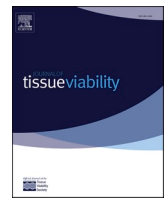




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Personal protective equipment related skin changes among nurses working in pandemic intensive care unit: A qualitative study

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ABSTRACT

Aim: The respiratory tract is the main transmission way of the SARS-CoV-2 virus and nurses who care for COVID-19 patients in intensive care units (ICUs) are required to constantly use personal protective equipment (PPE) during their daily work. This study aimed to examine the PPE-related skin changes experienced by the nurses working in pandemic ICU during the COVID-19 pandemic.

Methods: Using a descriptive phenomenological approach, semi-structured interviews were conducted between November 1st and December 25th, 2020, in the pandemic ICU of a training and research hospital in Usak, Turkey. The nurses who worked in the pandemic ICU for at least one week and experienced skin changes due to PPE use were included. Individual interviews were carried out online through video conferencing. Colaizzi's method was used in data analysis by using the ATLAS.ti 8.0.

Results: The main themes were main causes of PPE-related skin changes, its location along with secondary adverse effects, symptomatology, prevention, and therapeutic interventions used for curing PPE-related skin changes. Nurses mostly reported PPE-related skin changes behind their ears, over their nose, cheeks and jaw due to wearing N95 masks and on the forehead due to wearing face shields. Wearing PPE at least 2 h, the type/quality of PPE, and being dehydrated were identified as the common causes.

Conclusion: This study provides a deeper understanding into the PPE-related skin change experiences of pandemic ICU nurses and the importance of the quality of the PPE used. It is recommended to enable shortened working shifts and ergonomic PPE materials for ICU nurses.

1. Introduction

Coronavirus disease 19 (COVID-19), which first appeared with the first unknown cases of pneumonia in Wuhan, Hubei province of China, and declared as a pandemic by the World Health Organization (WHO) as of March 2020, globally leads to serious health problems [1,2]. In infected patients, the virus may cause simple symptoms that can be treated at home, as well as may cause more severe symptoms requiring hospitalization and treatment in intensive care units (ICUs), and even death [3,4]. It has been reported that, as of May 06, 2021, there are 155,665,214 confirmed COVID-19 cases, including 3250,648 confirmed deaths in the worldwide [5]. In Turkey, as of May 07, 2021, Ministry of Health has reported that there are 4998,089 confirmed COVID-19 cases, 3,260 of them are at the severe state and 3.2% of them are being treated

for pneumonia and the ventilator occupancy rate at ICUs was 33.8% [6].

Globally, many ICUs are struggling to treat patients infected with life-threatening COVID-19 [7,8]. In this process, healthcare professionals who care for suspected or confirmed COVID-19 patients constitute a population of high risk in becoming infected with SARS-CoV-2 [9,10]. As the main transmission way of the virus is the respiratory tract, nurses who care for COVID-19 patients are required to use constantly personal protective equipment (PPE) such as face masks, face shields and goggles during their daily work [11–13]. WHO recommends the use of N95 or FFP2 standard, or equivalent types of face masks and face protective devices such as face shields, or goggles; especially during care interventions in which aerosols are exposed [14]. However, using these protective equipments for more than 4 h during a day may lead to certain facial skin changes among health professionals,

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especially among nurses who work in ICUs. It was reported that many healthcare workers who care for COVID-19 patients over 6 h per a day had pressure injuries due to the use of N95 masks (81.7%), goggles (87.9%) and face shield (58.6%) [13,15,16].

COVID-19 cases continue to be reported worldwide today, and healthcare professionals are at the forefront of combating this condition. At that point, it is important to give nurses the opportunity to express their feelings about the challenges they experience to determine the problems, for instance PPE-related skin changes which is reported as one of the most common problems experienced by ICU nurses [13,15]. In this way, it will be possible to increase the awareness regarding this topic and help nurses to prevent PPE-related skin problems in their future practice, so that they can contribute their preparedness for such problems in the ongoing pandemic process. Therefore, the aim of this study is to examine the PPE-related skin changes experienced by the nurses working in the pandemic ICU during the COVID-19 pandemic.

2. Material and methods

2.1. Study design

In the present study, among the qualitative research methods, the phenomenology perspective, which is based on describing and making sense of the experiences of individuals, was taken into consideration; and within the scope of phenomenology, descriptive phenomenological approach was adopted, which aims to enlighten the new perspective of a phenomenon by describing it [17].

2.2. Sampling and setting

In qualitative studies, there is no set rule for sampling and the sample is determined in line with the purpose of the research [18]. In the present study, convenience sampling method was used. With this method, researchers select individuals whose feelings, thoughts and/or experiences help to achieve the purpose of the research. It is appropriate to use this sampling method when variations in the characteristics of the sample do not have a specific effect on the subject studied [18]. The study invitation was announced in the pandemic ICU of a training and research hospital in Usak, Turkey and voluntary participation of the nurses were asked. The inclusion criteria were being 18 years or older, working as a nurse in the pandemic ICU for at least one week, and experiencing skin changes due to PPE use. Data collection process was started on the November 1, 2020 and on the December 25, 2020 data saturation was achieved with the participation of 14 nurses. When no new information emerged during the interviews, in other words, when the findings provided sufficient knowledge about the phenomena, it was accepted that the data saturation was achieved, and data collection process was terminated [19].

2.3. Data collection tools

For data collection “Data Collection Form” and “Semi-Structured Interview Questions Form” were used.

2.3.1. Data collection form

This form included sixteen questions to determine the descriptive characteristics of nurses (such as age, gender, marital status, educational status, etc.), and the experiences and the working status of nurses (such as working duration at the unit, working schedule, being trained or professionally experienced on caring COVID-19 patients, etc.).

2.3.2. Semi-structured interview questions form

This form was developed by the researchers in accordance with the literature [12,20,21] and included five main interview questions to determine the status of using PPE, nurses’ experiences of having PPE-related skin changes, the methods used for preventing and healing

these injuries and the effects of these skin changes both on their working comfort and their daily life.

2.4. Data collection

Firstly, the researchers determined the nurses who meet the criteria by considering the sample selection criteria, briefly explained the purpose and scope of the study to the nurses. The participants who accepted to participate were then asked to inform the researchers about their availability to conduct the interviews. It was intended that the nurses had all the flexibility to decide the day and time of the interview so that they could spend enough time for the interview and they could have the privacy needed for being able to conduct a one-to-one session. Due to the fact that the data collection was realized during the pandemic, each interview was conducted online through video conferencing. Interviews with the nurses were carried out with double-sided protection in an encrypted protected environment with a video-conference program. Each interview was recorded and archived digitally in a password protected drive. Before starting the recording, participants were asked again to confirm their voluntary participation in the present study and their acceptance for recording of the interview session.

The questions in the semi-structured interview form followed the rhythm of the answers given by the nurse, allowing the order of the questions to be changed or skipped when necessary, making it easier to get answers for the purpose of the study when necessary, and continued with additional questions to ensure a better understanding. The additional questions were chosen with care to ensure that they would not direct the nurses’ responses and that they would instead help them express their practices, feelings, and thoughts regarding the use of PPE use. Examples of the additional questions are: “Can you explain how you use the surgical mask at the same time while using the N95 mask?”, “You said that you use materials under the N95 masks. Can you describe these materials?”, “What’s the longest time you have worked without replacing your N95 mask?”. There were no planned or anticipated restrictions on the duration of the interview. It was explained that the nurse’s individual decision may be decisive in the termination of the interview, and that rest periods can be provided if desired. One other determining factor in termination of the interview session was the fact that all planned questions have been asked, new topics and cases were no longer discussed during the interview, and the nurse started to express the previously spoken topics in a repetitive manner.

To ensure the confidentiality of the nurses’ information during the interview, attention was paid to the absence of other people in the room. In case of necessity to interrupt the interview, video recording was stopped, and the conversation was resumed after the suitable meeting environment is restored. During the data collection process, it is thought that this will increase the reliability and sincerity of the results, as nurses will participate in the interview at a time when they are resting at their own homes and in an environment where they feel comfortable and safe. In addition, with this data collection method, it was ensured that the working schedule of nurses is not interrupted. The interview length of the interviews ranged from 18 to 36 min.

2.5. Data analysis

In the present study, Colaizzi’s phenomenological data analysis method was used with following the 7-stepped process [18,22]. The steps of the Colaizzi’s descriptive phenomenological method were presented in Fig. 1. After the interviews were written verbatim, content analysis was performed using the ATLAS.ti 8.0 qualitative data analysis software program.

2.6. Trustworthiness of the study

Lincoln & Guba’s criteria to evaluate the trustworthiness of qualitative studies (credibility, transferability, dependability, confirmability,

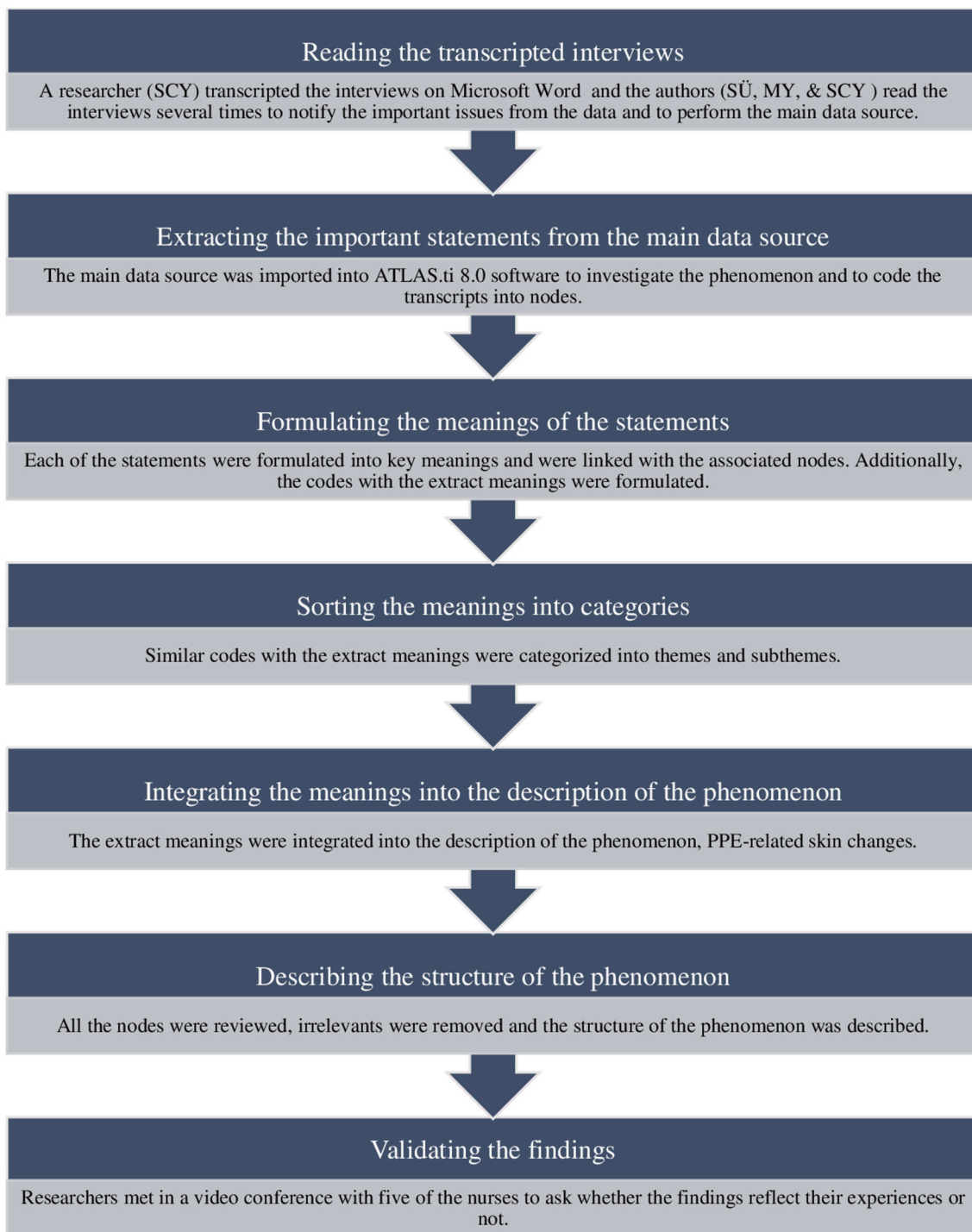


Fig. 1. Steps of Colaizzi's data collection.

and reflexivity) were considered. In order to increase the credibility of the results one-to-one interview method was chosen to increase the comfort level of the nurses during the interviews, and representative quotations were presented from the verbatim transcriptions. Transferability was assured by conducting the study in a pandemic ICU where the nurses were using PPE on a daily basis. Additionally, not extending the data collection process for too long and using a semi-structured interview guide during the interviews helped for questioning the same concepts for all nurses and helped to increase the dependability of the findings. To guarantee the confirmability of the results, the preliminary results were evaluated by all the researchers to ensure a unique

perspective. At last, the researchers and the participants do not have any personal or professional relationship which confirms that given answers were not affected by a possible relationship so the reflexivity of the results were ensured [23,24].

2.7. Ethical considerations

As a first step, the permissions to conduct this study was obtained from the Republic of Turkey Ministry of Health, and General Directorate of Health Services COVID-19 Scientific Research Evaluation Commission. Later on, the ethical permission (date: November 16, 2020/

number: E.4515) was obtained from the University Ethics Committee of the Faculty of Medicine and the institutional permission (date: September 04, 2020/number: 602.03.99-E9867) was obtained from the hospital directory where the study was conducted. The nurses digitally signed the informed consent forms, and they were informed that the data will be kept confidential and will only be used for the study aim. All procedures of this study were performed in accordance with the ethical standards, and the Helsinki Declaration. A random code was given to each participant to save the transcription documents and the recordings were deleted after the transcriptions were completed.

3. Results

3.1. Sample characteristics

The study sample included 14 nurses who work in pandemic ICUs. Participants' descriptive characteristics are presented in Table 1.

3.2. Thematic findings

6-main themes were found following the phenomenological descriptive analysis. These main themes, their sub-themes and the relation between them are presented in Fig. 2.

3.2.1. Main causes of PPE-related skin changes

The nurses expressed that PPE use causes certain level of skin changes while in use and it was understood that there are three main causes for the development of PPE-related skin changes which were *working with PPE for hours*, *having wide variety of PPE* regarding their type and quality, and *being dehydrated while working* with PPE.

- Working with PPE for hours

The nurses were emphasizing frequently that working with PPE for long hours was one of the main causes of PPE-related skin changes, and the accompanying factors such as sweating, lack of breathability of the skin, and even insufficient number of staff were found to be complicating the severity of the problem.

“Due to lack of nursing staff, we are working much more than normal ... therefore, we are wearing that equipment more hours that we used to be.” — #4/Female

“The time of [PPE] use is long ... if you think that sometimes we are wearing them continuously during 1,5-2 hours, yes, it affects ...” — #7/Female

Table 1
Participants' descriptive characteristics.

Participant Number, Age, Gender	Duration of working in pandemic	The maximum duration of continuous PPE use
#1, 26, Female	3 months	5 h
#2, 26, Male	3.5 months	4 h
#3, 34, Female	9 months	3 h
#4, 28, Female	9 months	2 h
#5, 24, Female	2.5 months	4 h
#6, 25, Female	8 months	4 h
#7, 25, Female	9 months	2 h
#8, 24, Male	9 months	3 h
#9, 25, Female	7 months	6 h
#10, 42, Female	10 months	5 h
#11, 25, Male	9 months	4 h
#12, 30, Female	4 months	2 h
#13, 29, Male	8 months	1 h
#14, 25, Female	9 months	3 h

“Using the same equipment for hours, not being able to change it ... Also, your skin is not breathing, and sweating ... and there is a continuous pressure ... all causes skin changes.” — #12/Female

- Wide variety of PPE (type and quality)

Apart from the fact that they need to wear many different PPE at once, the nurses were also underlining that the types and quality of the PPE are playing an important role in the development of PPE-related skin changes.

“I think it is also related to [PPE] its level of functionality, I don't think they are very ergonomic. In many of them [masks] the positioning wires are going off, even sometimes they are as hard as paper and irritates a lot.” — #5/Female

“I don't think that the materials [of PPE] are of high quality, they could have been use better quality materials for the production.” — #7/Female

“Apart from using them for hours, I think the other important factor is that sometimes the strips [of the masks] are very tight and you cannot adjust them well.” — #13/Male

- Being dehydrated while working

As commented before, sweating is one of the accompanying problems while working for long hours with PPE. In addition to that, the nurses also pointed out that being dehydrated while working is another factor that facilitates the development of PPE-related skin changes.

“It is a consequence of the pandemic ... It is unavoidable that you become dehydrated [while working with PPE] ... Absolutely your risk of developing pressure ulcer is increasing.” — #5/Female

“[Being dehydrated] is affecting, you don't have time to drink water ... I think it facilitates the appearance of pressure ulcers.” — #14/Female

3.2.2. The location of the skin changes caused by PPE

Various PPE products cause skin changes in various parts of the face, for instance, the FFP2 (N95) masks are frequently causing *skin changes mainly behind the ears, additionally over the nose and the zone around the cheeks and the jaw*. In the second place, the use of *face shield* was uniquely associated with *skin changes on the forehead*.

“It [skin changes] was especially happening when using face shield and those masks that the rubber stripes goes behind your ear. [We have] rashes over the forehead because of the face shield, and over the nose and around the jaw because of the FFP2 mask.” — #1/Female

“At first, I had a rash over my nose, and aching behind the ears like it was getting cut.” — #8/Male

3.2.3. Secondary adverse effects of PPE-related discomfort

In addition to the facial skin changes observed due to mask and face shield use, the nurses also commented that, PPE-related discomfort have certain secondary adverse effects such as *decreased comfort while working* and *headache*.

- Decreased comfort while working

The nurses underlined that the sense of pressure that the PPE are

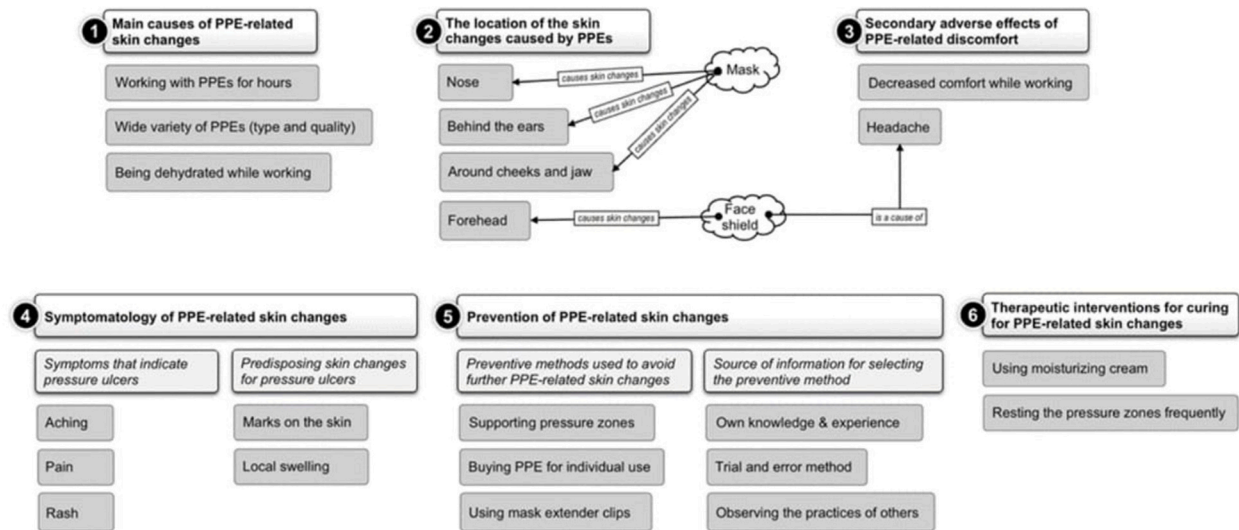


Fig. 2. Distribution of the main themes and their sub-themes.

causing decreased their level of comfort while working, especially made them rush more while they provide nursing care.

“When your face is under that much pressure, you feel like leaving the patient room as soon as possible.” — #6/Female

“It [PPE] is hurting, you want to get rid of it as fast as possible, and of course it affects your performance, it affects the quality of the care you are giving to the patient.” — #12/Female

“It [PPE use] is affecting my working routine, because I am uncomfortable, and it is possible that I did everything in a rush when I was caring for them [the patients].” — #14/Female

- Headache

The nurses pointed out that they suffer from a headache due to face shield use that the complaints last much longer than the other PPE-related skin changes, even sometimes they need to use analgesics in order to relieve themselves.

“When I use the face shield for a long time, I suffer from a headache as unsupportable as a migraine, and it doesn’t go when I take off the face shield. At night I usually end up taking a painkiller.” — #2/Male

“When I arrive home, I usually suffer from a headache because of having a face shield squeezing my head all day. There were times that I needed to take an analgesic for it.” — #8/Male

3.2.4. Symptomatology of PPE-related skin changes

The symptoms that accompany PPE-related skin changes often include *aching*, *pain*, and *rash*; which can be considered as the indicators of 1st degree pressure ulcers. On the other hand, there were certain predisposing skin changes pointed out such as *marks on the skin* and *local swelling*.

“After finishing the shift, I find myself with pain behind my ears, with marks over my nose ... It’s quite bothering.” — #2/Male

“Because of the mask, I had an injury like a local swelling and rash, but later it disappeared.” — #4/ Female

“Especially during summer, in addition to the increased temperature it’s aching. Also, I have a sensitive skin, and I had rashes on my forehead because of the continuous pressure of the face shield ...

Because of the marks that the N95 mask created on my face, sometimes I was realizing later at home that my face is divided into two sections with a prominent mark.” — #6/Female

“I remember that I had a severe pain behind my ears ... that one day that the strip of the mask has twisted my ear. Also, normally there are rashes that last half an hour or so to be relieved ... And normally it takes time for the marks to disappear, for example, when I coincide with an acquaintance after leaving my shift, I am being told ironically like « *Are you coming out of a pandemic o what?* »” — #9/Female

“Most of the times, it [PPE-related skin changes] was painful ... when I rest, when I try to sleep ... it was aching. I wasn’t even able to touch my face because of pain.” — #10/Female

“I had some marks behind my ears, on my forehead, and on my nose, which were staying there almost half an hour.” — #14/Female

3.2.5. Prevention of PPE-related skin changes

Following the initial skin changes due to PPE use, the nurses intended to look for methods that may prevent the development of PPE-related skin problems and discomfort.

- Preventive methods used to avoid further PPE-related skin changes

The most frequent preventive actions taken were supporting the *pressure zones* with cotton pads or dressing tapes, buying higher quality *PPE for individual use*, and *using mask extender clips* in order to avoid direct contact with the ears.

“Primarily I try to decrease the pressure when I use PPE and I support the pressure zones with pads that we normally use to close patients’ eyes, because when if I don’t do it, then I start feeling pain as soon as I start using them (PPE).” — #1/Female

“I bought myself a better face shield, because the ones I was using in the hospital were standard in size, it is impossible not to cause headache. Additionally, it was causing rashes and I don’t think it was very useful either. The one [face shield] I bought is adjustable in size and it is very practical.” — #2/Male

“You know those clips that you can use to extend the mask strips and tie them behind the back of your head, I bought one of them to protect the zone behind my ears. It also helped me to relieve the pressure over my nose.” — #10/Female

“I am placing cotton pads on the contact zones ... and also I bought myself a face shield because the ones given from the hospital were very uncomfortable.” — #11/Male

- Source of information for selecting the preventive method

When the nurses were asked about the source of their information for selecting the previously explained preventive methods, it was seen that they decided to use these methods considering their *own knowledge and experience*, using the *trial-and-error method*, and *observing the practices of others*.

“As far as I know, to be able to prevent pressure ulcers, the key is to eliminate the pressure, so I thought that I must do this.” — #1/Female

“In order to prevent those skin changes, I tried to find which method prevents best using the trial-and-error method.” — #2/Male

“At first, I was wearing a surgical mask over a N95 mask, but later on I realized that it is worsening the pressure, so I changed it. Now first I am wearing a surgical mask, and then wear the N95.” — #7/Female

“I am placing cotton pads on the contact zones and I chose to do this based on my own experience.” — #11/Male

“We [some ICU nurses] saw in social media that people are using mask extenders, so we decided to buy one as well.” — #14/Female

3.2.6. Therapeutic interventions for curing for PPE-related skin changes

In addition to preventive actions, when the PPE-related skin changes were inevitable, the nurses were trying certain therapeutic interventions for speeding up the healing process. The most common methods preferred were *using moisturizing cream* and *resting the pressure zones frequently*.

“Both before and after the use of PPE, I always moisturize the pressure zones and it helped a lot.” — #3/Female

“I used moisturizing cream that facilitates the epithelialization and I tried to those [damaged skin] zones to have contact with the air as much as possible. I think it was the best way to heal these injuries.” — #12/Female

4. Discussion

4.1. Main causes of PPE-related skin changes

In the present study, the nurses underlined that the main causes of PPE-related skin changes were *working with PPE for hours*, *the type and quality of PPE*, and *being dehydrated while working* with PPE.

Working with PPE for hours. In the present study, some nurses emphasized that they used to work with PPE continuously for 1.5–2 h due to insufficient number of staff and were not able to change it frequently, so that they were sweating, their skin was not able to breathe enough and was under a continuous pressure. The literature indicates that prolonged use of PPE causes pressure on the skin, and the friction within pressure increases the risk of developing skin problems [16,25]. As supporting this knowledge, in a web-based survey from Australia including 2711 healthcare professionals who work in ICUs including COVID-19 patients, 44% of the adverse effects of wearing PPE included pressure areas on the skin and this effect was found to be associated with increased working hours [26]. Similar to this finding, in the present study, wearing PPE at least 2 h was noticed to be enough to cause PPE-related skin changes. In a prospective study from UK, it was reported that the daily usage time of PPE significantly affects the

development of adverse skin reactions, redness blanching, rash and pressure related damage were reported to appear by the use of PPE for 3 h without any relieving application [27]. According to the literature, regarding N95 mask and goggles, prolonged duration of daily contact and working in COVID-19 units are reported to be the independent risk factors for facial pressure injuries among healthcare professionals [28]. In their study, Lan et al. [16] from China also stated that the incidence of skin damage through the PPE usage was increased with the length of wearing time, especially for more than 6 h. In their multicentered cross-sectional study from Turkey where PPE related physical problems of nurses who care for COVID-19 patients were examined, Atay & Cura [29] reported a correlation between the increased risk of developing redness on the cheeks, nose bridge, the back of the ears and the fact of wearing N95 mask and goggles for more than 4 h. They also stated that shorter shifts were helpful for reducing the development of PPE related physical problems. In addition, shortening working hours may be beneficial to reduce the PPE related skin problems and to support the well-being of healthcare professionals.

The type and quality of PPE. In the present study, nurses stated that the types and quality of PPE are important predictors in the development of PPE-related skin changes. For some nurses, the PPE materials were not ergonomic, the masks were as hard as paper, the elastic bands were going off, the strips were too tight and these factors were severely irritating their skin. According to the instructions of using N95 masks, it is recommended to bend the nose-piece with both hands and squeeze the metal clip hard to fit the mask on the face to ensure a complete protection [21,30]. However, this instruction may cause important facial skin changes. In this study, although the nurses discussed how uncomfortable the masks were to wear, they did not discuss how the masks fit on their face and they did not report performing the fitting test. It was noticeable that, the nurses were doing more emphasis to the comfort of the mask in order to prevent facial skin changes rather than its effectiveness. Indeed, they were placing supportive materials on pressure areas, which may leave open areas for unprotected respiration. On the other hand, the low quality of the PPE materials is the other important predictor in the development of skin damages. In their studies Locatelli, LaVella & Gosh [31] and Ruskin et al. [32] draw attention on the design and quality of PPE to benefit the comfort and tolerability during healthcare professionals' use. Similarly, Montero-Vilchez et al. [33] recommend high-quality PPE use to prevent skin damages and to improve adequate skin prevention. According to the feedbacks of the nurses, there is still a need to improve the quality and design of the PPE and it is important to prefer highly qualified products for preventing skin injuries among healthcare professionals. It would also be useful for nurses to test whether the masks fit on the face and to mention this issue in the in-service trainings.

Being dehydrated while working. The nurses in the present study pointed out that being dehydrated while working is a predisposing factor for the development of PPE-related skin changes including pressure ulcers. Supporting this finding, in a questionnaire-based web survey conducted with healthcare professionals in National Health Service (NHS) settings in United Kingdom (UK), sweating was experienced by 98.7% of the participants and 8% of them were dehydrated regarding to the use of N95 mask [34]. According to the literature, local over hydration effect of PPE usage is one of the main reasons in the development of skin complications [28]. Remarkably, in a cross-sectional study, the temperature (33.19 °C vs 32.54 °C) and water loss (22.82 vs 13.69 gm⁻²h⁻¹) was found to be significantly greater under the mask compared by uncovered face area which means that epidermal barrier of the skin may be impaired by wearing masks [33]. As underlined in a brief review, skin damage was developing due to the moisture caused by sweating under the PPE [35]. Another review article about skin problems related to PPE use and prevention methods also pointed out that the moisture under the PPE progressively results with skin harm when combined with the pressure [36]. These findings highlight that avoiding dehydration while working is an important preventive factor for skin

health and for the prevention of skin injuries.

4.2. The location of the skin changes caused by PPE

The nurses in this study experienced skin changes including rash and ach like if it was getting cut behind their ears, over their nose, around their cheeks and jaw due to wearing FFP2 (N95) masks and on the forehead due to wearing face shields. Similarly, in general, face masks with elastic bands are reported to cause discomfort and skin irritation behind the ears if worn for an extended period of time. Likewise, N95 masks are worn tightly to ensure an appropriate safety, so that commonly affected areas are reported as nasal bridge and cheeks [37]. In an article that outlines recommendations to improve frontline nurses' wellbeing, various skin reactions (such as irritant contact dermatitis, pressure and moisture associated skin damages) related to masks, were commonly reported to occur on the nose bridge because of the malleable nose guard; on the cheeks and chin because of the abrasions caused by the mask material, and behind the ears because of the elastic bands [38]. Similarly, in a study from UK, the staff who care for suspected and/or infected COVID-19 patients had skin reactions due to PPE use mostly on the bridge of their nose, their ears, cheeks, and the forehead was specific due to the eye protective equipment [27]. In their study, Lan et al. [16] reported that 526 of 542 (97%) of the healthcare professionals had skin damage related to wearing N95 mask and goggles and the most affected site was the nasal bridge with following cheeks and forehead. According to a recent cross-sectional study from India, scarring on the nasal bridge and pain on the back of ears were the major skin problems experienced by the frontline nurses who use N95 masks in ICUs of pandemic hospitals [30]. These findings were also supported with the results of Soraganvi et al.'s [39] study which was conducted with healthcare professionals working in a hospital in India. These findings are remarkable in terms of emphasizing the areas that are at risk for the development of skin injuries related to PPE use.

4.3. Secondary adverse effects of PPE-related discomfort

Although this theme does not primarily describe the PPE-related skin changes, it was considered important to be add in this study because these secondary adverse effects were mentioned often by the nurses during the interviews. In the present study, the nurses underlined certain additional adverse effects of PPE use and reported that they were uncomfortable while working and suffering from serious headache related to wearing face shields. The fact that nurses were interviewed at home in a comfortable environment after work might have triggered their negative thoughts about PPEs due to the relief they felt when they took off the masks. Similar with these findings, discomfort related to wearing filtering face-piece respirators was found to be associated with skin irritation, marks on face and tightness in a qualitative study from Florida Veterans Affairs, whereas this was reported to influence patient care negatively. Nurses in this study had also stated that they needed to leave the patients' room as soon as possible and remove their PPE due to the discomfort [31]. Additionally, it was reported that, they mostly feel discomfort because of the headache, the pain on the face and back of the ears while they are using PPE [40]. This report was consistent with findings of a qualitative descriptive study conducted by Gordon, Magbee & Yoder [41], that PPE use was reported to be a contributing factor to critical care nurses' discomfort and headaches. In a descriptive study from Turkey to determine the comfort of PPE used in the pandemic services, protective goggles were also described to be uncomfortable and making nurses' job harder [42]. These findings are also discussed below as sub-themes.

Decreased comfort while working. Because of the sense of pressure that the nurses have their faces due to the PPE that they wear, they need to rush more while they provide nursing care and they wanted to leave the patient room as soon as possible. These findings were similar with the results of a descriptive study conducted by Davey et al. [34] in UK to

determine the PPE related heat stress among healthcare professionals, and showed that 89.7% of the 224 participants were feeling uncomfortable, 76.8% of them had to remove their PPE to relieve their discomfort. In this study participants also reported that PPE wearing impaired their physical performance (76.2%), caused difficulties in completing procedures (22.3%) and affected the patient care (17.8%) [34]. Duan et al. [43] conducted a cross-sectional survey to determine the effect of PPE on health care workers who care for COVID-19 patients and found the discomfort rate as 97%. Consistently, in Xia et al.'s [44] study conducted in ICUs in China, nurses wearing PPE more than 4 h reported pressure injuries and discomfort. Chauhan, Mullan & Mistry [45] from India conducted a cross-sectional study among health care workers to determine the barriers for PPE use and reported that 53.2% of the nurses were agreed and 38.7% were strongly agreed that wearing PPE was causing discomfort during the nursing care activities of the COVID-19 patients. A descriptive qualitative study by Chen et al. [46] from Wuhan, China explored the experiences of 15 nurses regarding to wearing full gear PPE and participants reported discomfort while caring activities and need help of their colleagues on occasion to complete their nursing cares. These results clarified the importance of comfortable PPE use in proper patient care.

Headache. Nurses experienced headache due to face shield use and they emphasized that the pain was not relieving by taking off the face shield, so that they had to take an analgesic. According to a qualitative study from China that was conducted with nurses, headache was the most uncomfortable consequence of wearing PPE (e.g. N95 masks, goggles, face shields) due to the continuous pressure over the head, and nurses were concerned that if the bands or belts were so tight, they would suffer from a headache [46]. Similarly, in a cross-sectional study conducted with 158 healthcare professionals in Singapore, Ong et al. [15] reported a correlation between using PPE and increased headache among healthcare workers who used PPE (N95 mask and eyewear) for more than 4 h per day in the pandemic wards, emergency rooms and intensive care units. In a cross-sectional study conducted by Rebmann, Carrico & Wang [47], N95 mask related headache was reported with the nurses working in the intensive care units. According to a study conducted by Garra, Parmentier & Garra [48], the headache incidence associated with surgical mask was 44% and N95 was 56% among healthcare professionals, though no statistically significant difference was observed. Similar with this finding, nurses who experienced headache in the present study had to wear head shields nearly 3–4 h continuously. Another study from Turkey conducted with nurses who care for COVID-19 patients reported that the use of goggles and face shields for more than 4 h was related to headaches [29]. In a cross-sectional study from Morocco conducted with frontline healthcare workers, headache comorbidities related to PPE use were described and, in this study, working more than 8 h per shifts while wearing PPE including masks and eye protections more than 4 h were found to be correlated with aggravated headache [49]. These results are also supported with the findings by Ong et al. [15] who reported that 81% of the healthcare professionals had headache related to PPE use during COVID-19 pandemic and they needed to take analgesics with a frequency 1–9 days per month to release the headache. With these findings it is acknowledged that nurses suffer from headache and feel uncomfortable while they are wearing PPE during the patient care in pandemic units.

4.4. Symptomatology of PPE-related skin changes

According to the nurses' expressions in this study, the main symptoms of PPE-related skin changes included aching, pain, and rash which can be considered as the indicators of 1st degree pressure ulcers, local swellings and marks over their nose, forehead and ears which were staying there almost half an hour. In a rapid systematic review to report the health risks at workplaces during the COVID-19 pandemic, the prevalence of skin changes (such as pressure erosions, erythema, skin

irritation) associated with goggles, face shields and masks was reported to be between 42.8% and 97% and the prevalence was found to be associated with the wearing duration especially exceeding 4 h [50]. Similarly, in a study by Jiang et al. [51], the skin damages related to PPE use were reported with three types including device related pressure injury, skin tears and moist associated skin damage. In another study, the most common skin symptoms related to PPE usage were redness blanching, itching and pressure damage among healthcare workers who cared for COVID-19 patients [27]. In a multicentered cross-sectional survey conducted in China to examine the effect of PPE use on healthcare workers, device-related pressure injury rate was reported as 13% and face acne rate was reported as 10% among healthcare professionals who wear PPE for average of 5 h per day [43]. Finally, high incidence of skin injuries, and negative effects of PPE on healthcare professionals may draw attention to the provision of alternative solutions to prevent skin problems for the future studies.

4.5. Prevention of PPE-related skin changes

The nurses in the present study mostly preferred supporting the pressure zones with cotton pads or dressing tapes, buying qualified and adjustable in size PPE materials, and using mask extender clips to prevent the PPE-related skin changes. Similarly, in Abiakam et al.'s [27] study, skin protective materials such as cosmetics, moisturizers, and preventive dressings were used to prevent the skin reactions and discomfort related to PPE usage. In the literature, it is recommended to place hydrocolloid or foam dressings on the PPE related pressure areas including bridge of the nose, forehead, cheeks, behind the ears etc. [52, 53]. In a COVID-19 special section published in the Journal of Wound, Ostomy and Continence Nursing, using a thin layer of a moisture barrier to the affected areas and using moisturizing on the skin where facemask pieces touch with waiting it to dry completely (at least 90 s) before wearing were recommended to prevent and treat skin damages related to PPE. Additionally, for the skin types that moisture or sweat more, alcohol free barrier films were recommended to be used [54]. In an update paper regarding the prevention of device related pressure ulcers, it is recommended to keep the skin clean and hydrated, apply a moisturizing cream at least 30 min before wearing the PPE [55]. Designing effective, skin-friendly and useful PPE to prevent the significant adverse skin problems and using suitable sized goggles that covers the periorbital area and the nose to ensure that it is stable are also reported to be effective [30,56]. Similarly, studies conducted with ventilated patients also report using gauze pieces under the facemasks as a useful method in preventing skin damage and development of pressure injuries, and providing comfort [57,58]. In a study conducted with patients requiring non-invasive ventilation, the application of pressure relieving dressing was found to be effective in reducing the risk of 2nd grade pressure injuries on the nasal bridge area [59]. Alternatively, to relieve pain and the pressure on the skin, healthcare professionals may prefer using their masks with tie bands or with devices such as mask extender clips to attach the straps behind the head [37].

In the present study, the nurses stated that the key point to prevent skin changes such as pressure ulcers is to eliminate the pressure. According to the consensus document of the European Pressure Ulcer Advisory Panel (EPUAP), the National Pressure Injury Advisory Panel (NPIAP) and the Journal of Wound Care regarding device-related pressure ulcer prevention, relieving the mechanical load of the PPE, loosening the pressure on the skin at least every 2 h and repositioning the device periodically are reported as some of the most important prevention strategies to prevent the formation of pressure ulcers and skin deformations [21,52,60]. The nurses in the present study also underlined that with trial-and-error method they realized that wearing a surgical mask over a N95 mask was worsening the pressure on their nose and cheeks, so that they started to wear the surgical mask under the N95 mask. Wearing N95 masks in combination with surgical masks may be preferred by healthcare professionals to prolong the usage time of the

N95 mask and to be more protected from the virus, however this combination may increase the discomfort [61]. A non-randomized cohort study hypothesized that using surgical mask caused fewer physiologic complaints when compared with using N95 mask and found that healthcare professionals wearing N95 mask with/without overlying a surgical mask had more facial irritation and bruising than those who wear a surgical mask alone [48]. As reported in a consensus document about device-related pressure ulcer prevention, using interface materials and dressings within the device and the skin is effective in preventing [52]. In accordance with this information, nurses' experience in the present study about wearing the surgical mask under the N95 mask seems to be a helpful intervention with releasing the pressure on the face and presenting an interface material between face and N95 mask. However, with these explanations of the nurses several mask use errors were also identified in this study such as the wearing a surgical mask under the N95 and the use of cotton pads to support pressure zones. These methods may seem to be helpful for the pressure prevention on the skin, but on the contrary, they prevent the achievement of an adequate seal of the masks. As a result, these methods may cause a higher risk of contracting COVID-19 and/or other hospital-related viruses. Because the reason for the misuse could be a lack of sufficient knowledge about the topic, it is critical to provide adequate information to nurses.

4.6. Therapeutic interventions for curing for PPE-related skin changes

Among the nurses in the present study who experienced PPE-related skin changes, the most common therapeutic interventions were using moisturizing cream that facilitates the epithelialization before and after the use of PPE and resting the pressure zones frequently. In the literature, barrier dressing, DuoDERM Extra Thin, were advised during the use of N95 masks as because it is yet thin and physically proper [21]. In a review article from India about reducing the skin problems, it was recommended to apply the moisturizer on the T-zone including forehead, cheeks, chin, over the nose and behind the ears 1–2 h before wearing PPE and let it dry for 1 min [36]. In a multicenter, cross-sectional study from Turkey conducted by Metin, Turan & Utlu [62] to evaluate dermatological problems in 173 nurses and 353 doctors, it was found that participants were using moisturizers more than 3 times to treat their skin changes due to PPE use. An alternative way to prevent PPE related skin problems was using a skin lubricant (such as lanolin containing petrolatum, combination of coconut oil, cocoa butter, and beeswax) that reduces friction on the skin for approximately 4 h [63]. Nurses in the present study also stated that to heal the skin changes it is important to eliminate the pressure. Supporting, in a position paper from the NPIAP, the best practices in preventing skin damages related to PPE were presented and to relieve the pressure and the shear effect on the skin, off-loading the sides of the mask for 5 min every 2 h or removing it for 15 min every 2 h were recommended with evidence [64]. Consequently, relieving the pressure on the skin is an effective method in preventing the skin changes and healing the pressure injuries.

4.7. Strengths and limitations

Although there are many descriptive studies that explore the PPE-related skin problems among nurses during the COVID-19 pandemic, the qualitative studies revealing the primary expression and experiences of nurses are limited. The important contribution of the present study was that it provided further insight into the skin change experiences of nurses working in pandemic ICUs. This study clarified the importance of the quality of the PPE in establishing comfort for nurses and in providing better patient care. Thus, it is believed that this study will contribute to literature on the PPE-related skin problems of frontline nurses. As the pandemic is still going on, it is thought that these results will inspire future technology to produce ergonomic PPE materials for healthcare professionals.

In this study, there are some limitations to be considered. Firstly, the nurses in this study were coming from a single training and research hospital in Turkey, thus, the results cannot be compared with nurses from other settings. Secondly, the findings are focused on the facial skin changes of nurses and do not include different anatomical areas. Therefore, the comparison of the present study results in the literature is limited to the PPE-related facial skin damages. Thirdly, the results about nurses' skin change experience on PPE use is limited with the interview questions and descriptive characteristics of the nurses are not considered. Fourthly, nurses in this study mentioned only about FFP2 (N95) masks during their interviews. So that, the results cannot be generalized to other mask types, such as FFP3 masks. In addition, we recommend for the future studies to take the individual factors into consideration, that may influence the development of skin damages, and to search the effects of skin protection materials including the ergonomically improved PPE in randomized designed studies.

5. Conclusion

The findings of this qualitative study revealed that the nurses who work in a pandemic ICU experience skin changes related to PPE use in accordance with the prolonged wearing, the type, quality of PPE and dehydration. To minimize the risk of PPE-related skin changes and to support the well-being of healthcare professionals, we recommended that they should work in shortened shifts wherever possible. Besides these findings, nurses feel uncomfortable in wearing PPE, and this seriously affect their patient care activities, therefore there is a need to improve PPE comfort. The feedbacks of the nurses about prevention and treatment of the skin changes are valuable to alert that there is still a need to improve the dermatological quality and design of the PPE and prefer the qualified products for prevention of skin injuries among healthcare professionals.

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Declaration of competing interest

None.

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