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Oral health in a cohort of individuals on a plant-based diet: a pilot study

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Abstract

Introduction. Plant-based diets are associated with a lower: (i) body mass index, (ii) rates of death from ischemic heart disease, (iii) serum cholesterol, (iv) incidence of high blood pressure, (v) type II diabetes mellitus and cancer, with an overall longer life expectancy. However, little data concerning the oral health in individuals on a plant-based diet are available.

Aim. The aim of the present study was to investigate the general and clinical oral health status in a cohort of adults who had been following a plant-based diet for a minimum of 24 months.

Materials And Methods. For this purpose, individuals were administered two questionnaires (a.Questionnaire investigating risk areas for oral diseases; b. Italian version of the Oral Health Impact Profile -14 (IOHIP-14)) by a dental hygienist and clinical examination of the oral cavity was carried out.

Results. Seventy-seven adult individuals were enrolled. On average, they followed a plant-based diet for the last four years, had four meals a day and brushed their teeth twice a day. Fruit was the most frequently consumed food at breakfast by 48 of the participants. Thirty-four responders did not drink beer or wine, 65 did not drink spirits, 57 avoided carbonated beverages and 62 (80.5%) did not consume any highly-sugared beverages. Different dental therapies in the previous three years were reported in 36 of the responders. Overall, answers "never and almost never" to the IOHIP-14 questionnaire were observed in 87% to 100% of the individuals. Multiple logistic regression analysis revealed that fresh fruit consumption at lunch had a protective effect against caries ($p < 0.05$).

Conclusion. In conclusion, this study showed that individuals on a plant-based diet have good overall oral health conditions. These features are in agreement with the behavior of these subjects towards an overall healthy life style. ***Clin Ter 2020; 171 (2):e142-148. doi: 10.7417/CT.2020.2204***

Key words: *vegan, vegetable diet, lifestyle habits, dietary patterns, plant-based diet, oral hygiene, dental hygiene*

Introduction

According to the 2017 Eurispes report, 3% of Italians consume a plant-based diet (1.800.000 people), with a suggestive increasing trend in comparison with previous reports. In India, the birthplace of vegetarianism based on religious beliefs, approximately 30% of the population consumes a plant-based diet or is vegetarian (1). In Europe, Germany is the country with the most vegetarians (7 millions of people) (2), while approximately 5% of people in Great Britain are vegetarian and, according to data from the British Vegetarian Society, at least 2 thousand people switch to a vegetarian diet every week (3). While vegetarian diets are also based on food from animals, such as milk, milk derivatives and eggs, a plant-based diet exclude all kinds of animal meat (red meat, poultry and/or fish) or derived products (dairy, eggs). Vegan diet components encompass a whole-food plant-based nutrition including whole grains, vegetables, legumes and soy, nuts, seeds and fruits (4-5).

Although, apparently, a plant-based diet goes against most of the dietetic recommendations widely found in the literature, clinical and epidemiological studies conducted over the past 30 years show that the choice of a plant-based diet is associated with a lower body mass index, lower rates of death from ischemic heart disease, lower serum cholesterol and a lower incidence of high blood pressure, diabetes mellitus type II and cancer (prostate and colon) (6-13). Moreover, Tracy et al. found that plant-based diets are associated with a longer life expectancy compared to other diets of the general population (14).

Recently, the Academy of Nutrition and Dietetics published its position paper on plant-based diets, stating that such diets are appropriate throughout the entire life cycle, providing that they are appropriately planned. These diets have to be considered healthful, nutritionally adequate and capable of providing health benefits for the prevention and treatment of certain diseases. This position paper was adopted by the House of Delegates Leadership Team in 1987 and has been periodically reviewed and recently confirmed (15).

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To the best of Authors' knowledge, there is little available data on oral health in individuals consuming a plant-based diet. Some epidemiological studies (16-19) suggest a multifactorial etiology for white spot lesions (incipient enamel demineralization), dental erosion, erosive tooth wear and abrasion, for which special nutrition habits, such as plant-based and raw plant-based diets, may play a significant etiological role. On the other hand, the same authors reported a lower incidence of gingival inflammation and better overall oral care among individuals on a plant-based diet. A recent clinical study by Laffranchi et al. (16) found a higher prevalence of white spot lesions on buccal surfaces and a more acidic salivary pH in a sample population of 15 subjects following a plant-based diet than in 15 control subjects.

The aim of the present study was to investigate the general and clinical oral health status of a cohort of adults who had been following a plant-based diet for a minimum of 24 months. No data were available on the subjects 'previous oral and general medical conditions.

Material and methods

Study Design

Sample size

Since there were no data in Literature on which to base our survey, and considering the rarity of the plant-based condition, we considered >=70 as a reasonable sample to obtain a preliminary estimate.

Study Design

Seventy-seven adult individuals (35 males, 42 females; range 21–67) following a plant-based diet for a minimum of 24 months were enrolled in a two-phase clinical observational study. Subjects were recruited mainly through social networks in Central and North Italy in September 2015. Exclusion criteria: individuals with relevant medical conditions and not adherent to vegan diet for a minimum of 24 months. Study duration was of 6 months. A signed informed consent form was required from all individuals prior to participation in the study. The study was approved by the Institutional review board of territorial NHS facilities (n. 3003). The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki.

The first phase (P1) consisted of the administration of two questionnaires by a dental hygienist. In the second phase (P2), a subset of the overall cohort underwent a clinical examination of the oral cavity carried out by a team "dentist / hygienist" at the 1st Observation Unit of Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome.

Data collection

P1 - survey phase

The first questionnaire investigated risk areas for oral diseases. It consisted of 43 questions and reported on several phageal reflux disease (GERD), drug intake, smoking/alcohol consumption, oral health problems and dentine hypersensitivity. The second questionnaire was the Italian version of the Oral Health Impact Profile -14 (IOHIP-14) (21), the aim of which is to investigate the Oral Health Related Quality of Life (OHRQoL) and identify problems, unfavorable oral conditions and dysfunctions that could possibly affect the patient's quality of life, well-being and self-esteem.

P2 - clinical phase

The clinical examination was performed by using sterilized disposable kits, disposable personal protective equipment (mask, gloves and glasses), dental units and an air/water syringe. The condition of the oral cavity was evaluated, and the following data were recorded:

1. Presence or absence of dental plaque (VPI-Visible Plaque Index), as described by Ainamo and Bay (22);
2. Presence or absence of calculus;
3. Gingival bleeding on probing (BOP), in accordance with WHO recommendations (23);
4. Caries experience: DMFT (Decayed, Missing and Filled Teeth) according to WHO recommendations and using the D3 (= involvement of dentine) diagnostic threshold (23);
5. Presence or absence of enamel hypomineralization on vestibular crown areas;
6. Presence or absence of gingival recession;
7. Presence or absence of erosive tooth wear, scored using the BEWE Index. (24) The four-level score assesses the clinical expression or severity of wear on the tooth surfaces, dividing the oral cavity in sextants. BEWE scores include "no loss (0), initial loss of enamel surface texture (1), distinct defect, hard tissue loss less than 50% of the surface area (2) or hard tissue loss more than 50% of the surface area (3)". In this scoring system, evaluations of enamel and dentine involvement are not considered.
8. Presence or absence of dentine hypersensitivity, scored with the SCHIFF Index (25) with values from 0 to 3 (0: no response to air stimulation; 1: response to air stimulation, no required interruption; 2: response to air stimulation, required interruption or stimulus removal; 3: response to air stimulation, pain perception, required interruption and stimulus removal).

Statistical analysis

Statistical analyses were employed to compare the study results using a software program (SPSS Version 10, SPSS Inc., Chicago, USA). First, simple descriptive statistics were obtained to determine the relationship between special nutrition habits and each of the other variates. Only variates that were significantly correlated were chosen to be analyzed in the following steps. The association between special nutrition habits and the potential risk factors associated with caries, recession, erosive tooth wear, abrasion, hypersensitivity and periodontitis were examined using multivariate logistic regression based on the questionnaires and on the clinical visit dataset. Odds ratios (OR) for the

variables such as the patient's age, gender, height, weight, oral hygiene and food habits (fresh fruit and vegetables consumption at lunch and dinner), the presence of gastroesophageal reflux symptoms, nine (11.7%) reported a previous or current long period of drug intake, and five (6.5%) reported a food allergy (Table 1).

multivariate analysis and 95% confidence intervals (95% CI) were calculated. p values < 0.05 were considered to be statistically significant.

Several outcomes were analyzed. Binary variables for the presence (or not) of Caries experience, Abrasion, Bleeding on probing, Erosion, Dental hypersensitivity are defined. Similarly, predictors referring to diet or general behaviors which may impact on the outcomes are investigated. Individual-specific confounders like age, gender and health habits (in which the months from the last visit is a proxy) are also considered. The presence for effect modification is not investigated and left for future researches.

Results

Seventy-seven individuals (35 males, 42 females; range 21–67) were enrolled in the study and completed the questionnaires.

P1-survey phase

On average, the participants declared that they followed a plant-based diet for the last four years (70 % last four years, 13% last three years and 17% last two years), had four meals a day and brushed their teeth twice a day. Among the 77 individuals, 32 (41.6%) of the subjects reported a 6.84 kg mean weight loss since they started to follow a plant-based diet. Twelve of the 77 (15.6%) reported being a smoker for at least 11 years, with an average consumption of 7 cigarettes per day. Four participants (5.2%) in the survey reported gastroesophageal reflux symptoms, nine (11.7%) reported a previous or current long period of drug intake, and five (6.5%) reported a food allergy (Table 1).

Table 1.Results of questionnaire 1 (general information)

General health	Mean
Adherence to vegan diet (years)	4.39
Daily food and beverage intake	3.83
Weight lost since starting vegan diet (kg)	6.84
Tobacco smoking (years)	11.16
Cigarettes (number)	7.58
Tobacco smoking	15.58%
Weight loss since starting vegan diet	41.55%
Gastroesophageal reflux	5.2%
Drug intake	11.7%
Food allergy	6.5%
Food and beverage habits	
Food consumption at breakfast	Fruit 62.3%
Beer or wine consumption	44.15% never
	55.84% sometimes
	84.41% never

With regard to nutrition, fruit was the most frequently consumed food at breakfast by 48 (62.3%) of the participants. Thirty-four responders (44.2%) did not drink beer or wine, 65 (84.4%) did not drink spirits, 57 (74%) avoided carbonated beverages and 62 (80.5%) did not consume any highly sugared beverages (Table 1).

Concerning oral health, seven participants (9.1%) reported having been informed by the dentist about the presence of enamel demineralization and 12 (15.6%) reported dry mouth in the morning. In addition, six (7.8%) reported oral aphthae since the plant-based diet started, eight (10.4%) reported gingival irritation, 20 (26%) reported gingival bleeding during tooth brushing and 21 (27.3%) reported dental sensitivity. On average, 13 months had elapsed since the last dental visit and 19 months had elapsed since the last professional oral hygiene appointment. Different dental therapies in the previous three years were reported in 36 (46.8%) of the responders, 16.9% of which reported dental extractions, 36.4% reported dental fillings and 7.8% reported dental implants. Overall 11 participants (14.3%) reported bruxism, 4 (5.2%) reported periodontitis and 34 (44.2%) reported dental caries (Table 2).

The results of the IOHIP-14 questionnaire are reported in Table 3. Overall, respondents answered "never and almost never" in a percentage ranging from 87% to 100%. Only with respect to pain did 41% of participants answered "sometimes."

P2 - clinical and epidemiological phase

Among those who completed the questionnaires, 20 (13 females and 7 males) underwent a clinical evaluation.

The results of the oral examination are reported in Fig. 1 and can be summarized as follows:

1) Fourteen participants (70%) showed visible dental plaque and 10 (50%) showed the presence of calculus;
2) Gingival bleeding on probing (BOP) was observed in 11 participants (55%);

Table 2. Percentages of questionnaire 1 (oral health)

Dental cleaning (daily)	2.39
Last visit to the dentist (months)	13.17
Last oral hygiene appointment (months)	19.55
Presence of aphtosis since starting vegan diet	7.8%
Gingival irritation	10.4%
Gingival bleeding when brushing teeth	26.0%
Heat sensitivity	3.9%
Cold sensitivity	23.4%
Bruxism	14.3%

Spirits consumption	84.41% never
	15.58% sometimes
Carbonated beverage consumption	74.02% never
	25.79% sometimes
Sugared beverages consumption	80.51% never
	19.48% sometimes

Periodontitis	5.2%
Caries	44.2%
Dental extractions	16.9%
Dental fillings	36.4%
Dental implants	7.8%

Table 4. Results of the logistic regression methods. Un-adjasted estimates

Independent variables	Dependent variables									
	Caries experience		Abrasion		Bleeding on probing		Erosion		Dental hypersensitivity	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Plant-based diet (years)	-0.08312	-0.208 ; 0.023	0.04594	-0.275 ; 0.462	-0.06455	-0.445; 0.250	-0.0037	-0.691 ; 0.219	0.1212	-0.196 ; 0.549
Fresh fruit at breakfast	-0.4918	-1.433 ; 0.437	0.4418	-1.412 ; 2.380	-0.4055	-2.235 ; 1.368	0.9808	-0.960 ; 3.192	0.4055	-1.368 ; 2.235
Vegetables at lunch	0.02079	-1.088 ; 1.161	-0.6931	-4.041 ; 2.648	n.a.		n.a.		-0.2231	-3.557 ; 3.109
Fresh fruit at lunch	-1.4991	-3.034 ; -0.253	0.7885	-1.544 ; 3.145	-0.2513	-2.570 ; 2.061	0.3102	-2.024 ; 3.448	-1.099	-4.222 ; 1.183
Vegetables at dinner	-0.5194	-1.99 ; 0.89	n.a.		n.a.		0.9555	-2.397 ; 4.317	-0.2231	-3.557 ; 3.109
Fresh fruit at dinner	-1.677	-4.643 ; 0.159	n.a.		n.a.		n.a.		n.a.	
GERD	0.2478	-1.916 ; 2.412	n.a.		-0.2231	-3.557 ; 3.109	-0.9555	-4.317 ; 2. 397	n.a.	
Use of drugs	1.050	-0.367 ; 2.670	0.2877	-1.963 ; 2.389	-0.8109	-3.062; 1.245	-0.6061	-2.760 ; 1.668	0.8109	-1.244 ; 3.062
Bruxism	0.4877	-0.804 ; 1.819	7.885e-01	-1.544 ; 5.145	n.a.		0.3102	-2.024 ; 3.448	0.2513	-2.061; 2.570

Table 5. Results of the logistic regression methods. Estimates have been adjusted for gender, age and access to oral health care

Independent variables	Dependent variables									
	Caries experience		Abrasion		Bleeding on probing		Erosion		Dental hypersensitivity	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Esti-mate	95% CI	Estimate	95% CI
Plant-based diet (years)	-0.073	-0.204; -0.037	0.079	-0.272 0.517	-0.015	-0.428 0.377	-0.090	-0.654 0.290	0.350	-0.048 0.946
Fresh fruit at breakfast	-0.502	-1.502 0.480	0.260	-2.067 2.629	-0.161	-2.471 2.171	0.749	-1.760 3.563	0.720	-1.707 3.550
Vegetables at lunch	0.070	-1.067 1.244	-0.716	-4.136 2,663	n.a.		n.a.		-0.162	-3.615 3.246
Fresh fruit at lunch	-1.513	-3.076 -0.238	0.432	-2.086 2.950	-0.217	-2.744 2.349	0.028	-2.583 3.289	-1.084	-4.391 1.564
Vegetables at dinner	-0.595	-2.128 0.873	n.a.		n.a.		1.258	-2.461 5.299	-2.165	-6.434 1.667
Fresh fruit at dinner	-1.670	-4.658 0.225	n.a.		n.a.		n.a.		n.a.	
GERD	0.468	-1.724 2.673	n.a.		-0.203	-3.604 3.165	-1.237	-4.980 2.216	n.a.	
Use of drugs	1.035	-0.418 2.692	0.430	-1.875 2.680	-0.865	-3.172 1.238	-6.499e-01	-2.932 1.696	0.799	-1.462 3.288
Bruxism	0.364	-0.978 1.736	0.360	-2.233 2.933	n.a.		-0.102	-2.802 3.207	0.366	-2.380 3.312

these individuals were found with good oral health conditions and exhibited good self-care and self-prevention through the administration of questionnaires. Moreover, in a subset of these individuals, a clinical evaluation of the

tions and exhibited good self-care and self-prevention.

It has been suggested that individuals adhering to plant-based and raw plant-based diets may be at an increased risk for white spot lesions, dental erosion, erosive tooth wear or abrasion. (16-19) However, there is little data available concerning the oral health in these individuals. Recently, Laffranchi et al. (16) found a higher prevalence of white spot lesions and a more acidic salivary pH in a small subset of 15 subjects consuming a plant-based diet than in 15 control subjects.

The Authors designed a study to assess the oral health status of a cohort of 77 individuals on a plant-based diet in a subset of these individuals, a clinical evaluation of the oral cavity was carried out. The current study results, compared to the results of similar studies on the general Italian population, showed that the participants paid attention to their daily balanced food intake and that there was a lower percentage of smokers, as well as a higher percentage of people who did not drink spirits (15% smokers in the present study versus 21% smokers in the general Italian population and 15.6% drinkers versus 43.2%, respectively) (27). The study also revealed an optimal OHRQoL among the participants. More than 90% of the subjects reported "no problems, unfavorable conditions or oral dysfunction" affecting their

quality of life in the last year. A notable attention to home oral care also emerged, resulting in, on average, toothbrushing twice per day, which corresponds to the gold standard of oral hygiene.

Regarding dental professional care, the Authors found that the last dental visit and the last professional oral hygiene appointment occurred, on average, in the previous 13 and 19 months, respectively. Approximately 50% of the subjects reported one dental visit in the last three years. By contrast, in the general Italian population, (2013 Italian Institute of Statistics) (28), only 38% of the population accessed professional dental care in the previous 12 months, and 29.2% of the population reported one visit in the last three years (29).

Among the 20 participants who underwent a clinical evaluation, good self-care and self-prevention was found, as demonstrated by the relationship between untreated tooth decay and filled teeth in the assessment of caries experience. The untreated decayed teeth were only 6%, the missing teeth were 5% and the filled teeth were 88% of the DMFT index. These data indicated good overall oral care, which is in contrast to the general Italian population, in which a significant decrease in dental interventions (from 17.1% in 2005 to 9.6% in 2013) has recently been reported.

Despite the fact that periodontitis was reported in only 4 out of 77 subjects before following a plant-based diet, gingival bleeding on probing (BOP) was observed in 55% of the subjects and 70% showed visible dental plaque with the presence of calculus in half of them; in the WHO CAPP Italy database, calculus was found in 45% of the subjects (23).

In 85% of the study sample, no erosive tooth wear was observed. By contrast, 15% of the subjects showed mild erosive tooth wear (BEWE code 1). On the other hand, mild dentine hypersensitivity was reported in 45% of the subjects (Schiff code of 1). Finally, 7.8% of the individuals reported episodes of oral aphthous ulceration, which disappeared after adoption of the plant-based diet in most cases.

According to the multivariate logistic regression analysis (Table 4), no correlation was found between caries, recession, erosive tooth wear, abrasion hypersensitivity, periodontitis and the lifestyle habits of the population following a plant-based diet ($p < 0.05$), except for the fresh fruit consumption during daytime variate. The absence of dental decay was in fact closely related to the fresh fruit consumption at lunch, which was shown to play a significant

Limitations

The main limitation of this study is the lack of a control group. In addition, the number of subjects who underwent a clinical examination is limited, thus making the conclusions difficult to generalize. Future case-control studies on a larger cohort of patients will be needed to further investigate the relationship between the oral health status and the adherence to a plant-based diet.

Conclusion

In conclusion, the current study showed that individuals on a plant-based diet have good overall oral health conditions and exhibit good self-care and self-prevention. These features are in agreement with the behavior of these subjects towards an overall healthy lifestyle.

Future clinical studies on a large cohort of patient following plant-based diet with a well-structured control group are needed. Further studies are also required in order to document, for example, on oral conditions and hypomineralization/developmental defects of enamel prevalence among children with vegan pregnancy and vegan nutrition in the first five years of life.

Dental care professionals should be aware of the importance of providing these patients with recommendations regarding appropriate use and prescription of oral care products.

DAta availability statement

The questionnaires used to support the findings of this study are available as Supplementary Materials.

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MM and SB: conception and design of the study.

AL: analysis and interpretation of data.

DB: acquisition of data and drafting the article.

LO and DC: revising critically for important intellectual content.

IV: final approval of the version to be submitted.

Conflict of interest

The authors declare no conflicts of interest.

consumption at lunch, which was shown to play a significant protective role in caries development.

In all the subjects, at least one gingival recession was observed, indicating possible inadequacies in the daily oral hygiene techniques or materials. As reported in the current study, patients used non-fluoridated toothpastes with various compositions (some of them from commercial brands, others home-made) but with no ascertainable abrasive properties. On the other hand, a very recent meta-analysis including 159 clinical studies showed no association between the presence of gingival recession and tooth brushing technique (manual or powered, bristle hardness, tooth brushing duration and frequency) (30). Moreover, the etiology of gingival recession is complex and multifactorial (31). A recent epidemiological study on the etiology and occurrence of gingival recession in India showed that the development of recession is the result of more than one factor, all acting together (32).

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