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Alterations in The Salivary Flow Rate as A Result of The Effect of Different Associated Factors: A review

Raad Salih Al-Ani[1, *]

[1] *Department of Dentistry, Al Rafidain University College, Baghdad 10014, Iraq*
[*] **Corresponding author name:** *Raad Salih Al-Ani*, **Email:** raad.saleh@ruc.edu.iq

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ABSTRACT

Saliva is a complex non-invasive biological fluid that possesses a large number of important properties and functions; it plays an important role in the protection of the oral, dental, and general health through its several protecting systems. The flow rate of saliva is defined as "the amount of saliva produced by salivary glands in the time unit, expressed in mL/min or g/min", which is considered an important salivary factor that has an impact on different oral and systemic diseases. Unstimulated whole salivary flow rate is considered a more dependent clinically reliable parameter and during collection, is considered as the basal flow rate, whereas stimulated salivary flow rate reflects saliva secretion during food intake. Secretion of saliva is affected by several factors resulting in increases or decreases in the levels of its flow rate, this alteration will share in the initiation of different abnormal systemic or local oral and general conditions and disturbances demonstrated by hyposalivation causing a feeling of dry mouth. Some of these factors affect the unstimulated and stimulated flow rates. An increase or decrease in salivary flow rate will play a role in determining the nature of some diseases as a diagnostic tool. This review aimed to determine the impact of some of the different factors that cause an alteration in the salivary flow rate and the effect of this alteration in the initiation of oral and systemic diseases and other disturbances that then affect oral and general health.

Keywords: Saliva, Salivary Flow rate, Salivary Factors, Alteration in salivary flow rate.

1 Introduction

Saliva is a complex non-invasive biological fluid characterized by a large number of important properties and functions [1], it plays an important role in protection of the oral, dental, and general health through its several protecting systems [2]. Saliva is secreted by parotid and sublingual as well as submandibular glands, in addition to many minor glands [3], flow rate of saliva is "the amount of saliva produced by salivary glands in the time unit, expressed in mL/min or g/min", which can be affected by the presence of stimuli [4]. The flow rate of unstimulated saliva is defined as "the volume of saliva secreted by major and minor salivary glands in a minute without any stimulation" [5]. An unstimulated whole salivary flow rate is considered a more dependent and clinically reliable parameter [4]. Under the unstimulated condition, a parotid gland which is a purely serous exocrine salivary gland produces about 20–30% of the total amount of saliva and about 53% after stimulation, while the submandibular gland which is a mixed gland that secretes mucin produces about 65% of the total amount of saliva under unstimulated condition, and sublingual gland which secretes mucin-containing secretion produces under unstimulated condition about 7–8% of the amount of saliva, whereas the 400–500 minor salivary glands produce less than 10% of the amount of saliva under unstimulated condition and secrete mucin [6]. The average of the unstimulated saliva flow rate is 0.25–0.35 ml/min due to the effects of several factors related to age and the stimulated flow rate of saliva is 1–3 ml/min. and salivary flow rate which is considered low is 0.1 - 0.25 ml/min while

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less than 0.1 ml/min is considered a very low salivary flow rate [7,8]. This variation in the salivary flow rate affects the concentration of the different components and constitutes of the saliva [9]. During collection, the flow rate of unstimulated whole saliva is used as the primary flow [8,10] whereas stimulated salivary flow rate reflects saliva secretion during food intake. In resting conditions, whole saliva represents the basal measurement of salivary flow rate, it is the secretion which protects the oral tissues, whereas stimulated saliva represents fluid secreted during intake of food which is considered as physiologic stimulation present in mouth for 2 hours [9,11]. In addition, stimulation of the salivary flow rate can cause alteration in the composition of saliva such as an increase in the bicarbonate concentration according to duration of stimulation [8,10]. The unstimulated salivary flow rate of the whole saliva will decrease during life and the rate of this reduction is affected by several factors such as the regular intake of medicines; this reduction occurs due to slow replacement of parenchyma by connective tissue and fat [6], whereas stimulated saliva means salivary rate becomes high in presence of several different stimuli so studying of unstimulated secretion is considered as an accurate method for analyzing the condition of the salivary gland, whereas the stimulated saliva secretion is beneficial in studying "the functional reserve" [12]. According to gender, in men, the mean flow rate is 0.36 ml/min while in women it is 0.25 ml/minute [13]. Others reported that the normal range of unstimulated rates is about 0.3–0.5 while the stimulated salivary flow is about 0.5–0.7 mL/min. [5], if the flow rate becomes below 0.1 ml/min, the condition is hyposalivation and any change in the resting whole salivary flow rate will play a part in the pathogenesis of oral disorders [14]. Reduction in the salivary flow rate was found to be associated with several oral health problems such as "periodontitis, dental caries, xerostomia, mucosal inflammation, burning mouth, taste disturbance, tooth demineralization, mastication difficulties, speech disorders, and poor denture retention", and can also "affect food intake patterns and nutritional status, which in turn negatively affect the quality of life" [15]. Salivary flow rate, regarding stimulated and non-stimulated saliva, can be influenced by several factors such as "the source of stimulus, smoking habit, glandular size, vomiting reflex, olfactory reflex, food, hydration, body position, previous stimulation, circadian rhythm, drugs, age, psychological effects, functional stimulation, and weight" [8].

2 Factors affecting the salivary flow rate

Saliva composition varies between individuals and depends on a multitude of factors, including sex, age, health status, and time of day. Saliva pH, protein content, and lysozyme activity differ between men and women. The rate of saliva secretion can be modulated by different factors. Secretion of saliva is affected by several factors that cause an increase or decrease in the levels of its flow rate, this alteration will share in the initiation of different abnormal systemic or local oral and general conditions and disturbances. Some of these factors affect the unstimulated salivary flow rate such as circadian rhythms, the degree of hydration, exposure to light, and medications [15], as well as physical activities, exercise, age, food intake, supplementation, and preservatives in addition to internal diseases, and smoking [16]. Reduction in the salivary flow rate is considered a common alteration [17], especially in elderly people due to the continuous use of medication and due to the effect of diseases [18] but it can occur naturally for a short period due to the effect of psychological stress [19]. Reduction in salivary flow rate and changes in the fluid can occur as a result of the effect of some diseases, infections, and disorders such as diabetes mellitus, and infection of glandular parenchyma such as Sjögren's syndrome [19,20]. Salivary disorders associated with decreased saliva flow include Sjögren's syndrome, diabetes, depression, and Down syndrome [21]. as well as radiotherapy of the head and/or neck [22], or it may be associated with mood disorders and as a result of adverse effects caused by the use of some medications [13], or it can also be idiopathic [23].

3 Some of these associated factors are

3.1 Age

Reduction in the salivary flow rate among older and younger adults is prevalent due to the effect of some systemic diseases [16], this reduction is considered one of the side effects of some drugs among elderly people [24]. The prevalence of reduction in secretions of saliva differs from one individual to another [25], and the prevalence of self-reported dry mouth was found to increase with increasing age [26].

3.2 Salivary flow rate about age-related changes

Salivary flow rate was found to increase with increasing ages [27], whereas others concluded that there was no relationship between the flow rate of stimulated saliva with the age [28] and that salivary flow rate is not affected by age-related changes but occurs in salivary gland's structure "in the absence of systemic diseases and medications, this may be due to functional reserves within the salivary glands" [29] and it may be due to the impact of psychological conditions [30].

3.3 Salivary flow rate among the elderly

Many diseases are affecting elderly people which cause modification in the flow rate of saliva such as diabetes mellitus and Sjogren's syndrome, in addition to Alzheimer's and Parkinson's diseases [31]. There is a controversial result regarding salivary flow rate among elderly people,

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studies reported that salivary glands undergo degenerative changes in their histological structure will increase with increasing age leading to a reduction in salivary flow rate, these alterations are considered age-related changes.

3.4 Gender

is considered one of the important factors that plays a crucial role in determining and measuring the salivary flow rate [24], according to gender, there is a difference in salivary secretion between males and females, this difference is demonstrated by the higher salivary flow rate among males than in females [32], this difference may be due to the effect of the small parotid and submandibular glands in females than in males who have larger gland size [33]. in addition to an increase in the fibrous and fatty tissues among saliva gland in males [18], other interpretations for this difference are that it may be due to the increase in the total body surface area in males which is "directly proportional to the salivary gland size" leading to an increase in salivary flow rate [24], whereas females had lower labial and buccal saliva secretion averages than males and other reported that "healthy women with no drugs use, experienced a lower mean for total unstimulated salivary flow rate and stimulated salivary flow of the parotid in comparison with that in men" [34].

4 Oral and dental diseases

Reduction in the salivary secretion was found to cause an increase in the occurrence of oral and dental diseases such as dental caries and periodontal disease [35]tal disease, that some studies reported that the lower flow rate of unstimulated whole saliva was occurring in the presence of periodontal disease [28], while others reported higher flow rate of unstimulated whole saliva [36], other studies did not find any association between them [37], whereas Rajesh et al. concluded that "increased salivary flow rate was directly proportional with developing periodontitis" [38]. While Hirotomi et al found no association between resting salivary flow rate and periodontal disease [37], a low stimulated salivary flow rate was found to be associated with increased dental caries among older adults [39].

4.1 Dental caries

Reduction in the salivary flow rate was reported to play a part in the initiation of dental caries [40]. Dental caries is a chronic, infectious, and irreversible disease of the calcified tissues of teeth, demonstrated by demineralization of inorganic materials leading to the destruction of dental structures, which often end in cavity formation [41]. It is a complex process that is affected by many factors that increase or decrease disease progression [42]. Saliva plays an important role in the prevention of dental caries; its alteration or deterioration in its functions causes a significant reduction or increase in the progression of dental caries. Saliva affects the incidence of dental caries by the role of its factors such as flow rate, buffer capacity, and pH through a cleansing function that results in a reduction of dental plaque accumulation and by causing a reduction in enamel solubility through the utilization of calcium and phosphate in addition to fluoride, by buffering and neutralizing acids produced by cariogenic bacteria [43]. The function of the salivary flow rate is considered an important factor since it enhances the cleansing process in the oral cavity leading to a reduction in bacterial counts and substrates, but its reduction allows the accumulation of bacterial biofilm and increases the count of acidogenic bacteria, resulting in increasing the production of acids resulting from fermentation of carbohydrates forming an acidic environment in the oral cavity causing increases in the activity and growth of acidogenic bacteria in addition to increasing the adherence and maturation of the bacterial biofilm on the tooth surfaces [43,44]. It was reported by many studies that there was an association between dental caries and reduced salivary flow rate, as well as with lower pH "and/or buffer capacity" [45,46] in addition to its association with an increase in the count of Streptococcus mutans [45,47]. Also, they reported that any reduction in salivary flow rate will cause a reduction in the protective constitutes of saliva, which will result in a reduction in its pH, and increase in the demineralization process as well as an increase in dental caries formation. [45,48] In conclusion, many studies have reported "a high prevalence of caries in subjects with a decreased salivary flow rate, decreased buffer capacity, and early and/or high colonization counts for Streptococcus mutans in saliva" [17].

4.2 Fasting and Nausea

Short-term fasting was found to cause a reduction in salivary flow rate, but did not cause hyposalivation, then return to normal values immediately after the end of the fasting period [27], saliva is affected by changes in eating behavioral habits as well as environmental and physical factors [5]. Fasting will reduce the metabolism of body tissues cells including oral cavity cells, leading to a reduced rate of saliva during fasting [49]. At the time of fasting, the activity of the salivary gland will reduce because of restriction in food eating and drinking, this will lead to a reduction in the production of saliva.

4.3 Chemotherapy

Chemotherapy can cause salivary gland atrophy, with other manifestations in the oral cavity such as mucositis, gingival inflammation, opportunistic infections, bleeding, and oral soreness [50,51]. It may cause discomfort because it is accompanied by oral dysgeusia and dysphagia. These conditions may increase the susceptibility to dental caries,

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periodontal disease, and oral mucosal infections which interfere with "nutrient intake and oral hygiene" [52]. Hyposalivation is a subjective feeling of oral dryness characterized by the presence of hyposalivation or reduction in salivary flow rate, which is associated with a reduction in salivary pH because of the reduction in the salivary buffer capacity [53,54].

4.4 *Alteration in salivary parameters and oral health*

Saliva plays an important role in maintaining oral health and any alteration in salivary parameters such as salivary flow rate and pH was found to cause different changes in the oral environment. Reduction in salivary flow rate was reported to cause a reduction in salivary composition and its functions, especially in the protection of the oral cavity against dental caries and other oral conditions. In addition, several pathogens will grow in an acidic salivary pH by providing a suitable environment for their growth and their aggravation. Alteration in salivary flow rate can occur due to the effect or presence of several factors such as the presence of systemic diseases, nausea, stress or emotional state, body position, body weight, level of exercise, drugs including chemotherapy agents, age, gender, exposure to light, food and water intake, size of the salivary glands, circadian rhythms, and the concentration of electrolytes [55]. Chemical and mechanical stimuli were found to affect the salivary secretion and acids are considered strong stimuli that cause an increase in the salivary flow rate [56].

4.5 *Xerostomia*

Xerostomia is a disease caused by a reduction in the flow of saliva as a result of the effect of several different factors [5], one of these factors is the continuous use of drugs mainly in elderly people [57,58]. It can occur as a result of "salivary gland fibrosis or concomitant Sjogren's syndrome", with "salivary flow rates and salivary pH values" [59,60]. The reduced salivary flow rate in patients with concomitant Sjogren's syndrome may occur due to a "considerable replacement of glandular tissue with fibrous tissue, as well as acinar atrophy" [61].

5 The circadian and circannual cycle

Circadian rhythm is "the daily oscillations of biological processes, which is influenced by the body's biological clock", it is "centrally controlled by the suprachiasmatic nucleus, located in the hypothalamus, which is linked to the dark–light cycle and transmits information to peripheral organs including peripheral cycles to modulate the waking up–sleeping rhythms every day and other organ functions", and is shifting regularly, either increase or decrease through 24 hours [62]. Circadian rhythm resembles the peak during late afternoon while circannual rhythm resembles the peak during winter. Salivary secretion varies in a circadian manner and both cycles are affecting the flow rate of saliva [1], the peak of this cycle is attained at the end of the afternoon but diminished during sleeping [63], and it also affected by the circannual rhythm that during summer the volume of saliva secreted from the parotid gland will reduce, while it reaches its peak volumes of secretion in winter, and reduction in salivary flow may be associated with dehydration in hot weather, and at the time of a day when saliva is collected [1], and the flow rate that determined in spring is higher than that measured in autumn, for this reason, during fasting, an experimental study should be conducted at 11.00 pm due to the effect of circadian rhythm, whereas Karami-Nougurani et al reported that in order to avoid the effects of circadian rhythms studies should be carried out at 9:00–11:00 pm [64], and the increase in the flow rate of saliva reaches its higher peak in the late afternoon so that its collection is better to be done one hour after mealtime [61].

5.1 *Body posture and body weight*

Hyposalivation was found to be more prevalent among individuals with high body mass index [65]. Some reported the effects of physiological factors such as the body profile [9], posture, and position [13]. In addition to the bite force, the saliva flow rate is controversial [66]. Salivary flow rate varies according to the body posture in a standing-up position flow rate will be higher than in a seated position, while in a lying-down position, it will be lower than in a seated position [12] and it was found that the high bite force will increase the saliva output [67], and a study conducted by Modeer et al also showed that childhood obesity is associated with decreased salivary flow rate [68].

5.2 *Taste*

Initially, saliva appears isotonic in relation to plasma and when it runs through the ducts, it will become hypotonic [12], regarding this hypotonicity, "saliva appears with low levels of glucose, sodium, chloride, and urea, and its ability to provide the dissolution of substances allows the gustatory buds to perceive different flavors, and Gustin, which is a salivary protein, appears to be necessary for the growth and maturation of these buds" [13]. There are five main basic types of taste stimulation these are salt, umami, sweet, bitter, and sour [69]. These tastes cause an increase in the flow rate of saliva [70,71] and gustatory stimulation, "especially acid stimulation", will play a main role in increasing the salivary flow rate [72,73].

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5.3 Exposure to light

There is a reduction of about 30% to 40% in salivary flow rate among blindfolded subjects or in dark fields. However, in comparison with normal vision subjects, saliva flow is not less in blind individuals because they are adapting to the little light exposed to their eyes [12].

5.4 Smoking

Saliva as a biological fluid is directly exposed to several toxic compounds in cigarette smoke that are responsible for the mutagenic, cytotoxic, and carcinogenic alterations [74]. The first gland that can be affected is the parotid gland which is responsible for "the secretion of watery saliva". This effect will cause loss of the function of this gland that "is compensated by submandibular and sublingual glands which secrete thick mucus saliva" [75]. "Evidence suggests that cigarette smoke obliterates protective macromolecules of saliva, enzymes, and proteins, thus compromising the protective function of saliva. Subsequently, the exposure of saliva to cigarette smoke acts as a harbinger of carcinogenesis and malignancy [76]." Smoking can be reported to cause a reduction in salivary flow, this "indicates that smoking is one of the most influential extrinsic factors that cause a reduction in salivary secretions" [77]. Long-term smoking was reported to significantly cause a reduction in the flow rate of saliva and subsequently increase the risk of dry mouth and xerostomia [78]. The salivary flow rate was reported to be affected by smoking [79], that smoking would cause a temporary increase in the flow rate of unstimulated saliva [12], and stimulated salivary flow rate was significantly higher in smokers than non-smokers, and the irritating effect of tobacco was causing an increase in the glandular excretion [80]. Long-term smoking and chewing tobacco were found to significantly cause a reduction in the salivary flow rate and salivary secretion, and "some of these studies have reported an increase in salivary flow rate especially in short-term smoking [76] while other studies [77] have reported that smoking causes a short-term increase in the salivary secretion, and "intense smokeless tobacco use results in degenerative changes of more than 40% of minor salivary glands located in the site of chronic tobacco placement" [78], and long-term tobacco use would be found to affect "the primary site for salivary secretion, thus affecting the salivary reflex" [79]. The mean value of salivary flow rate in smokers was found to be significantly lower than that in non-smokers, "this reduction may be due to the effect of smoking on taste receptors which is considered a primary receptor site in the oral cavity that is exposed constantly to the tobacco particles, generally, the use of tobacco decreases the sensitivity of taste receptors with subsequent depression in salivary reflex, presumably, this might lead to change the taste receptors response and hence alter in salivary flow rate" [80]. The mean value of DMFT was found to be higher in smokers than that in non-smokers [81, 82], this may be attributed to "the deficient in the salivary flow rate which leads to deficiency in clearing capacity of the cariogenic food from the mouth and deficiency in neutralizing effect and buffer capacity of acids produced by cariogenic bacteria" [83], or as a result of "shifting of the bacterial population towards lactobacillus and the cariogenic streptococci in smokers all might argue for increased dental caries" [84, 85].

6 Radiation and post-irradiation syndrome

Salivary flow rate is affected by previous cancer radiation therapy [86]. Radiotherapy is used for the treatment of tumors and cancers such as the treatment of head and neck tumors where salivary glands are located and directly exposed to radiation leading to an alteration in the functions of these glands, causing hyposalivation due to the effect of local irradiation [87]. Generally, exposure to irradiation "causes damage in DNA, leading to the death in the cells or "senescence in proliferating cells" [88].

6.1 The degree of individual hydration, and dehydration

There is a relationship between low flow rate and dehydration [89], which is considered an important factor because it interferes with salivary secretion. "When the body water content is reduced by 8%, the salivary flow will decrease to zero", whereas hyperhydration causes an increase in salivary flow [12], so in dehydration condition "salivary gland will not secrete saliva to keep the remaining water". This dehydration condition is affected by several factors including local factors such as developmental defects of the duct of the salivary gland, damage due to the use of radiation therapy for cancer treatment or the presence of tumors, or salivary stones because dehydration causes a reduction in salivary flow rate level [90]. "If the body hydration is decreased, the salivary glands will adapt by reducing salivary secretion to maintain the amount of water in the body, and vice versa. if the degree of hydration increases, which means hyper-hydration, salivary flow rate also increases" [16, 23].

6.2 Medication

The most common cause of hyposalivation is due to the side effects of medications. Several types of drugs, especially those with anticholinergic action such as antihistamines, antidepressants, antipsychotics, diuretics, antihypertensive, and anxiolytics may cause a reduction in salivary flow rate causing xerostomia and hyposalivation which are considered a significant side effect of these widely used drugs [12], and expose the elderly people to a greater risk to xerostomia because they are more frequently used by them [44], and patients use tricyclic

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antidepressant drugs have dry mouth due to the effect of atropine [91]. Herbal medicines can be used to increase the salivary flow rate in obese individuals [17].

6.3 Infections

Chronic inflammation may lead to the appearance of a condition called "Sialadenitis which is an accumulation of lymphocyte infiltrate in the duct system that causes obstruction and hampering of the secretory system", resulting in the occurrence of xerostomia, in addition to painful swelling. Therapeutic treatments can cause a reduction in the saliva flow, this will help the establishment of several colonies of bacteria in the mucosa and cause an increase in the risk of infections mainly by the Streptococcus strains and Staphylococcus aureus [92]. Reduction in the salivary flow rate is considered a cause of occurrence of oral candidiasis [93], and increasing in the count of oral Candida Albican [94]. Endocrine disorders caused by a systemic disease were also found to cause a reduction in the salivary flow rate [52] in addition to the effect of aspiration pneumonia [95].

6.4 Diet, Nutrition, and Nutritional deficiency

Saliva is considered a diagnostic fluid [96], and is affected by many different factors that can cause alterations in its flow rate, or composition, some of these factors related to the diet are the dietary characteristics and habits [47]. Ingestion of foods with different compositions and sensory characteristics resulted in increasing or decreasing the salivary flow rate [52], and an increase in food consumption and frequent mastication especially during breakfast will cause an increase in saliva secretion [60]. Reduction of salivary flow is also related to nutritional deficiencies and eating disorders [97]. Hyposalivation was found to be associated with different conditions of nutrition and affected by malnutrition [2]. Nutritional deficiencies may also influence salivary function and composition [98]. The salivary flow rate was found to be lower among malnutrition children in comparison with well-nourished children.

6.5 Food and thinking or smelling of food

6.5.1 Thinking about the type of the food or smelling or tasting

The food, are considered potent stimuli, in addition to visual stimulation, while looking at food is considered as weak salivation stimuli [95], while after thinking about food, simple salivation will occur, whereas a small increase in salivation will occur by visual stimuli but sometimes will not affect the salivation process [12].

6.5.2 Psychological conditions

Different conditions and disorders are included such as stress, depression, and anxiety which are the main psychological factors that have an association with the alteration in the salivary flow rate, especially with unstimulated one [52], and about 41.9% of individuals who are suffering from oral dryness feeling affected by depression, delirium, dementia and sleep disorders [99]. These main factors cause a reduction in saliva flow and increasing xerostomia. Whereas Matos-Gomes et al, concluded that stress was increasing flow rate [51], Kim and Suh reported that it was only associated with the reduction of unstimulated flow rate [100]. Naumova et al also reported no effect on acute stress [101], whereas "Queiroz et al" reported that it could be able to decrease it, and the mild stage such as "Premenstrual syndrome" showed no effect [102]. This also occurs by the effect of depression [103], in addition, psychological conditions and stressful lives can cause an increase in dry mouth, and anticholinergic drugs have an association with depression and cause a reduction in the whole saliva flow rate [104] along with mental stress either as a result of the sequelae of the disease itself or as an adverse effect of drugs used in their treatment [5].

6.5.3 Emotional status

Secretion of the parotid gland was reported to depend on the emotional status of the individual [17], and as a conclusion during the examination, there was a relationship between the reduction of flow rate in students with the stress of examinations [102]. Depression and stressful conditions, mental stress, psycho-emotional conditions, and uneasy emotional states were all found to reduce the flow of saliva [63,105].

6.5.4 Physical exercise

Several physical activities were reported to have an influence on the salivary flow rate by affecting the sympathetic stimulation, which can cause a reduction in the flow rate of saliva [63,105]. Exercise as reported by several studies could cause an alteration in the salivary flow rate [104] and increase the saliva output [37] while prolonged exercise could cause a reduction in the unstimulated flow rate [106]. In addition, earlier studies reported that there was a modification in the salivary flow rate occur during exercise [107]. This modification mainly reduction occurs due to an increase in the sympathetic activity by causing vasoconstriction [108], this may also have a relationship with sweat-induced dehydration, in addition to in case of restricted intake of fluid during the time of exercise. Horswill (2006) found a significant reduction in stimulated salivary flow rate during training even during water consumption [109], and three hours after exercise a modification in hydration status can be detected [110]. There are different salivary flow rate values among different individuals due to differences in the number of fluids consumed during exercise [107].

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6.5.5 *Hormonal changes, pregnancy, and menopause*

In a postmenopausal period, the flow rate declines among women due to hormonal changes because estrogen and progesterone hormones are causing an increase in the viscosity of saliva and this will cause a reduction in a salivary flow rate [28]. Regarding menopause, some studies reported no change in salivary flow rate [111], while in postmenopausal women, other studies showed a reduction, while the values of unstimulated salivary flow rates in premenopausal women were found to be higher than those found in postmenopausal women [112].

7 Conclusions

Salivary flow rate is affected by several factors, and any change in the nature of these factors will cause either an increase or decrease in flow rate level, this alteration will play a part in the initiation of systemic diseases or abnormal local or systemic disturbances such as hyposalivation which is a feeling of dry mouth. Some of these factors affect both unstimulated and stimulated flow rates, this alteration will play a role in clinical diagnosis and any increase or decrease in the salivary flow rate will play a part in determining the nature of some diseases so considered a diagnostic tool.

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