal disease. This link is due to leakage of periodontal pathogens into the bloodstream as well as inflammatory markers from periodontal disease found throughout the body (Hedge & Awan, 2019). The progression of periodontal disease is marked by an increase in the body's immune response due to the increasing amounts of pathogenic bacteria within dental plaque (Liccardo et al., 2019).

The link between cardiovascular disease and periodontal disease is best described by a chronic, mild inflammation model (Hedge & Awan, 2019). An individual that has periodontal disease will have increasing levels of bacteria, locally within the periodontal pocket. These

bacteria will increase systemically throughout the body as the disease worsens inducing both the local and systemic immune response (Liccardo et al., 2019; Hedge & Awan, 2019). Liccardo et al. (2019) indicate that the DNA from oral bacteria has been found within the tissues of the heart. These pathogens have been proven to cross the atrial walls in the heart, creating atherosclerotic plaques characteristic in heart disease. Increasing levels of the inflammatory cytokines (such as IL-6) and C reactive protein can also be observed throughout the body as periodontal disease progresses (Hedge & Awan, 2019). Therefore, individuals diagnosed with periodontal disease have an increased incidence of cardiovascular events such as myocardial infarctions, stroke and heart attacks (Liccardo et al., 2019).

Periodontal disease has been observed to have a bi-directional relationship with diabetes. This means that an individual with periodontal disease is at a greater risk for developing diabetes and someone who has diabetes has an increased likelihood of developing periodontal disease (Hedge & Awan, 2019). As previously noted, individuals with periodontal disease have a greater level of circulating inflammatory markers, such as C-reactive protein and IL-6. This can cause problems with regulating metabolic control and can affect insulin resistance (Hedge & Awan, 2019). Additionally, the imbalance of unhealthy bacteria within the oral cavity as well as a modified healing processes in diabetic patients can be observed as a risk factor in developing periodontal disease (Torrejon-Moya et al., 2021).

Obesity is also another condition that is linked to periodontal disease. An individual who is overweight has an increased risk of developing periodontal disease due to chronic inflammation and oxidative stress (Doke et al., 2021; Torrejon-Moya et al., 2021). Doke et al. (2021) indicate that inflammatory cytokines activate a host response in the bacterial pathogens of periodontal disease by activating leukocytes. Abdominal obesity is observed to have a strong

correlation with periodontal disease as these cytokines are controlled by adipocytokines that are secreted by abdominal fat (Doke et al., 2021).

Concept Three

Inflammation is considered a crucial part of the body's innate immune response to injury and infection. However, if this system is poorly regulated it can contribute to the development and maintenance of chronic disease such as higher levels of inflammatory biomarkers (Flynn et al., 2019). The biomarkers that are often observed in chronic disease are inflammatory cytokines, such as interleukin-6 (IL-6) (Chandy et al., 2017). When these inflammatory cytokines circulate throughout the body, there is an increased chance that the liver will start to produce acute phase proteins, such as C-reactive protein (CRP) (Chandy et al., 2017). Bacteria from periodontal disease in combination with these proteins, can increase the risk of developing chronic diseases, such as cardiovascular disease and diabetes (Chandy et al., 2017: Hedge & Awan, 2019). A review article by Martinez-Garcia & Hernandez-Lumus (2021) states that the local inflammation that occurs with periodontal disease often becomes systemic, initiating a full-body inflammatory response. On the contrary, the inflammation that occurs with systemic inflammation from chronic diseases can worsen existing periodontal health (Martinez-Garcia & Hernandez-Lumus, 2021).

Concept Four

There are many benefits of physical activity including being associated with improved metabolic function and reduced systemic inflammation (van Waveren et al., 2020). As mentioned previously, systemic inflammation has been found to be associated with increased levels of cytokines, elevating the risk of individuals developing chronic diseases such as obesity and diabetes (Pederson, 2017).

Obesity. Obesity is depicted by excessive fat accumulation in the body and is a major public health concern as more than 10% of the adult population is obese (Alkan et al., 2020). Obesity has been found to have a link between chronic conditions such as cardiovascular disease, type 2 diabetes, asthma and cancer (Lamster & Pagan, 2017). It has been observed that 70-80% of individuals classified as obese have an adipose tissue turnover that causes systemic inflammation (Nicolin et al., 2020). People who are obese also possess excessive amounts of inflammatory cytokines and hormones called adipokines, that lead to chronic low grade systemic inflammation (Alkan et al., 2020; Suvan et al., 2018).

Pederson (2017) found that in both longitudinal and cross-sectional studies, prolonged lifestyle changes involving increasing physical activity and reducing energy intake diminish inflammatory markers in humans. Moreover, Marynowski et al (2021) concur as regular physical activity has been shown to have a beneficial effect on the inflammatory status in humans. However, it is important to note that the intensity and duration of the activity is important as physical activity that is longer in duration or higher in intensity will increase inflammatory markers (van Waveren et al., 2020).

Obesity also increases the risk of developing periodontal disease possibly due to oxidative stress and adipose tissues releasing inflammatory factors (Omori et al., 2018; Torrejon-Moya et al., 2021). There is local inflammation in both obesity and periodontal disease, and it is augmented when the two are active together therefore obesity may exacerbate periodontal disease (Iwashita et al., 2021). Cytokines associated with inflammation have been found in the gingival crevicular fluid of obese individuals compared to those of a normal weight (Roa & del Sol, 2018). Further evidence suggest that overweight individuals have 2-3 times the risk of periodontal disease independent from traditional risk factors such as smoking, age and gender

(Suvan et al., 2018). Omori et al (2018) concur that the likelihood of periodontal disease is slightly elevated in those considered obese when looking at body mass index compared to those not classified as obese. This evidence suggests that there is a causal relationship between obesity and periodontal disease.

Physical activity has been shown to improve the health of individuals who are obese in addition to improving periodontal status. Regular walking has been shown to lower vascular inflammation, reduce oxidative stress and is quite effective in preventing obesity (Han et al., 2019). Omori et al (2018) support this claim as physical activity improves lifestyle related diseases by reducing systemic inflammation. It was also found that a decrease in physical activity correlates to an increased risk of many chronic diseases. There is also a relationship found between the absence of physical activity and the amount of plaque and bleeding noted in the gum tissues (Omori et al., 2018).

Diabetes. Diabetes is the most common multifactorial chronic disease characterized by metabolic and hormonal imbalances (Wernicke et al., 2021; Chen et al., 2020). There are two types of diabetes that can affect an individual. Type 1 Diabetes is where the beta-cells of the pancreas do not produce any insulin and Type 2 Diabetes is where the body does not produce enough insulin or becomes resistant to insulin (Andrade et al., 2018). It has been shown that individuals with diabetes are more prone to developing various health complications, such as periodontal disease, than people without diabetes (Andrade et al., 2018; Chen et al., 2020). Patients with Type 2 Diabetes also have an increased risk of developing periodontal disease than healthy people (Wernicke et al., 2021). This bi-directional relationship is not fully understood yet but the local and systemic inflammation that occurs in both diseases could be the link (Wernicke et al., 2021).

Physical activity is one of the most prescribed non-pharmacological methods of glycemic control among adults with Type 2 Diabetes. It has been shown that physical activity helps to increase glucose uptake through the muscles and reduce insulin resistance in adipocytes (Andrade at al., 2018). Furthermore, individuals with Type 2 Diabetes will see a reduction in their inflammatory response and cardiovascular mortality, improvement in lipid levels and blood pressure and overall quality of life by becoming more physically active (Andrade et al., 2018; Wernicke et al., 2021). Physical activity improves periodontal health by lowering plaque indices, reducing clinical attachment loss (CAL) and significantly reducing the risk of developing periodontal disease when compared to sedentary individuals (Wernicke et al., 2021; Andrade et al., 2018).

In their randomized control trial (RCT), Wernicke et al. (2021) found that when individuals with Type 2 Diabetes participated in sports (e.g., strength endurance training) for 6 months periodontal health improved. A significant reduction in the severity of periodontal disease and bleeding on probing along with improved glycemic control (HbA1C) compared to the control group was found in the intervention group that took part in the training. Furthermore, a meta-analysis was carried out by Han et al. (2019) where an improvement in glycemic control in Type 2 Diabetic patients, a reduction in high blood pressure as well as a decrease in oxidative stress and inflammation was found through walking. These findings indicate that there is a potentially important relationship between walking and reducing inflammation, for example, in periodontal disease (Han et al., 2019). A systematic review by Chen et al. (2020) confirmed the findings related to improvement of health in Type 2 diabetic patients with regular physical activity. It was proven from this study that individuals with Type 2 Diabetes saw decreases in

inflammatory markers, such as c-reactive protein and IL-6 and has the potential to reduce low grade systemic inflammation (Chen et al., 2020).

Summary

This literature review demonstrates the benefits of physical activity and chronic inflammatory conditions through a reduction in inflammatory markers throughout the body. The current literature is limited when looking at the relationship of physical activity and periodontal disease. Furthermore, there has been a lack of studies regarding the use of physical activity in combination with the current treatment options for periodontal disease.

Chapter 3. Theoretical Framework

Introduction

As the literature review indicates current publications are limited when looking at the relationship between physical activity and periodontal disease. The benefits of physical activity are numerous, and the literature indicates the positive use of physical activity to improve many chronic inflammatory conditions such as diabetes and obesity (Andrade et al., 2018; Pederson, 2017).

Research Problem

Current research investigated either walking steps or self-reported physical activity using various physical activity questionnaires. Additionally, the current literature does not use the most up-to-date periodontal disease classification guide. Therefore additional research should be completed to understand the relationship between the two, using both objective and subjective measures of physical activity, and the new 2017 American Academy of Periodontology Classification System. Further investigation of whether the frequency of physical activity will

have an impact on periodontal health should be carried out as well. These areas need to be scrutinized to potentially improve oral health and in turn, the overall health of individuals with periodontal disease.

Purpose

Through an extensive search of the literature, it appears physical activity does improve many inflammatory conditions additionally to improving periodontal health. Individuals with chronic conditions, such as diabetes and obesity, have observed improvements in their oral health status by using physical activity. Although the benefits of physical activity are numerous there are some gaps in the published literature.

Hypotheses

Considering the findings of Han et al. (2019), it seems likely that those who walk regularly will have a lower incidence of periodontal disease than those who are not physically active. Therefore hypothesis #1 is that there will be a relationship found between the objective measure of average daily walking steps measured by a FitBit and periodontal disease. The literature from Ferreira et al. (2019) suggests that there is a positive relationship with individuals who partake in physical activity and a lower risk of periodontal disease than those who are sedentary. Hypothesis #2 is that there will be a relationship found between the subjective measure of physical activity determined by the self-reported physical activity questionnaire, and periodontal disease. Finally, hypothesis #3 is that there will be a relationship found between BMI, sex, age and socioeconomic status and periodontal disease. This is supported by numerous studies as males, increasing age and lower socioeconomic status all have been linked to an increase in the incidence of periodontal disease (Han et al., 2019; Ferreira et al., 2019; Omori et al., 2018).

Chapter 4. Methodology

Introduction

For this study nonprobability convenience sampling was used, and a letter of information was sent out to eligible participants. In the end, a total of 25 participants (n=25) were used for this study and a cross sectional study design was implemented. Periodontal disease was evaluated following the 2017 American Academy of Periodontology Classification Guide and physical activity levels were determined through the Godin Leisure Time Index physical activity questionnaire and a FitBit fitness tracker. All data was then analyzed in the SPSS software system (version 27).

Paradigm

The research paradigm that this study encompassed was the positivist paradigm. This paradigm sought to answer questions that predict behaviour and used tools to help discover whether a phenomenon was really happening (i.e., If there is a relationship between physical activity and periodontal disease). Historically this paradigm is used in quantitative research (Bunniss & Kelley, 2010).

Research Question

This study sought to answer the following research question: What was the relationship between physical activity, using both the FitBit and a physical activity questionnaire, and periodontal disease, using the 2017 American Academy of Periodontology Classification Guide?

Research Design

To understand if there was a relationship between periodontal disease and physical activity a quantitative approach using a descriptive cross-sectional study design was used in this proposed study. This descriptive cross-sectional study design was an observational study design

where the outcome and the exposures were measured at the same point in time, to better understand the relationship between variables (Setia, 2017; Bowden, 2011).

The goal of this study was to gain reliable data that allowed the researcher to make confident conclusions and generate new hypotheses that could be used in future research (Zangirolami-Raimundo et al., 2018). In cross sectional study designs, participants were selected based of on inclusion and exclusion criteria and were typically used to assess the prevalence of diseases or in population-based surveys (Setia, 2017). Using a cross-sectional study design to assess the relationship between periodontal disease and physical activity was an appropriate study design as it permitted an unobstructive view into the relationship between the variables of this study (Zangirolami-Raimundo et al., 2018).

Sampling

Non-probability convenience sampling was used for this study. The sample population was chosen non-randomly, using subjective methods to decide what inclusion criteria would be used in the study (Battaglia, n.d.). A sample size calculation by G Power Software version 3.1.9.7 based on the power of 0.80, medium effect size (0.15) and beta error probability of 0.05 was completed and recommend a sample size of 68 participants. After considering the scope of this master's thesis and timeline, as well as realistically, how many participants could be recruited for this study, a sample size of 40-60 participants was agreed upon between the principal researcher and thesis supervisor.

Participants

Participant eligibility was determined after an initial assessment exam completed by certified Periodontists at Park Lane Dental Specialists located in Halifax, Nova Scotia, by a thorough periodontal exam determining periodontal status using the American Academy of

Periodontology Classification System (American Academy of Periodontology, 2017). Interrater reliability was ensured as all periodontists are highly trained dental professionals and all used the Hu-Friedy SP86 colour coded probe to assess the participants periodontal status. Participants were included based on the following criteria:

- Adults (>19 years of age)
- Clients of Park Lane Dental Specialists
- Have periodontal disease as defined by the 2017 American Academy of Periodontology Classification Guide
- Have not yet received non-surgical periodontal treatment at Park Lane Dental Specialists

Recruitment

Prospective participants were sent an information letter via their email address (Appendix A). Interested participants were then sent an information letter and those interested contacted the principal investigator to set up a time to talk over the phone to gain some more information about the research study. Only after potential participants had the opportunity to discuss the study, informed consent was received (Appendix B). Participants periodontal health was then assessed by a dental specialist using a dental probe as well as other diagnostic measures, including radiographs, clinical attachment loss (CAL), bleeding on probing and tooth loss. The American Academy of Periodontology Classification System was then used to diagnose a stage and grade of periodontitis (Appendix C). Participants were given a Baseline Intake Physical Activity Questionnaire to collect initial demographic information as well as typical physical activity and walking behaviours (Appendix D). Participants also took home a FitBit fitness tracker to wear for 24hours/day for one week and recorded their daily steps (Appendix E).

Ethics

Ethical approval was obtained from the Athabasca University Ethics Review Board (REB) (Appendix F).

Data collection

Periodontal status was measured at the assessment appointment using the Hu-Friedy SP86 colour coded periodontal probe, looking at various diagnostic criteria including pocket depths, sites of bleeding, tooth loss, clinical attachment loss (CAL) and radiographic bone loss. American Academy of Periodontology Classification System was then used to stage and grade periodontitis (American Academy of Periodontology, 2017).

After the periodontal assessment was complete, participants were given a baseline intake questionnaire that looked at components of physical activity. The participants filled out this questionnaire using the well validated Godin Leisure Time Index to determine the quantity of physical activity they took part in during a typical week and basic demographic information (Godin & Shephard, 1985; Craig et al., 2003). The participants were also given a FitBit that measured steps per day and were required to wear the FitBit for 24 hours a day for one week (Tudor-Locke & Bassett, 2004; Balbim et al., 2021). At the end of the week, the participants had the option to either send their pedometer results via email or in the mail through a postcard.

Measures

Demographic Data. Basic demographic information was collected from all participants through the Baseline Physical Activity Questionnaire. The form that used to collect the data (Appendix C) gave participants an option to report their height and weight either using the imperial or metric system, whatever they were most familiar with. However, since BMI is typically reported in metric units, all height and weight data were converted for consistency. For

this study, age, BMI and income were analyzed and were treated as continuous variables. Sex was also analyzed and was a categorical variable.

BMI. The data collected from the self-reported height and weight were used to calculate the BMI measure. BMI was calculated by dividing an individual's weight (kgs) by height (m^2) and was used to determine if a person was considered underweight, normal weight, overweight or obese compared to the general population (Diabetes Canada, 2023). According to Diabetes Canada (2023) someone has a healthy BMI between the range of 18.5 to 24.9 kg/m^2. An individual would be considered overweight at a BMI of 25-29.9 kg/m^2 and obese with a BMI of over $30kg/m^2$ (Government of Canada, 2021).

Physical Activity. Physical activity was subjectively calculated using the self-reported physical activity questionnaire. Participants reported their typical weekly physical activity, over 10 minutes in length. Physical activity was divided into mild, moderate or vigorous categories and was estimated based on frequency and length of time per week. Physical activity was treated as a continuous variable.

MVPA. MVPA was calculated from each participant's self-reported physical activity data. The length of time was multiplied by the frequency of time in the moderate and strenuous categories of self-reported physical activity data. To lower the incidence of health-related diseases, the World Health Organization (WHO) recommends 150 minutes of physical activity per week (Almohamad, 2022).

Walking Steps. Walking steps were objectively calculated through a FitBit Inspire 2. Each participant wore the FitBit for 24 hours a day for one week and recorded their daily steps. From this, the average daily steps over one week were calculated and used for the purpose of this study. The FitBit was chosen for participants to wear to calculate walking steps as this method

accurately calculated step count 50% of the time (within +/- 3%) in controlled testing settings and tended to underestimate steps (Feehan et al., 2018). The cut off of 7,500 steps per day was used for step count as this is equivalent of meeting the minimum amounts of MVPA per day (Tudor-Locke et al., 2011). Walking steps were treated as a continuous variable.

Data analysis

Data from participant questionnaires was entered using a Microsoft Excel spreadsheet and transferred to the SPSS Statistics software (version 27). Summary data was then presented using relative proportion (for categorical data) and mean and standard deviation (for continuous data). Linear regression analyses were used to measure the relationship between the independent variables (moderate to vigorous physical activity and walking steps) and the dependent variable (periodontal status). Adjustments for covariates including sex, age and socioeconomic status were considered where appropriate (Sweet & Grace-Martin, 1999).

Chapter 5. Results

Introduction

Participants who met the eligibility criteria were sent an invitation letter for this study. Of those that were interested to partake, N= 25 individuals agreed to participate. Linear regression as well as a bivariate regression analysis were used to analyze the participants general characteristics. Linear regression was then used to analyze average weekly walking steps and periodontal disease. Physical activity levels, using a self -reported measurement of moderate to vigorous physical activity (MVPA), and periodontal disease were also analyzed using linear regression.

General participant characteristics

Table 1 demonstrated that most participants (40%) in this study were between the ages of 30-39 with the mean age being 45 (SD= 10) years old. Of the 25 participants, 44% were male, 88% were married and 72% were Caucasian. 80% had a university or trades degree, 76% were full time employees and 52% had an annual household income of 100,000$ or more (Table 1).

Table 1 also reported lifestyle factors associated with periodontitis. 20% of participants reported smoking, 8% have Type 2 Diabetes and 4% smoke and have diabetes. The average daily walking steps were 9217 (SD= 3740). A total of 44% of participants reached the recommended 7,500 steps or more per day (Tudor-Locke et al., 2011) (Table 1). The average body mass index was 27 (SD= 5) and 40% of participants were considered to have normal body mass index (BMI) whereas the remaining 60% were either overweight (28%) or obese (32%) (Table 1).

Table 1.

Participant characteristics (n=25)

Characteristics	Frequency (n=25 %)	Mean (SD)
Sex (% males)	44%	
Age		45 (10)
Marital Status		
Married or common law	88%	
Not married (never married, divorced)	12%	
Education		
High school or less	20%	
University	44%	
Trades	36%	
Income		
$59, 999 or less	8%	
$60,000-79,999	16%	
$80,000-99,999	24%	
$100,000 or more	52%	
Employment		
Full time	76%	
Part time	8%	
Unemployed	4%	
Retired	12%	
Ethnicity		
Caucasian	72%	

Non-Caucasian	28%	
Lifestyle Behaviours		
Smoker	20%	
Type 2 Diabetes	8%	
Smoker & Type 2 Diabetes	4%	
Average daily steps		9216 (3740)
MVPA (minutes)		153 (186.75)
Under 150 minutes	60%	
Over 150 minutes	40%	
BMI (kg/m^2)		27 (5)
Normal	40%	
Overweight	28%	
Obese	32%	

Note: Data presented as the mean (SD= standard deviation) for continuous variables and as a frequency (percentage) for categorical variables. Abbreviations: MVPA, moderate to vigorous physical activity. BMI, Body Mass Index.

Table 2 showed that 76% of participants were diagnosed with more severe periodontitis (stage 3 and 4). Almost half of the participants (48%) were given a diagnosis of grade B.

Table 2.

Periodontitis staging and grading

Periodontitis Stage	**%**
Stage 1	4
Stage 2	20
Stage 3	40
Stage 4	36
Periodontitis Grade	
Grade A	32
Grade B	48
Grade C	20

Note: The periodontitis stage classifies the measurable severity and extent of damaged periodontal tissue because of periodontitis. The grading identifies the rate of progression and risk factors that can contribute to periodontitis worsening over time (AAP, 2017).

After running a crosstabulation analysis, Table 3 further explained the distribution of diagnoses of periodontitis staging and grading of the participants in this study.

Table 3.

Periodontitis staging and grading crosstabulation

Stage	Grade			
	A	B	C	Total
1	0	1	0	1
2	4	1	0	5
3	3	6	1	10
4	1	4	4	9
Total	8	12	5	25

Note: The periodontitis stage classifies the measurable severity and extent of damaged periodontal tissue because of periodontitis. The grading identifies the rate of progression and risk factors that can contribute to periodontitis worsening over time (AAP, 2017).

Ten participants were diagnosed with stage 3 and 9 participants were diagnosed with stage 4 periodontitis (Table 3).

Covariates of periodontal disease

Table 4, 5 and 6 provided an overview of the relationship between periodontitis and demographic characteristics of the sample. The fitted regression model was: Periodontitis stage=3.894 – 0.012 (BMI) + 0.297 (Income) – 0.006 (Age) – 0.484 (Sex= female) (Table 6). The overall regression was not statistically significant ((R^2 = 0.114, F (4,20) = 0.645, p =0.636)) (Table 4 and Table 5).

Table 4.

Regression analysis of periodontitis staging when looking at income, age, sex and body mass index

Regression Analysis	
Multiple R	0.338
R Squared	0.114
Adjusted R Square	-0.063
Standard Error	0.889
Observations	25
Controlling for periodontitis grading	
Multiple R	0.542
R Squared	0.294
Adjusted R Square	0.108
Standard Error	0.814
Observations	25

It was found that BMI (β= -0.012, p= 0.751), income (β=0.297, p= 0.508), age (β= -0.006, p=0.763) or sex (β= -0.484, p= 0.197) were not significantly associated with the periodontitis stage (Table 6).

The fitted regression model when controlling for periodontitis grade was: Periodontitis stage=1.975 + 0.010 (BMI) + 0.085 (Income) + 0.005 (Age) – 0.372 (Sex) + 0.558 (Periodontitis grade) (Table 6). The overall regression indicated that 29.4% (R^2 = 0.294) of the variance in staging was contributed to variables in the model; however, this was not statistically significant (F (5,19) = 1.581, p =0.213)) (Table 4 and Table 5).

Table 5.

ANOVA of periodontitis staging when looking at income, age, sex, and body mass index

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2.040	0.510	0.645	0.636
Residual	20	15.800	0.790		
Total	24	17.840			
		Controlling for periodontitis grading			
Regression	5	5.243	1.049	1.581	0.213
Residual	19	12.597	0.663		
Total	24	17.840			

It was found that BMI (β= 0.010, p= 0.244), income (β=0.085, p= 0.840), age (β= 0.005, p=0.775), sex (β= -0.372, p= 0.281) were not significantly associated with the periodontitis stage. Periodontitis grade (β=0.558, p= 0.041) was found to be associated with the periodontitis stage (Table 6).

Table 6.

Coefficients table of periodontitis staging when looking at age, sex and body mass index (n=25)

	Coefficients	Standard Error	T Stat	P-value	Lower 95%	Upper 95%
Intercept	3.894	1.517	2.567	0.018	0.730	7.059
BMI	-0.012	0.039	-0.321	0.751	-0.093	0.068
Income	0.297	0.440	0.674	0.508	-0.621	1.214

Age	-0.006	0.018	-0.305	0.763	-0.043	0.032
Sex 0= male, 1= female	-0.506	0.339	-1.495	0.148	-1.207	0.194
		Controlling for periodontitis grading				
Intercept	1.975	1.641	1.203	0.244	-1.460	5.410
BMI	0.010	0.037	0.266	0.793	-0.067	0.087
Income	0.085	0.414	0.204	0.840	-0.783	0.952
Age	0.005	0.017	0.290	0.775	-0.031	0.041
Sex 0= male, 1= female	-0.393	0.310	-1.265	0.219	-1.036	0.251
Perio grade	0.532	0.217	2.454	0.023	0.082	0.981

Note: Sex is coded as 0 and 1 therefore it is bi-serial, R^2=0.114, R^2 (when periodontitis grading is controlled) =0.294, F= 0.645, F (when periodontitis is controlled)=1.581. Perio = periodontitis.

A bivariate analysis was also used to examine the relationship between covariates and staging, as the number of participants were not large (Table 7). A commonly used rule of thumb when running a multiple regression is a minimum of 10 observations per variable (Pennsylvania State University, 2018). The results confirmed what was observed in the multiple regression analysis as no relationship was found between the periodontal staging and grading when looking at covariates.

Table 7.

Bivariate analysis of the covariates (n=25)

		Perio stage	BMI	Income	Sex	Age	Perio grade
Perio stage	Pearson Correlation	1	0.004	0.164	-0.298	-0.084	0.482
	Sig. (2-tailed)		0.984	0.433	0.148	0.688	0.015
BMI	Pearson Correlation	0.004	1	0.310	-0.109	0.029	-0.194
	Sig. (2 tailed)	0.984		0.132	0.605	0.892	0.354
Income	Pearson Correlation	0.164	0.310	1	-0.121	-0.030	0.169
	Sig. (2 tailed)	0.433	0.132		0.565	0.885	0.420
Sex	Pearson Correlation	-0.298	-0.109	-0.121	1	0.047	-0.150
	Sig. (2 tailed)	0.148	0.605	0.565			0.475
Age	Pearson Correlation	-0.084	0.029	-0.030	0.047	1	-0.283

	Sig. (2 tailed)	0.688	0.892	0.885	0.822		0.171
Perio grade	Pearson Correlation	0.482	-0.194	0.169	-0.150	-0.283	1
	Sig. (2 tailed)	0.015	0.354	0.420	0.475	0.171	

Note: Correlation is significant at 0.05 level (2-tailed), Perio= periodontitis

Periodontal disease and average daily walking steps

Tables 8, 9 and 10 provide an overview of the relationship between periodontitis and average daily walking steps over one week. The fitted regression model was: Periodontitis stage=2.957 + 1.333E-5 (Table 10). The overall regression was not statistically significant ((R^2 = 0.003), F (1,23) = 0.077, p =0.784)) (Table 8 and 9).

Table 8.

Regression analysis of periodontitis staging when looking at daily average walking steps over one week

Regression Analysis	
Multiple R	0.058
R Squared	0.003
Adjusted R Square	-0.040
Standard Error	0.879
Observations	25
Controlling for periodontitis grading	
Multiple R	0.487
R Squared	0.238
Adjusted R Square	0.168
Standard Error	0.786
Observations	25

It was found that average daily walking steps (β= 1.333E-5, p= 0.784) was not significantly associated with periodontitis (Table 10). The fitted regression model when controlling for periodontitis grade was: Periodontitis stage=1.847 + 1.642 E-5 +0.575 (Table 9).

Table 9.

ANOVA table of periodontitis staging when looking at daily average walking steps over one week

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.060	0..060	0.077	0.784
Residual	23	17.780	0.773		
Total	24	17.840			
		Controlling for periodontitis grading			
Regression	2	4.237	2.119	3.427	0.051
Residual	22	13.603	0.618		
Total	24	17.840			

The overall regression was not statistically significant ((R^2 = 0.238), F (2,22) = 3.427, p =0.051)) (Table 8 and 9). It was found that average daily walking steps (β= 1.642 E-5, p= 0.706) was not associated with periodontitis when controlling for grade. However, periodontitis grade (β=0.575, p=0.016) was found to be associated with the periodontitis stage (Table 10).

Table 10.

Coefficients table of periodontitis staging when looking at daily average walking steps over one week (n=25)

	Coefficients	Standard Error	t-stat	P-value	Lower 95%	Upper 95%
Intercept	2.957	0.476	6.213	<0.001	1.973	3.942
Avr walk	1.333E-5	0.000	0.278	0.784	0.000	0.000
		Controlling for periodontitis grading				
Intercept	1.847	0.476	3.064	0.006	0.597	3.098
Avr walk	1.642E-5	0.000	0.382	0.706	0.000	0.000
Perio grade	0.575	0.221	2.599	0.016	0.116	1.034

Note: R^2=0.003, R^2 (when periodontitis is controlled)=0.238, F= 0.077, F (when periodontitis is controlled)= 3.427, Avr walk is the average amount of daily steps participants took in one week recorded by a FitBit watch; Avr = average; perio = periodontitis.

Periodontal disease and weekly moderate to vigorous physical activity

Table 11, 12 and 13 provided an overview of the relationship between periodontitis disease and the weekly moderate to vigorous physical activity levels of the participants (MVPA). The fitted regression model was: Periodontitis stage=3.123 + 0.000 (Table 13). The overall

regression was not statistically significant ((R^2 = 0.004), F (1,23) = 0.086, p =0.086)) (Table 11 and 12). It was found that MVPA (β= 0.000, p= 0.772) was not associated with periodontitis stage (Table 13).

Table 11.

Regression analysis of periodontitis staging when looking at moderate to vigorous physical activity levels per week

Regression Statistics	
Multiple R	0.061
R Squared	0.004
Adjusted R Square	-0.040
Standard Error	0.87907
Observations	25
Controlling for periodontitis grading	
Multiple R	0.482
R Squared	0.232
Adjusted R Square	0.163
Standard Error	0.78893
Observations	25

The fitted regression model when controlling for periodontitis grade was: Periodontitis stage =2.002 + 0.6.248E-6 +0.573 (Table 13). The overall regression was not statistically significant ((R^2 = 0.232), F (2,22) = 0.3.331, p =0.054)) (Table 11 and 12).

Table 12.

ANOVA table of periodontitis staging when looking at moderate to vigorous physical activity levels per week

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.067	0.067	0.086	0.772
Residual	23	17.773	0.773		
Total	24	17.840			
		Controlling for periodontitis grading			
Regression	2	4.147	2.073	3.331	0.054
Residual	22	13.693	0.662		
Total	24	17.840			

It was found that MVPA (β= 6.248E-6, p= 0.994) was not associated with periodontitis. However, periodontitis grade (β=0.573, p= 0.018) was associated with periodontitis stage (Table 13).

Table 13.

Coefficients table of periodontitis staging when looking at moderate to vigorous physical activity levels per week (n=25)

	Coefficients	Standard Error	t-stat	P-value	Lower 95%	Upper 95%
Intercept	3.123	0.229	13.628	<0.001	2.649	3.597
MVPA	0.000	0.001	-0.293	0.772	-0.002	0.002
		Controlling for periodontitis grading				
Intercept	2.002	0.484	4.137	<0.001	0.998	3.005
MVPA	6.248E-6	0.001	0.007	0.994	-0.002	0.002
Perio grade	0.573	0.224	2.560	0.018	0.109	1.037

Note: R^2=0.004, R^2 (when periodontitis is controlled) = 0.232, F= 0.086, F (when periodontitis is controlled for)=3.331, MVPA, moderate to vigorous physical activity; perio, periodontitis.

Summary

The results of this study found no relationship between the participants characteristics and periodontal disease. Moreover, no relationship was found between physical activity, from both walking steps and moderate to vigorous physical activity levels, and periodontal disease.

Chapter 6. Discussion

The aim of this cross-sectional study was to establish a relationship between periodontal disease and physical activity. Physical activity was assessed subjectively, through self-reported physical activity questionnaires and objectively, using a FitBit to track participants daily steps for one week. We discovered that both daily walking steps and MVPA had no relationship with periodontal disease stage. This study was the first to look at finding a relationship between physical activity and periodontal disease through objective and subjective measures, using the new 2017 American Academy of Periodontology Periodontitis Classification System.

Support for Hypotheses

All findings for this study do not support the hypotheses and furthermore, it was difficult to determine if the null findings were true or due to the small sample size. Hypothesis #1 was that there would be a relationship found between average daily walking steps and periodontal disease. This hypothesis was made based on the findings from Han et al. (2019) that found walking have a positive correlation to a lower incidence of periodontal disease. Hypothesis #2 was that there would be a relationship found between physical activity and periodontal disease. This study was supported by the findings of Ferreira et al. (2019) that showed individuals who were most physically active had a lower rate of periodontal disease. Hypothesis #3 was that there would be a relationship found between covariates (ie. sex, socioeconomic status and age) and periodontal disease. This hypothesis was made based on the findings of several studies by Han et al. (2019), Ferreira et al. (2019) and Omori et al. (2018).

When covariates (age, sex, income and body mass index (BMI)) were analyzed, we did not observe a significant relationship found between any covariate and the dependent variable (periodontitis stage). One study had found an association between lower socioeconomic status and an increased risk of developing periodontitis (Han et al, 2019). Another study found that age was correlated to the development of periodontitis as adults over the age of 65 had an increased risk of developing this disease (Almohamad et al., 2022). In a cross-sectional study by Iwasaki et al (2021) sex was found to be an important predictor in the development of periodontitis, as Japanese women who were more physically active had better periodontal health. However, there was no relationship found between physical activity and men in this same study (Iwasaki et al., 2023). The relationship between sex and periodontitis is conflicting as Almohamad et al. (2022) reported that males had a higher prevalence of periodontal disease than women.

On average, individuals diagnosed with periodontal disease in our study walked 9217 (SD=3740) steps per day. Only one other recent study has looked solely at the effect that walking had on periodontal health. This cross-sectional study concluded that routine walking, as defined by the International Physical Activity Questionnaire (IPAQ), had a significant impact on lowering the prevalence of periodontitis than those that did no walking (Odds Ratio (OR)=0.793, CI= 0.699, 0.898) (Han et al., 2019). After adjusting for age, sex , income, education level, diabetes and smoking, it was found that regular walking had a preventative effect on developing periodontitis (OR= 0.793, CI= 0.699–0.898) (Han et al., 2019).

The results of our study demonstrated that the participants took part in, on average, 153 (SD=183.75) minutes of MVPA per week. Based on our results, we found no association between periodontitis stage and moderate to vigorous physical activity (MVPA). An instrumental variable study conducted by Baumeister et al. (2023), used the International Physical Activity Questionnaire (IPAQ) and found that there was no clear evidence to associate a relationship between moderate to vigorous physical activity and the risk of periodontitis. A correlation study was carried out using the Global Physical Activity Questionnaire and found that any leisure MVPA was associated with lower risk of periodontal disease compared to individuals reporting no leisure MVPA (36.7% vs 56.5%, $p < 0.001$) (Almohamad et al., 2022). In this same study, higher rates of sedentary behaviour were also found to be correlated with higher prevalence of periodontal disease (49.1% vs 59.8%, $P < 0.001$) (Almohamad, 2022). A cross sectional study of Korean adults was conducted by Hwang et al. (2022) and their findings concurred with previous studies as those who took part in the recommended physical activity per week had a lower incidence of periodontal disease. Physical activity was considered to have a protective effect on

the development of periodontal disease as it reduced the inflammatory markers (such as c-reactive proteins) systemically (Hwang et al., 2022).

A correlational study by Ferreira et al. (2019) found that individuals who were physically active and former smokers had a 74% decreased prevalence of periodontitis than those who were not physically active. Additionally, a randomized control trial looked at the effects of implementing a 6-month sports intervention for individuals with Type 2 Diabetes. A total of 37 individuals were randomly assigned to either aerobics, strength, strength and aerobics or a control group. It was found that a regular sports routine had a significant beneficial impact on periodontal health and overall HbA1C levels compared to a control group who did not partake in the intervention (Wernicke et al., 2021).

Our study is difficult to generalize to a larger population as participants all lived in Nova Scotia and were referred patients to a periodontal specialists' office (Park Lane Dental Specialists). The majority (72%) of participants were Caucasian, the mean age was 45 (SD= 10) years old, 80% had a university degree, 52% had household incomes of over $100,000. Future studies should look to include a more diverse population such as different ethnicities, socioeconomic status, and age ranges.

Strengths and Limitations

This study had some strengths. It was the first study conducted using the new 2017 American Academy of Periodontology Classification Guide on periodontal disease diagnosis looking to find a relationship with physical activity. Another strength of this study was using a combination of both objective (FitBit fitness trackers) and subjective (physical activity questionnaires) measures to collect data. This was beneficial as the use of questionnaires only

(subjective) could be inaccurate (ie. Participants may over or underestimate their physical activity levels).

This study had several limitations and could be the reasons why none of the hypotheses were supported. First off, the study was underpowered and this was a major limitation. The recruitment of participants for this study were based on the patients who came to Park Lane Dental Specialists for an appointment. The principal researcher did not have any influence on the way the patients were booked so this could be one of the reasons sample size was small. A small sample size, such as in this study, would need a large effect size to reach significance. Typically, small sample sizes results in large standard error that lack statistical power (Pennsylvania State University, 2018). Another reason the sample may not have been representative was because convenience sampling was used to recruit participants and unfortunately this method did not recruit enough participants with different stages and grades of periodontal disease. Most of the participants in this study were diagnosed with more severe stages and grades of periodontitis. One explanation for this is that more severe cases of periodontitis are easier to diagnose than the "grey area" initial stages (stage 1 and stage 2, grade A and B) (Buffoli et al., 2019).

Another limitation was in the data analysis of the variables. In this study we looked at comparing a discrete dependent variable (periodontal stage and grade) with continuous independent variables (walking steps and MVPA in minutes). This may have caused some differences in the results that we saw in this study compared to if we had two discrete independent variables. Cross-sectional analysis was another weakness in this study as we can only discover if a relationship exists between two variables and cannot determine a cause-effect association (Setia, 2017).

Physical activity questionnaire data could have been skewed as participants may not have accurately assessed their weekly physical activity levels or misinterpreted the questions. This could have been a reason why there was no relationship found between MVPA and periodontal disease. Wearing the FitBit fitness device continuously for 7 days also may have been an answer to why the hypothesis of walking and periodontal disease was not supported. Participants may have forgotten to wear the device if they happen to take it off to charge it or for an activity that did not allow them to keep the device on. This would have led to a misrepresentation of the walking data. Furthermore, some participants were very active in their profession (ie. working in construction) but did not partake in any moderate to vigorous physical activity outside of their jobs. Their daily walking steps were remarkably over the 7,500 steps per day cut off that this study looked at but their MVPA scores were negligible.

Finally, there was a limitation on the technology used for the FitBit fitness tracker. Some potential participants did not feel comfortable to use this type of technology, which involved syncing the device to a downloaded application on a smartphone to track walking steps. Some participants declined to partake in this study for this reason. Additionally, some potential participants' phones could not download the FitBit application due to the age and/or model of the phone.

Future Directions

The current literature on physical activity and periodontal health is minimal so further research in this area would be beneficial. Given the minimal statistical power due to sample size in this study, future studies should look at increased sample sizes to establish a relationship between physical activity and periodontal disease. With an increase in sample size, it is likely that a more diverse population would be represented. Looking at participants from different

ethnic, socioeconomic and educational backgrounds as well as a more diverse age range may be beneficial to future research.

Moreover, using other study designs in the future, such as randomized control trials, could strengthen the data and may be more valuable in establishing a causal effect of physical activity and periodontal disease. Finally using different devices to track walking steps, such a pedometer, may be beneficial in recruiting more participants and diversifying the studied population.

Chapter 7. Conclusion

Periodontal disease is a major, inflammatory oral health problem that affects many individuals. Previous studies had suggested that physical activity improved other chronic, inflammatory conditions such as diabetes and obesity. It was hypothesized that by using a cross sectional methodology it would be possible to examine a relationship between periodontal disease and physical activity. However due to some of the study limitations, no association was found between periodontal disease and the independent variables of walking and MVPA. Still this study was able to add information regarding the 2017 American Academy of Periodontology Classification System as this was the first study to use this classification system looking to establish a relationship with physical activity. Further studies using this classification system and addressing the limitations could potentially help to guide future research and treatment options for periodontal disease.

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Appendix A: Letter of Information

Physical Activity and the Periodontal Status in Adults Over the Age of 19

Principal Researcher:
Anastasia Karst
akarst1@athabascau.edu

Supervisor:
Dr. Steven Johnson
sjohnson@athabascau.ca

Introduction
My name is Anastasia Karst and I am a Masters of Health Studies student at Athabasca University. As a requirement to complete my Masters of Health Studies degree, I am conducting a research project about the relationship between physical activity and periodontal disease (gum disease). I am conducting this project under the supervision of Dr. Steven Johnson.

This form is part of the process of informed consent. The information presented should give you the basic idea of what this research is about and what your participation will involve, should you choose to participate. It also describes your right to withdraw from the project. In order to decide whether you wish to participate in this research project, you should understand enough about its risks, benefits and what it requires of you to be able to make an informed decision. This is the informed consent process. Take time to read this carefully as it is important that you understand the information given to you. Please contact the principal investigator, Anastasia Karst, if you have any questions about the project or would like more information before you consent to participate.

It is entirely up to you whether or not you take part in this research. If you choose not to take part, or if you decide to withdraw from the research once it has started, there will be no negative consequences for you now, or in the future. This also includes any current or future dental care at Park Lane Dental Specialists.

Background:
Periodontal disease (gum disease) is a major public health concern that affects a large portion of the population and can not only lead to adverse oral health problems it also has large economic costs. Periodontal disease starts with localized inflammation that can then move systemically and can lead to tooth mobility, tooth loss and other health concerns if left untreated. Research has shown that there is a relationship between physical activity and the inflammatory component of many chronic diseases, including periodontal disease. Anastasia Karst, a master's student at Athabasca University, along with guidance from her supervisor Dr. Steve Johnson, will conduct research on physical activity and periodontal health. The goal of this research project is to see if physical activity has a relationship with periodontal health status. Since your periodontal health has been assessed and you have periodontal disease, we are asking for your participation in this cross sectional study to determine if there is a relationship between physical activity and periodontal disease.

Why are you being asked to take part in this research project?
You are being invited to participate in this project because you meet the inclusion criteria which includes the presence of periodontal disease (gum disease).

What is the purpose of this research project?

The purpose of this study is to look at the relationship between physical activity and periodontal status. This project hopes to answer questions about whether those who are more physically active have better periodontal status than those who are sedentary.

Your role in this study:

You are being asked to take part in a research study that will focus on the relationship between physical activity and periodontal status. Your baseline periodontal health status will be evaluated by a dental professional. After this, you will be asked to fill out a physical activity questionnaire to assess how physically active you typically are. A FitBit tracker will also be given to you at this time which you will wear for 1 week and record your daily steps. Demographic information, such as age and gender, will be collected from your patient chart at Park Lane Dental Specialists.

What will you be asked to do?

You will be asked to take part in an in-person evaluation of your periodontal status at Park Lane Dental Specialists, at a time convenient to your schedule. This evaluation appointment will be completed by a licensed dental professional. The initial evaluation will take approximately 1 hour and will look at various markers of periodontal health using the American Academy of Periodontology classification system.

You will then be asked to fill out a physical activity questionnaire that will evaluate how active you typically are. A FitBit tracker will also be given to you to wear for 1 week and you will record your daily steps.

Data will be collected: Data will be collected using three different methods for the purpose of this study.

Periodontal Exam: Your periodontal health status will be assessed using the American Academy of Periodontology (AAP) Classification System. A periodontal probe will measure the periodontal pockets around your teeth and the number of missing will be recorded. The stage and grade of your periodontal disease will then be calculated following the AAP guidelines.

Physical Activity Questionnaire: You will be asked to complete the Godin Leisure Time Index questionnaire about your typical physical activity levels. This questionnaire will ask you to reflect on how active you are during a normal week by looking at the frequency and intensity you take part in physical activity.

FitBit: You will be asked to wear a FitBit and to record your daily steps for 1 week. This will allow us further insight into how physically active you are in a typical week.

Benefits to you

The main benefit of participating in this study will be the potential for improved periodontal status and oral health practices as well as a better understanding of your oral health. Another benefit will be discovering if there is a relationship between periodontal disease and physical

activity. This potential relationship could be advantageous to further studies and treatment options for periodontal disease.

Risks to you

The main risk to you through participating in this research study would be the potential for your periodontal status to stay the same or worsen throughout the course of the study duration. Another risk of this study could be some discomfort felt during the periodontal assessment.

Confidentiality

All personal information relating to this study will be kept confidential. Only the principal investigator and research staff will have access to your personal information. Any data that is collected throughout this research study will be given a unique ID code and your name will not be used.

Data will be collected at Park Lane Dental Specialists and then entered in an electronic database on a computer that is password-protected. Any data that is entered into this electronic database will also be only accessible by using a password and access to these files will be limited to the principal investigator and supervisor, who will access data through a secured, shared network.

Any published report related to this study will not use your name. Any data collected for the purpose of this study will be kept, in accordance with Athabasca University and the University of Alberta policy, for a minimum of five years before destruction of files.

Results of this study will be used to help fulfill the requirements of a masters level thesis. A summary of results can be emailed to you if you are interested.

Incentives and compensation

The cost that you will incur by taking part in this study is the cost of your dental evaluation/periodontal therapy appointment (dental cleaning).

You will be able to keep the FitBit provided to you for this study. Parking for the duration of your appointment times will be provided to you by Park Lane Dental Specialists.

There will be no other incentives provided. You will be responsible to pay for the dental treatments received, either through personal private insurance or paying out of pocket.

What happens if I decide to withdraw my consent to participate in this study?

Participation in this study is entirely voluntary and you may withdraw your participation at any point. If you decide to longer participate in this study, there will be no penalty or loss of benefits to you in any way, including your dental care.

What do I do if I have any questions or concerns throughout the duration of this study?

If you have any questions, need clarification or would like more details prior to or throughout the duration of this study, please contact the principal researcher Anastasia Karst at akarst1@athabascau.edu

Who do I contact if I have any questions about my legal rights as a participant in this study?

Participation in this study is entirely voluntary and you have the right to leave this study at any point. It is also important to note that by signing this consent form, you are not giving up any of your legal rights.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Athabasca University Research Ethics Board (REB) by calling 1-800-788-9041 Monday through Friday 8:30am – 4:30pm MST; or through email at rebsec@athabascau.ca.

Thank you for your assistance in this project.

Appendix B: Consent

CONSENT:

I have read the Letter of Information regarding this research study, and all of my questions have been answered to my satisfaction. I will keep a copy of this letter for my records.

My signature below confirms that:

- I understand the expectations and requirements of my participation in the research;
- I understand the provisions around confidentiality and anonymity;
- I understand that my participation is voluntary, and that I am free to withdraw at any time with no negative consequences;
- I am aware that I may contact the researcher or the Research Ethics Officer if I have any questions, concerns or complaints about the research procedures or ethical approval processes.
- I understand that the data I provide will be anonymized and that data set (or sets) from this project will be stored in a MacBook Air kept in a locked drawer.

Name: _____

Date: _____

Signature: _____

I would like to receive a copy of the results of this research study by:

e-mail address: _____

Appendix C: Periodontal Classification System

PERIODONTITIS: STAGING

Staging intends to classify the severity and extent of a patient's disease based on the measurable amount of destroyed and/or damaged tissue as a result of periodontitis and to assess the specific factors that may attribute to the complexity of long-term case management.

Initial stage should be determined using clinical attachment loss (CAL). If CAL is not available, radiographic bone loss (RBL) should be used. Tooth loss due to periodontitis may modify stage definition. One or more complexity factors may shift the stage to a higher level. See **perio.org/2017wwdc** for additional information.

	Periodontitis	Stage I	Stage II	Stage III	Stage IV
Severity	**Interdental CAL** *(at site of greatest loss)*	1 – 2 mm	3 – 4 mm	≥5 mm	≥5 mm
	RBL	Coronal third (<15%)	Coronal third (15% - 33%)	Extending to middle third of root and beyond	Extending to middle third of root and beyond
	Tooth loss *(due to periodontitis)*	No tooth loss		≤4 teeth	≥5 teeth
Complexity	**Local**	• Max. probing depth ≤4 mm • Mostly horizontal bone loss	• Max. probing depth ≤5 mm • Mostly horizontal bone loss	In addition to Stage II complexity: • Probing depths ≥6 mm • Vertical bone loss ≥3 mm • Furcation involvement Class II or III • Moderate ridge defects	In addition to Stage III complexity: • Need for complex rehabilitation due to: – Masticatory dysfunction – Secondary occlusal trauma (tooth mobility degree ≥2) – Severe ridge defects – Bite collapse, drifting, flaring – < 20 remaining teeth (10 opposing pairs)
Extent and distribution	**Add to stage as descriptor**	For each stage, describe extent as: • Localized (<30% of teeth involved); • Generalized; or • Molar/incisor pattern			

Appendix D: Baseline Intake Physical Activity Questionnaire

Baseline Intake Physical Activity Questionnaire

[to be completed following Informed consent]:

The following survey includes questions about your physical activity, and about yourself.

SECTION A: PHYSICAL ACTIVITY

A1.
We would like you to recall your <u>average weekly physical activity</u> over the past month.
Think of an average week in the past month (IE. How many times (sessions) and for how long did you do the following kinds of activity?)
Only count sessions that were for more than 10 minutes and were during <u>your free time.</u>
Please:

- Only count physical activity sessions that lasted **10 minutes or longer**.
- Do not count physical activity like housework or activity done at work.
- **If you have not performed any physical activity, please enter '0' in that space.**

In an average week my physical activity is:

	Times per week	**Average length of each session**
a. Strenuous physical activity (heart beats rapidly, sweating) (e.g., running, jogging, hockey, soccer, squash, judo, vigorous swimming, vigorous long distance bicycling, vigorous aerobic dance classes, heavy weight training)		
b. Moderate physical activity (not exhausting, light perspiration) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, popular and folk dancing)		
c. Mild physical activity (minimal effort, no perspiration) (e.g., easy walking, yoga, archery, fishing, bowling, lawn bowling, shuffleboard, horseshoes, golf, gardening)		

A2. [Walking questions from the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003)]
The following questions are about the walking you did in the **LAST 7 DAYS** at work, getting from place to place, and for recreation, sport, physical activity or leisure.

A2a. The first question is about the walking you do at WORK ONLY. Work includes paid and unpaid work (volunteer) you do outside of your home. Do not include unpaid work you do at home such as housework, or any walking you do to travel to or from work.

During the **last 7 days** on how many days did you walk for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____ days per week OR None --- go to question 2

How much time did you usually spend on ONE of those days **walking** from place to place?
_____hours _____ minutes per day.

A2b. This question is about **walking you do to travel from place to place ONLY**, including walking to and from places like work, stores, movie stores, coffee shops and so on.

During the **last 7 days** on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____days per week OR None --- go to question 3

How much time did you usually spend **on ONE of those days** walking from place to place?
_____hours _____ minutes per day.

A2c. This question is about walking **you do for recreation, sport, physical activity or leisure ONLY.** This does **NOT** include walking you do to get from one place to another, like walking from home to a movie store or from work to a coffee shop.

Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ days per week OR None

How much time did you usually spend on **ONE of those days** walking in your leisure time?
_____hours _____minutes per day.

A3. Sedentary Behaviour
Occupational Sitting and Physical Activity Questionnaire (OSPAQ)]:

The next few questions are about your activities during workday. First,

a) How many hours did you work in the last 7 days? _____ hours

b) During the last 7 days, how many days were you at work? _____ days

We are interested in knowing what percent of your WORK time spend doing 4 activities: sitting, standing, walking, and doing heavy labor or physically demanding tasks in your typical work day in the last 7 days. This involves only your work day, and does NOT include travel to and from work, or what you did in your leisure time.

c) What percent of your typical work day in the last 7 days would you say that you spend:

1. Sitting (including driving)?	_____**%**
2. Standing?	_____**%**
3. Walking?	_____**%**
4. Heavy labour or physically demanding tasks?	_____**%**
Total	_____**%**

(NOTE: Make sure the total adds up to 100%)

SECTION B: Demographics

These last few questions are about you. This information is useful for describing the people who completed the survey.

G1 What is your age?

_____ YEARS OLD

G2 What is your CURRENT marital status?

1 Single (never married)
2 Married
3 Common-Law Relationship/Live-In Partner
4 Separated/Divorced
5 Widowed

G3 What level of education have you achieved?

1 Some high school
2 Completed high school
3 Trades certification/college diploma
4 University degree

G4 How would you best describe your ethnic background?

1 First Nation
2 Métis
3 Inuit
4 Asian
5 Latin, South American
6 Arab
7 Caucasian/White
8 African/African-Canadian
9 Other, please specify _____

G5 What is the average annual income for your HOUSEHOLD for the past year, BEFORE taxes and deductions? (Household includes immediate family members residing together. We're just looking for a ballpark figure.)

1 Less than $20,000
2 $20,000 to $59,999
3 $60,000 to $79,999
5 $80,000 to $99,999
6 $100,000 or more
7 prefer not to answer

G6 What is your current employment status?
1 Full-time paid employee
2 Part-time paid employee
3 Casual employee
4 Other, please specify_____

G7 What is your occupation?

_____

G8 a [BMI]
What is your current height?
_____ feet _____ inches OR _____ centimeters

G8 b
What is your current weight?

_____ pounds OR _____ Kilograms

THANK YOU FOR COMPLETING THIS SURVEY!

_____ _____
First Name Last Name

_____ _____
_____
Mailing address City Postal code

_____ _____
Email address Phone Number

Appendix E. Walking steps form

Physical Activity and Periodontal Disease Study
-Walking Steps Per Day-

Name:
Date:

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Appendix F: Ethics Approval

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL

The Athabasca University Research Ethics Board (REB) has reviewed and approved the research project noted below. The REB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) and Athabasca University Policy and Procedures.

Ethics File No.: **25062**

Principal Investigator:
Ms. Anastasia Karst, Graduate Student
Faculty of Health Disciplines\Master of Health Studies

Supervisor/Project Team:
Dr. Steven (Dr.) Johnson (Supervisor)

Project Title:
Physical Activity and the Periodontal Status in Adults Over the Age of 19

Effective Date: February 24, 2023 **Expiry Date**: February 23, 2024

Restrictions:

Any modification/amendment to the approved research must be submitted to the AUREB for approval prior to proceeding.

Any adverse event or incidental findings must be reported to the AUREB as soon as possible, for review.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

An Ethics Final Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date: February 24, 2023**

Barbara Wilson-Keates, Chair
Faculty of Health Disciplines, Departmental Ethics Review Committee

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Athabasca University Research Ethics Board
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