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Nutrition and Oral Health: Experiences in Iran

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ABSTRACT

Background: Oral health is a crucial factor for overall well-being and there is a mutual relationship between nutrition and oral health. The aim of this study was to review the publications which have examined the association between nutrition or diet and oral health status or oral disease in Iran. **Methods:** The electronic databases of PubMed, Scopus, Google scholar, scientific information database (SID), and Magiran were searched using key words of diet, nutrition, oral health, oral disease, and Iran to reach the related articles published up to 2016. The English and Persian articles with cross-sectional, clinical trial, prospective, and case-control designs were selected. The Persian studies were then translated into English. The animal studies were not investigated. **Results:** The findings showed that nutrition and diet were associated with oral health. However, the majority of studies focused on evaluation of the relation between nutrition and dental caries. Further, a few studies were conducted on the association between nutrition and other oral problems such as periodontal disease or oral cancer. Moreover, the limited nutritional or dietary factors were investigated in the literature. **Conclusions:** Nutrition and diet are related to oral health and prevention of oral disease. Further studies are therefore recommended to evaluate the association between nutrition and oral health with considering various dietary or nutritional factors and different types of oral problems in Iran.

Keywords: *Nutrition; Diet; Oral health; Oral diseases; Iran*

Introduction

Oral health is essential for general well-being and good quality of life; it refers to have healthy teeth, gums, and lack of oral disease (WHO, 2003). There is a close association between nutrition and oral health. Studies showed that nutrition and diet have a strong influence on oral health. Additionally, an imbalanced diet is associated with oral diseases such as periodontal disease (PD), oral cancer, and dental disease. On the other hand, oral diseases have a great impact on the dietary intake and may lead to undesirable

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nutritional status and decrease quality of life (Chicago, 2011, Dye *et al.*, 2011, Reeves, 2010, Scardina and Messina, 2012, Scardina and Messina, 2008, Touger-Decker *et al.*, 2003). The present paper is intended to review the present evidences on the relationship between nutrition and oral health in Iran with a focus on oral disease including dental carries, PD, and oral cancer.

Materials and Methods

The various electronic databases including PubMed, Scopus, Google scholar, scientific information database (SID), and Magiran were used for searching of the literature published up to year 2016 using key words such as diet, nutrition, dietary or nutritional factors, nutritional status, oral health, oral disease, and Iran. The relevant studies in English and Persian with cross-sectional, clinical trial, prospective, and case control designs were included. The Persian articles were later translated into English. The animal studies were not reviewed in this study.

Results

Oral health problems and nutrition

1. Dental caries

Dental caries is one of the public health problems worldwide (WHO, 2002). The prevalence rate of caries is high in the developing countries especially countries where fluoride is not enough and consumption of free sugars and other fermentable carbohydrates is high (Hong-Ying *et al.*, 2002, Moynihan and Petersen, 2004). Dental caries occur because of demineralization of enamel and dentine by organic acids produced by bacteria in dental plaque through the anaerobic metabolism of fermentable carbohydrates found in the diet (Moynihan and Petersen, 2004). Dietary factors can be effective in prevention of caries including increase in the fiber intake, diets characterized by a ratio of many amides/little sugars, cheese, nutrients especially calcium, phosphorus, fluoride (Moynihan *et al.*, 1999, Scardina and Messina, 2012), vitamin D, vitamin A, zinc, iron, and protein (Moynihan and Petersen, 2004, Navia, 1996).

1.1 Dental caries and obesity

Both obesity and dental caries are considered as major public health problems in the world including developing countries (Popkin, 2001, WHO, 2002). Dental caries and obesity are both associated with dietary habits (Marshall *et al.*, 2007). In the last decade, consumption of sugar-sweetened beverages, snack foods, fast foods, and decrease in physical activity contributed to obesity globally (Willershausen *et al.*, 2004). Moreover, along with the increase of obesity, prolonged exposure to fermentable carbohydrates by frequent consumption of high caloric and cariogenic substances has been also linked to dental caries (Hilgers *et al.*, 2006, Kopycka-Kedzierawski *et al.*, 2008, Palmer, 2005). Furthermore, obesity is related to many non-communicable diseases including oral disease (Hilgers *et al.*, 2006, Palmer, 2005). Several studies have evaluated the association between body mass index (BMI) and dental caries in Iranian children and adolescents. The majority of them focused on the relationship between BMI or consumption of cariogenic foods and dental caries. For instance, Malek Mohammadi et al. evaluated the association between BMI and dental caries among 420 children aged 6 years, in Kerman. They used decayed, missing and filled primary (dmft), as well as permanent teeth DMFT for diagnosis. A significant association between DMFT/dmft score and BMI was found ($P = 0.04$). Interestingly they reported that, about 40% of underweight children were in "very high caries" group (Malek Mohammadi *et al.*, 2012). Similarly, in another study from Kerman in 2009-2010, it was observed that caries rate reduced with increase in body weight in a sample of 3–6 years old children (Bafti *et al.*, 2015). However, a cross-sectional survey on a population of children aged 6-11 years in Isfahan indicated no relationship between BMI-for-age and DFT/dft (decayed and filled permanent/primary teeth) indices (Sadeghi and Alizadeh, 2007). In addition,

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researchers conducted a cross-sectional study to examine the relation between tooth decay and BMI-for-age among a group of Iranian adolescents in Rafsanjan (747 students aged 12-15 years). They found no association between DMFT scores and BMI-for-age (Sadeghi *et al.*, 2011). Meanwhile, the results of a study on 1213 children aged 6-11 years in Zahedan showed that the mean DFT in the overweight children was higher than that of underweight or normal weight groups (Shahraki *et al.*, 2013). In a survey from Shiraz, Edalat et al. evaluated the association between early childhood caries and BMI in a population of 3- to 6-year-old children. They reported that there is no significant association between increasing dental caries on the one hand and reducing height, weight, and BMI on the other hand (Edalat *et al.*, 2014). Another study also reported no relationship between tooth decay and BMI in a group of children in Hamedan (Mojarad and Maybodi, 2011). Ghasempour et al. also investigated the association between dental caries and BMI among pre-school children in Babol. The results indicated that the caries rate increased with the increase of BMI (Ghasempour *et al.*, 2011). But, researchers did not find any relationship in a population of female students (12-14 years old) in Tehran (Faezi *et al.*, 2013). In a survey on a sample of children aged 7-11 years from Yazd, a higher DMFT/dmft was observed in the group with higher BMI (Bahrololoomi *et al.*, 2014). However, the findings of another study suggested that DMFT decreases with increase of BMI in 9-11 years old children in Shiraz (Khosravani *et al.*, 2014). Montazeri F et al. examined the relation among dietary intakes, obesity, and dental caries in children aged 6-11 years. They concluded that obesity is a risk factor for developing tooth decay (Montazeri *et al.*, 2015). In fact, studies considering the association between dental caries and BMI status led to inconclusive results. The majority of studies had a retrospective approach and there is no evidence on any prospective studies in this regard to the best of our knowledge.

1.2 Dental caries and diet

The results of investigations showed that the components as well as cariogenic, cariostatic, and anticariogenic properties of the diet can have impact on susceptibility and developing dental caries (Mobley, 2003, Sanders, 2003). Anticariogenic agents are foods which can increase saliva pH to an alkaline level and result in protection of enamel from caries (Radler and touger-decker 2007, Touger-Decker and Mobley, 2007). The cariostatic agents are foods that are not metabolized by microorganisms and cannot lead to a reduction in salivary pH to values lower than 5.5 within 30 minutes. The cariogenic agents are foods or drinks containing fermentable carbohydrates that are metabolized by microorganisms; they can cause a drop in salivary pH to less than 5.5 and lead to demineralization and plaque formation (Bolan *et al.*, 2007, Touger-Decker and Mobley, 2007). The important factors for production of cariogenic property are including food form, solubility, amount and frequency of fermentable carbohydrates intake, nutrients composition, potential to stimulate saliva, sequence of food consumption, as well as combinations of foods (Bolan *et al.*, 2007, Mobley, 2003, Sanders, 2003). In Iran, Mohammadi et al. investigated the relationship between dental caries and consumption of sugars from diet in 5-6 years old children. They found no significant association between dietary intake and tooth decay. But, there was a significant association between using bottle with sweet drinks through infancy and higher risk of caries (Mohammadi *et al.*, 2008). In addition, researchers in another study observed no significant relationship between consumption of sugars and fizzy (carbonated) drinks in Tehranian children (Pourhashemi and Golestan, 2009). Moreover, a survey was conducted by Pourhashemi et al. on the assessment of dietary intakes and their relationship with anthropometric indices and dental health in 788 primary school children (7 years old). Dietary intakes were assessed by 24-h-recalls and food frequency questionnaire (FFQ). Dietary intakes were

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calculated and compared with recommended dietary allowance (RDA). Findings of the study suggested a protective affect for saturated fatty acids in prevention of teeth decay so that, the DMFT/dmft was higher in children with an intake less than 75% of recommendation. Further, they found that the intakes of calcium, iron, and zinc from diet are not enough in the children which can cause malnutrition and failure to thrive. In addition, a significant relationship was observed between low intake of calcium and iron and DMFT/dmft indices; the indices were higher in children with intakes lower than 75% of the RDA than those with sufficient intake (Pourhashemi *et al.*, 2008, Pourhashemi *et al.*, 2007).

The researchers evaluated the association between consumption of snacks and sweet drinks on the one hand and tooth decay on the other hand among a group of male school children (8-12 years old) in Tabriz. The food intakes were assessed by a validated questionnaire. Snacks were classified into two groups. The first group was biscuit, cookie, pastry, sugar, bread, and jam. The second group included raisins, dried berries, chocolate, candy, chips, salty snacks, and dried fruit purees. Drinks group were sweet drinks and carbonated drinks. The findings showed a high consumption of snacks and sweet drinks among children. A higher intake of the mentioned foods was associated with higher risk of caries (Savadi Oskoee *et al.*, 2008).

In a survey on population of postpartum women, the relationship between intake of calcium, iron, and multivitamin supplements during pregnancy and dental health was examined. The consumption of calcium supplement was associated with a decreased DMFT. While, the intake of iron supplement was related to increase of DMFT (Faezi *et al.*, 2014).

Another study also investigated the association between dietary patterns and dental health between a group of children with type 1 diabetes (31 patients) and the healthy group (31 healthy children). The dietary intakes were evaluated by FFQ. This questionnaire contained 11 cariogenic foods (biscuits, chocolate, ice cream, soft drink, sweetened hot tea, dry fruits, sweetened hot milk, candies, confectionery cookies and cakes, canned fruits/ jams, sugary gum) and four foods with protective properties against decay (walnut and almond, cheese and bread, apple and cucumber, sugar-free gums). The consumption frequency of food items were asked per day or week. Consumption of cariogenic foods was higher in the control group than the patients. There was no difference in using protective foods between groups except for intake of cheese and bread as snack which was higher in patients than controls. However, the mean DMFT did not differ between the two groups (Bassir *et al.*, 2014).

Ghasempour et al. examined the dental caries and related factors in preterm and low birth weight children in comparison with normal birth weight group. They found no difference between groups in terms of breast feeding, a combination of breast and bottle feeding, or snack consumption (Ghasempour *et al.*, 2009). Whereas, the results of another study showed a relationship between early childhood caries and bottle feeding at night among children aged 1-3 years in Tehran (Mohebbi *et al.*, 2008). Mosahab P et al. conducted a survey on the association between food intake and dental caries in a population of children aged 6-11 years in Shemiranat, Tehran. Food intake was assessed by using a FFQ. This questionnaire consisted of 64 food items. The food items were categorized into 21 groups as follows: grain, meat and substitutes, processed meat (sausages), milk and dairy, sweet milk and dairy (ice cream, Milk chocolate, milk, coffee, milk, bananas), vegetables, starchy vegetables (corn and potatoes), fruits, dried fruits, nuts, sweets (biscuit, cake, cream cakes, cookies, pastries, donuts, pastry cream, pancake), sugar, honey and jam, desserts, bakery products, salty snacks, sugary drinks, artificial sweeteners, fruit juice, compote, and tea. The findings demonstrated a relationship between higher frequencies of consuming snacks particularly dried fruits, sweets, sugar, bakery products, salty snacks and caries. In contrast, consumption of milk and dairy was inversely

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associated with caries (Mosahab *et al.*, 2011). In another study, researchers examined children's diet related to oral and dental health indices in Mashhad. Dietary assessment was conducted by three-day food history. There was no significant relationship between dmft and main food groups of food pyramid. But, an inverse association between intake of fat and protein and dmft was observed. (Talebi *et al.*, 2007). Ebrahimi M et al. investigated the dental health and its association with macronutrients intake and anthropometric indices among elderly in an elderly dwelling in Tabriz. Dietary intake and the foods' weights were assessed by direct observation for three days. Anthropometric indices were also measured. The researchers found no significant relationship between dental status, anthropometric indices, and dietary intake (Ebrahimi Mamaghani *et al.*, 2008). Furthermore, in another study, the association of diet with oral and gum health was evaluated in a population of preschool children in Mashhad; no association was reported (Talebi *et al.*, 2006).

Faezi et al. examined the relationship of dmft with diet and social factors among a group of school children (aged 6-12 years) in Tehran. They found an association between consumption of cariogenic foods and tooth decay (Faezi *et al.*, 2012). In addition, the results of another study showed that prevalence of caries was higher in children with frequent bottle feeding at night than the group with breast feeding among a sample of children aged 4-6 years in Zahedan (Shirzaiy and Heidari, 2010). Similarly, it was indicated in the study carried out by Javadinejad et al. that the caries rate was higher in the premature or underweight children than children with normal weight. Moreover, the consumption frequency of sweets, sugar, and bottle feeding was higher in the former than latter (Javadinejad *et al.*, 2009). Eskandarian and Joshan conducted a study about the relationship between caries and consumption of iron supplement; they found no association between tooth decay and intake of iron supplement (Eskandarian and Joshan, 2006).

1.3 Dental caries and drinking water fluoride

Fluoride is an essential micronutrient for fortification and stability of apatite matrix in skeletal tissues and teeth (Hurtado *et al.*, 2000). One of the major sources of receiving fluoride is water (Carton, 2006, Osmunson, 2007, Spittle, 2008). All natural waters have fluoride in a wide range from trace levels to several dozen mg/L (Hurtado *et al.*, 2000, Whelton *et al.*, 2004). In the regions where the concentration of fluoride in the water is naturally low (<0.5 mg/L), it is recommended to add fluoride to drinking water (Hurtado *et al.*, 2000, WHO, 2011). However, the previous studies showed that the high concentration of fluoride may cause some problems including dental caries, skeletal fluorosis, renal and neuronal disorders, as well as myopathy (Hussain *et al.*, 2003, Hussain *et al.*, 2010, Pérez and Sanz, 1999, WHO, 2011). So, the high or low concentrations of fluoride both have adverse effects on health (Hussain *et al.*, 2003, Hussain *et al.*, 2010). Due to this reason, monitoring of fluoride concentration in the drinking water is crucial (Dehghani *et al.*, 2013).

Many studies were conducted on concentration of fluoride in drinking water and its relationship with dental caries. In a survey on a population of children in Dashtestan, no significant relationship was observed among level of fluoride in the drinking water, the number of decayed permanent teeth (Dt), and the number of decayed deciduous (dt). But, a weak increase in the Dt and dt scores with increment fluoride level was reported in the area with highest water fluoride levels in comparison with the area having the lowest levels (Dobaradaran *et al.*, 2008). The findings of another study in Arsanjan revealed a non-significant association of water fluoride level with the Dt and dt scores (Rahmani *et al.*, 2010a). Dehghani et al. examined the DMFT index and its relationship with water fluoride among a group of students aged 7-11 years in 4 districts of Shiraz. The results indicated that the DMFT index was higher in districts with low concentrations of fluoride than districts with desirable concentrations (Dehghani *et al.*, 2013). Similarly,

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in another survey in Behshahr, it was observed that the concentration of fluoride in drinking water was lower than the standard level and the DMFT index was higher in girls than boys (Mahvi *et al.*, 2006). Nazemi and Raei evaluated the concentration of fluoride in the drinking water and the DMFT index in a population of 7 year-old children in Shahroud for a period of 6 years (2004-2009). They found a significant difference between concentration of fluoride and the DMFT index in different years. It was also observed that the DMFT index was increased along with fluoride levels in the drinking water (Nazemi and Raei, 2012). This is while, results of another study showed that fluoride levels were lower in drinking water of Noorabademamasani than the national levels. However, a very weak reduction was observed in the reduction of Dt and dt scores with increase of fluoride levels in some villages; this association was not statistically significant (Rahmani *et al.*, 2010b). Besides, in a survey on a sample of children aged 6-11 years in Khartooran, an inverse association was observed between fluoride concentration in the drinking water and caries rate (Nazemi and Dehghani, 2014).

Similarly, the study of Davil et al. demonstrated that the concentration of fluoride in drinking water was lower than national level in Mianeh, but, it was within the WHO recommended range. Additionally, the DMFT index was higher in children aged 6-9 years in comparison with national mean. The researchers suggested that the lower level of fluoride may be associated with higher DMFT index (Davil *et al.*, 2013). Whereas, the results of another study showed no relationship between concentration of fluoride in the drinking water sources and DMFT index in a population of guidance school students in Piranshahr and Poldasht, west Azarbayjan, Iran (Aghdasi *et al.*, 2014). However, Khademi H and Taleb M observed lower DMFT index among a sample of school children aged 7-12 years in areas with higher fluoride levels in the drinking water than the areas with lower fluoride levels (Khademi and Taleb, 2000).

2. PD

PD is a common oral health problem which is caused by gram negative anaerobic bacteria and leads to destruction of periodontal tissues, inflammation and in sever forms, tooth loss (Borrell *et al.*, 2005, Buhlin *et al.*, 2009, Dalla Vecchia *et al.*, 2005). The factors which may increase the risk of PD include smoking, diabetes, osteoporosis, cardiovascular disease, immune status of the host, stress, and age (Dervis, 2005, Genco, 1996, Genco *et al.*, 2005, Ritchie *et al.*, 2002, Schillinger *et al.*, 2006, Yoshihara *et al.*, 2004). In addition, behavioral factors such as poor oral hygiene, tobacco use, and diet are the risk factors of PD (Al-Zahrani *et al.*, 2005, Pihlstrom *et al.*, 2005). The results achieved from studies showed that the adequate intake of various nutrients including protein, vitamins C, E and D, beta-carotene, folate, magnesium, and calcium could have a protective role against PD (Moynihan, 2005, Touger-Decker and Mobley, 2007). In addition, the researchers reported an association between higher risk of PD and obesity (Dalla Vecchia *et al.*, 2005), increased BMI (Haffajee and Socransky, 2009), and increased waist circumference (WC) (Reeves *et al.*, 2006). Few studies were carried out about the association between nutrition and PD in Iran which focused on the relationship between BMI, body composition or a few of nutritional factors such as omega-3 fatty acids, resveratrol, and PD.

2.1 PD and obesity

Some researchers indicated that there is a relationship between increased BMI (Dalla Vecchia *et al.*, 2005, Haffajee and Socransky, 2009, Kopelman, 2000, Nishida *et al.*, 2005, Saito *et al.*, 2001), WC (Reeves *et al.*, 2006), and increased risk of PD. In a survey, researchers investigated the relationship between body composition and PD in a sample of men aged 30-60 years. Periodontal status was evaluated by gingival and plaque indices as well as means of attachment loss. According to gingival and plaque indices, bleeding from the gingival margin and visible plaque receives a score of “1,” whereas,

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lack of bleeding and visible plaque get a score of "0." Attachment loss (the distance from the Cementoenamel junction to the base of pocket) was measured by Williams periodontal probe (PWD, Hu-Friedy Immunity, USA) for all of the teeth on four areas (buccal, mesial, distal, and palatal or lingual) and the mean of values were obtained. Based on the assessment, the individuals were categorized into 4 groups: Group 1: normal with no gingival inflammation and no attachment loss, Group 2: simple gingivitis with gingival inflammation and no attachment loss, Group 3: initial periodontitis with gingival inflammation and attachment loss of <2 mm, and Group 4: established periodontitis with gingival inflammation and attachment loss of more than 2 mm. The anthropometric measurements included weight, height, WC, and BMI. The body composition (body water, body fat, skeletal muscle, and bone mass) were analyzed by bioelectrical impedance analysis (BIA) and diagnostic scale. The results indicated a relationship between severe forms of PD and body composition in males. In this regard, the mean BMI, WC, and the percentage of body fat were significantly higher in the participants with periodontitis in comparison to healthy and gingivitis groups. Meanwhile, the percentage of body water was lower in the periodontitis group than other groups. In addition, the findings of comparisons between groups showed that the percentage of skeletal muscle was greater in the healthy individuals and patients with gingivitis in comparison with the group with periodontitis. But, the bon mass was higher in the healthy group than participants with PD (Salekzamani *et al.*, 2011).

Sarlati et al. conducted a case control study to examine the association between obesity and periodontal status among a group of Iranian adults. The assessment of periodontal status (including Plaque Index (PLI), Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL)), BMI, and WC were carried out. Moreover, socio-demographic status and risk factors of PD (age, sex, education, time elapsed since last dental visit, smoking, and diabetes) were examined. The findings showed that there was a relationship between overall and abdominal obesity and periodontal problems rate. Thus, PPD and CAL were significantly higher in the obese participants than controls (Sarlati *et al.*, 2008).

In a case-control study, the relationship between BMI, serum lipids, and PD were investigated among a population aged 30-50 years (55 healthy subjects and 55 patients with chronic periodontitis with same age range). The exclusion criteria were systemic disease, medication, being pregnant, smoking, alcohol, and addiction. The Clinical attachment loss (CAL) was examined by measuring the interval from the cementenamel junction to the bottom of the gingival crevice as the index of PD. The PD was defined as presence of proximal or mesial to distal CAL greater than 4 mm in two or more teeth based on the previous studies (Page and Eke, 2007). The researchers defined the 3-4 mm attachment loss as moderate PD and attachment loss of more than 5 mm was considered as severe PD. The lipid profile was measured via enzymatic method and auto analyzer. The cutoff points of lipid profile based on laboratory's recommendation were as follows: triglyceride (TG) higher than 200 mg/dL, total cholesterol (TC) more than 200 mg/dL, low density lipoprotein cholesterol (LDL-c) higher than 130 mg/dL, and high density lipoprotein cholesterol (HDL-c) less than 35 mg/dL. Anthropometric variables included weight, height, and BMI. The results indicated that BMI was significantly higher in PD group than healthy participants. However, in the patients with PD, TG was higher, while LDL-c, HDL-c, and TC were lower in comparison to controls; these differences were not statistically significant (Fatemeh *et al.*, 2015).

2.2 PD and dietary factors

Findings of the previous investigations indicated that a balanced diet and adequate intake of nutrients, such as protein, vitamins C, E and D, beta-carotene, folate, magnesium, and calcium, might prevent from PD. On the other hand,

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malnutrition and imbalanced diet might lead to increased risk of PD (Al-Zahrani *et al.*, 2005, Moynihan, 2005, Pihlstrom *et al.*, 2005, Touger-Decker and Mobley, 2007). In addition, some surveys reported the beneficial effects of omega-3 fatty acids (Farhad *et al.*, 2014, Jenabian *et al.*, 2013) or natural polyphenols derived from plants such as resveratrol as adjunctive therapy in the treatment of PD (Rizzo *et al.*, 2012). Omega-3 fatty acids are polyunsaturated fatty acids (PUFAs) which are found in the marine sources, such as eicospentaenoic acid (EPA) and docosa-hexaenoic acid (DHA), and vegetable sources, such as alpha-linolenic acid (ALA) (Campan *et al.*, 1997, Eberhard *et al.*, 2002, Zhao *et al.*, 2007). The studies suggested that omega-3 fatty acids have anti-inflammatory, protective, and therapeutic effects in different inflammatory diseases such as diabetes mellitus (Caballero, 2004, Calder, 2006), cardiovascular diseases (Calder, 2006, 2014, Ross, 1999), and PD (Chee *et al.*, 2016). Resveratrol is a polyphenolic compound which is taken from food sources including grapes, peanuts, pistachio, and cranberry (Szkudelska and Szkudelski, 2010, Vallianou *et al.*, 2013). The researches demonstrated that resveratrol has anti-microbial (Fordham *et al.*, 2014), anti-inflammatory, anti-apoptotic (Brasnyó *et al.*, 2011), anti-cancer (Uysal *et al.*, 2011), antioxidant properties and can be effective in management of PD (Bhatt *et al.*, 2012, Brasnyó *et al.*, 2011, Park *et al.*, 2009).

Few studies were conducted on the relationship between nutrition and PD in Iran and those published focused on the effect of a few of nutritional factors such as omega-3 fatty acids or resveratrol. Jenabian N et al. conducted a clinical trial to investigate the influence of omega-3 fatty acids in treatment of moderate gingival inflammation in a population of patients aged 20-40 years. The patients were divided into two groups. The intervention group was given 1000 mg of omega-3 PUFAs and the control group received 1000 mg of glucose as a placebo daily for 10 days as gelatinous capsules. Gingival index (GI), bleeding index (BI), and plaque index (PI) were evaluated at baseline and after 5, 10, and 20 days. The results showed a significant greater reduction of indices in the omega-3 supplemented group compared with controls. The study proposed that supplementation with omega-3 PUFAs might be effective in the treatment of gingivitis (Jenabian *et al.*, 2013). In a another study, the researchers evaluated the effect of low-dose aspirin plus Omega-3 fatty acids on management of chronic periodontitis in comparison with low-dose doxycycline among 45 patients with mild to moderate chronic periodontitis. The phase 1 of periodontal treatment was carried out for patients and then, the participants were assigned into three groups. Group one received Omega-3 (300 mg/d) plus aspirin (80 mg/d). Group 2 received doxycycline (20 mg/d) and group 3 was given a placebo tablet daily. The clinical parameters including bleeding on probing (BOP), periodontal pocket depth (PPD), and clinical attachment loss (CAL) were measured at the baseline and after six weeks. The findings showed that the mean values of BOP, PPD, and CAL were lower in the test groups than placebo group. Furthermore, the reduction of indices was higher in the omega-3 group when compared to doxycycline group (Farhad *et al.*, 2014).

Zare Javid et al. conducted a double-blind clinical trial to evaluate the influence of resveratrol supplementation on blood glucose, TG, periodontal status, and some inflammatory markers in type 2 diabetic patients with PD. The patients were divided to two groups. The intervention group was given 480 mg/d resveratrol capsules (480 mg Polygonum Cuspidatum providing 240 mg resveratrol) while the control group received placebo capsules (contained 480 mg starch) (2 pills) for four weeks. The non-surgical treatment, including removal of dental plaque, scaling, and root planning was conducted for all patients. Anthropometric indices, i.e., 24-hour dietary recall, fasting blood glucose, serum level of insulin, TG, interleukin 6 (IL6), tumor necrosis factor alpha (TNFα), insulin resistance (HOMA-

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IR), and pocket depth were examined in all individuals before and after intervention. There were no significant differences in the mean levels of fasting blood glucose, serum level of TG, IL6, and TNFα between the two groups after intervention. However, the mean serum levels of fasting insulin and HOMA-IR were significantly lower in the intervention group than the controls after intervention (P = 0.02, P = 0.045, and P < 0.001, respectively). Moreover, the results showed that the mean serum level of IL6 was decreased significantly in the intervention group (Zare Javid *et al.*, 2016).

3. Oral cancer and nutrition

Oral cancer is one of the most common cancers worldwide (Baharvand *et al.*, 2014, Krishnaswamy *et al.*, 1995). The main risk factors of oral cancer are alcohol and tobacco use, some viral infections, genetics, and diet (Itagappa and Rao, 2004, Paul *et al.*, 2002). Nutrients such as vitamins A, E, C, beta carotene, zinc, and folate can have a protective effect against oral carcinogenesis by means of the following mechanisms: prevention of procarcinogens activation, inhibition of chromosomal aberration, and inhibition of the development in lesions with malignancy properties (Giovannelli *et al.*, 2002, Scardina and Messina, 2012, Taghavi and Yazdi, 2007). Moreover, a diet characterized by lower intake of energy, saturated fat, red or processed meats, as well as higher intake of fruits, vegetables, and cereals are associated with decreased risk of oral cancer (Taghavi and Yazdi, 2007). In addition, some studies showed that changes in the serum levels of copper, ferritin, and zinc may be involved in the pathogenesis of cancers including oral cancer because they have a considerable role in the structure and function of many enzymes including antioxidant enzymes (Beguin *et al.*, 1987, Fukuda *et al.*, 2004, Prasad, 1994, Prasad *et al.*, 1992, Toyokuni, 1999, Yelinova *et al.*, 1996). There were a few studies investigating the relationship between nutrition or diet and oral cancer in Iran. Baharvand M et al. evaluated the serum levels of ferritin, copper, and zinc among 60 patients with oral and maxillofacial cancer and 66 healthy individuals as controls. The results indicated that the mean serum levels of ferritin, copper, and zinc were significantly higher in the patients than the healthy group (P < 0.001) (Baharvand *et al.*, 2014).

Discussion

The current review showed that studies investigated the association between BMI and dental caries led to inconsistent results. So, it seems that other factors such as socio-economic factors or oral hygiene might be involved in the development of dental caries (Bafti *et al.*, 2015, Bahrololoomi *et al.*, 2014, Edalat *et al.*, 2014, Faezi *et al.*, 2013, Ghasempour *et al.*, 2011, Khosravani *et al.*, 2014, Malek Mohammadi *et al.*, 2012, Mojarad and Maybodi, 2011, Montazeri *et al.*, 2015, Sadeghi and Alizadeh, 2007, Sadeghi *et al.*, 2011, Shahraki *et al.*, 2013). In addition, researchers found an association between higher consumption of cariogenic foods and higher risk of dental caries (Faezi *et al.*, 2012, Javadinejad *et al.*, 2009, Mossaheb *et al.*, 2011, Savadi Oskoee *et al.*, 2008). Although the low intake of dietary iron and calcium was related to higher rate of caries (Pourhashemi *et al.*, 2008, Pourhashemi *et al.*, 2007), a relationship was observed between the high consumption of iron supplement and caries among postpartum women (Faezi *et al.*, 2014). In this regard, adequate intake of dietary protein, fat (Talebi *et al.*, 2007), and saturated fatty acids (Pourhashemi *et al.*, 2008, Pourhashemi *et al.*, 2007) were associated with decreased tooth decay. In addition, bottle feeding at night increased the risk of caries in children (Javadinejad *et al.*, 2009, Mohammadi *et al.*, 2008, Mohebbi *et al.*, 2008, Shirzaiy and Heidari, 2010). It was observed in majority of studies that the rate of dental caries was higher in the areas with lower levels of fluoride drinking water than the areas with higher fluoride levels, in Iran (Davil *et al.*, 2013, Dehghani *et al.*, 2013, Khademi and Taleb, 2000, Mahvi *et al.*, 2006, Nazemi and Dehghani, 2014, Rahmani *et al.*,

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2010a). In addition, researchers found an association between higher values of BMI, WC, and body fat percentage with higher severity of periodontitis (Fatemeh *et al.*, 2015, Salekzamani *et al.*, 2011, Sarlati *et al.*, 2008). Furthermore, the literature suggested that using omega 3 fatty acids (Farhad *et al.*, 2014, Jenabian *et al.*, 2013) or resveratrol (Zare Javid *et al.*, 2016) supplement can be useful in the management of periodontitis. Investigations in Iran have also revealed that serum levels of ferritin, copper, and zinc were greater in the patients with oral cancer compared with healthy participants (Baharvand *et al.*, 2014).

Finally, the results of this review indicated that appropriate nutrition and diet could be effective in maintaining oral health and prevention of oral disease. Nonetheless, the majority of surveys were concentrated on assessment of the association between nutrition or diet and dental caries. A few studies were carried out to investigate the relation between nutrition or diet and other oral disorders such as PD or oral cancer. Moreover, a few nutritional or dietary factors were evaluated in these studies. Consequently, more studies are recommended to examine the association between nutrition and oral health that include several dietary or nutritional factors and various types of oral disease. Furthermore to the best of our knowledge there has been no prospective cohort studies on the association between dietary factors and oral diseases. Conducting this type of studies might help to see if previous associations found by retrospective studies are causal or not.

Conclusions

Nutrition and diet are related to oral health and prevention of oral disease. Further studies are therefore recommended to evaluate the association between nutrition and oral health with considering various dietary or nutritional factors and different types of oral problems in Iran.

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Authors' contributions

Sangsefidi ZS collected data. Sangsefidi ZS and Salehi-Abargouei A wrote the draft of article. Salehi-Abargouei A approved the final version of manuscript to be submitted. All authors read and approved the final version of article.

Conflicts of interest

The authors disclose no conflict of interest associated to the article.

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