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# Enfermedades Infecciosas y Microbiología Clínica

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Original article

## Can “YouTube” help healthcare workers for learning accurate donning and doffing of personal protective equipments?



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### ABSTRACT

**Introduction:** Healthcare workers have a high risk of cross-infection during the care of Covid-19 cases. Personal protective equipment can reduce the risk. However, healthcare workers must be trained for the proper use of personal protective equipment to decrease exposure risk. This study aimed to investigate whether videos available on YouTube, presenting procedures of donning and doffing personal protective equipment, can be a useful learning resource for healthcare workers.

**Methods:** A search of YouTube was conducted using the keywords “Covid-19, personal protective equipment, donning, doffing”. Two investigators reviewed each video and collected the basic video information. Total videos were assessed independently as educationally useful and non-useful categories using a valid tool. The relationship of each video’s usefulness with viewers’ preferences and the upload source were analyzed.

**Results:** A total of 300 videos were assessed; 66 (22%) fulfilled the inclusion criteria. Total video scores of educationally useful videos were higher than non-useful ones; the differences were significant. Healthcare/government agencies and hospitals mostly created educationally useful videos, e-learning platforms, and individuals mainly created non-useful videos. Significant correlations were observed between the video’s usefulness and the total view and views per day.

**Conclusions:** During a pandemic, YouTube might be a resource for learning donning and doffing of personal protective equipment for healthcare workers if an appropriate selection process applied for determining educationally useful videos.

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## ¿Puede «YouTube» ayudar a los trabajadores de la salud a aprender a ponerse y quitarse con precisión los equipos de protección personal?

### RESUMEN

**Introducción:** Los trabajadores de la salud tienen un alto riesgo de infección cruzada durante la atención de los casos de COVID-19. El equipo de protección personal puede reducir el riesgo. Sin embargo, los trabajadores de la salud deben estar capacitados para el uso adecuado del equipo de protección personal para disminuir el riesgo de exposición. Este estudio tuvo como objetivo investigar si los videos disponibles en YouTube, que presentan procedimientos para ponerse y quitarse el equipo de protección personal, pueden ser un recurso de aprendizaje útil para los trabajadores de la salud.

**Métodos:** Se realizó una búsqueda en YouTube utilizando las palabras clave «COVID-19, equipo de protección personal, ponerse, quitarse». Dos investigadores revisaron cada video y recopilaron la información básica del mismo. Los videos totales se evaluaron de forma independiente como categorías educativas útiles y no útiles utilizando una herramienta válida. Se analizó la relación de la utilidad de cada video con las preferencias de los espectadores y la fuente de carga.

#### Palabras clave:

YouTube

COVID-19

Poner

Quitar

Equipos de protección personal

**Abbreviations:** HCW, healthcare workers; PPE, personal protective equipment; CDC, Centers for Disease Control and Prevention; WHO, World Health Organization.

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**Resultados:** Se evaluaron un total de 300 videos; 66 (22%) cumplieron los criterios de inclusión. Los puntajes totales de videos útiles para la educación fueron más altos que los no útiles; las diferencias fueron significativas. Las agencias de salud/gubernamentales y los hospitales en su mayoría crearon videos útiles para la educación, plataformas de aprendizaje electrónico y las personas crearon principalmente videos no útiles. Se observaron correlaciones significativas entre la utilidad del video, la vista total y las vistas por día.

**Conclusiones:** Durante una pandemia, YouTube podría ser un recurso para aprender a ponerse y quitarse el equipo de protección personal para los trabajadores de la salud si se aplica un proceso de selección apropiado para determinar videos útiles desde el punto de vista educativo.

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## Introduction

On March 11, 2020, the World Health Organization (WHO) declared the Covid-19, caused by SARS-CoV-2, a pandemic.<sup>1</sup> Since December 31, 2019, and as of Oct 30, 2020, 44 888 869 confirmed cases of Covid-19 have reported, including 1 178 475 deaths.<sup>2</sup> Given the threat of Covid-19, it is essential to emphasize the use of appropriate measures for infection control in healthcare settings. Covid-19 can cause transmission person-to-person through a cough or respiratory droplets, contact with bodily fluids, or contaminated surfaces.<sup>3</sup> Health care workers (HCWs), especially those performing aerosol-generating procedures on known or suspected Covid-19 patients, face an increased risk for exposure to the virus.<sup>4</sup> Centres for Disease Control and Prevention (CDC), WHO and European Centre for Disease Prevention and Control (ECDC) proposed infection control interventions combining universal source control, early identification, and isolation of patients with suspected diseases and environmental disinfection to reduce transmission of Covid-19.<sup>5–7</sup> Also, current recommendations advise wearing appropriate levels of personal protective equipment (PPE) in health care environments to protecting staff and other patients from Covid-2019 cross-infection.<sup>5–8</sup> However, HCWs should rigorously follow all procedures for putting on (donning) and safely removing (doffing) PPE according to the correct sequence to decrease exposure risk. During the severe acute respiratory syndrome (SARS) pandemic, some HCW infections probably occurred from the incorrect usage of PPE.<sup>9</sup> Therefore, it is crucial to assure that all HCWs must be trained for the proper use of PPE during the care of Covid-19 cases.

Social media platforms like Facebook and Twitter are an emerging tool for health communication during past major outbreaks; therefore, the CDC and WHO have regularly posted content discoverable on the internet in Covid-19 pandemic.<sup>10</sup> YouTube, the second most popular social media platform, presents many medical videos prepared for HCWs as an educational visual guide for different procedures.<sup>11,12</sup> Online visual images can improve the effectiveness of health education materials.<sup>13</sup> If the educational videos in youtube are well designed, scientifically correct content, adequately presented, and meet the students' learning needs may provide useful conceptual links between theory and practice. However, YouTube does not have strict regulations or standards concerning the educational aspects of the videos. Therefore a bothersome number of misleading information in health-related videos shared on YouTube could present a risk to healthcare professionals or their patients.<sup>14</sup>

There is a lack of data in the literature evaluating the videos on YouTube about proper donning and doffing PPE as a resource for learning for HCWs. The present study aimed to evaluate the basic components and the usefulness of YouTube of videos presenting donning and doffing PPE.

## Methods

### Searching YouTube

YouTube (<http://www.youtube.com>) searched for videos containing relevant information about donning and doffing PPE on 17 May 2020. "Covid-19, donning/doffing PPE" was used as the search term. It was shown that over 90% of Internet users click on the first three pages of the query results.<sup>15</sup> Two anesthesiologists specialist using PPE in routine daily practice independently evaluated the 300 videos on the first fifteen pages. The videos achieved using a default setting on YouTube and results sorted according to most viewed. This search method has applied in several studies linked to the evaluation of the educational value of YouTube for medical literature.<sup>16–18</sup> A total of 114,000 videos yielded as a result of the search.

The levels of PPE for protection changes with types of transmission and airborne precautions also cover droplet and contact transmission. Therefore we only included the videos explaining the level of PPE for airborne protection. Videos excluded if they were (1) published before 2020, (2) in a language other than English, (3) with nonmedical content, (4) including an advertisement and containing live-action footage with no education format. Duplicated and irrelevant videos also excluded.

### Data collection

For each video, the following data were collected: total views, duration on YouTube (day), views per day, video length (second), a scoring system that viewers can assign to videos (number of likes and dislikes), and source of uploads. Video power index (VPI) was calculated to assess the popularity of videos.

$$\begin{aligned} \text{VPI} &= \text{like ratio} \times \text{view ratio}/100; \text{ with like ratio} \\ &= \text{like} \times 100/(\text{like} + \text{dislike}) \text{ and view ratio} \\ &= \text{number of views/days} \end{aligned}$$

### Sources of video upload

Videos divided into five groups conforming to the source of loading: (Source 1) universities and institutes, (Source 2) public/government health institutions and associations (Source 3) hospitals and health care centres, (Source 4) digital learning platforms, health information websites, medical advertisement for-profit companies, and (Source 5) individuals.

**Table 1**  
Criteria used in evaluating the videos.

<i>Major criteria</i>	
1	Contents about donning and doffing PPE are scientifically correct.
2	Images are clear.
3	The creator/organization is mentioned.
4	The topic is clearly presented.
5	Sounds are clear, and background is free from noise.
<i>Minor criteria</i>	
1	The video covers the topic identified in the title.
2	Designed at the level of undergraduate medical science students.
3	The time to download is reasonable.
4	Information about the creator is up-to-date.
5	The educational objectives are stated.
6	Demonstrating the donning/doffing PPE procedure on a human instead of illustration.

### Video assessment for educationally usefulness

Videos were categorized as educationally useful and non-useful using a valid instrument based on educational principles, with some modification to match the study's needs, developed by Azer SA (Table 1).<sup>19</sup> This instrument includes five major and six minor criteria and covered the following parameters; the accuracy of content, clarity of the message given, authority, pedagogy, educational basis, and technical design. Two points for major criteria and one point for minor criteria were given for each step covered in the video. If an item is completed, the allocated score is given; if not, zero is given. Educationally useful videos should score 13 or higher, fulfilling all of the major criteria and at least 3 of the minor criteria. This instrument has been tested in several studies that evaluate the usefulness of videos created for surface anatomy, respiratory, cardiovascular, and nervous systems examination on YouTube.<sup>14,19–21</sup> Two investigators independently evaluated all the videos. Investigators blinded to each other's evaluations. When there was an event of a discrepancy, a third investigator appraisal inquired for the final decision.

### Evaluating the content

To standardize the evaluation of each video's content and the donning and doffing PPE procedure, the investigators used the European Centre for Disease Prevention and Control Guidance as a reference to guide their assessment.<sup>8</sup> The content item in the criteria contained the following for donning PPE; preparing for donning, washing hands accurately, wearing the gown and FFP2 or FFP3 mask, testing the fit of the mask, wearing eye protection, and gloves accurately. For the doffing of the PPE, the content item in the criteria was as follows; removing gloves, gowns and eye protection accurately, leaving to clean area, removing masks correctly, washing the hands in each step, and check for correct doffing order.

### Statistical analysis

The Statistical Package for the Social Sciences version 22 software (SPSS, Chicago, IL, USA) was used for statistical analyses. Numerical variables were presented as means  $\pm$  standard deviations or median and interquartile range (IQR) values. The normal distribution of the data checked using the Shapiro–Wilk test. In the comparison of numerical variables, the Independent-Samples *T* test or Mann–Whitney *U* test applied. Categorical variables presented as number (*n*) and percentage (%). In the comparison of categorical variables, the Chi-square and Fisher's Exact tests used. The relationship between total video score and basic video characteristics were analyzed with Pearson and Spearman correlation. Inter-rater agreement was determined using Cohen's kappa score. A *p* value of 0.05 or less was considered to be significant.

## Results

Using the search term of “Covid-19, donning/doffing PPE”, the first 300 most viewed videos on YouTube reviewed. A total of 234 videos excluded and 66 included in the study for further analysis (Fig. 1). Of the 66 videos presenting donning and doffing PPE, nine videos (13.6%) contained only wearing PPE, six (9.1%) videos showed only doffing PPE, and 51 (77.3%) videos demonstrated both of them (Fig. 1). Donning and doffing sections were evaluated and compared separately in the videos (Fig. 1). Table 2 summarizes the descriptive statistics of the educationally useful and non-useful videos for donning and doffing PPE.

The median total views of these videos were 1701 (range: 180–12 089). The median length of these videos was 244 s (range: 179–340). The average duration on Youtube videos was for  $48 \pm 15$  days. The median views per day for a video was 41.91 (range: 4.02–282.83). The median number of video power Index for a video was 1213 (range: 200–6600). Total scores of educationally useful videos were  $14.81 \pm 0.68$  and  $14.85 \pm 0.60$  for donning and doffing PPE presentations. Compared to non-educationally useful videos, the differences were significant ( $p < 0.001$  for both). Non-educationally useful videos failed to fulfil the two of the major criteria for both donning and doffing PPE. The assessment of the total video scores the kappa statistic for the inter-observer agreement was 0,901 (95% CI: 0.819–0.983) and 0.895 (95% CI: 0.872–0.918), for donning and doffing videos, respectively, showing a high inter-rater correlation between evaluators. While educationally useful videos were mostly designed by healthcare agencies/government agencies and hospitals, non-useful videos were mainly created by e-learning platforms and individuals (Table 3). When we compare the source of upload among educationally useful and non-useful videos, the differences were significant for both donning and doffing PPE videos ( $p = 0.013$  and 0.010, respectively).

The correlations between, the total video scores and the total view and views per day were significant for both the donning PPE videos ( $r = 0.401$ ,  $p = 0.001$ ), ( $r = 0.415$ ,  $p = 0.001$ ) and the doffing PPE videos ( $r = 0.415$ ,  $p = 0.001$ ) ( $r = 0.410$ ,  $p = 0.002$ ). There were no significant correlation between the total video scores and VPI, video length and duration on YouTube (day) for both donning PPE videos ( $r = 0.211$ ,  $p = 0.106$ ) ( $r = 0.092$ ,  $p = 0.486$ ) ( $r = -0.057$ ,  $p = 0.663$ ) and doffing PPE videos ( $r = 0.209$ ,  $p = 0.118$ ) ( $r = -0.046$ ,  $p = 0.735$ ), ( $r = -0.050$ ,  $p = 0.711$ ).

A detailed content analyses of YouTube videos were shown in Figs. 2 and 3. The frequency of proper practices in all steps was higher in educationally useful videos for both groups. However, only the frequency preparing for donning PPE and correctly washing hands before donning PPE was statistically significantly higher in educationally useful videos when compared to non-useful ones ( $p = 0.011$  and  $p = 0.004$ ). The frequency of washing hands in each step was statistically higher in educationally useful videos when compared to non-useful ones for doffing PPE videos ( $p = 0.005$ ).

## Discussion

During coronavirus pandemics, commitment to social distance has produced the choosing and application of technologies in medical education, comprising social media platforms. The quick and easy access, lack of charge, and registration make YouTube videos an attractive learning tool for medical students and residents. In this study, we aimed to evaluate the basic characteristics of YouTube videos prepared for donning and doffing PPE and determine whether these were educationally useful for HCWs in their self-regulated learning. This research is the first in the literature examining this issue. Our results show that almost half of them

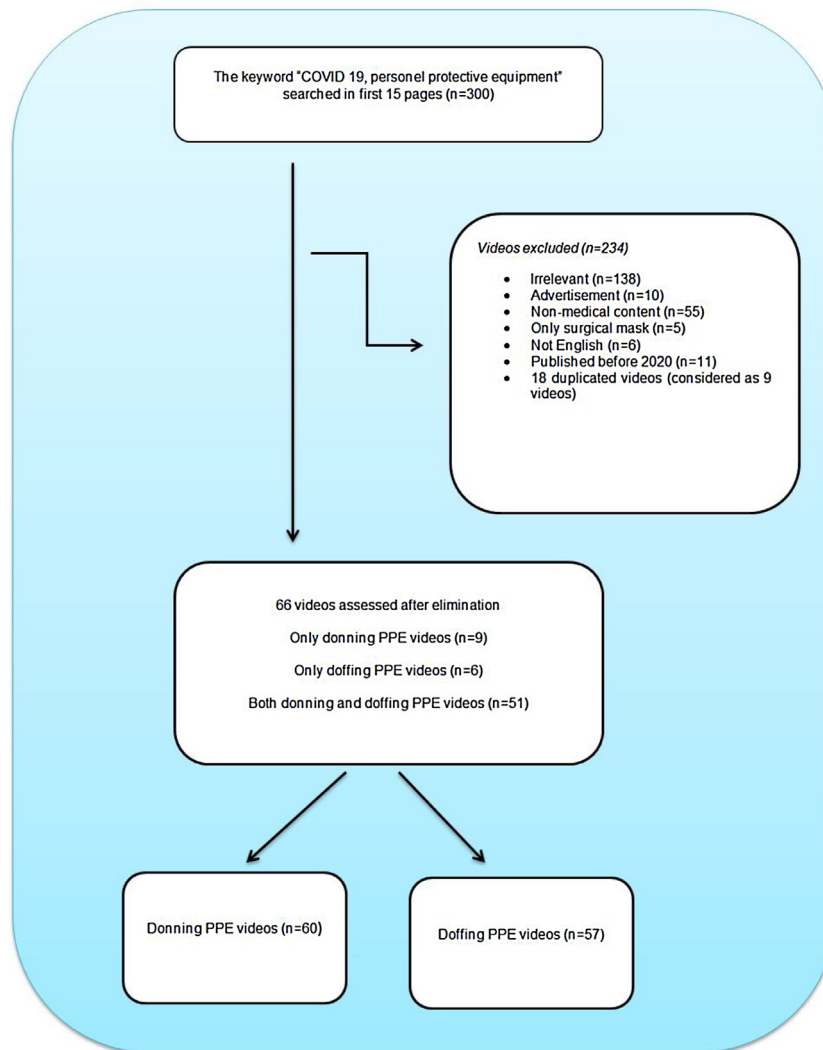


Fig. 1. Selection of eligible YouTube videos for the study.

**Table 2**  
Analysis of basic videos characteristics and educational value of donning and doffing PPE videos.

	Number of videos n (%)	Total view	Video length, s	Duration on YouTube (day)	Views per day	VPI	Total video score
Donning PPE	60	1701 (183–10,938)	244 (171–345)	48 ± 14	41.91 (4.24–277.33)	1200 (200–6100)	12.07 ± 3.08
Educationally useful	27 (%45)	8563 (812–48,521)	270 (195–350)	47 ± 15	164.67 (19.80–808.68)	2200 (200–11990)	14.81 ± 0.68
Educationally not useful	33 (%55)	789 (132–3600)	200 (152–340)	49 ± 13	16.55 (2.75–77.97)	600 (200–3800)	9.82 ± 2.35
<i>p</i> value		<b>0.003</b>	0.126	0.621	<b>0.002</b>	0.101	<b>&lt;0.001</b>
Doffing PPE	57	1840 (180–9589)	194 (129–312)	48 ± 14	42.92 (3.55–266.36)	1225 (200–5600)	12.28 ± 3.03
Educationally useful	27 (%47.4)	5400 (812–23,387)	210 (135–412)	47 ± 15	98.18 (19.63–427.24)	2200 (800–11990)	14.85 ± .60
Educationally not useful	30 (%52.6)	666 (92–3600)	173 (100–303)	49 ± 13	16.45 (1.90–77.97)	600 (200–3840)	9.97 ± 2.39
<i>p</i> value		<b>0.006</b>	0.250	0.573	<b>0.004</b>	0.081	<b>&lt;0.001</b>

Variables were presented as mean ± standard deviation or median (Q1–Q3) or frequency (%), and *p* < 0.05 was expressed as bold point.

were useful for education. We also found that while universities, health care agencies/government agencies, and hospitals mostly created educationally useful videos, non-useful videos were mainly designed by e-learning platforms and individuals (Table 3).

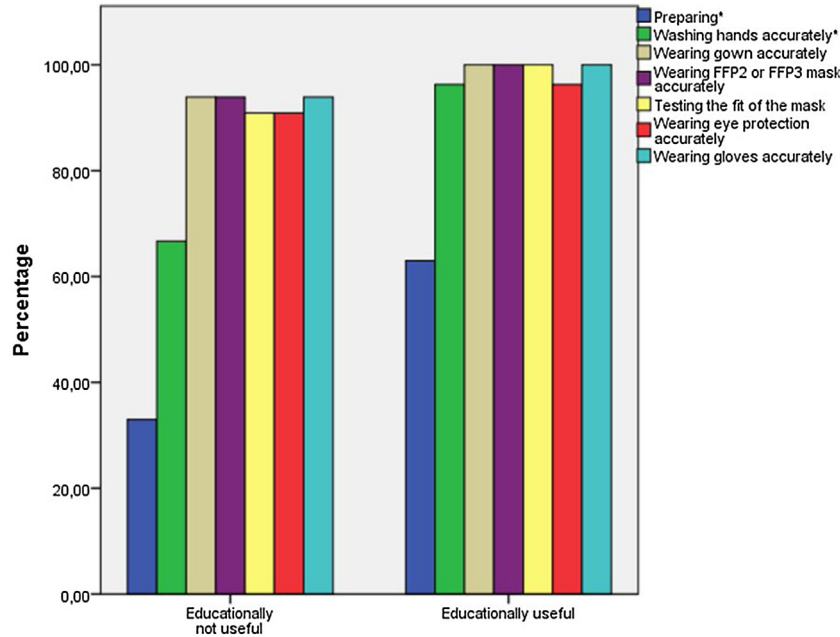
Studies analyzing the educational value of medical YouTube videos generally focus on finding which video characteristics can be positively correlated with the video’s scientific accuracy. The most statistically analyzed parameters were reported as the number of

likes against the video scores and the source of loading against the video score.<sup>22</sup> Although some studies have not found a significant relationship between usefulness and viewers’ responses other studies have shown that viewers prefer misleading videos.<sup>23–28</sup> Azer SA reported that useful videos for learning surface anatomy have a higher view rate than non-useful ones.<sup>19</sup> In this study, in line with Azer’s research, total views and views per day were significantly correlated with video usefulness. These results intend

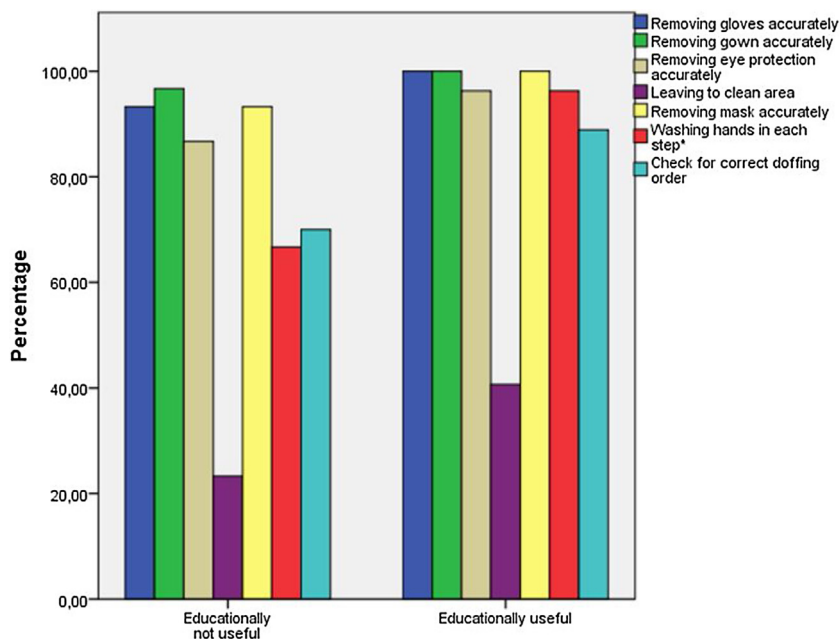
**Table 3**  
Sources of uploads among donning and doffing PPE videos.

	Source of uploads				
	University	National Health Agency	Hospital/Healthcare Centre	E-learning platform	Individuals
Donning PPE	10 (16.7%)	14 (23.3%)	13 (21.7%)	8 (13.3%)	15 (25.0%)
Educationally useful	5 (18.5%) <sup>*,†</sup>	9 (33.3%) <sup>†</sup>	8 (29.6%) <sup>†</sup>	4 (14.8%) <sup>*,†</sup>	1 (3.7%)*
Educationally not useful	5 (15.2%) <sup>*,†</sup>	5 (15.2%) <sup>†</sup>	5 (15.2%) <sup>†</sup>	4 (12.1%) <sup>*,†</sup>	14 (42.4%)*
<i>p</i> value			<b>0.013</b>		
Doffing PPE	10 (17.5%)	14 (24.6%)	10 (17.5%)	9 (15.8%)	14 (24.6%)
Educationally useful	5 (18.5%) <sup>*,†</sup>	10 (37.0%) <sup>†</sup>	6 (22.2%) <sup>†</sup>	5 (18.5%) <sup>*,†</sup>	1 (3.7%)*
Educationally not useful	5 (16.7%) <sup>*,†</sup>	4 (13.3%) <sup>†</sup>	4 (13.3%) <sup>†</sup>	4 (13.3%) <sup>*,†</sup>	13 (43.3%)*
<i>p</i> value			<b>0.010</b>		

Variables were presented as frequency (%), and *p* < 0.05 was expressed as bold point. Each superscript symbol (\*,†) denotes a subset of source group categories whose column proportions do not differ significantly from each other at the 0.05 level.



**Fig. 2.** Detailed content analyses of YouTube videos for donning PPE.



**Fig. 3.** Detailed content analyses of YouTube videos for doffing PPE.

that viewers are most likely watching videos with useful information about PPE donning and doffing. However, because viewers' video popularity index were similar between useful and non-useful groups, viewers were probably unlikely to notice the inaccurate content.

Covid-19 infections affected HCWs range from 11 to 29% among different countries.<sup>29–31</sup> To prevent disease transmission in healthcare settings, donning and doffing procedures be performed by using a checklist for each step in a recommended sequence.<sup>8</sup> Also, performing hand hygiene in each step is essential during doffing. We found that all recommended sequence steps were higher in educationally useful videos for donning PPE (Fig. 2). Also, “washing hands in each step” was statistically significantly higher in educationally useful videos than non-useful ones (Figs. 2 and 3). The risk of contamination HCWs may be reduced with an improvement in the competency of the staff's donning and doffing of PPE training.

During aerosol-generating procedures, there is an agreement among international organizations that N95, FFP2, or comparable standard respirators contribute better protection than surgical masks.<sup>5,32</sup> However, all relevant staff members should undertake individual mask fit-testing to prevent the inhalation of small airborne particles before they contact patients. In the present study, useful videos showed a higher ratio for an accurate wearing technique for respirators than non-useful videos; however, this was not statistically significant.

Based on the findings obtained in this study, HCWs should use a preferred search strategy to find videos with the best and most comprehensive content. The videos created by public health institutions, hospitals, and universities tended to have a higher video score than videos uploaded by individuals. Also, these videos were more often classified as useful for education. Hence, HCWs can actively search for videos uploaded by such institutional resources. To find appropriate training videos for donning and doffing PPE on YouTube, first, HCWs should use a relevant keyword in the video selection, then identify the source of the video and the total view time criteria.

## Limitations

This study has several limitations. First, this study shows a snapshot of only accessible information on YouTube during the beginning of the Covid-19 pandemic. However, as YouTube is a dynamic platform, the content may have changed over time as the outbreak has extended. Therefore, further research is needed to assess whether there is an increase in the quality and content of videos on YouTube in this regard. Second, the authors used an unvalidated but objective Covid-19 specific items based on international guidelines for evaluating the content of the videos. Finally, only-English-language videos were evaluated.

## Conclusion

As a result, in this research, we found significant correlations in video usefulness and viewers' choices. YouTube can be used as a learning resource during the Covid-19 outbreak if applying an appropriate selection process. Reviewing the upload source and viewer responses can help to determine videos that are educationally useful for donning and doffing PPE procedures.

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## Conflict of interest

No potential conflict of interest was reported by the authors.

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