

Oral fungal infections in the geriatric population of Municipal Health Centre for Older and Dependent Individuals, and participants of three-month rehabilitation programme — mycological study and clinical correlations

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Abstract: The aim was to analyse the results of the oral mycological examination and the relationship with selected parameters of the questionnaire and clinical examination. The study included 50 residents of the Municipal Health Centre for Older and Dependent Individuals and 30 participants in a three-month rehabilitation programme at the Daily Medical Care House.

The study examined the following: type of prosthetic restorations, hygiene of removable dentures using the Ambjörnssen index, denture stomatitis according to Newton's classification, pathologies of the oral mucosa according to the classification of Górska and their localisation, mycological examination.

Mycological examination was mostly positive (MHCOD 80%, DMCH 81%). The Ambjörnssen index indicated that 72% of residents with a positive mycological result had inadequate denture hygiene. The most frequently isolated fungal species were *Candida albicans* (89%) and *Candida glabrata* (39%). In 51% of the cases more than 1 fungal species was isolated. Fungal infection of the oral cavity often took place without accompanying subjective symptoms and increased the risk of red lesions. Abundant and very abundant growth increased a risk of white lesions on the tongue.

Senior patients are at an increased risk of developing oral fungal lesions. As infections often occur without subjective symptoms, it is important to include this group in systematic check-ups. Oral candidiasis is typically identified incidentally during routine examination or in instances of intense proliferation, manifesting



as mucosal lesions. This emphasises the role of a detailed examination of the whole mouth. Because of the lack of adherence to proper hygiene is a risk factor for fungal infection, it is crucial to educate both seniors and care staff regarding proper oral hygiene.

Key words: seniors, oral cavity, candidiasis.

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Introduction

Over the past two centuries, life expectancy has doubled in most developed countries, including Poland [1, 2]. Consequently, there is a growing need for facilities providing specialised medical care for seniors. In Poland, the main places offering such assistance are Municipal Health Centres for Older and Dependent Individuals (MHCODs) and Daily Medical Care Houses (DMCHs). A Municipal Health Centre for Older and Dependent Individuals (MHCOD) provides continuous nursing care and continues to treat individuals who have completed hospital treatment, have been diagnosed and operated on, but no longer require hospitalisation. Due to the severity of their illness, disability, or inability to function independently, they require further medical, nursing and rehabilitation care. Patients are eligible for admission to the MHCOD based on the international Barthel scale, where a score of up to 40 indicates a moderate or severe condition. Daily Medical Care Houses (DMCHs) cater for dependent individuals whose health status does not allow them to be cared for by primary care and specialist outpatient care alone, but who do not require 24-hour supervision. The primary functions of these facilities include nursing care, occupational therapy, cognitive stimulation, counselling in the selection of medical devices, motor improvements and preparation of the family and carers for further care. Patients who have been treated in hospital in the past 12 months and have scored between 40 and 65 on the Barthel scale are eligible for DMCHs. The population of seniors in institutional care consists of vulnerable, dependent individuals, often with frailty syndrome.

As individuals age, numerous changes occur in the oral mucosa. These changes include an increase in the smoothness, a reduction in the elasticity and flexibility of the mucosa, as well as a thinning of the epithelium that covers it. Additionally, the synthesis of collagen slows down, which reduces immunity and regenerative capacity and decreases cell mitotic activity [3]. This results in an increased prevalence of mucosal disease and injury, further influenced by a number of factors, including poor oral hygiene, dental deficiencies, general diseases, medications used, metabolic changes, nutritional deficiencies, changes in saliva secretion, nicotine addiction and alcohol abuse [4, 5].

The most prevalent oral mucosal conditions in older individuals are candidiasis, lichen planus, burning mouth syndrome (BMS), post-traumatic and pigmented lesions, leucoplakia and recurrent aphthous stomatitis [5]. As the necessity for prosthetic restorations increases with age, it is important to recognise that their improper utilisation can result in pathological mucosal alterations, known as denture stomatitis. One such change is proliferative mucosal inflammation of the denture foundation, resulting from an improper fit of the denture margins, particularly in the anterior region of the mouth. This manifests as a mobile mucosal fold at the top of the alveolar ridge. Prosthetic stomatopathies, complicated by fungal infection, known as *stomatitis prothetica*

mycotica, are associated with changes in the composition of the bacterial and fungal flora, with a marked increase in *candida albicans* in denture wearers [6]. The main form of this type of stomatitis is *pseudomembranous candidiasis*, manifested by white patches on the hard palate, cheeks or tongue. Following the removal of the plaque, a bleeding mucosa persists.

The objective of this study was to analyse the results of the mycological examination and to investigate the relationship between these findings and selected parameters from the questionnaire and clinical examination.

Materials and Methods

A total of 80 participants were enrolled in the examination, comprising 50 residents from the Municipal Health Centre for Older and Dependent Individuals (MHCOD) in Kraków and 30 participants from a 3-month rehabilitation programme which is organised at the Daily Medical Care Houses (DMCH).

The inclusion criterion was an assessment of cognitive abilities by a psychologist employed at the MHCOD, using the Mini-Mental State Examination (MMSE) Short Scale, along with written consent to participate in the examination. The objective was to identify a homogeneous group in terms of cognitive ability.

According to the MMSE scale, subjects scoring more than 25 points exhibit normal cognitive abilities, while scores between 21 and 24 points suggest a suspicion of cognitive impairment. Significant cognitive impairment is indicated by a score of 20 points or less.

The study consisted of both a questionnaire and a clinical part.

The clinical examination was conducted by three dentists who had received training in this area. Each of them had several years of experience working with senior patients. Dentists were presented with the same indicators and methods of collecting material for the study. Examination was carried out in medical office setting under a headlamp light, using a mirror and a dental probe.

The study examined the following:

1. type of prosthetic restorations, specifying fixed dentures, removable frame dentures and removable mucosal dentures,
2. the hygiene of removable dentures using the Ambjörnson index (1982) (modified bacterial plaque index for upper dentures involving immersing the denture in a basic fuchsin solution for 30 seconds and then checking for the presence of plaque in five areas of the denture; denture hygiene is then assessed as follows: 0 — good hygiene — no plaque visible on visual examination or when scraped with an instrument; 1 — unsatisfactory hygiene — moderate plaque accumulation visible to the eye, partially covering the denture; 2 — poor hygiene, denture surface profusely covered with visible plaque accumulation),
3. denture stomatitis according to Newton's classification (1962) (this classification is used to assess mucosal changes caused by the use of removable prosthetic restorations; it distinguishes three stages: stage 1 — pink points of congestion, stage 2 — diffuse congestion, stage 3 — hypertrophic granulomatous inflammation),
4. pathologies of the oral mucosa according to the classification of Górska (2011) and their localisation (according to this classification, the following lesions are distinguished: white, red, white-red, pigmented, nodular, papulopustular, vesiculobullous and ulcerative),

5. mycological examination

(it was conducted using swabs from the oral mucosa, collected with dedicated kits containing transport medium (Copan Transystem™ 108C, Brescia, Italy); in the event of pathologies identified during the clinical examination, swabs were taken from the lesion; in the absence of pathologies, swabs were taken from the mucosa of all areas of the oral cavity; the material was submitted for culture on the day of collection, which was performed at the Jan Bóbr Centre of Microbiological Research and Autovaccines in Kraków; in the event of a positive result, the fungal species and growth rate were assessed).

The quantitative traits were described by the arithmetic mean, median, minimum, maximum, and standard deviation. The qualitative traits were described by the number of teeth per group (n) and percentage (%). The results were summarised in contingency tables. The evaluation of differences in quantitative traits between the two groups was carried out using the Student's t-test or the Mann–Whitney test, depending on the distribution of the traits. The assessment of differences in qualitative traits was verified with the chi-square test or Fisher's exact test, depending on the abundance of the data. The dependence of variables on the nominal scale was examined with Fisher's exact test. The normality of the distributions of variables on the continuous scale was examined using the Shapiro–Wilk test and by calculating the skewness and kurtosis parameters. The statistical calculations were performed with STATISTICA 13 and using the statistical language R (version 4.1.1; R Core Team, 2021) on Windows 10 × 64.

The study was approved by the Jagiellonian University Bioethics Committee 1072.6120.187.2017.

Results

Study Group

The group comprised 21 women (70%) and 9 men (30%) from the Kraków's DMCH and 31 women (62%) and 19 men (38%) from the MHCOD. No statistically significant differences in the number of women and men were observed between the DMCH and MHCOD groups ($p = 0.467$).

The mean age of women in the DMCH group was 72.9 years, while that of women in the MHCOD group was 78.2 years. The mean age of men in the DMCH group was 70.6 years, while that of men in the MHCOD group was 66.5 years. The analysis showed no statistically significant differences in age between women in the DMCH and MHCOD groups ($p = 0.222$) or between men in the DMCH and MHCOD groups ($p = 0.657$).

A comparison of DMCH rehabilitation participants and MHCOD residents using the MMSE revealed no statistically significant differences (median 26; $p = 0.360$; mean in DMCH = 25.8; mean in MHCOD = 25.0)

Characteristics of prosthetic restorations

Prosthetic restorations were used by 71.2% of patients. The most prevalent type of prosthetic restoration employed in both groups was removable mucosal dentures (67.5% in the overall sample and 94.7% among patients utilising restorations). The distribution of utilisation of a specific type of prosthetic restoration did not differ significantly between the study groups of seniors (Table 1).

Table 1. The distribution of prosthetic restoration types accompanied by the results of the independence test.

Group	Prosthetic restoration types					df	p	V
	None	Fixed	Removable frame	Removable mucosal	Total			
DMCH	8 (26.7%)	0	2 (6.7%)	20 (66.7%)	30	1	0.313	0.22
MHCOD	15 (30%)	1 (2%)	0	34 (68%)	50			
Total	23 (28.8%)	1 (1.2%)	2 (2.5%)	54 (67.5%)	80			

Hygiene assessment of removable prosthetic restorations

A hygiene analysis of removable dentures was conducted using the Ambjörnsen index [7]. The results indicated that good hygiene was observed in only 14 cases, representing 27% of the denture users (Table 2).

Table 2. The distribution of Ambjörnsen test results accompanied by the results of the independence test (N = 52).

Group	Ambjörnsen test results			df	p	V
	Good hygiene	Unsatisfactory hygiene	Poor hygiene			
DMCH	7 (35%)	7 (35%)	6 (30%)	3	0.74	0.13
MHCOD	7 (22%)	15 (47%)	10 (31%)			
Total	14 (27%)	22 (42%)	16 (31%)			

Analysis of the prevalence of denture stomatitis using Newton's classification

The prevalence of denture stomatitis among residents utilising prosthetic restorations was analysed according to Newton's classification (1962) (Table 3). The most prevalent form of stomatitis was stage I, characterised by pink congestion points.

Table 3. Prevalence of denture stomatitis in the study population according to Newton.

Newton's stages	Number of people	Percent (%)
N = 54		
Stage I	48	89
Stage II	4	7
Stage III	2	4

Results of mycological examination

A total of 77 patients were examined for mycological purposes, with 27 from the DMCH and 50 from the MHCOD. The majority of patients exhibited positive test results (81% of DMCH patients and 80% of MHCOD patients). Statistical analysis revealed no significant differences between the two study groups (Table 4).

Table 4. Results of the study on fungal infections among the DMCH and MHCOD patients.

Mycological examination result	N = 77	DMCH	MHCOD	p ²
		N = 27 ¹	N = 50 ¹	
positive		22 (81%)	40 (80%)	0.876
negative		5 (19%)	10 (20%)	

Pearson's Chi-square test

Among seniors with a positive result of mycological test, follow-up tests were conducted to identify the species responsible for the infection. The most prevalent species was *candida albicans*, present in 89% of cases. In 32 patients (51.6%), more than one fungal species was diagnosed. The second most common species was *candida glabrata* (Table 5).

Table 5. Diversity of *Candida* in the study group of seniors.

<i>Candida</i>	N = 62 ¹	Frequency
<i>albicans</i>		55 (89%)
<i>glabrata</i>		24 (39%)
<i>tropicalis</i>		8 (13%)
<i>krusei</i>		3 (4.8%)
other species of <i>candida</i>		6 (9.7%)
non- <i>candida</i> types		1 (1.6%)

The analysis of the subjective symptoms reported by the residents revealed no statistically significant correlations with the result of the mycological swab. This may indicate that the residents were infected with a fungus, but that they were asymptomatic (Table 6).

Table 6. Relationships between the result of the mycological examination and subjective feelings from the oral cavity in the study group of seniors.

Parameter	Answer	Mycological result		p ²
		Positive N = 62 ¹	Negative N = 15 ¹	
Decrease in saliva	no	33 (53%)	10 (67%)	0.347
	yes	29 (47%)	5 (33%)	
Increase in saliva	no	59 (95%)	15 (100%)	1.00
	yes	3 (4.8%)	0 (0%)	
Taste disorders	no	58 (94%)	15 (100%)	0.581
	yes	4 (6.5%)	0 (0%)	
Burning sensation of the oral mucosa	no	53 (85%)	15 (100%)	0.192
	yes	9 (15%)	0 (0%)	
Pain	no	54 (87%)	13 (87%)	1.00
	yes	8 (13%)	2 (13%)	

Parameter	Answer	Mycological result		p ²
		Positive N = 62 ¹	Negative N = 15 ¹	
Problem with food intake	no	45 (73%)	14 (93%)	0.170
	yes	17 (27%)	1 (6.7%)	
Problem with oral hygiene	no	55 (89%)	13 (87%)	1.00
	yes	7 (11%)	2 (13%)	
Problems with using removable dentures	no	49 (79%)	10 (67%)	0.323
	yes	13 (21%)	5 (33%)	
VAS	0.00 (0.00; 3.00)	0.00 (0.00; 1.50)	0.612	0.612

Fisher's exact test; Pearson's Chi-square test; Wilcoxon rank sum test

The analysis revealed that instances of poor restorative hygiene were exclusively observed among patients who had tested positive for mycological agents (Table 7).

Table 7. Relationship between Ambjörnsen index and mycological examination result in a study group of seniors.

Ambjörnsen index N = 50	Results of mycological examination		p ²
	Positive	Negative	
	N = 44 ¹	N = 6 ¹	0.218
good hygiene	12 (27%)	2 (33%)	
unsatisfactory hygiene	17 (39%)	4 (67%)	
poor hygiene	15 (34%)	0 (0%)	

Fisher's exact test

The study demonstrated that there was no statistically significant correlation between the mycological swab and the stage of stomatitis. However, stages II and III were diagnosed exclusively among patients with a positive result of mycological swab. Furthermore, the most severe lesions were observed only in residents with a diagnosed very abundant growth (Table 8).

Table 8. Relationship between growth intensity in mycological examination and Newton's classification score in a study group of patients.

Newton's classification N = 52	Growth intensity				p ²
	Very abundant	Medium abundant	Poor	Negative	
	N = 25 ¹	N = 15 ¹	N = 4 ¹	N = 8 ¹	0.448
Stage 1	22 (88%)	13 (87%)	3 (75%)	8 (100%)	
Stage 2	1 (4.0%)	2 (13%)	1 (25%)	0 (0%)	
Stage 3	2 (8.0%)	0 (0%)	0 (0%)	0 (0%)	

Fisher's exact test

The analysis of the type of mucosal lesions and positive result of mycological flora infection revealed significant correlations only between the mycological result and red lesions. Seniors with a positive mycological result were characterised by a higher proportion of red lesions on the lips, tongue, corners of the mouth and hard palate. In contrast, respondents with a negative result of mycological examination were overwhelmingly characterised by an absence of red lesions. For the other parameters, the distributions within the groups did not differ significantly (Table 9).

Table 9. Relationship between a positive result of mycological examination and the type and location of a mucosal lesion in a study group of seniors.

Lesion type	N = 77	Positive N = 62 ¹	Negative N = 15 ¹	p ²
White				0.351
none		41 (66%)	7 (47%)	
gums		1 (1.6%)	0 (0%)	
tongue		18 (29%)	8 (53%)	
cheeks		2 (3.2%)	0 (0%)	
Red				0.046
lip mucosa		0 (0%)	1 (6.7%)	
none		21 (34%)	11 (73%)	
lip redness		10 (16%)	0 (0%)	
gums		1 (1.6%)	0 (0%)	
tongue		11 (18%)	0 (0%)	
mouth corners		8 (13%)	1 (6.7%)	
soft palate		1 (1.6%)	0 (0%)	
hard palate		7 (11%)	1 (6.7%)	
cheeks		3 (4.8%)	1 (6.7%)	
White and red				1.000
none		61 (98%)	15 (100%)	
cheeks		1 (1.6%)	0 (0%)	
Pigmented				0.090
none		57 (92%)	11 (73%)	
lip redness		4 (6.5%)	3 (20%)	
tongue		1 (1.6%)	0 (0%)	
hard palate		0 (0%)	1 (6.7%)	
Nodular				1.000
none		59 (95%)	15 (100%)	
lip redness		1 (1.6%)	0 (0%)	
hard palate		1 (1.6%)	0 (0%)	
cheeks		1 (1.6%)	0 (0%)	

Lesion type	N = 77	Positive N = 62 ¹	Negative N = 15 ¹	p ²
Papulopustular				0.483
none		60 (97%)	14 (93%)	
tongue		0 (0%)	1 (6.7%)	
cheeks		1 (1.6%)	0 (0%)	
oral vestibule		1 (1.6%)	0 (0%)	
Vesiculobullous				n/a
none		62 (100%)	15 (100%)	
Ulcerative				1.000
none		60 (97%)	15 (100%)	
lip redness		1 (1.6%)	0 (0%)	
oral vestibule		1 (1.6%)	0 (0%)	

Fisher's exact test

Amongst the senior group with a positive result of mycological swab, the most frequently observed growths were those of a very abundant (n = 29) and medium abundant (n = 23) nature. This group demonstrated an elevated risk of developing white lesions and red lesions on the tongue, corners of the mouth and hard palate, in conjunction with very abundant growths (Table 10).

Table 10. Relationship between the intensity of growth in the mycological examination and the type of mucosal lesions in the study group of patients.

Lesion type	Growth intensity				p ²
	Very abundant N = 29 ¹	Medium abundant N = 23 ¹	Poor N = 10 ¹	Negative N = 15 ¹	
White					0.369
none	17 (59%)	17 (74%)	7 (70%)	7 (47%)	
gums	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	
tongue	11 (38%)	4 (17%)	3 (30%)	8 (53%)	
cheeks	1 (3.4%)	1 (4.3%)	0 (0%)	0 (0%)	
Red					0.046
lip mucosa	0 (0%)	0 (0%)	0 (0%)	1 (6.7%)	
none	9 (31%)	6 (26%)	6 (60%)	11 (73%)	
lip redness	4 (14%)	4 (17%)	2 (20%)	0 (0%)	
gums	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	
tongue	5 (17%)	6 (26%)	0 (0%)	0 (0%)	
mouth corners	6 (21%)	2 (8.7%)	0 (0%)	1 (6.7%)	
soft palate	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	
hard palate	4 (14%)	2 (8.7%)	1 (10%)	1 (6.7%)	
cheeks	1 (3.4%)	1 (4.3%)	1 (10%)	1 (6.7%)	

Lesion type	Growth intensity				p ²
	Very abundant	Medium abundant	Poor	Negative	
	N = 29 ¹	N = 23 ¹	N = 10 ¹	N = 15 ¹	
White and red					0.623
none	29 (100%)	22 (96%)	10 (100%)	15 (100%)	
cheeks	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	
Pigmented					0.327
none	27 (93%)	20 (87%)	10 (100%)	11 (73%)	
lip redness	2 (6.9%)	2 (8.7%)	0 (0%)	3 (20%)	
tongue	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	
hard palate	0 (0%)	0 (0%)	0 (0%)	1 (6.7%)	
Nodular					0.950
none	27 (93%)	22 (96%)	10 (100%)	15 (100%)	
lip redness	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	
hard palate	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	
cheeks	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	
Papulopustular					0.722
none	27 (93%)	23 (100%)	10 (100%)	14 (93%)	
tongue	0 (0%)	0 (0%)	0 (0%)	1 (6.7%)	
cheeks	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	
oral vestibule	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	
Vesiculobullous					n/a
none	29 (100%)	23 (100%)	10 (100%)	15 (100%)	
Ulcerative					0.861
none	28 (97%)	22 (96%)	10 (100%)	15 (100%)	
lip redness	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	
oral vestibule	0 (0%)	1 (4.3%)	0 (0%)	0 (0%)	

Fisher's exact test

A statistical analysis of the relationship between the occurrence of oral fungal infection among senior patients using fixed and removable dentures revealed that the coefficient of statistical significance was not associated with the type of prosthetic restoration. It is noteworthy that among the 51 senior patients with mucosal dentures, 46 were positive, indicating that the use of mucosal removable dentures is a risk factor for the development of infection.

The group of mucosal removable denture wearers had a higher risk of developing very abundant and medium abundant growths (Tables 11, 12).

Table 11. Relationship between the mycological examination result and type of prosthetic restoration in a study group of seniors.

Denture type N = 54	Results of mycological examination		p ²
	Positive	Negative	
	N = 48 ¹	N = 6 ¹	0.303
Fixed	1 (2.1%)	0 (0%)	
Removable frame	1 (2.1%)	1 (17%)	
Removable mucosal	46 (96%)	5 (83%)	

Fisher's exact test

Table 12. Relationship between the intensity of growth in the mycological examination and the type of prosthetic restoration in the study group of patients.

Denture type N = 54	Growth intensity				p ²
	Very abundant	Medium abundant	Poor	Negative	
	N = 26 ¹	N = 16 ¹	N = 6 ¹	N = 6 ¹	0.455
Removable frame	0 (0%)	1 (6.2%)	0 (0%)	1 (17%)	
Removable mucosal	25 (96%)	15 (94%)	6 (100%)	5 (83%)	
Fixed	1 (3.8%)	0 (0%)	0 (0%)	0 (0%)	

Fisher's exact test

Discussion

One of the key aspects of the ageing is the quality of the ageing process itself. This means that a key objective of social and health policy is to take measures to enable healthy ageing. Given the role of the oral cavity in maintaining the proper functioning of the body, it is important to take care of the health of its structures and its proper functioning.

The examined group of seniors was characterised by poor hygiene. In the questionnaire survey, 55 individuals (68%) reported performing oral and denture hygiene once a day or less frequently. Analysis using the Ambjörnsen index indicated that 73% of seniors inadequately clean their dentures. Patients with poor and unsatisfactory denture hygiene, according to the index mentioned above, accounted for up to 72% of all those with a positive result of mycological swab. Despite the limited size of the reference group, it can be concluded that a lack of adherence to proper hygiene was a risk factor for fungal infection in the study group. This is consistent with the findings of other researchers, who have reported that this may be related to insufficient knowledge on the subject and manual limitations that may appear and increase with age in older people. Furthermore, many studies have confirmed that dentists do not provide advice on proper denture care [8–10].

Analyses of dentures and oral hygiene practices among nursing home residents indicates that dentures and the mouth cleaned by nursing staff are no cleaner than those cleaned by the able-bodied seniors themselves. This finding underscores the importance of providing instructions on denture hygiene measures to the elderly; in the case of those living in care facilities, it is

also essential to ensure that the institution's staff receives instructions and training in this area. Proper denture hygiene should include daily cleaning using non-abrasive means, refraining from using dentures at night and storing them properly during this time, and utilising various types of adhesives as needed and temporarily. However, it is important to note that these adhesives with Zn content have the potential to cause bone marrow damage and should only be considered as an ad hoc measure to improve denture adhesion. Furthermore, it is recommended that each senior undergoes a professional examination and cleaning of their dentures at least once a year [8, 11].

Newton's classification divides denture stomatitis into 3 stages: pink points of congestion (stage I); diffuse congestion (stage II), and hypertrophic granulomatous inflammation (stage III). In the study group, there were no statistically significant relationships between the intensity of fungal growth in the culture and the severity of the lesion. These findings are consistent with those of a previous study that examined the relationship between Newton's classification and the amount of fungi present in swabs taken from the denture base and palatal mucosa [12]. It has been demonstrated that fungal infection represents a significant risk factor for denture stomatitis. However, the severity of this condition is also contingent upon a number of other factors, including chronic trauma with ill-fitting or old dentures, poor hygiene, local factors associated with acrylic degeneration, and general factors affecting the weakened body of seniors [13].

It is notable that stages II and III were diagnosed among the analysed seniors only in the case of a positive result of mycological swab, which is in agreement with the Naik study. In this study, it was found that stage I according to Newton is usually caused by trauma, while stages II and III have a multifactorial pathogenesis, among which *candida* infection is the most important [14]. Furthermore, it should be noted that stage III according to Newton was only found at the highest fungal ratio in the swab which was confirmed in Barbeau's study. He observed higher fungal titres in swabs taken from dentures of patients with stage III compared to stages I and II [15].

One of the parameters studied among seniors was the presence of pathological oral mucosal lesions. For this purpose, a classification into white, red, white and red, pigmented, nodular, papulopustular, vesiculobullous and ulcerative lesions was employed. Although there were no statistically significant differences between the MHCOD and DMCH groups studied, it was demonstrated that red lesions were the most frequently diagnosed lesions, occurring in 58.8% of the patients, predominantly in the redness of the lips and tongue. The second most frequent lesions were white lesions (37.5%) diagnosed within the mucosa of the tongue. In 66 residents (82.5%), at least one type of lesion was diagnosed. The high prevalence of mucosal lesions in the elderly has been confirmed by other studies, with prevalence rates ranging from 35% to 98% [16–20]. The propensity for red lesions is consistent with the results of a study conducted in Brazil, in which the authors found that the most common oral lesion was a red spot, and that the palate was the most affected area. It was observed that these results were directly related to the use of dentures by older people, who demonstrated poor oral hygiene and poor adaptation of prosthetic restorations [17]. Nevertheless, any comparison between epidemiological studies is challenging, as they differ in methodology, sample size, diagnostic criteria and cultural and demographic characteristics.

It is important to note that various chronic factors can contribute to the development of pathological changes in the oral mucosa. These include mechanical trauma, reduced salivation, skin diseases, malnutrition, vitamin and micronutrient deficiencies, diabetes mellitus, cardiovascular disease, gastrointestinal disease, topical and systemic medication, stimulants such as alcohol and tobacco and inadequate oral hygiene [3, 4, 21]. Studies have demonstrated that the use of removable dentures is also significantly associated with a higher incidence of damage to the oral mucosa.

These dentures should not be used for more than five years, after which time they can have a detrimental effect on the oral tissues as a result of progressive changes in the mouth and wear of the material from which they are made [8]. In the context of the discussed problem, it is also important to highlight the changes associated with the ageing of oral structures. Atrophy of the mucosal epithelium, lower mitotic activity and tissue regeneration capacity, reduced cell density, degeneration of muscle tissue and a decrease in collagen and elastin are observed [17, 19]. These factors collectively affect the oral environment, promoting irritation and damage to the epithelium.

The results of the mycological examination obtained in the study indicate that there were no statistically significant differences between the study groups. Overall, more than 80% of the seniors participating in the study showed a positive test result. Of particular concern is the fact that, among the seniors with a positive result, more than 83% showed abundant and medium abundant culture growth. The lack of difference between MHCOD residents and rehabilitation camp participants obtained in the study is at odds with the findings of other researchers, who have reported that patients under the care of inpatient facilities are at a higher risk of oral fungal infections [22–24]. This phenomenon might be explained by the lack of difference in self-reported hygiene performance between the two study groups. Furthermore, although the DMCH group reported a statistically significant higher frequency of tooth and denture cleaning, the values of PI and the quality of removable dentures indicate that these activities are of poor quality in both study groups. These results clearly demonstrate the need for pro-health education and support in oral hygiene for the seniors studied.

The high incidence of positive results of oral mycological swabs in the elderly is often attributed to a number of predisposing factors [4, 18, 25], including female gender, poorly controlled diabetes mellitus, xerostomia, radiotherapy, cancer, nutritional deficiencies, immunocompromised states, long-term use of corticosteroids and antibiotics and haematological disorders [13, 16, 18, 26–29]. The primary local risk factor is the utilisation of removable dentures, particularly mucosal dentures [23, 25, 30]. This was corroborated by the studies conducted. Patients utilising removable mucosal dentures have been demonstrated to exhibit a higher frequency of fungal infections and a heightened risk of developing very abundant and abundant growths. The presence of a denture is a prerequisite, and poor oral hygiene and prolonged use of dentures are the most important risk factors for the development of mycosis. Nevertheless, it is important to remember that candidiasis can also occur in patients using intraoral removable orthodontic appliances and obturators [31]. Furthermore, studies have demonstrated that senior patients are less likely to attend regular check-ups, and that their prosthetic restorations have been in use for an extended period, often exceeding the recommended lifespan. Over time, acrylic resin undergoes natural ageing, resulting in degradation. This process increases the material's porosity, creating favourable conditions for microbial colonisation.

A statistical analysis of the fungal genera isolated from positive mycological swabs revealed that *candida albicans* is the most prevalent species. The second most common is *candida glabrata*, and more than one species was identified in 51% of positive swabs. The most common combination was *candida albicans* and *candida glabrata*. This is consistent with the findings of other authors who have demonstrated that these fungal species are most commonly associated with oral fungal infections [23, 26, 32, 33].

Candida species are a natural component of the oral microflora and are present in approximately 40–60% of healthy individuals. In addition to the common *candida albicans*, other *candida* species, including *candida glabrata*, *candida tropicalis*, *candida parapsilosis* and *candida krusei*,

are also found in healthy individuals. The immune system of healthy individuals is responsible for maintaining the equilibrium of the oral microbiota. However, a compromised immune system can result in dysbiosis and elevate the risk of bacterial, viral or fungal infections. *Candida albicans* is the most common causative agent of oral candidiasis due to its commensal nature and widespread occurrence. It is of concern that other species, such as *candida glabrata* and *candida krusei*, have been observed to exhibit resistance to azole drugs [34, 35]. Ageing may be associated with a weakened immune system, making older people more susceptible to fungal infections. The presence of *candida* species that show reduced sensitivity to antifungal agents can be a particular problem for this patient group. Therefore, follow-up examinations and prevention of fungal infections in the elderly are important.

The fungal infection in the study group of seniors was asymptomatic. The residents did not report any impairment of saliva secretion, taste, swallowing or the presence of excessive pain. This is also corroborated by studies conducted in other facilities [26, 36]. The findings indicate that a significant proportion of denture wearers are unaware of the presence of an ongoing fungal infection, which may potentially lead to complications such as oesophageal mycosis.

Oral candidiasis is typically identified incidentally during routine check-ups or in instances of intense proliferation, manifesting as mucosal lesions. In the study group, this was confirmed by an increase in the incidence of red lesions in seniors with a positive mycological result. These lesions were characterised by a higher proportion occurring on the lips, tongue, corners of the mouth and hard palate. In addition, white lesions on the tongue were more frequently observed in the group with abundant and medium abundant growth. These lesions are characteristic of oral fungal infections [37].

Red lesions on the area covered by the denture base with smoothing and reddening of the tongue are referred to as chronic atrophic candidiasis and are most commonly observed in patients who wear prosthetic restorations on a continuous basis [13]. Angular cheilitis is a lesion that occurs most often bilaterally in patients who utilise removable dentures with a reduced intercuspatation height. The formation of wrinkles around the mouth and deepened nasolabial folds can result in the retention of saliva, creating a moist environment that favours the development of painful, easily cracked cutaneous conditions [38]. Pseudomembranous candidiasis represents the most common type of fungal infection. It is characterised by the presence of a soft, easily removable, white plaque that, upon removal, reveals a red, painful and bleeding surface. Such lesions frequently manifest on the mucosa of the cheeks, palate and tongue. They may affect the entire oral cavity or specific areas where natural cleansing mechanisms are limited [39].

Limitations of the study

The results presented here originate from a centre with residents from the southern part of Poland. Consequently, they reflect the specificity of a limited area of the country. Furthermore, the analysis was conducted on a group of only 80 individuals who consented to participate in the study. The participants were a homogeneous group in terms of cognitive ability. Extending the study to include the other MMSE groups could provide a more comprehensive understanding of the complexity of oral health issues among senior patients.

Conclusion

It is well established that senior patients are at an increased risk of developing oral fungal lesions. As infections often occur without subjective symptoms, it is important to include this group in systematic check-ups. Oral candidiasis is typically identified incidentally during routine examination or in instances of intense proliferation, manifesting as mucosal lesions. Red lesions of oral mucosa among senior usually accompanied by a positive mycological result. This emphasises the role of a detailed examination of the whole mouth during dental check-ups. Because of the lack of adherence to proper hygiene is a risk factor for fungal infection, it is crucial to educate both seniors and care staff regarding proper oral hygiene.

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Author contributions

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Conflict of interest

None declared.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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