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THE DIFFERENCES OF SALIVARY VOLUME, pH AND ORAL CONDITIONS BETWEEN MENOPAUSAL AND NON-MENOPAUSAL WOMEN

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ABSTRACT
Background: *Menopause is the permanent cessation of menstrual cycles due to the loss of ovarian activity. This phase is characterized by physiological changes, mostly influenced by the decrease of estrogen and progesterone, as well as by the aging of tissues. These changes can involve oral cavity. Postmenopausal women are prone to changes in the oral cavity such as volume, salivary pH and oral conditions such as ulceration, bleeding gums, dry mouth and caries due to hormonal changes.* ***Purpose:*** *This study aimed to determine the differences in volume, salivary pH and oral conditions in menopausal women and non-menopausal women.* ***Method:*** *This study was using an analytic comparative method. The data obtained was secondary data from the results of the Unpad Lecturer Competency Research (RKDU) by taking a convenience sampling of 27 menopausal women and using simple random sampling of 27 non-menopausal women. The volume and salivary pH were analyzed using the non-parametric Mann-Whitney test and the data on the condition of the oral cavity were analyzed using the z-parametric test with a significance level of p<0.05.* ***Results:*** *The results showed that there were significant differences in salivary volume (p=0.0016), salivary pH (p=0.0191) and caries (p=0.0142), and there was no significant differences in ulceration conditions (p=0.5), bleeding gums (p=0.0806) and dry mouth (p= 0.2756) in menopausal women and non-menopausal women.* ***Conclusion:*** *There are differences in salivary volume, salivary pH and caries conditions, but there are no differences in ulceration, bleeding gums and dry mouth conditions in menopausal women and non-menopausal women.*

Keywords: *Menopausal women, Oral changes, Saliva pH, Saliva volume*
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INTRODUCTION

Menopause is a phase of a woman's life marked by the permanent cessation of the menstrual cycle due to the loss of ovarian activity. This phase is characterized by physiological changes that are largely influenced by a decrease in estrogen, progesterone, and tissue aging.[1] These changes will affect the entire body, including the oral cavity.[1,2] The elderly population is expected to continue to increase along with the increase in life expectancy. The life expectancy of women in West Java continues to increase from 2016-2020, from 74.39% to 75%.[3] The projected proportion of the elderly population in West Java in 2035 is 16.02%.[4] It has also caused, over the last few decades, women's health to be a worldwide concern.[5]

The menopause process is preceded by the permanent cessation of ovarian follicle function at the age of 45-55 years. Women are called menopausal after the cessation of menstruation for 12 months.[6] There is a decrease in the production of the hormones estrogen, gonadotropin and progesterone as a result of ovarian aging, and has an impact on changes in oral conditions such as salivary gland hypofunction and oral mucosal atrophy.[7] The oral mucosa is very sensitive to hormonal changes. Menopausal women can experience changes in the volume, composition, pH, and quality of saliva which will have an impact on other oral conditions.[7] Changes in the oral cavity in postmenopausal women include changes in taste, burning mouth syndrome, increased sensitivity to hot and cold foods, and decreased salivary flow which can cause dry mouth. The decrease in estrogen during menopause can also increase the risk of decreased bone density, especially in the jaw, and can cause tooth loss.[8]

When a woman reaches menopause, they need to evaluate and choose a healthy lifestyle to anticipate long-term health problems in the future.[6] Increasing predictions of the demographics of elderly

women in the world require special attention and treatment, while a review of the literature regarding differences in volume, salivary pH and oral cavity conditions of postmenopausal women that are discussed comprehensively has not been found. The above description encourages the author to conduct research with the aim of knowing the differences in the value of saliva volume, salivary pH and oral cavity conditions of menopausal and non-menopausal women. It is necessary to know so that postmenopausal women can minimize the impact of disease on the oral cavity by preventing and treating oral diseases appropriately.

MATERIAL AND METHODS

The type of research conducted is comparative analytic research using secondary data from research results of Unpad Lecturer Competency Research entitled "Analysis of Saliva Calcium Levels in Various Conditions Associated with Increased Oral Disease" in 2018-2019. The population of this study were menopausal and non-menopausal women around the Faculty of Dentistry, Padjadjaran University, Bandung and Jatinangor. The inclusion criteria in the study were menopausal women aged 45-65 years and had menopause at least 2 years. Exclusion criteria were respondents who had systemic disease (high blood pressure, diabetes mellitus, metabolic disorders and hypertension) and respondents who were or had undergone hormone replacement therapy. Research samples used as research respondents were postmenopausal and non-menopausal women. The number of samples that met the research criteria and were used as research respondents were 27 menopausal women and 27 non-menopausal women. The sample selection used was convenience sampling technique for menopausal women data and simple random sampling for non-menopausal women data.

All secondary data that has been collected were processed and statistically analyzed to determine the differences between menopausal and non-menopausal women groups. Data on saliva volume and pH values that were not normally distributed were analyzed using the Mann-Whitney test. Oral cavity condition data which is nominal scale data were analyzed using the z proportion test. The significance value used is the p value with a 95% confidence degree, if $p < 0.05$ then there is a difference, and vice versa. The research was conducted in March–April 2021 and has received permission from the Research Ethics Commission of Padjadjaran University with number 238/UN6.KEP/EC/2021 on March 31, 2021.

RESULTS

The general and systemic conditions of the menopausal and non-menopausal groups in Table 1 show significant differences in general conditions such as age, height and weight, as well as in systemic conditions of blood pressure and blood glucose, which is seen with p-value <0.05 as the result of the analysis using independent t-test statistical test.

Table 1. General and systemic conditions of postmenopausal and nonmenopausal women

	Menopause (n = 27)	Non Menopause (n = 27)	T-test	p-value
	Mean ± SD	Mean ± SD		
General condition				
Age (years)	57.0 ± 5.0	24.0 ± 3.8	-27.31	8.28E-33*
Height (cm)	148.2± 5.0	152 ± 11.1	1.84	3.57E-02*
Weight (kg)	59.9 ± 11.6	53.6 ± 10.4	-2.09	2.07E-02*
Systemic Condition				
Systolic Pressure (mmHg)	128 ± 14.9	101.1 ± 11.2	-7.52	3.64E-10*
Diastolic Pressure (mmHg)	84.5 ± 8.2	69.0 ± 9.6	-6.4	2.21E-08*
Random Blood Glucose (mg/dL)	120.3 ± 48.6	93.9 ± 20.2	-2,61	5.88E-03*

* Significant (p-value = p<0.05)
SD: standard deviation

Salivary volume and pH values in the group of menopausal women and non-menopausal women are data that are not normally distributed. Mann-Whitney test analysis was used and showed that there were significant differences in saliva volume and pH with p-value <0.05. Salivary volume and pH were lower in the postmenopausal women group as shown in Table 2.

Table 2. The results of the Mann-Whitney test analysis of saliva volume and pH

	Menopause (n = 27)	Non Menopause (n = 27)	p-Value
Saliva Volume (ml/5 min)			
Mean ± SD	1.4 ± 1.1	2.4 ± 1.4	0.0016*
Saliva pH			
Mean ± SD	6.2 ± 0.5	6.6 ± 0.6	0.0191*

* Significant (p-value = p<0.05)
SD: standard deviation

The results of the analysis using the z proportion test on the oral cavity conditions of

menopausal and non-menopausal women showed significant differences in caries conditions, and no significant differences in conditions of ulceration, bleeding gums and dry mouth. This can be seen with p-value <0.05 as shown in Table 3.

Table 3. The results of the z test analysis of the proportion of oral cavity conditions

	Ulceration	Bleeding Gums	Dry Mouth	Caries
Non Menopause				
n	27	27	27	27
x	2	3	7	11
%	7%	11%	26%	41%
p(x)	0.07	0.11	0.26	0.41
Menopause				
n	27	27	27	27
x	2	7	9	19
%	7%	26%	33%	70%
p(x)	0.07	0.26	0.33	0.70
p(x) gab	0,07	0,19	0,30	0,56
Z hitung	0,00	-1,40	-0,60	-2,19
p-Value	0.5000	0.0806	0.2756	0.0142 *

* Significant (p-value = p<0.05)

DISCUSSION

Menopausal women in this study had a mean age (57.0 ± 5.0). This group of menopausal women has the inclusion criteria of having menopause for at least 2 years, so that it is in accordance with the average age of menopause in the world, which is around the age of 45-55 years.[6] The results of the analysis of the general condition of weight and height between the two groups showed a significant difference (p=2.07E-02*), where menopausal women's weight was higher (59.9 ± 11.6), but their height was lower (148.2 ± 5.0). These results are similar to the research by Tjahajawati et al. to 26 postmenopausal women and 35 nonmenopausal women that the average weight, blood pressure and blood glucose during menopause women were higher than the other groups.[2] According to S. R. Davis et al., physiological aging causes weight in postmenopausal women to increase.[9] Weight gain during menopause starts from the pre-menopausal period, which is also caused by a decrease in spontaneous activity so that it reduces energy expenditure in postmenopausal women.[10,11]

Systemic conditions of systolic and diastolic blood pressure in the two groups showed a significant difference (p=3.64E-10*, 2.21E-08*) where postmenopausal women (128 ± 14.9, 84.5 ± 8.2) were higher than non-menopausal women (101.1 ± 11.2, 69.0 ± 9.6). The rate of increase in blood pressure during the menopausal transition is much greater than in men of the same age range. Recent studies have found that Estrogen-β receptors are located on endothelial cells and smooth muscle cells of blood vessels and play a role in mediating the dilation phase, so that the decrease in estrogen in postmenopausal women will increase the vasodilatory response.[12] Random blood glucose of the two groups also showed a significant difference (p=5.88E-03*) with postmenopausal women being higher (120.3 ± 48.6) than non-menopausal women (93.9 ± 20.2) but still within normal limits according to the ADA (The American Diabetes Association).[13] Menopausal conditions have a significant impact on insulin metabolism where postmenopausal women have lower pancreatic insulin secretion and insulin elimination rates. Postmenopausal women have a risk of increasing fasting plasma glucose concentrations 2.64 times higher than premenopausal women.[14]

Saliva Volume

The results of the analysis of saliva volume values showed a significant difference in postmenopausal and non-menopausal women (p=0.0016), where the salivary volume value for menopausal women (1.4 ± 1.1) was lower than non-menopausal women (2.4 ± 1.4). It was explained by Endah A, et al., that the decrease in salivary volume in postmenopausal women was caused by salivary gland hypofunction.[15] Rini Irmayanti, et al. stated that, in postmenopausal women, there was a decrease in the value of the salivary flow rate.[16] The decrease in salivary volume is caused by a partial or total reduction in estrogen production during menopause.[17]

Salivary pH

Based on the analysis of salivary pH values, there was a significant difference between postmenopausal and non-menopausal women (p=0.0191), where the salivary pH value of menopausal women (6.2 ± 0.5) was lower than that of non-menopausal women (6.6 ± 0.6). These results are in accordance with the study of salivary pH using a pH-meter by Foglio Bonda, et al. to 60 postmenopausal women and 60 nonmenopausal women who stated that the salivary pH in menopausal women (6.75 ± 0.34) was lower than in non-menopausal women (6.86 ± 0.24).[1] The decrease in salivary flow rate, which is a modulator of salivary pH, causes the release of less bicarbonate content at low salivary flow rates, so that the salivary pH decreases.[8]

Oral Cavity Condition

Changes in saliva that occur can directly affect the condition of the oral cavity of menopausal women. Estrogen receptors are found in the oral mucosa as well as in the salivary glands. The decrease in the hormone estrogen will have a direct impact on the oral cavity and also the microflora in it. Estrogen deficiency can affect the maturation process of the oral mucosal epithelium.[18] The decrease in saliva volume and pH which is the impact of menopause will affect salivary function. Changes in salivary function can cause damage to oral tissues and have a major impact on quality of life.[19] Decreased secretion and salivary flow rate as well as changes in saliva composition cause dry mouth.[20] Dryness in the mouth is also usually followed by gingival conditions that bleed easily and ulceration in the form of menopausal gingivostomatitis.[21] The decrease in saliva volume and its antibacterial content due to menopause will also increase the potential for caries.[17]

Caries

There was a significant difference in the results of the caries conditions analysis in menopausal and non-menopausal women (p=0.0142), where the percentage of menopausal women who experienced caries was higher (70%) than non-menopausal women (41%). These results are consistent with the study by Rukmini, et al., where there was a significant difference in caries conditions (P<0.001) between a group of 40 postmenopausal women and 40 nonmenopausal women who had their DMF-T index checked.[5] These results are also in accordance with the research of Aleksandra Cydejko et al. which mentions the further impact of hormonal changes in postmenopausal women will affect the teeth and periodontal tissue. This then results in an increased risk of caries which is damage to the hard tissues of the teeth caused by acids produced by bacteria due to the buildup of food debris that has been left in place for a long time.[18]

Decreased salivary flow will cause abnormalities in the quantity and quality of saliva and result in loss of antibacterial properties of saliva, accelerate *Candida albicans* infection, increase the risk of tooth decay and periodontal disease.[22] Salivary pH and plaque pH, if they are below the critical value (5.5), will cause tooth enamel to begin to dissolve. Calcium and phosphate ions in saliva will then begin to repair damaged mineral crystals in tooth enamel (remineralization process). The acidic conditions in the oral cavity will bring the phosphate and hydroxyl ions below the saturation level, and allow the solid hydroxyapatite crystals of dental mineral to dissolve.[23]

Ulceration

Analysis of ulceration conditions in menopausal and non-menopausal women did not show a significant difference (p=0.5), where the percentage of both groups was the same (7%). Research by Patil Santosh et al. showed that only 13 out of 365 (3.6%) postmenopausal women had ulceration.[24] Ulceration can be a complication caused by decreased salivary volume and causes dry mouth.[25] Estrogen deficiency causes a decrease in cell proliferation, cell differentiation, and keratinized gingival epithelium, which causes a decrease in the formation of collagen tissue. This condition causes a decrease and atrophy of the thickness of the gingival epithelium, so that the mucosa is prone to inflammation and irritation.[2]

The primary data study did not indicate the location of the ulceration, but the results of this study contradicted the article compiled by Puneet Mutneja et al. which stated that, in menopausal women, there are changes in the oral mucosa in the form of ulceration of the gingiva called menopausal gingivostomatitis.[26] Gingivostomatitis is characterized by pale, atrophic oral mucosa and thinning of the gingival layer. The gingiva becomes dry, bleeds easily and may become reddish in color due to capillary blockage and dilation.[27] Decreased estrogen causes menopausal gingivostomatitis which is preceded by dry oral mucosa.[21] Gingivostomatitis during menopause can be caused by decreased salivary secretion, as well as dry and irritated gums and mucosa.[28]

Bleeding Gums

There was no significant difference (p=0.0806) in the analysis of bleeding gum conditions, where the percentage of menopausal women who experienced bleeding gums was higher (26%) than non-menopausal women (11%). Systematic literature review by G. Farronato et al. found that one of the clinical findings in the oral cavity of postmenopausal women is gingivitis, inflammation of the gums characterized by swollen gums, redness, an increase in temperature and bleeding from increased plaque.[28] Bleeding gums are also found from the symptoms of menopausal gingivostomatitis on atrophic mucosa that looks pale and bleeds easily.[26]

Bleeding in the gingival margin is a sign of a reversible inflammatory condition of the gums called gingivitis.[29] Food and bacteria easily adhere to tooth surfaces and increase plaque retention when salivary flow rates are low.[2] Saliva contains immunoglobulin A as the largest immunological component and has a role as an antibody to bacterial antigens and inhibits the attachment of bacteria to oral tissues. Decreased saliva volume and antimicrobial content in it can affect the host's

resistance to inflammation and the occurrence of gingivitis.[25,30]

Research by Tjahajawati et al. mentioned that the average BOP (bleeding on probing) value in 26 postmenopausal women was higher (6%) than 35 non-menopausal women (5.73%). BOP is one of the clinical signs of gingivitis during menopause which shows the presence of inflammatory lesions in the epithelium and gingival connective tissue. Gums that bleed when the gingival margin is touched by a blunt instrument indicate that epithelial and vascular changes have occurred.[2] The decrease in estrogen levels causes reduced collagen formation which results in a decrease in gingival microvascular permeability.[31,32] Progesterone plays a role in stimulating the production of prostaglandins, which is the body's response to inflammation, so a decrease in progesterone can cause the oral mucosa to be more easily infected by bacteria.[31]

Imbalance of hormone levels in postmenopausal women can disrupt homeostasis and may also cause periodontitis if gingivitis is not treated, where the most common bacteria found are *A. tannerae, F. nucleatum, P. gingivalis* and *P. multiformis*.[33] Bleeding gums experienced by postmenopausal women are affected not only by hormonal changes but also by oral hygiene.[2]

Dry Mouth

The results of the analysis of dry mouth conditions in menopausal and non-menopausal women did not show a significant difference (p=0.2756), where the percentage of menopausal women who felt dry mouth conditions was higher (33%) than non-menopausal women (26%). The results of this analysis are similar to those of EM Minicucci et al. who conducted a study of 30 postmenopausal women and 30 nonmenopausal women using the Xerostomia Inventory (XInv) and Visual Analogue Scale (VAS) questionnaire, found that dry mouth conditions in menopausal and nonmenopausal women did not differ significantly as a clinical symptom experienced. The menopausal group did not show symptoms of dry mouth, but their salivary flow decreased.[17]

It is different with the results of Agha Hosseini et al's research on 70 menopausal women who stated that dry mouth was the main complaint in menopausal women and the feeling of dry mouth was strongly related to menopausal conditions.[34] Reduced stimulated and unstimulated salivary flow in postmenopausal women suggests abnormal or hypofunctioning salivary glands that may be due to age-related physiological and hormonal changes.[17,24] Salivary gland hypofunction will also cause changes in sensory receptors and decreased salivary flow rate will cause qualitative changes in saliva composition.[19] Dry mouth that occurs in menopausal women is also caused by the process of maturation of mucosal epithelial cells and causes thinning and atrophy of the epithelium due to decreased estrogen.[7] Physiological aging of oral tissue causes acinar cells in the salivary glands to decrease and saliva production decreases, resulting in dry mouth symptoms.[35]

Changes in the condition of the oral cavity in groups of postmenopausal and non-menopausal women can depend on various factors, such as economic, educational, socio-cultural factors, the response of each individual to various irritants and oral hygiene behavior. The level of public knowledge about the importance of maintaining oral hygiene will also affect oral health in both groups.[2]

These various factors may explain the results of the study which showed a decrease in saliva volume and pH, but there were no statistically significant differences regarding the condition of ulcerated oral cavity, bleeding gums and dry mouth in the two groups. Complaints of oral conditions in menopausal women can be avoided, and non-menopausal women can also experience various complaints of oral conditions such as caries, ulceration, bleeding gums and dry mouth due to other factors. Researchers do not have data on the demographic characteristics of respondents such as occupation, educational history, or level of knowledge of respondents which is one of the shortcomings in this study, in addition to complaints about the condition of the respondent's oral cavity, it is known only by questionnaires and without direct examination.

Researchers suggest to continue this research by conducting research on the description of other components of saliva and oral cavity that often occur in postmenopausal women. Research can be done directly or through secondary data with a larger number of samples. Suggestions for the health sector are to take preventive and curative measures, especially among menopausal women regarding the importance of knowing the effect of menopause on the oral cavity and to prevent and treat as early as possible the various complaints of oral cavity conditions that occur.

Based on the research that has been done, it can be concluded that there are significant differences in the volume and pH of saliva between menopausal women and nonmenopausal women, where the volume and pH of saliva are lower in the menopausal women group. Menopausal women experience hormonal changes and physiological aging that causes hypofunction of the salivary glands resulting in a decrease in saliva volume and pH. There was a significant difference in the condition of the oral cavity and caries in the two groups where caries was more common in the postmenopausal women group, but there was no significant difference in the

incidence of ulceration, bleeding gums and dry mouth. Changes in the condition of the oral cavity in postmenopausal women are caused by a decrease in the quality and quantity of saliva and also as a direct impact of hormonal changes on the oral cavity.

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