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Cennet Ciris Yildiz & Dilek Yildirim

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Developing the personal protective equipment comfort scale

Cennet Ciris Yildiz [a] and Dilek Yildirim [b]

[a]Nursing Department, Istanbul Kent University Faculty of Health Sciences, Istanbul, Turkey; [b]Nursing Department, Istanbul Aydin University Faculty of Health Sciences, Istanbul, Turkey

ABSTRACT

This is a methodological, cross-sectional descriptive study designed with the purpose of developing a valid and reliable measurement instrument allowing determination of the Comfort of PPE used by healthcare workers. The draft scale which was reduced to 20 items after content validity analysis was prepared as a 5-point Likert-type scale and applied to 502 volunteering healthcare workers employed at state, university and private hospitals in the province of Istanbul in Turkey. The scale was tested for validity and reliability. Internal consistency and test-retest reliability analyses were used to assess reliability, exploratory factor analysis was conducted with the SPSS software, and confirmatory factor analysis was conducted with the Lisrel software. As a result of the analyses, a 20-item scale consisting of 3 dimensions and explaining 63.14% of the total variance was developed. The Cronbach's α value for the entire scale was determined as 0.93. For test-retest reliability, the scale was applied again on the same group with a two-week interval, and the correlation coefficient was found significant. The three-factor construct was confirmed with the confirmatory factor analysis. The PPE Comfort Scale may be used in a group of healthcare workers as a valid and reliable instrument.

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KEYWORDS
Comfort; personal protective equipment; reliability and validity; healthcare personnel; scale development

Introduction

At the workplace, the first step of developing a comprehensive safety and health program is to determine threats that may harm employee health. In the literature, this process is defined as 'hazards assessment'. Potential hazards may be physical or health related. Physical hazards include variable temperatures, high-density lighting and electrical connections. Examples of health-related hazards may be listed as harmful dusts and exposure to chemicals, infections or radiation (OSHA 2020). In cases where hazards cannot be completely eliminated due to the nature of the job, to protect the health of the employee, it is recommended to use Personal Protective Equipment suitable for the working field (Gül et al. 2020).

PPE are equipment that are designed to protect individuals from injuries or diseases at the workplace. OSHA (2020) defined PPE as 'special clothing and equipment worn by employees to be protected from contagious substances' (OSHA 2020). PPE serve as a physical barrier that prevents the contamination of healthcare personnel. These contaminants include all bodily secretions and wastes that may contaminate individuals by direct contact with a patient or their surroundings including contagious particles in the air (Brown, Munro, and Rogers 2019). The equipment recommended for use by healthcare workers includes coats, surgical masks/N95/FFP2, goggles/face shields and gloves (WHO 2020; Hakim, Abouelezz, and El Okda 2016; Verbeek et al. 2020).

The equipment recommended for use by healthcare workers in the COVID-19 pandemic process includes coats, surgical masks/N95/FFP2, goggles/face shields and gloves (WHO 2020). The equipment used in the protection of the healthcare worker needs to have a set of protective properties such as fluid repellence, impermeability to fluids and air permeability (Kaplan, Aksüzek, and Acar 2012). However, it

CONTACT Cennet Ciris Yildiz cennetciris.yildiz@kent.edu.tr; cennet_ciris@hotmail.com Nursing Department, Istanbul Kent University Faculty of Health Sciences, Istanbul, Turkey

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has been determined that the reinforcement material used for increasing the protective properties of this equipment increases the thermal isolation capacity of the equipment. Of course, this is an unwanted situation in terms of clothing comfort (Kaplan, Aksüzek, and Acar 2012).

Clothing comfort refers to not being psychologically or physiologically influenced by what we wear and feeling comfortable inside it. The concept of comfort has been defined as a pleasant state of psychological and physiological compatibility between a person and the environment and relaxedness (Slater 1985). Comfort is also a complicated and interconnected combination of physical, psychological and sensory perceptions. As to be understood from these definitions, as comfort is dependent to a great extent on the subjective assessments of individuals, it is highly difficult to explain. Comfort is a factor connected to subjective perceptions of visual, thermal and tactile sensations, psychological processes, body-clothing interactions and environmental effects (Li 2020; Slater 1985). Although it is not easy to define comfort, discomfort may be easily defined with words such as itching and tingling.

Considering in particular that this equipment is used for long durations in the pandemic process, it needs to have qualities that will provide clothing comfort for the users. This is because users want to choose clothes in which they feel comfortable that are easy to use and maintain (Kaplan, Aksüzek, and Acar 2012). Similarly, OSHA (2020) proposed that the employer needs to consider the compatibility and comfort of PPE while selecting suitable items for workplaces as PPE use creates a burden on the employee. In their study on healthcare workers, Ciris Yildiz, Ulasli Kaban, and Tanriverdi (2020) determined that the discomfort caused by PPE negatively affected the use of PPE and the health of healthcare workers. Moreover, a significant relationship was determined between the PPE use of healthcare workers in the COVID-19 pandemic period and their depression, anxiety and stress levels (Polat and Coşkun 2020). The study by Swaminathan, Mukundadura, and Prasad (2020) on healthcare workers found that PPE use affected general performance and caused difficulties in using surgical instruments. In the study on surgeons conducted by Yanez Benitez et al. (2020), it was observed that the use of PPE during the COVID-19 pandemic period influenced surgical performance. Determination of PPE comfort, which has serious effects especially on bodily health, is important in terms of employee health and satisfaction and patient care quality.

In this context, it is needed to assess the comfort of PPE, which is prevalently used in the pandemic period and affects employee productivity and performance to a significant extent. However, considering previous studies the focus has been frequently on the effects of PPE on employee health, and employee comfort has not been comprehensively investigated. Furthermore, it was determined that in these studies, PPE comfort has been generally assessed with questionnaire forms without tested validity and reliability, and there has been no valid and reliable scale developed towards determining PPE comfort.

Materials and methods

Study design

Equipment that is recommended for use by healthcare workers in pandemics such as COVID-19 include coats, surgical masks/N95/FFP2, goggles/face shields and gloves (WHO 2020). The purpose of this study is develop a valid and reliable measurement instrument to determine the Comfort of PPE used by healthcare workers in pandemic situations. A methodological, cross-sectional descriptive design was applied for the develop measurement instrument.

Population and sample

The population of the study consisted of healthcare workers (doctor, nurse, midwife and technician) working at state hospitals under the Ministry of Health, university hospitals and private hospitals in Istanbul city center. While forming the sample, the inclusion criteria for the participants were being an actively working healthcare worker in the pandemic process, having used PPE (coat, surgical masks/N95/FFP2, goggles/face shields and gloves) in this process and being voluntary to participate in the study. Comrey and Lee (1992) defined the necessary sample size in scale development studies as 500 = very good and 1000 = excellent. Accordingly, the sample of the study consisted of a total of 502 healthcare workers who were working at the specified hospitals, satisfied the inclusion criteria, voluntarily agreed to participate in the study and filled out the data collection instrument completely. The sociodemographic data and work-related characteristics of the participants are shown in Table 1.

Table 1. The sociodemographic data and work-related characteristics of the participants ($N = 502$).

Parameters		n (%)
Age, years	**20–30**	308 (61.3%)
	31–40	139 (27.7%)
	41–50	46 (9.2%)
	< 51	9 (1.8%)
Sex	**Female**	362 (72.1%)
	Male	140 (27.9%)
Level of education	**High school**	37 (7.4%)
	Vocational school	137 (27.3%)
	Undergraduate	209 (41.6%)
	Postgraduate	119 (23.7%)
Occupation	**Nurse**	277 (55.2%)
	Health Technician	133 (26.5%)
	Doctor	75 (14.9%)
	Midwife	17 (3.4%)
Department	**Clinic**	171 (34.1%)
	Emergency Service	121 (24.1%)
	Intensive Care Unit	98 (19.5%)
	Surgery Service	77 (15.3%)
	Pandemic Clinic	35 (7%)
Total working years	**< 5 years**	244 (48.6%)
	6–11 years	141 (28.1%)
	12–17 years	57 (11.3%)
	18–24 years	34 (6.8%)
	> 25 years	26 (5.2%)

Data are expressed as frequency (percentage of the total frequency).

Inclusion criteria

The study included healthcare workers who were 18 years old or older, volunteered to participate in the study, were not on leave within the dates where the data were collected, worked actively in the COVID-19 pandemic process and used coats/overalls, surgical masks/N95/FFP2, goggles/face shields and gloves in this process.

Data collection instruments

As the data collection instrument, a questionnaire form consisting of 2 parts was utilized. The first part of the instrument consisted of the 'Descriptive Information Form' developed by the researcher in line with the relevant literature which included questions on the sociodemographic and work-related characteristics of the participants, whereas the second part consisted of the 39-item 'Draft Personal Protective Equipment Comfort Scale' prepared by the researcher for the purpose of determining the comfort of PPE used by healthcare workers. The draft was developed with support from the literature (Ciris Yildiz, Ulasli Kaban, and Tanriverdi 2020; Mitchell, Spencer, and Edmiston 2015; Slater 1985; Veenema and Corley 2015) and arranged by considering the clothing comfort classification specified by Slater (1985) (physical, psychological and emotional perception). It is a 5-point Likert-type scale scored between '5' absolutely agree and '1' absolutely disagree. Higher scores in the scale indicate the reduced comfort of PPE used by healthcare workers. The data were collected through the Google Forms platform between the dates of 20 November 2020 and 1 December 2020.

Data analysis

The analyses were carried out with the SPSS 21.0 and LISREL 8.71 package software. For the content validity of the draft scale, the Lawshe technique was used in the assessment of expert opinions. Descriptive statistics, including frequency, and percentage for the nominal variables and mean and standard deviation for the continuous variables were used. Kolmogorov–Smirnov test was used to assess the distribution of the data for normality. Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were applied to examine the suitability of the sample for factor analysis. Additionally, the validity and reliability of the scale were evaluated using psychometric tests (content validity ratio, item–total correlation, exploratory factor analysis and internal consistency coefficient).

Ethical approval

Before starting the study, the Ethics Committee approval no:08 was obtained from Istanbul Kent University Health Sciences Research and Publications Ethics Committee on 17.11.2020. Research permission was obtained from the General Directorate of Health Services for the research. The healthcare workers who participated in the study were informed about the objective and method of the study, and their consent to participate voluntarily in the study was obtained.

Results

Development of the scale

In the scale development process, the first step is formation of an item pool. To create an item pool the literature on clothing comfort and PPE was reviewed. By taking the clothing comfort classification that was stated by Slater (1985) and has been the most accepted one as a basis, a 39-item pool was created. The content validity of the scale was tested based on expert opinions. The item pool was submitted for the opinions of ten experts (two infection experts, four infection control nurses, three faculty members expert in the field of nursing and one faculty member expert in the field of validity and reliability). Additionally, the infection experts are specialist physicians who actively took part at the emergency, intensive care and pandemic services of pandemic hospitals in the pandemic process. The Lawshe technique was applied for the expert opinions. The experts assessed each potential scale item in the form of 'suitable', 'suitable, but inadequate' and 'unsuitable' based on the representativeness of the item for the characteristic to be measured, the suitability of the item for the sample and the comprehensibility of the item. After collecting the forms coming from the experts, all responses were combined in a single form. The content validity ratio (CVR) reported as a limit for recommendations made at the stage of testing content validity is 0.62, and 19 items which had CVR values of lower than this limit and found incomprehensible by the expert opinions were removed from the draft scale. When the remaining 20 items and the items removed from the scale were considered, with the assumption that there was one factor, the Content Validity Index (CVI) value for a single factor was determined as 0.92 (p>0.05).

The expressions in the draft scale were prepared as a 5-point Likert-type scale (Responses to the statements were scored from 1 'Absolutely Disagree' to 5 'Absolutely Agree').

Pilot implementation

A pilot implementation was carried out with a 50-person group with similar characteristics to those of the sample. As there was no item that was not understood as a result of the pilot implementation, no items were removed from the scale at this stage.

Findings on validity and reliability

The 20-item and three-factor scale designed at the end of the pre-application was applied to 502 participants, and analyses were conducted in line with the collected data. As a result of the analyses, it was proven that the KMO value was 0.93, and the Bartlett's sphericity test results ($X^2(190) = 6227.595$; $p < 0.001$) were significant. The total variance explained by the construct that was determined to have 3 factors was 63.14%. It was also determined that the first factor's factor load values were between 0.85 and 0.48, those of the second factor were between 0.78 and 0.62, and those of the third factor were between 0.75 and 0.61 (Table 2).

The means and standard deviations of PPECS of the first and second assessments are provided in Table 3. The PPECS domains exhibited excellent intraclass correlation coefficient (ICC) values. The ICC was 0.93 (95% CI: 0.86-0.96) for the physical comfort subscale, 0.93 (95% CI: 0.86-0.96) for the psychological comfort subscale and 0.95 (95% CI: 0.89-0.97) for the functional comfort subscale. The internal consistency of PPECS was strong, with an α value of 0.936. The Cronbach's alpha values were calculated as 0.92 for the

Table 2. Exploratory factor analysis of PPECS ($N = 502$).

Item No		Load Values After Converting: Physical comfort	Psychological comfort	Functional comfort	Common Factor Variance (h^2)	Item-Total Correlation
6	Personal protective equipment use prevents me from doing my job (condensation on glasses, etc.).	0.85			0.61	0.70
5	I feel tired/exhausted when I use personal protective equipment.	0.80			0.63	0.71
7	Personal protective equipment damages my body image as it leads to sweating and body odor (overalls, aprons).	0.78			0.37	0.72
1	I feel difficulty in communicating with my colleagues as I use personal protective equipment.	0.75			0.72	0.62
9	Personal protective equipment use increases my workload.	0.74			0.79	0.77
8	I think long term personal protective equipment use harms my body (redness, itching and wounds in the hands and face; headache, wounds in the ears and nose due to mask use, feeling of suffocation, etc.).	0.72			0.72	0.70
3	Personal protective equipment use leads me to interrupt my work.	0.72			0.73	0.65
11	I do not feel comfortable when I use personal protective equipment.	0.65			0.73	0.67
4	I am having difficulty finding personal protective equipment suitable for my body.	0.48			0.58	0.55
14	I feel undecided on the necessity of using personal protective equipment.		0.78		0.57	0.43
30	I think personal protective equipment use increases the risk of making a mistake.		0.74		0.62	0.63
31	I spare less time for the patient as I use personal protective equipment.		0.72		0.66	0.60
15	The thought of using personal protective equipment during procedures concerns me.		0.69		0.55	0.68
13	Personal protective equipment use is a highly complex process.		0.69		063	0.59
28	My personal protective equipment use leads me to delay the help needed by the patient.		0.62		0.63	0.64
23	The low quality of the personal protective equipment provided by my institution affects my willingness to use it negatively.			0.75	0.57	0.52
29	As the personal protective equipment that I need is not adequately provided, I cannot use it properly.			0.72	0.57	0.52
22	I feel less protected when I use single-use personal protective equipment repeatedly.			0.70	0.59	0.50
27	The thought of putting on / taking off personal protective equipment such as overalls reduces my level of drinking water.			0.61	0.65	0.63
26	The thought of putting personal protective equipment (gloves, overalls, masks, etc.) back on prevents me from eating.			0.61	0.61	0.67
Percentage of variance explained		27.22	19.79	16.12		

Table 3. Test-retest reliability and internal consistency of PPECS ($N = 30$).

PPECS Subscales	Mean ± SD		Reliability		Internal Consistency Cronbach's Alpha
	First Assessment	Second Assessment	*P*	ICC (95% CI)	
Physical comfort	32.73 ± 8.39	33.76 ± 8.24	< 0.001	0.93 (0.86-0.96)	0.92
PH1	3.89 ± 1.26	4.10 ± 1.09			
PH2	3.73 ± 1.29	3.76 ± 1.07			
PH3	3.77 ± 1.30	3.90 ± 1.12			
PH4	3.39 ± 1.33	3.66 ± 1.21			
PH5	3.87 ± 1.25	4.03 ± 1.03			
PH6	4.05 ± 1.21	4.30 ± 1.02			
PH7	3.22 ± 1.30	3.56 ± 1.07			
PH8	3.49 ± 1.39	3.70 ± 1.11			
PH9	3.12 ± 1.37	2.73 ± 1.33			
Psychological comfort	17.04 ± 6.20	18.06 ± 6.12	< 0.001	0.93 (0.86-0.96)	0.86
PS1	2.33 ± 1.27	2.56 ± 1.22			
PS2	2.83 ± 1.28	2.96 ± 1.40			
PS3	2.92 ± 1.40	3.36 ± 1.42			
PS4	2.94 ± 1.34	2.80 ± 1.27			
PS5	2.83 ± 1.25	2.96 ± 1.29			
PS6	3.16 ± 1.40	3.40 ± 1.24			
Functional comfort	17.53 ± 5.30	17.60 ± 5.30	< 0.001	0.95 (0.89-0.97)	0.82
F1	3.80 ± 1.35	3.83 ± 1.28			
F2	3.25 ± 1.41	2.96 ± 1.54			
F3	3.57 ± 1.41	3.63 ± 1.49			
F4	3.53 ± 1.37	3.63 ± 1.21			
F5	3.35 ± 1.21	3.53 ± 1.19			
Total	67.15 ± 17.88	69.43 ± 17.35	< 0.001	0.96 (0.92-0.98)	0.93

Abbreviations: CI, Confidence interval; ICC, Intraclass correlation coefficient; SD, Standard deviation; PH: Physical; PS: Psychological; F: Functional.

physical comfort subscale, 0.86 for the psychological comfort subscale and 0.82 for the functional comfort subscale (Table 3).

The relationship between the factor scores of PPECS is presented in Table 4. The mean score was 35.56 ± 9.27 for the physical comfort, 17.04 ± 6.20 for the psychological comfort and 17.53 ± 5.30 for the functional comfort subscales. There were significant relationships between the three factors ($p = 0.001$). Physical comfort was significantly correlated with psychological comfort (rho = 0.57, $p = 0.001$) and functional comfort (rho = 0.51, $p = 0.001$). Besides, there was a significant relationship between psychological comfort and functional comfort (rho = 0.56, $p = 0.001$). The total score was significantly correlated with all factors ($p = 0.001$) (Table 4).

For the model to be tested, the RMSE, GFI, NFI, NNFI, CFI, IFI, RMR and ^{2}א/df fit indices were examined for the factors in the established model (Table 5). According to the model results, x^2/df was 3.80, and RMSEA was 0.075, which showed an acceptable fit. The GFI, NFI, NNFI, CFI, IFI and RMR fit indices showed a good fit. Accordingly, it may be stated that the data had a good fit, and the model was statistically significant and valid ($p = 0.001$; $p < 0.01$). Additionally, the diagram of the suitable model obtained with the confirmatory factor analysis is given below (Figure 1).

Table 6 shows the confirmatory factor analysis path coefficients of PPECS. It is seen that the AVE value was greater than 0.5, and the CR coefficient was greater than 0.70. In line with these results, it may be stated that the 3-factor PPECS had convergent validity, and this supported construct validity.

Table 4. Correlations between factor scores of PPECS ($N = 502$).

	Physical comfort	Psychological comfort	Functional comfort
Physical comfort	–	0.57 (0.001)**	0.51 (0.001)**
Psychological comfort	0.57 (0.001)**	–	0.56 (0.001)**
Functional comfort	0.51 (0.001)**	0.56 (0.001)**	–
Total	0.84 (0.001)**	0.84 (0.001)**	0.77 (0.001)**

Spearman's correlation test *p<0.05, **p<0.01
Data are expressed as rho(p).

Table 5. PPECS Confirmatory Factor Analysis Fit Criteria.

Fit Criteria	Good fit*	Acceptable fit**	Model
	$0 \leq \chi^2/df \leq 2$	1–5	3.80**
GFI	$0.95 \leq GFI \leq 1$	$0.90 \leq GFI \leq 0.95$	0.99*
NFI	$0.95 \leq NFI \leq 1$	$0.90 \leq NFI \leq 0.95$	0.97*
NNFI/TLI	$0.97 \leq NNFI \leq 1$	$0.95 \leq NNFI \leq 0.97$	0.98*
CFI	$0.97 \leq CFI \leq 1$	$0.95 \leq CFI \leq 0.97$	0.98*
IFI	$0.97 \leq IFI \leq 1$	$0.95 \leq IFI \leq 0.97$	0.98*
RMR	$0 \leq RMR \leq 0.05$	$0.05 \leq RMR \leq 0.08$	0.20*
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq 0.08$	0.075**

χ^2/df: Minimum Fit Function Test; GFI = goodness of fit index; NFI: The Normed Fit İndex; NNFI: Nonnormed Fit Index; TLI: Trucker-Lewis Index; CFI: Comparative Fit Index; IFI: Incremental Fit Index; RMR = Standardized Root Mean Square Residual; RMSEA: Root Mean Square Error of Approximation.

Discussion

Throughout the past year, the importance of PPE has been understood yet again in the fight against the COVID-19 pandemic. With the prevalent use of this equipment, it has been revealed that it has significant effects on employee health and performance. Especially for being able to more effectively fight against

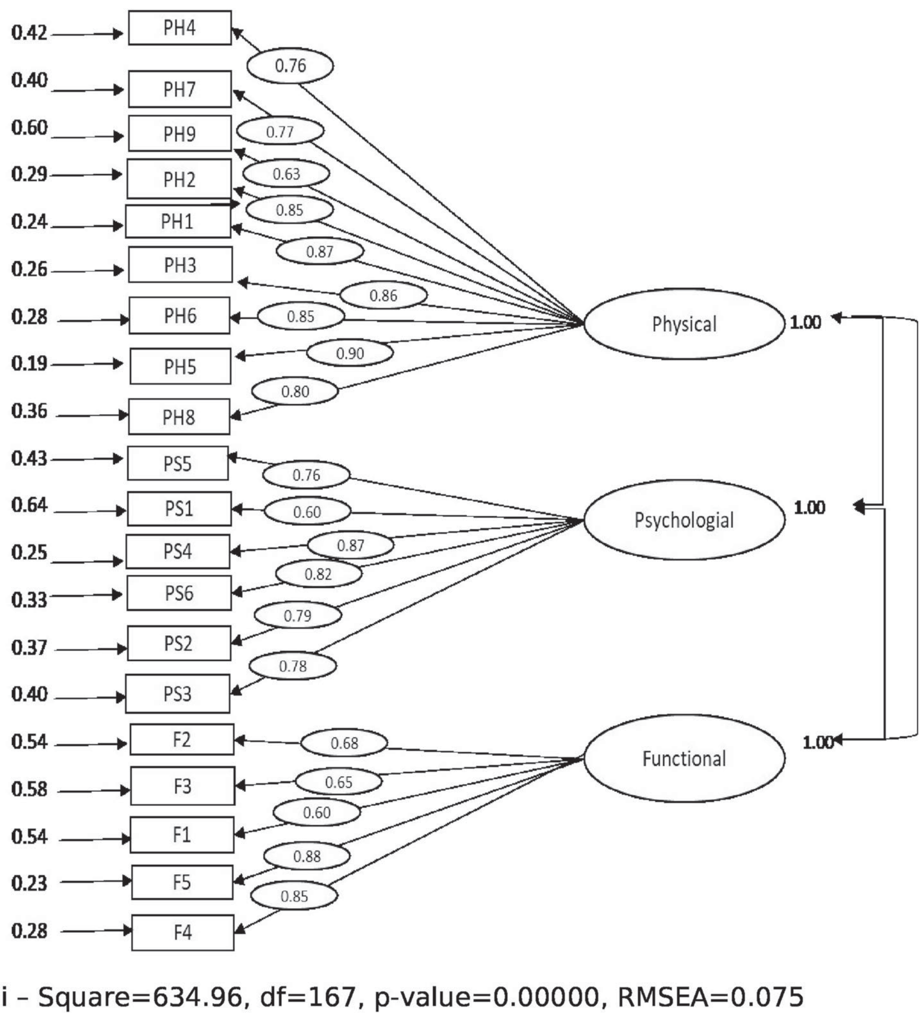

Figure 1. Path diagram for PPECS.

Table 6. PPECS Confirmatory Factor Analysis Path Coefficients.

Factor	Factor Item	Estimate	Standardized estimate	Standard error	T	R^2	AVE	CR
Physical comfort	PH1	1.88	0.87	0.038	49.13	0.76	0.662	0.945
	PH2	2.03	0.85	0.044	46.59	0.71		
	PH3	1.93	0.86	0.046	41.48	0.74		
	PH4	1.10	0.76	0.037	29.66	0.58		
	PH5	1.92	0.90	0.033	58.84	0.81		
	PH6	2.09	0.85	0.059	35.52	0.72		
	PH7	1.03	0.77	0.028	36.39	0.60		
	PH8	1.63	0.80	0.054	30.44	0.64		
	PH9	0.72	0.63	0.038	18.99	0.40		
Psychological comfort	PS1	0.69	0.60	0.045	15.34	0.36	0.599	0.898
	PS2	0.99	0.79	0.068	29.83	0.63		
	PS3	1.08	0.78	0.033	28.85	0.60		
	PS4	1.09	0.87	0.026	42.33	0.75		
	PS5	0.93	0.76	0.038	24.17	0.57		
	PS6	1.32	0.82	0.044	29.64	0.67		
Functional comfort	F1	1.61	0.68	0.11	14.49	0.46	0.568	0.866
	F2	1.16	0.68	0.068	17.02	0.46		
	F3	1.63	0.65	0.10	16.14	0.42		
	F4	1.46	0.85	0.043	33.95	0.72		
	F5	1.33	0.88	0.034	39.42	0.77		

(p>0.05); AVE, Average Variance Extracted; CR, Critical Ratio.

epidemics in the future, it is needed to assess the comfort of this equipment. In this context, when national- and international-level studies are examined, it is seen that some studies have been carried out to assess the comfort of PPE. However, in these studies, it was seen that PPE comfort has been generally assessed with questionnaire forms without tested validity and reliability, and there has been no valid and reliable scale developed towards determining PPE comfort. In this sense, the purpose of this study was to design a valid and reliable measurement instrument for the purpose of determining the Comfort of Personal Protective Equipment used by healthcare workers.

For scales to be able to make accurate and standardized measurements, they need to have validity and reliability properties. Validity is the extent to which a measurement instrument measures the desired property accurately (Kartal and Bardakcı 2018) Reliability was defined as 'consistency between responses given by individuals to test items' (Büyüköztürk 2011). In this context, analyses were conducted related to the validity and reliability of the PPEC scale.

Content validity is tested to detect the extent to which each item in the scale measures the desired concept. Accordingly, by collecting the opinions of experts with capacity related to the topic, adjustments need to be made on the measurement instrument. The items prepared in this study were submitted for the opinions of 10 experts. Based on the expert responses, the content validity ratio (CVR) for each item was calculated. Afterwards, by taking the average of the calculated CVRs, the content validity index (CVI) was found as 0.92 (p>0.05). The CVR value is used for each item to determine whether or not the experts see the item as necessary (Yurdugül 2005). According to the Lawshe table, for items to be included in a scale, they need to have a CVR value of higher than 0.62 (for 10 experts) (Lawshe 1975). Based on this, 19 items that had a CVR value of smaller than 0.62 and were found incomprehensible by the experts were removed from the scale. The scale was reduced to 20 items.

Factor analysis was carried out to measure the construct validity of the draft scale. According to the literature, KMO test as a criterion of sample adequacy is used to compare the observed correlation coefficients and partial correlation coefficients (Akgül 1997; Büyüköztürk 2011). It is stated that the KMO value needs to be higher than 0.50 for the dataset to be suitable for factor analysis, while it needs to be close to 0.90 for the dataset to be sufficient on an excellent level. Additionally, this suitability needs to be statistically assessed by Bartlett's hypothesis test (Büyüköztürk 2011). Bartlett's test is used to determine whether or not the correlation matrix is a unit matrix, and whether or not the use of the factor model is appropriate is determined based on the result (Akgül 1997; Büyüköztürk 2011). According to the result of the Bartlett's test applied on PPECS, it was found suitable to use the factor model. It was determined that the data obtained from the scale in the study were suitable for factor analysis to an excellent extent (KMO: 0.93, and $p = 0.001$; $< \alpha = 0.01$).

For the purpose of determining the number of dimensions into which PPECS would be divided, first of all, dimension reduction was applied by principal component analysis. When factor rotation was applied for this, as the percentages of the total variance explained by all factors were close to each other (27.22%, 19.79% and 16.12%), it was concluded that PPECS could be divided into three dimensions. The distribution of the items into the factors was assessed in detail by two experts as a result of the exploratory factor analysis, and the factor names were determined as ‘physical comfort, psychological comfort and functional comfort’. While Tavsancıl (2010) stated that rates of explained variance between 40% and 60% are expressed adequate in analyses in the social sciences, this value was found as 63.14% in this study. Additionally, the factor loads of the items varied in the range of 0.48-0.85.

While there is no certain standard about the item-total correlation coefficient, Karasar argued that this value should be higher than 0.50, and Öner stated that it should be higher than 0.30 (Esin 2014). In this study, the value of 0.30 was taken as a criterion for the item-total correlation coefficients. The item-total correlation coefficients of the scale varied in the range of 0.43-0.77. These coefficients were greater than 0.30, and the correlations of all items were significant on the level of $p < 0.01$.

The Cronbach’s alpha coefficient is frequently used in calculating the internal consistency in Likert-type scales (Esin 2014). If the Cronbach’s alpha coefficient is between 0.80 and 1.00, the scale is considered to be highly reliable (Kartal and Bardakcı 2018). The finding in this study that the Cronbach’s α for the entire scale was 0.93, and the Cronbach’s α value for the dimensions were higher than 0.80 showed that the scale as a whole and its dimensions were internally consistent. In this context, the developed scale was highly reliable (Kartal and Bardakcı 2018).

The second approach to determining the consistency of measurements is to apply the same test to the same individuals under the same conditions with a certain time interval and calculate the correlation between the two measurements. This method is known as the test-retest method. It is desired that the correlation obtained from the two tests does not fall below 0.70 (Tavsancıl 2010). According to the analyses, it was observed that the responses of the healthcare workers to the scale items at two different times were consistent. The general correlation of the scale was found as positive and highly significant ($r = 0.96$; $p = 0.001$) ($p>0.05$). According to the correlation analysis conducted to detect the relationships among the factors, it was determined that there were positive and significant relationships among all factors and between the total score and each factor, and all factors were under the same construct.

It is important in terms of construct validity to confirm the measurement model discovered with exploratory factor analysis by using confirmatory factor analysis (Kartal and Bardakcı 2018). Confirmatory factor analysis allows testing of the hypothesis developed by the researcher based on their theory or the theory itself (Esin 2014; Kartal and Bardakcı 2018).

In confirmatory factor analysis, the fit of the model is checked based on different fit index results (Esin 2014). The first of these fit indices is RMSEA. RMSEA values of equal to or smaller than 0.08 and p values of smaller than 0.05 show that the model has an acceptable fit (Esin 2014). As a result of the factor analysis, it was found that the RMSEA fit index value was 0.075, and the model showed an acceptable fit. Additionally, the findings that 0.95≤GFI≤1, 0.95≤NFI≤1, 0.97≤NNFI≤1, 0.97≤CFI≤1, 0.97≤IFI≤1 and 0.90≤RMR≤1 showed a good fit of the model (Kartal and Bardakcı 2018; Esin 2014). Additionally, 2א /df values of 2 and lower indicate a good fit, and values of 5 and lower indicate an acceptable fit (Esin 2014; Kartal and Bardakcı 2018). According to this, the value in the model (2א /df:3.80) showed an acceptable fit. In terms of construct validity, it was determined that the fit indices of the applied confirmatory factor analysis showed acceptable and good fit results ($p = 0.001$; $p < 0.01$). Additionally, confirmatory factor analysis path coefficients were calculated to assess the construct validity of PPECS. AVE values of higher than 0.5 show that the factor has convergent validity (Kartal and Bardakcı 2018). In this study, the AVE value was found to be higher than 0.5. The CR coefficient takes values between 0 and 1, and it is expected to be greater than 0.70 (Kartal and Bardakcı 2018). In this study, the CR value was found to be higher than 0.70. Accordingly, these three factors had high construct validity, and therefore, convergent validity.

Limitations

This study has an international quality. However, it is needed to state that the study had some limitations. First of all, the working conditions and equipment every country has are different. Second of all, the results of the study are based on the statements of the healthcare workers who participated in the study. Third of all, the distribution of the sample indicated a majority of female participants. Despite these limitations, the scale that was developed is a valid and reliable instrument for determining the comfort of PPE that is used in epidemics and pandemics like COVID-19. In particular, using the scale that was developed, PPE comfort and factors that affect PPE comfort may be determined. This way, the comfort levels and usability of PPE may be increased, and it may be possible to fight against future pandemics more effectively.

Conclusions

The internal consistency coefficient of the scale was found as 0.93. In this form, the item-total correlation values of the scale varied between 0.43 and 0.77. As a result of the test-retest analysis that was conducted, the correlation coefficient between the two measurements was found as 0.96, and a linear and strong relationship was determined between the two measurements. As a result of the factor analysis conducted for the construct validity of the scale, three factors were obtained. These factors were named as physical comfort, psychological comfort and functional comfort. Consequently, it was observed that Personal Protective Equipment Comfort Scale which was developed to measure the comfort of PPE used by healthcare workers consisted of 20 items in its final form, and it was determined to be a measurement instrument with high validity and reliability indicators.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

Cennet Ciris Yildiz got his PhD in the field of Nursing from the Unıversity of Marmara University Health Sciences Institüte. She is currently serving as a Doctor for Istanbul Kent Unıversıty/Faculty of Health Scıences/Department of Nursıng. Her research areas, health and nursing education and practice, health and nursing management, evidence-based practice.

Dilek Yildirim got his PhD in the field of Internal Medıcine Nursing from the Istanbul University Health Sciences Institute. She is currently serving as a Doctor for Istanbul Aydin Unıversıty/Faculty of Health Scıences/Department of Nursıng. She has already published more than 50 tecnical papers, and she wrote many book chapters in her field.

ORCID

Cennet Ciris Yildiz http://orcid.org/0000-0002-1351-5439
Dilek Yildirim http://orcid.org/0000-0002-6228-0007

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