Cogitare Enfermagem

ORIGINAL ARTICLE

USE AND ADHERENCE TO PERSONAL PROTECTIVE EQUIPMENT BY RESIDENTS: VALIDATION OF A MEASURING INSTRUMENT

HIGHLIGHTS

1. There is evidence of low adherence to PPE among residents.
2. The instrument is valid for assessing the use of PPE.
3. The validated instrument assesses adherence to biosafety measures.
4. The instrument can direct actions aimed at protecting residents.

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ABSTRACT

Objective: To validate the measuring instrument that assesses healthcare residents' use and adherence to personal protective equipment. **Method:** Methodological study developed in a virtual environment between August 2020 and March 2021 with primary care and hospital residents from the five regions of Brazil. The participants answered the adapted version of the "P.P.E.-PHC" for residents. Confirmatory factor analysis was used to validate the instrument. **Results:** 227 residents took part, the majority of whom were cis women (82.8%), worked in the Southeast region (58.1%), and in-hospital care (47.6%). The structure in eight domains (cap, gloves, safety behavior, N95 mask, hand hygiene, apron/coat, surgical mask, goggles/face shield) was confirmed. Only two items with a factor load of less than 0.5 were kept. **Conclusion:** The tool is valid for measuring residents' use of and adherence to personal protective equipment, which helps to guide training and occupational safety.

DESCRIPTORS: Surveys and Questionnaires; Validation Study; COVID-19; Personal Protective Equipment; Internship and Residency.

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INTRODUCTION

COVID-19 has had an impact worldwide and has brought about the need to rethink the way care is provided and protective guidelines for professionals in the health sector. This brings new challenges for frontline workers[1]. Professionals involved in care have an increased risk of contamination and illness from COVID-19 compared to the general population due to the high transmissibility of the disease, close contact with sick people, lack of resources for protective devices, and deficiencies in actions involving professional safety[2].

Health residents are among the professionals who have worked to deal with the pandemic. This group of workers is an important part of the Unified Health System (UHS) workforce. In the Brazilian context, the health residency is a proposal for in-service training at the post-graduate level, developed through the insertion of the resident in the work context. In addition, the residency aims to train and educate professionals in line with the principles of the UHS[3-4].

The COVID-19 pandemic has affected residency programs in many ways, including some of the problems generated by the shortage of personal protective equipment (PPE)[5] that has affected the whole world. In addition, low adherence to and incorrect use of PPE and lack of knowledge of correct donning and doffing techniques can increase the risk of exposure and illness among health professionals[6-8]. It is worth noting that the rationing of PPE promoted institutional actions such as a daily record of purchases among workers and monitoring of the use of PPE. Among the workers, there was an intensification of discomfort related to the prolonged use of PPE, which affected basic vital aspects such as eating, hydration, and elimination. There were reports of using hygienic diapers to avoid removing PPE during the working day and even adherence to hormonal treatments among women to suppress the menstrual cycle[9].

Given this, it is worth emphasizing that PPE is essential for reducing the spread of the virus among professionals[10]. Therefore, for good health practices, it is essential to guarantee the safety of workers through the satisfactory supply of PPE and the respective training for its proper handling[1]. In this sense, knowing about the use and adherence to PPE among healthcare residents can shed light on the managerial actions needed in different instances to correctly forecast and provide them and the need for training activities to ensure correct use and reduce occupational risks.

To obtain valid and reliable information, it is necessary to evaluate the selected measurement instruments. Given the above, this study aims to validate a measuring instrument that assesses healthcare residents' use and adherence to personal protective equipment.

METHOD

This is a methodological study with data from healthcare residents working in the five regions of Brazil during the COVID-19 pandemic. The data was collected virtually between August 2020 and March 2021. This study is linked to the research "Use of personal protective equipment by health professionals in the fight against COVID-19" - "P.P.E. COVID-19 Brazil". This report followed the recommendations Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and Checklist for Reporting Results of Internet E-Surveys (CHERRIES)[11-12].

Residents from the following areas were included: Physical Education, Nursing, Pharmacy, Physiotherapy, Speech Therapy, Veterinary Medicine, Nutrition, Dentistry,

Psychology, Social Work, and Occupational Therapy. Since the data was collected remotely, the study was disseminated through e-mail and telephone with institutions that offer health residency programs accredited by the Ministry of Education. Telephone contact was also made with medical societies, regional professional councils, and residency committees.

To broaden the reach of the study and attract potential participants, social media were used for dissemination, including the research website (https://www2.ufjf.br/epicovid19/), *Instagram* profile (@epicovidufjf2) and *Facebook* (E.P.I COVID-19 Brasil) and via the *WhatsApp* messaging application[13]. The data collection instrument was made available virtually on the free *KoBoToolbox* platform. It stores each participant's answers immediately after they are filled in on a cloud server, minimizing typing biases. The data was collected between August 2020 and April 2021.

The data collection instrument was the adapted "P.P.E. PHC" version. This instrument was developed for the research "P.P.E. COVID-19 Brasil"[14]. The modification made to the original version for application to residents consisted of replacing the term "PHC service" with "health service" in nine questions and excluding the term "PHC" in one question because the data collection involved residents from areas other than PHC. The other items did not undergo any changes, so it was decided to conduct the confirmatory factor analysis in this study.

The complete instrument contains 86 questions, including items assessing personal and professional characterization data, professional training, and participation in training courses. The items of interest include the 31 items that assess the use of PPE in daily work, which were organized into eight domains after evaluating the factorial structure with 455 PHC workers: disposable caps or hats, gloves, safety behavior, N95 mask, hand hygiene, disposable apron or cloak, disposable surgical mask, and goggles or individual protection mask[14].

The answers to the items of interest in this research are organized on a four-point Likert scale with the response options "never", "rarely", "almost always" and "always". To assess use and adherence, the answers are recorded as "no" (0 points) for "never", "rarely", "almost always"; and "yes" (one point) for "always". Questions that assess the reuse or lack of PPE have inverted scores. The domain score is calculated by adding the total points divided by the number of items in the domain and multiplying by 100.

Adequate use of the PPE assessed is considered when the score obtained in the domain is greater than or equal to 75%, according to other studies in the area[7,15]. To assess adherence, the number of domains with a score greater than or equal to 75% is divided by the total number of domains answered multiplied by 100.

The data stored on the *KoboToolbox* server was exported and organized in the *Microsoft Office Excel* program and then processed in the JASP statistical software (version 16.0.1.0)[16]. Confirmatory factor analysis used the Robust Diagonally Weighted Least Squares (RDWLS) estimation method, suitable for categorical data[17-18].

The fit indices used were χ^2; χ^2/gl; Comparative Fit Index (CFI); Tucker-Lewis Index (TLI); Standardized Root Mean Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA). The χ^2 values should not be significant, and the χ^2/gl ratio should be < 5 or < 3. CFI and TLI values should be > 0.90 and preferably above 0.95; RMSEA values should be < 0.08 or preferably < 0.06, with a confidence interval (upper limit) < 0.10[19]. The reliability of the measure was measured using composite reliability[20-21].

The study was previously assessed by the Ethics Committee for Research with Human Beings of the Federal University of Juiz de Fora and approved under opinion no. 5.429.839. Data was only collected after the participant ticked "I agree to participate" on the online ICF. To guarantee the secrecy and confidentiality of the data, the participants were described in the database using numerical codes. No financial or similar benefits were offered for taking part in the study.

RESULTS

Two hundred twenty-seven residents took part in the study, with a predominance of cis women 188 (82.8%), having a partner 178 (78.4%), and working in the Southeast region 132 (58.1%). The average age was 27.92 (SD - standard deviation ±5.92) years, and the average time working in the residency was 14.52 (SD ±9.24) months. The area of concentration of the residency is divided between hospital 108 (47.6%), primary health care (PHC) 102 (44.9%), and others 17 (7.5%). The characterization of the residents is shown in Table 1.

Table 1- Profile of the residents participating in the "P.P.E." survey COVID-19 Brasil".Juiz de Fora, MG, Brazil, 2021.

Variables	n	%
Professional category		
Nurse	85	37.5
Physiotherapist	25	11
Pharmacist	20	8.8
Social Worker	20	8.8
Psychologist	18	7.9
Medical	17	7.5
Dental Surgeon	12	5.3
Nutritionist	10	4.4
Physical Educator	7	3.1
Occupational Therapy	5	2.2
Other	6	2,6
Speech therapist	2	0.9
Gender		
Cis woman	188	82.9
Cis man	36	15.9
Trans woman	1	0.4
Others	1	0.4
Do not wish to declare	1	0.4
Region of Brazil		
South East	132	58.1
North East	33	14.5
Center-West	23	10
South	29	12.8
North	10	4.4
Length of time in residence		

0 to 12 months	119	52.4
13 to 24 months	101	44.5
25 to 34 months	7	3.1

Source: Authors (2021).

The eight-dimensional structure of the P.P.E PHC fitted well with the data obtained from the residents. Although the chi-squared value was significant ($p<0.001$), all the other fit indices supported the model (Table 2).

Table 2 - Model fit indices. Juiz de Fora, MG, Brazil, 2021.

χ^2 (gl)	χ^2/gl	CFI	TLI	SRMR	RMSEA (90% CI)
826.649 (406)	2.04	0.984	0.981	0.094	0.068 (0.061 – 0.074)

Note: $\chi^{2=}$ chi-square; gl = degrees of freedom; *CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; SRMR = Standardized Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation.*

Source: Authors (2021).

The factor loadings obtained for the instrument's items were ≥ 0.5, except for the items "how often do you adjust or touch the PPE (disposable cap or hat, face shield, goggles, disposable or N95 mask, disposable apron or cloak, gloves) during user care?" and "put the mask on carefully to cover the mouth and nose, minimizing the gaps between the face and the mask as much as possible" whose values were 0.328 and 0.415, respectively. Despite this, it was decided to keep both items because they could assess the frequency of adjusting the PPE, touching the face while wearing it, and adjusting the mask to the face. The composite reliability showed adequate values for all the domains evaluated (Table 3).

Table 3 - Factor loadings of the P.P.E. items presented in eight factors and respective composite reliability values. Juiz de Fora, MG, Brazil, 2021.

Domain (Composite Reliability)	Factor loading
Wearing a cap (0.940)	
In the last six months, how often has a disposable cap or hat been missing from the health service where you work?	0.914
In the last six months, how often have you reused a disposable cap or hat in the health service where you work?	0.938
Secure the hair when dressing, placing the cap or hat on the head starting from the forehead towards the base of the nape of the neck, covering all the hair and the ears.	0.879
Remove the cap from the top center without touching the hair.	0.836
Use of gloves (0.921)	

In the last six months, how often have there been no procedure gloves suitable for the size of your hands in the health service where you work?	0.832
When wearing an apron/coat, put on the gloves, extending them to cover the cuff of the apron/coat.	0.848
Do not unnecessarily touch surfaces and materials (such as telephones, door handles, and doors) when wearing gloves.	0.858
Do not touch the outside when removing gloves, holding the removed glove with the hand that is still gloved.	0.913
Safety behavior while wearing PPE (0.738)	
How often do you immediately change your PPE (disposable cap or hat, face shield, goggles, disposable or N95 mask, disposable apron or hood, gloves) when contaminated or damaged?	0.621
How often do you change the mask when it's damp?	0.663
How often do you touch your face while wearing PPE (disposable cap or hat, face shield, goggles, disposable or N95 mask, disposable apron or cloak, gloves)?	0.533
How often do you adjust or touch PPE (disposable cap or hat, face shield, goggles, disposable or N95 mask, disposable apron or cloak, gloves) during user care?	0.328
How often do you clean and disinfect surfaces in contact with users in your workplace?	0.587
How often do you dispose of disposable PPE (disposable cap or hat, disposable mask, disposable apron or cloak, gloves) after each use in a milky white bag with the infectious symbol?	0.638
Use of N95/PFF2 mask (0.926)	
In the last six months, how often has a respiratory protection mask (particulate respirator - N95/PFF2 or equivalent) been missing in your work health service?	0.879
When wearing a respiratory protection mask (particulate respirator - N95/PFF2), check the mask's seal to the face (positive and negative test of the mask's seal to the face).	0.889
Wear a surgical mask over an N95 mask or equivalent.	0.926
Hand hygiene (0.910)	
How often do you sanitize your hands before touching a user?	0.894
How often do you wash your hands after risking exposure to body fluids (e.g., saliva, phlegm, blood, urine)?	0.758
How often do you sanitize your hands after touching a user?	0.923
How often do you sanitize your hands after touching environments/surfaces/corridors close to the user?	0.802
Wearing an apron or cloak (0.936)	
In the last six months, how often has there been a shortage of cloaks/disposable long-sleeved aprons in the health service where you work?	0.933
Put the apron or cloak on by the sleeves, adjusting the ties at the back and waist, ensuring that the torso, arms, and cuffs are completely covered.	0.909
When you take it off, you don't touch the outside.	0.890
Use of surgical mask (0.756)	
In the last six months, how often has there been a shortage of surgical masks in the health service where you work?	0.884
In the last six months, how often have you reused disposable masks in the health service where you work?	0.781

Put the mask on carefully to cover the mouth and nose, minimizing the gaps between the face and the mask as much as possible.	0.415
Remove the mask using the proper technique (i.e., not by touching the front, but by removing the loop or knot from the back or pulling on the elastic that sits over the ears).	0.513
Use of goggles or face shield (0.836)	
In the last six months, how often has there been a shortage of face shields in the health service where you work?	0.755
In the last six months, how often have goggles been missing from the health service where you work?	0.770
Concerning the guidelines for wearing goggles or face shields, how often do you remove them without touching the front or pulling from the sides?	0.852

Source: Authors (2021).

DISCUSSION

This study aimed to confirm the factor structure of the P.P.E PHC - version adapted for residents to add knowledge by presenting evidence of the validity of a measuring instrument for assessing the use and adherence of PPE among this specific group. In addition, having tested an instrument previously validated among Primary Health Care (PHC) workers in the Brazilian context among health residents from different areas reaffirms the internal structure of the instrument and expands the possibility of its use for other scenarios and profiles of participants.

The factor loadings in their respective domains are similar to those obtained among PHC workers[14]. The confirmation of the instrument's factor structure with eight domains is robust as it reinforces the multidimensional theoretical concept related to the use of PPE in health services. Thus, it is understood that each domain represents a relevant aspect that needs to be considered when evaluating the use of and adherence to protective measures for workers in health services, including health residents[6,10]. It is understood that each domain of the E.P.I. PHC evaluates facets relating to the use and adherence to PPE, which may behave differently depending on the exposure situation and the specific type of precaution recommended.

The P.P.E PHC was built in the context of the pandemic due to the need to assess the use and adherence to PPE by PHC workers during this specific period. However, this evaluation was needed to expand to the residents, as they are a professional group with specific characteristics who collaborate significantly in direct care in health services[22].

Another aspect that should be considered in this perspective is pre-pandemic data that pointed to gaps related to using PPE among residents. A study carried out in the United States with residents found that 59% reported not having received prior training in the use of PPE and that 44% had been contaminated during simulation activities[23]. Another study that assessed the use of PPE among residents related to standard precautions classified their use as intermediate[24], highlighting the subject's relevance in professional training.

On the other hand, during the pandemic, a study in New York City with 340 residency programs involving 2,306 residents found that many programs reported reusing PPE and reassigning residents to meet specific demands related to the pandemic. The same study reported that 45.1% of the programs had at least one resident affected by COVID-19[25]. An investigation involving 1,420 residents and students from different countries involved in the direct care of COVID-19 patients highlighted limited access to PPE and testing and a high risk of contamination and burnout[26].

Thus, it is necessary to reinforce that biosafety training among health residents is a topic that needs to be explored more and requires investment from programs to address this gap. Other issues can impact residents' performance and learning during the training process, such as poor working conditions, a heavy workload, and an overload of activities, among others[22]. In this sense, it is important to provide an instrument with evidence of validity capable of measuring the use of and adherence to PPE in this context, as it will allow us to identify aspects and nuances that require interventions to change this scenario.

A limitation of the study is the limited application of the questionnaire to health residents in the Brazilian context. However, given the confirmation of the factorial structure obtained among PHC workers, we suggest replicating studies that assess the use of and adherence to PPE among residents beyond the context of the COVID-19 pandemic.

CONCLUSION

The "P.P.E. PHC" version adapted for healthcare residents, consisting of 31 items and organized into eight domains, showed evidence of validity confirming the factor structure obtained among PHC workers. Thus, future research is needed to assess the use and adherence of PPE among residents and the use of the instrument for different scenarios and participants.

The evidence of validity pointed out in this investigation indicates that the instrument can measure, among residents, the use of and adherence to personal protective equipment and can contribute to directing training and occupational safety.

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Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work - **Dutra HS, Assis CCG de, Laurindo CR, Costa KAR, Pereira AB, Lanza FM, Coelho A de CO.** Drafting the work or revising it critically for important intellectual content - **Dutra HS, Assis CCG de, Laurindo CR, Costa KAR, Pereira AB, Lanza FM, Coelho A de CO.** Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - **Dutra HS, Coelho A de CO**. All authors approved the final version of the text.

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