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[Victor Silva](#)^{*}, [Ceidy Silva](#), Coral Silva, [Rodrigo Gacitúa](#), [Hernan Salas](#), Claudio Alburquenque, Viviana Silva-Abello

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Article

Hand Carriage of Yeast in Student of Medicine, Nurses and Medical Laboratory Scientist. Impact of Infection Control Measures

Víctor Silva ^{1,*}, Ceidy Silva ², Coral Silva ³, Rodrigo Gacitúa ⁴, Hernan Salas ⁵, Claudio Alburquenque ⁴ and Viviana Silva-Abello ⁴.

¹ Carrera de Tecnología Médica, Facultad de Salud, Universidad Santo Tomás, Temuco, Chile

² Unidad de Medicina, Hospital Santo Tomas de Limache, Chile; ceidy.alejandra@gmail.com

³ Universidad Andrés Bello, Facultad Ciencias de la Vida, Santiago, Chile; coralsilvafebre@gmail.com

⁴ Escuela de Tecnología Médica, Facultad de Medicina, Universidad Mayor, Santiago, Chile; viviana.silva@umayor.cl; Claudio.alburquenque@umayor.cl

⁵ Unidad de Medicina, Hospital de Purranque, Osorno, Chile; eldocsalas@gmail.com

* Correspondence: contacto@victorsilvavargas.com

Abstract: We studied yeast hand carriage of 260 students from medicine (78), nursing (89), and medical laboratory scientist (93). We isolated yeasts in 27 students (10.4%), with no differences between careers or gender. A significant lower prevalence of carriage was shown in the clinical cycle (2.7%) compared to the basic cycle (13.5%) ($p=0.022$) and the preclinical cycle (13.5%) ($p=0.014$). Increased handwashing frequency and alcohol gel use decreased yeast carriage. Students who applied moisturizing hand cream two or more times a day had a lower frequency of yeast carriage (3.4%) compared to those who did not use it or used it only once a day (16.5%), showing a significant difference ($p=0.016$). The most prevalent species was *C. parapsilosis* sensu stricto (81.5%), followed by *Meyerozyma guilliermondii* (*C. guilliermondii*) (7.4%), *Trichosporon mucoides* (7.4%), and *R. mucilagenosa* (3.7%). And one case showed mixed carriage of *C. parapsilosis* and *C. albicans*. All strains were sensitive to voriconazole, caspofungin, and anidulafungin. This study shows the yeast carriage on the hands of health students, especially of *C. parapsilosis*, and its reduction with the frequent use of infection control measures and moisturizing hand cream.

Keywords: hand yeast carriage; healthcare students; *C. parapsilosis*; control infection; antifungal susceptibility

1. Introduction

Species of *Candida* spp are important agents of healthcare-associated infections (HAIs), primarily causing catheter-associated candiduria, invasive candidiasis, and sepsis associated with central venous catheters or medical devices, especially in patients admitted to intensive care units, onco- hematological, and immunocompromised patients [1-3].

Globally, HAIs caused by yeasts are mainly due to *C. albicans*, and the second most prevalent species varies by geographic area, type of candidiasis, and study period. *C. parapsilosis* has been reported as the second most frequent agent in candidemia in the Latin American region from the 2000s to the present, while *C. glabrata* is prevalent in candiduria [2,4-7].

Azoles and echinocandins are globally used to treat deep fungal infections. However, resistance to these antifungal drugs has increased in many of the *Candida* species [8]. In a recent meta-analysis, the lowest susceptibility in China was detected for the azole group; fluconazole susceptibilities were reported as follows: *C. parapsilosis* (93.25%), *C. albicans* (91.6%), *Nakaseomyces glabrata* (*C. glabrata*) (79.4%), *C. tropicalis* (77.95%), *Meyerozyma guilliermondii* (*C. guilliermondii*) (76%), *C. pelliculosa* (50%), and *C. auris* (0%). Amphotericin B and anidulafungin were the most susceptible drugs for all *Candida* species [9]. On the other hand, *Candida* species can form biofilms on implanted medical devices and in the host tissue, and these *Candida* biofilms are inherently resistant to

traditional antifungal therapies and the host immune system; therefore, biofilm-associated candidiasis are a huge clinical challenge [10].

Candida auris is a multidrug-resistant fungal pathogen that has been reported in more than 40 countries. Most importantly, *C. auris* is the first fungal pathogen to show pronounced and sometimes untreatable clinical drug resistance to all known antifungal classes, including azoles, amphotericin B, and echinocandins [11].

Candida species, mainly *C. parapsilosis* and *C. auris*, have the potential to cause outbreaks in healthcare settings, owing to their efficient transmission via skin-to-skin contact [11,12]. Recently, the WHO report identified 19 fungal priority pathogens to guide research, development, and public health action, placing *C. albicans* and *C. auris* as fungi from the critical priority group and *C. parapsilosis* and *C. tropicalis* as members of the high priority group according to the prioritization process focused on fungal pathogens that can cause invasive acute and subacute systemic fungal infections for which drug resistance or other treatment and management challenges exist [3].

Candida species, mainly *C. albicans*, can be part of the human microbiota, colonizing more frequently the mucous membranes of the intestinal tract (50% to 70%), oral cavity (30% to 50%), and vaginal mucosa (5% to 30%). In contrast, the presence of *Candida* spp on the hands of community individuals is low, with reported frequencies of less than 5% [7,13-15]. On the other hand, yeast colonization on the hands of healthcare workers ranges from 20% to 80%, being considered an important vehicle for the transmission of these agents in healthcare settings [16-18].

Frequent contact between healthcare workers and patients, as well as with healthcare-related items in a clinical or hospital setting, would favor colonization of the hands of healthcare workers. This was partially evidenced by a previous study from our group, which reported a 16% prevalence of yeast colonization on the hands of medical students, with significant differences between the first two years of university (basic cycle, 7%) and the last two years of study (clinical cycle, 30%). The amount of yeast and diversity of species on the hands increased as students advanced in their training, associated with longer contact time with the hospital environment. In contrast, the frequency of colonization, amount of yeast, and diversity of species remained constant in the engineering student group [12]. These data were partially confirmed by Muango et al., (2017) in medical and nursing students, with a prevalence of hand yeast carriage of 11.2% and 9.2%, respectively [19].

Sixty years ago, the main clinically significant *Candida* species was *C. albicans*, and its colonization frequency on hands ranged from less than 1% in community individuals to 17% on the hands of healthcare workers [13,14]. Later studies reported a broader spectrum of yeast species on the hands of healthcare workers and students, predominantly *C. parapsilosis*, followed by other species such as *C. tropicalis*, *C. famata*, *Nakaseomyces glabrata* (*C. glabrata*), *Meyerozyma guilliermondii* (*C. guilliermondii*), *Rhodotorula* spp., and *Cryptococcus albidus*, among others [5,12,15,17,19,20].

Both permanent and transient yeast colonization on hands is a potential vehicle for transmission to patients, both directly via skin-to-skin contact and indirectly through the contamination of medical devices, contributing to increased HAIs and outbreaks [4,7,17,18]. Handwashing can reduce the presence of yeasts by 50%, but if an antiseptic such as chlorhexidine, povidone-iodine, or alcohol gel is added, colonization decreases significantly, reaching 10.5%, 18.7%, and 21.1%, respectively [21].

Considering that the hands of healthcare workers play an important role as a vehicle for the exogenous transmission of yeasts to patients, and the constant reporting of HAIs caused by yeasts, it is essential to know the frequency of yeast carriage on the hands of individuals associated with hospital services. Therefore, we conducted this study to determine the prevalence of yeast carriage on the hands of students in the fields of medicine, nursing, and medical laboratory scientist, in relation to variables such as study cycle, frequency of application of biosecurity and infection control measures, as well as the prevalence of yeast species and antifungal susceptibility patterns, to obtain a background information that supports future recommendations in the prevention and control of cross-transmission of these opportunistic agents.

2. Materials and Methods

We conducted a descriptive, prospective, and analytical study to determine the prevalence of hand yeast carriage of healthcare students and the impact of infection control measures, as well as the prevalence of yeast species and the antifungal susceptibility profile of the isolated strains. Students from medicine, nursing, and medical laboratory scientist programs at a private university in Santiago de Chile were informed and invited to participate in the study through a consent letter.

A survey was administered to each volunteer, which included questions about age, gender, the field of study, the university study cycle: basic (1st and 2nd year), preclinical (3rd and 4th year), or clinical (5th year), the average daily frequency of clinical handwashing, alcohol gel use, moisturizing cream use, among others.

For sample collection, each student was asked to perform a simple hand wash for 1 minute using 10 mL of sterile saline solution kept in Falcon tubes. The saline solution was placed in the students' palms, who then performed handwashing for 20 seconds. The sample was collected using a swab, which was vigorously rubbed on the palms of both hands. The swab was then placed in a conical tube with 0.5 mL of sterile saline for transportation to the laboratory, at 4° to 6°C. The sample was received in the laboratory, where the quality of the sample, transportation conditions, and documents such as the signed consent form, completed survey, and time of sample collection were verified. The samples were plated on 2 Petri dishes one with Sabouraud dextrose agar plus chloramphenicol and the other with chromogenic agar (Chrom-agar Candida) within 4 hours of collection. The plates were incubated at 36 ± 1°C for 72 hours.

Yeast identification was performed using standard methodology. Briefly, after observing and analyzing the colony characteristics, a germ tube test in fresh human plasma incubated at 36 ± 1°C for 2.5 hours was conducted for suspected *Candida* spp. strains, and microcultures in rice agar with 1% tween 80 incubated at 30°C for 72 hours were conducted for suspected *Candida* spp. and *Trichosporon* spp. Biochemical tests were performed on all yeast strains using API 32C galleries (Biomérieux) incubated at 30°C for 24 or 48 hours, with the Api-Web™ software version 4.0 used for interpreting the bio-code [7].

Identification of species in the *C. parapsilosis* complex (*C. parapsilosis* sensu stricto, *C. methapsilosis*, and *C. orthopsilosis*) was performed by genotyping using the secondary alcohol dehydrogenase (SADH) gene polymerase chain reaction (PCR) amplification strategy, which generates a 716 bp fragment in the *C. parapsilosis* complex species. This fragment was digested with the *Ban*I restriction enzyme to molecularly discriminate between *C. parapsilosis* sensu stricto, which generates two bands of 521 bp and 196 bp, *C. orthopsilosis*, which presents a 716 bp band, and *C. methapsilosis*, which generates 4 bands of 370 bp, 188 bp, 93 bp, and 60 bp [22,23]. Briefly, primers S1F (5'-GTTGATGCTGTTGATTGT-3') and SIR (5'-CAATGCCAAATCTCCCAA-3') were used for the SADH gene. Amplified products were electrophoresed on 1.5% agarose gels, visualized under ultraviolet light, and analyzed on a photo documenter (Bio-Rad). The 716 bp PCR fragments were purified with a specialized kit (Qiagen), and digestion of the purified PCR product was carried out for 120 minutes at 37°C using the restriction enzyme *Ban*I (Thermo Scientific, USA). Digestion products were subjected to electrophoresis on 2% agarose gels (Invitrogen Life Technologies).

Confirmation of *C. albicans* or *C. dubliniensis* was performed by PCR with specific primers designed previously by our group from 18S, ITS1, and ITS2 of the main 6 clinically relevant *Candida* species, as indicated in Table 1 [7]. In summary, DNA was extracted with the Wizard Genomic DNA kit (Promega) from the culture of the strain identified as *C. albicans* by phenotypic methods. The PCR reaction included 25 pmol of primers and 3 µL of yeast DNA in a total volume of 25 µL. The PCR conditions were one cycle at 95°C for 3 minutes, followed by 40 cycles at 94°C for 1 minute, 60°C for 2 minutes, and 72°C for 3 minutes, with a final cycle at 72°C for 7 minutes. Amplification was performed in a T100 thermal cycler (Bio-Rad), and the amplified products were loaded onto 2% agarose gels containing ethidium bromide (0.5 mg/mL). A 100-bp DNA ladder was used as a molecular size (Invitrogen Life Technologies, USA).

Table 1. Specific primer sequence used to identify the main 6 *Candida* species.

<i>Candida</i> species	Primers name	Specific Sequence 5' - 3'	Position gen	Fragment size
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<i>C. albicans</i>	Ca-F1	TAACTGACGGAGCGAGC	18S – 1455bp	724bp
	Ca-3RF	AAAGCGATCCCGCCTTACC	ITS2 – 93bp	
<i>C. dubliniensis</i>	Cd-2F	TGTTCTGGACAACTTGC	ITS1 – 31bp	354bp
	Cd-3RC	CAAGCAATCTCCGCCTTAT	IST2 – 97bp	
<i>Nakaseomyces glabrata</i> (<i>C. glabrata</i>)	Cg-1F	CCAAGTCCTTGTGGCTTG	18S – 679bp	1725bp
	Cg-3RC	ACTGATATGGCCTACAAT	ITS2 – 45bp	
<i>Pichia kudriavzevii</i> (<i>C. krusei</i>)	Ck-1F	TACCTATGGTAAGCACTG	18S – 634bp	1200bp
	Ck-2RC	TTCGTTCCGCTCACGCAG	ITS1 – 19bp	
<i>C. parapsilosis</i> complex	Cpc-1K	TCCGGATTGGTTTAGAGA	18S – 1660bp	210bp
	Cpc-2RC	GCCCCATATAGAAGGCCT	ITS1 – 72bp	
<i>C. tropicalis</i>	Ct-2F	GGTGGCGGGAGCAATCCT	ITS1 – 20bp	340bp
	Ct-3RC	TGTGGTGGCCACTAGCAA	ITS2 – 90bp	

The antifungal susceptibility test was performed using the agar diffusion method following CLSI M44-A2 [24] recommendations. Briefly, from each yeast strain isolated on Sabouraud dextrose agar at 36 ± 1°C for 24h, a 0.5 McFarland inoculum was prepared using a turbidimeter to seed 1-5 x 10⁵ CFU/mL on Müller-Hinton agar plus 2% glucose and 0.5 µg/mL Methylene Blue for gradient strip testing (E-Test). The plates were incubated at 36 ± 1°C for 20 to 24 hours, and the reading of the inhibition ellipse was visual. The in vitro interpretative criteria were analyzed according to CLSI M27M44S [25].

The reference strains used for quality control were: *C. albicans* ATCC 90028, *C. dubliniensis*, *Pichia kudriavzevii* (*C. krusei*) 6258, and *C. parapsilosis* ATCC 22019.

Statistical analysis was performed using Fisher's test, relative risk, and odds ratio with a 95% confidence level or power for significance.

3. Results

We studied hand yeast carriage in 260 students (167 or 64.2% female) from medicine (78), nursing (89), and medical laboratory scientist (93) programs.

Table 2 shows that the prevalence of the hand yeast carriage was detected in 27 students (10.4%), with no significant differences among the three healthcare programs, although, nursing students showed a slightly higher carriage (13.5%), while medical laboratory scientist students showed the lowest carriage (7.5%). The distribution of hand yeast carriage by gender was slightly higher in women (20 – 12%) than in men (7 – 7.5%), with no statistical difference (data not shown).

Table 2. Students distribution with yeast carriage on hands by University Program.

Yeast Cultures	Medicine	Nurses	Medical Lab. Scientist	Total
Positive	8 (10.3%)	12 (13.5%)	7 (7.5%)	27 (10.4%)
Negative	70 (89.3%)	77 (86.5%)	86 (92.5%)	233 (89.6%)
Total	78 (100%)	89 (100%)	93 (100%)	260 (100%)

p> 0.05.

Table 3 shows a significant difference in yeast carriage on hands among students is evident according to the university study cycle, being less prevalent in the clinical cycle with 2 carriers (2.7%) compared to 12 (13.5%) and 13 (13.5%) in the basic (p=0.022) and preclinical (p=0.014) cycles, respectively. No yeasts were detected on the hands of students in the clinical cycle of the medicine and medical laboratory scientist programs.

Table 3. Student distribution according hand yeasts carriage and study cycle as basic, preclinic and clinic by each University Program.

Yeast Cultures	Nurse B – PC – C	Medicine B – PC – C	MTS B – PC – C	Total N°(%) B – PC – C
Positive	6 – 4 – 2	4 – 4 – 0	2 – 5 – 0	12(13.5) – 13 (13.5) – 2(2.7)*
Negative	24 – 23 – 30	26 – 26 – 18	27 – 34 – 25	77(86.5) – 83 (86.5) – 73(97.3)
Total	30 – 27 – 32	30 – 30 – 18	29 – 39 – 25	89(100) – 96(100) – 75(100)

MTS: Medical Laboratory Scientist. B: Basic cycle. PC: Preclinical cycle. C: Clinical cycle. *C vs B
p=0.022 and C vs PC p=0.014.

In Table 4, we show a tendency towards a decrease in the frequency of yeast carriage on hands according to handwashing frequency, decreasing from 15.8% in students who wash their hands 3 or fewer times a day to 7% in students who wash their hands 7 or more times a day, with a relative risk and odds ratio of 2.13 and 2.5, respectively. This tendency is similar with the use of antiseptic soap, as a 6.8% yeast carriage rate is observed in individuals who use this product compared to 14.2% in those who do not use it (p>0.05).

Table 4. Student distribution according hand yeasts carriage and daily handwashing frequency and use of antiseptic soap.

Yeast Cultures	Daily handwashing frequency			Total	Antiseptic soap	
	≤3	4–6	≥7		No	Yes
Positive	3 (15.8%)	15 (13,5%)	9 (7%)	27 (10.4%)	18 (14.2%)	9 (6.8%)
Negative	16 (86.5%)	97 (86.5%)	120 (93%)	233 (89.6%)	109 (85.8%)	124 (93.2%)
Total	19 (100%)	112 (100%)	129 (100%)	260 (100%)	127 (100%)	133 (100%)

p>0.05, Relative Risk IC 95% = 2.13 and Odds Ratio IC 95% = 2.5.

Table 5 shows that there is a tendency towards a decrease in yeast carriage frequency among students who use hand sanitizer 5 or more times a day (3.2%), compared to students who do not use hand sanitizer (14.4%), with a relative risk of 2.2 and an odds ratio of 5.1, but without a significant difference (p>0.05).

Table 5. Student distribution according hand yeasts carriage and use of daily hand sanitizer frequency.

Yeast Cultures	No	1-2	3-4	≥5	Total
Positive	17 (14.4%)	7 (9%)	2 (6.1%)	1 (3.2%)	27 (10.4%)
Negative	101 (85.6%)	71 (91%)	31 (93.9%)	30 (96.8%)	233 (89.6%)
Total	118 (100%)	78 (100%)	33 (100%)	31 (100%)	260 (100%)

p>0.05, Relative Risk IC 95% 2.2 and Odds Ratio IC 95%: 5.1.

In Table 6, we show a significant decrease in yeast carriage is evident (P=0.016) among students who apply hand moisturizing cream with a frequency of 4 or more times a day (0%) or 2 to 3 times a day (3.4%), compared to those who do not use it or apply it only once a day (16.5%), with a relative risk of 2.6 and an odds ratio of 5.5 and p=0.016.

Table 6. Student distribution according hand yeasts carriage and frequency of daily use of moisturizing cream.

Yeast Cultures	No	1	2-3	≥4	Total
Positive	11 (10.5%)	14 (16.5%)	2 (3.4%)*	0 (0%)*	27 (10.4%)
Negative	94 (89.5%)	71 (83.5%)	56 (96.6%)	12 (100%)	233 (89.6%)
Total	105 (100%)	85 (100%)	58 (100%)	100 (100%)	260 (100%)

Use of moisturizing cream 2 or mor vs one or less. *P=0.016, Relative Risk IC 95% 2.6 and Odds Ratio IC 95%: 5.5.

The yeast species most predominantly on the hands of nursing, medicine, and medical laboratory scientist students was *C. parapsilosis*, recovered in 22 out of 27 students (81.5%), followed by *Meyerozyma guilliermondii* (*C. guilliermondii guilliermondii*) in 2 students, one from nursing and one from medicine, *Trichosporon mucoides* in 2 medical laboratory scientist students, and *R. mucilagenosa* in one nursing student. One medical laboratory scientist student had simultaneous carriage of *C. parapsilosis* and *C. albicans* on their hands (Table 7).

Table 7. Distribution of yeast species isolated from the hands of nursing, medicine, and medical laboratory scientist students.

Yeast Species	Nurses	Medicine	MLS	Total
<i>C. parapsilosis</i> senso stricto	10	7	5*	22 (81.5%)
<i>Meyerozyma guilliermondii</i>	1	1	0	2 (7.4%)
<i>Trichosporon mucoides</i>	0	0	2	2 (7.4%)
<i>Rhodotorula mucilagenosa</i>	1	0	0	1 (3.7%)
Total	12	8	7	27 (100%)

*One student with simultaneous carriage of *C. parapsilosis* and *C. albicans*.

The 22 strains identified as part of the *C. parapsilosis* complex, using the conventional method, amplified the characteristic 716 bp fragment of the secondary alcohol dehydrogenase gene -SADH (Figure 1).

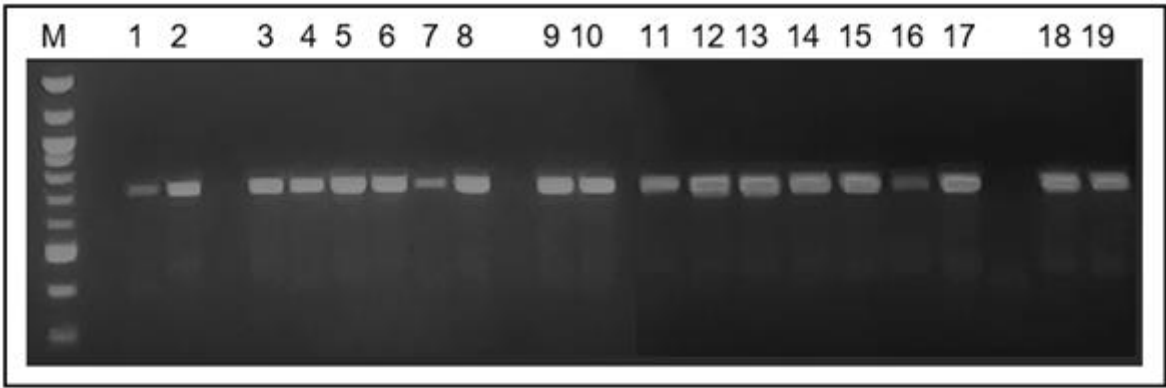


Figure 1. Amplification result of the secondary alcohol dehydrogenase (SADH) gene of the *C. parapsilosis* complex in 18 strains isolated from the student’s hands.

M: 100 bp Ladder. Lanes 1 to 18: *C. parapsilosis* strains isolated from the hands of students; lane 19: *C. parapsilosis* ATCC 22019 strains. All strains amplified the 716 bp fragment of the SADH gene.

According to the Ban I restriction pattern of the amplified SADH gene fragment, all isolates of the *C. parapsilosis* complex strains were molecularly discriminated as *C. parapsilosis* sensu stricto, as evidenced by the two bands of 521 and 196 bp that characterize this species (Figure 2). No profiles associated with *C. methapsilosis* or *C. orthopsilosis* were detected.

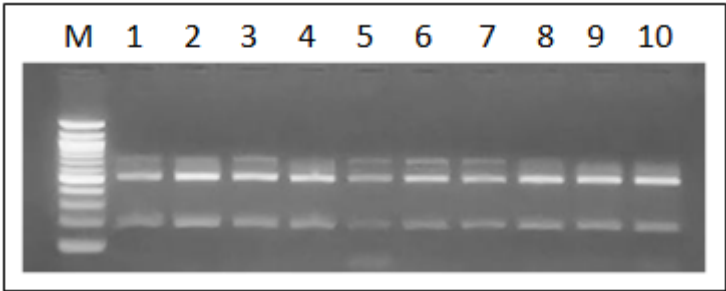


Figure 2. Results of *Ban I* digestion of the previously PCR-amplified SADH gene fragment in 9 strains of the *C. parapsilosis* complex isolated from the hands of health students. M: 100 bp Ladder. Lane 1 *C. parapsilosis* ATCC 22019; lanes 2 al 10 *C. parapsilosis* strains isolated from the hands of students. All strains presented 2 bands of 521 bp and 196 bp.

The species-specific PCR for 6 *Candida* species confirmed the identification of *C. albicans* by generating a 724 bp fragment (*C. dubliniensis* generates a 354 bp amplicon) (Figure 3).

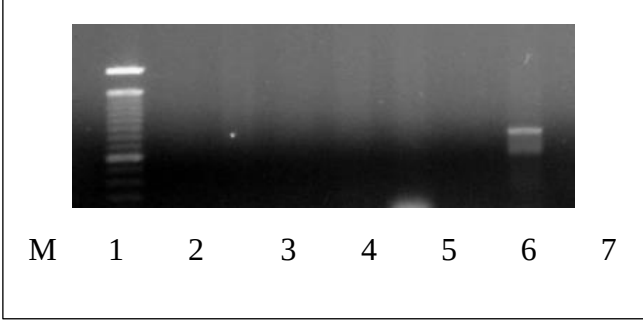


Figure 3. Result of *Candida* species-specific PCR showing a fragment of 724 bp of *C. albicans* strain. M: 100 bp Ladder. Lanes 1 to 6 *C. parapsilosis*; lane 7 *C. albicans* with amplicon of 724 bp.

As shown in Table 8, all isolated yeasts were sensitive to voriconazole, caspofungin, and anidulafungin, with MIC90 values of 1 µg/mL, 2 µg/mL, and 1 µg/mL, respectively.

Table 8. Susceptibility test from 28 yeast strains isolated from student’s hand.

	Voticonazole		Anidulafingin		Caspofungin	
	MIC mg/mL	S %	MIC mg/mL	S %	MIC mg/mL	S %
Range	0.5 - 1	100%	0.5 - 2	100%	0.125 - 1	100%
MIC 50	1	100%	1	100%	1	100%
MIC 90	1	100%	2	100%	1	100%

4. Discussion

Our study shows that the prevalence of yeast carriage on the hands of nursing, medicine, and medical laboratory scientist students was 10.4%, being slightly higher in nursing students at 13.5% and lower in medical laboratory scientist students at 7.5%. The distribution of yeast carriage by sex was slightly higher in women (12%) than in men (7.5%), with no statistical difference. These data are similar to those previously published for medicine students at 16% [12] and for nursing and medicine students at 9.9% and 11.2%, respectively [19]. The presence of yeasts on the hands of healthcare students is higher than reported for the general community [13-15], but lower than detected among hospital personnel, with carriage rates ranging from 20% to 80% [16,17]. Yildirim et al. [18] reported that 34.1% of the people analyzed carried *Candida* spp. on their hands: 30.7% were nurses, 25.8% were resident doctors, 28.6% were laboratory workers, 84.6% were dining room personnel, and 43.3% were officers.

In this study, the hand yeast carriage in healthcare students was significantly less prevalent among clinical cycle students (2.7%) compared to younger students in the basic (13.5%) and preclinical (13.5%) cycles. These results differ from previous reports, which indicated that the prevalence of yeast carriage in medical and nursing students increases progressively as they advance to the clinical cycle and spend more hours in the hospital environment [12,19]. Our results showing lower yeast carriage prevalence in the clinical cycle group may be explained by the greater adherence to clinical handwashing and infection control measures among advanced students. We found that the frequency of yeast carriage decreased from 15.8% in students who wash their hands 3 or fewer times a day to 7% in students who wash their hands 7 or more times a day. This tendency in controlling yeast carriage is reinforced with the use of antiseptic soap, as yeast carriage in students using this

product is 6.8% compared to 14.2% in those who do not use it, along with frequent use of hand sanitizer (3.2%) compared to students who do not use hand sanitizer (14.4%). Our results confirm the findings previously reported by Yildirim et al., who indicated that handwashing can reduce yeast presence by 50%, while the use of antiseptics such as chlorhexidine, iodine povacrylate, or hand sanitizer significantly decreases yeast carriage on hands to frequencies of 10.5%, 18.7%, and 21.1%, respectively [21], as well as chlorhexidine soap, which reduces microbial load when cleaning the skin [26].

We also detected that frequent use of moisturizing hand cream significantly decreases yeast carriage in students who apply this product 2 to 3 times (3.4%) and 4 or more times a day (0%) compared to those who do not use it or apply it only once a day (16.5%). This result can be partly explained by the protective role of the moisturizing cream on the keratinocytes of the skin surface, thus contributing to the integrity of the skin's mechanical barrier, which can be affected by the use of latex or vinyl gloves and chemical antiseptics [16,27].

The predominant isolated species from the hands of nursing, medicine, and medical laboratory scientist students was *C. parapsilosis* sensu stricto (81.5%), confirmed molecularly by the restriction pattern with Ban I enzyme of the amplified SADH gene fragment, affirming the usefulness of this genotyping technique by PCR [22,23]. Additionally, *Meyerozyma guilliermondii* (*C. guilliermondii*), *Trichosporon mucoides*, and *R. mucilagenosa* were isolated less frequently. The predominance of *C. parapsilosis* on the hands of healthcare students observed in this study agree with various previous studies on hand yeast colonization in healthcare-related individuals [5,12,15,17-20].

In many countries, especially in Latin America, *C. parapsilosis* has been reported as the second most frequently isolated fungal agent causing candidemia in both pediatric and adult patients over the past two decades [2,6], indicating the high level of circulation in hospital environments. The hands of healthcare personnel are a potential vehicle for transmitting this agent, highlighting the importance of understanding its carriage among healthcare-related individuals and implementing appropriate control measures to prevent infections caused by *C. parapsilosis*.

Only one student presented simultaneous carriage of *C. parapsilosis* and *C. albicans*, confirmed by specific PCR, thus ruling out *C. dubliniensis*, which has very similar phenotypic and biochemical characteristics [28]. The low frequency of *C. albicans* on the hands of community and healthcare personnel has been previously documented [12-15,19].

All yeasts isolated from the hands of students showed MIC values indicating sensitivity to voriconazole, caspofungin, and anidulafungin, consistent with other studies that have reported high sensitivity in *Candida* strains isolated from invasive infections [29,30]. However, this differs from the gradual increase in resistance to certain antifungals reported by some researchers [8,9]. It is important to note that in vitro sensitivity tests are performed with vegetative yeasts, whereas their condition can change radically when colonizing and forming biofilms on implanted medical devices such as catheters. These *Candida* biofilms are inherently resistant to traditional antifungal therapies and the host immune system [10].

5. Conclusions

This study highlights yeast carriage on the hands of nursing, medicine, and medical laboratory scientist students, with *C. parapsilosis* sensu stricto being the most prevalent species and no resistance detected among the analyzed strains. The frequency of yeast colonization on hands significantly decreased in clinical cycle students, since they show high adherence and greater frequency of application of biosafety and infection control measures.

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