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## Major Article

## Health care worker knowledge and attitudes towards uniform laundering during the COVID-19 pandemic

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## Key Words:

Health care worker  
Uniform  
Textile  
Domestic laundry  
Guidelines  
COVID-19  
Infection control

**Background:** The COVID-19 pandemic raised concerns towards domestic laundering of healthcare worker (HCW) uniforms; this is common practice in countries such as the United Kingdom (UK) and United States. Previous research suggested 4–32% of nurses did not adhere to laundry policies, which could be an infection control risk. This study aimed to investigate the knowledge and attitudes of UK healthcare workers towards domestic laundering of uniforms during the COVID-19 pandemic.

**Methods:** Online and paper questionnaires were distributed to HCWs and nursing students who regularly wear uniforms. Differences in knowledge between HCWs were analyzed by Chi-squared tests and attitudes were examined using exploratory factor analysis.

**Results:** About 86% of participants (n = 1099 of 1277) laundered their uniforms domestically. Respondents were confident in laundering their uniforms appropriately (71%), however 17% failed to launder at the recommended temperature (60°C). Most participants (68%) would prefer their employer launder their uniforms, with mixed negative emotions towards domestic laundering. Limited provision of uniforms and changing and/or storage facilities were a barrier to following guidelines.

**Conclusion:** Most HCWs domestically launder their uniforms, despite a preference for professional laundering. One-fifth of HCWs deviated from the UK National Health Service uniform guidelines; onsite changing facilities were the most significant barrier towards adherence.

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The stability of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) on textiles was not well understood at the start of the coronavirus disease 2019 (COVID-19) pandemic, therefore the infection control risk associated with contaminated healthcare worker uniforms was unclear. While personal protective equipment (PPE) is used during patient care to prevent uniforms from becoming contaminated (Public Health England,<sup>1</sup>), there is some evidence that self-contamination can occur during doffing of personal protective equipment (PPE)<sup>2</sup> which could be a potential contamination route for healthcare worker uniforms during the COVID-19 pandemic. In the UK, COVID-19 infection control guidance states that disposal aprons should be worn during direct patient care, while fluid resistant gowns or coveralls are required for higher-risk activities such as

aerosol-generating procedures (Public Health England,<sup>1</sup>). Osei-Bonsu et al.<sup>3</sup> reported that 3 of 12 participants contaminated their scrubs with fluorescent tracer powder and 1 of 12 were contaminated with fluorescent *Staphylococcus epidermidis* during doffing of gloves, gowns and surgical masks. Similarly, after applying a mixture of 2 bacteriophage species ( $\phi 6$  and MS2) to Ebola virus PPE of experienced HCWs, 1 participant's scrubs were contaminated with  $\phi 6$  and two with MS2 during doffing.<sup>4</sup> A recent study demonstrated that human coronavirus OC43 (HCoV-OC43) remained infectious for 6–72 hours on polycotton, cotton and polyester and transferred from polyester to other surfaces (Owen et al., 2021<sup>5</sup>), suggesting that contaminated textiles could be a potential vehicle for transmission of coronaviruses. Previous research has also demonstrated the colonization of healthcare worker uniforms with potentially pathogenic bacteria such as *Clostridioides difficile*, *Staphylococcus aureus*, *Enterococcus* spp., and *Escherichia coli* upon contact with patients.<sup>6,7</sup> Such bacteria can survive on textiles for weeks, for example *E. coli*, *S. aureus*, *Enterococcus faecium* and *Pseudomonas aeruginosa* persist for

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20–21 days on cotton<sup>(8)</sup>; Riley et al., 2017<sup>(9)</sup>), and they can also persist on textiles during laundering<sup>(10)</sup>; Riley et al., 2017<sup>(9,11)</sup>). This suggests that in addition to coronaviruses, there is also a risk of propagating other healthcare associated pathogens from healthcare uniforms.

It is common practice in countries such as Germany, Austria and the United States of America (USA) for healthcare worker uniforms to be laundered by the employer, either in-house or commercially.<sup>12,13</sup> There has been an increase in adoption in home laundering of uniforms, for example in the UK (National Health Service [NHS],<sup>14</sup>), Australia<sup>15</sup> the Republic of Ireland<sup>16</sup> and some healthcare facilities in the USA<sup>17</sup>, to reduce costs to the employer and for the convenience of staff.<sup>18</sup> However, the efficacy of domestic laundering has been debated, with previous research demonstrating that potentially pathogenic microorganisms (e.g., *Staphylococcus* spp.) survive on contaminated textiles during typical domestic wash cycles (Riley et al., 2017<sup>(9,19)</sup>). In the UK, workwear and uniform policies are set by individual National Health Service (NHS) trusts based on the NHS workwear guidelines,<sup>14</sup> which state the laundering processes that must be followed by all staff that wear uniforms.<sup>20</sup> Not all staff with direct patient contact wear uniforms, including doctors who either wear their own clothes or theatre scrubs which are not personally assigned to them. Local policies dictate dress standards and laundering guidelines for non-uniformed staff.<sup>20</sup> The NHS uniform guidelines state that staff uniforms should be laundered at “the hottest temperature suitable for the fabric”<sup>14</sup>; this maximum temperature can vary between textile types and there is no minimum requirement for heat tolerance of uniforms stated. The level of microbial reduction during laundering is dependent on washing time, temperature and type of detergent used,<sup>21</sup> indicating that there may be variation in laundering efficacy between healthcare workers. Moreover, previous research has suggested that healthcare worker uniforms may deviate from laundering policies, which could further reduce the efficacy of uniform decontamination; Riley et al.<sup>18</sup> determined that only 4–32% of respondents complied with all key parameters within the local hospital uniform policy (laundering temperature, use of detergent and drying conditions) and Potter and Justham<sup>22</sup> reported that 76% of nurses and healthcare assistants change at home after a shift, and 26–29% wash at 40°C rather than the stipulated 60°C. Given the above, concerns have been raised that there could be a risk of microbial transmission from contaminated healthcare worker uniforms (Riley et al., 2017<sup>(9,19)</sup>). On the emergence of the COVID-19 pandemic there was a lack of published research on the persistence of SARS-CoV-2 on textiles and during laundering; this further highlighted concerns towards domestic laundering and provides a rationale for the investigation of healthcare worker uniform laundering practices under a pandemic setting. Previous research has suggested that there may also be a lack of changing facilities available to healthcare workers in the UK<sup>18,23</sup> which could be a barrier to adhering to NHS recommendations to change out of uniforms at work after their shift, thereby leading to healthcare workers travelling to and from work in their uniforms.<sup>23</sup> Wearing healthcare uniforms home is viewed as unhygienic by the general public<sup>14</sup> and could risk cross-contamination of surfaces during transport.

In response to the COVID-19 pandemic the UK government initially recommended that uniforms should be laundered professionally where possible (Public Health England,<sup>1</sup>); this guidance was then superseded by recommendations to follow local domestic uniform laundering guidelines in August 2020 (Public Health England,<sup>1</sup>). It has been argued that the efficacy of domestic laundering is comparable to professional laundering,<sup>14</sup> however industrial laundry processes exert greater control over uniform disinfection and infection control measures in order to protect staff handling contaminated textiles.<sup>24</sup> It is not clear how laundering guidelines are being communicated to healthcare workers during the COVID-19 pandemic; Riley et al.<sup>18</sup> reported that information provided on laundering uniforms

varied between NHS Trusts and there were some instances of incorrect information being given.<sup>18</sup> This could lead to some healthcare workers laundering their uniforms inappropriately.

The attitudes of healthcare workers towards laundering their uniforms during the COVID-19 pandemic does not appear to have been explored in the published literature; healthcare workers may be concerned of the risk of handling contaminated uniforms within the home environment especially during the current COVID-19 pandemic. Indeed, healthcare workers in the UK have expressed fears they could become infected by caring for those who are most ill with COVID-19<sup>(25)</sup> or anxieties that they could bring it home to family due to incorrect PPE use.<sup>26</sup> Behavioral prevention strategies during this pandemic are wide-ranging and in the context of healthcare workers can include strategies to reduce infection risk, such as PPE use and uniform care. As a result, psychological and behavioral aspects should be considered to better understand the hygienic practices and areas for intervention. The Behavior Change Wheel (BCW)<sup>(27)</sup> has been demonstrated to help identify COVID-19 target behaviors, as well as policy interventions.<sup>28</sup> The Capability Opportunity Motivation-Behavior (COM-B) model sits at the hub of the BCW and provides a mechanism to understand the source of behavior. A UK study carried out in the earlier stages of the pandemic utilized the COM-B model to understand hygienic practices in the general public and demonstrated that all components (Capability, Opportunity and Motivation) predicted hygienic practices, with motivation being the strongest predictor.<sup>29</sup> However, this study looked at 5 broad behaviors recommended in the general public at the start of the pandemic (such as, covering mouth/nose when coughing, handwashing with soap and water), but it is also important that hygienic practices unique to healthcare workers environment are also understood when considering the differing fears expressed. A more thorough understanding of what influences such behaviors is also needed to inform practice and policy change.

The overall aim of this study is to investigate the knowledge of UK healthcare workers towards NHS uniform laundering guidelines and attitudes to laundering their uniforms at home during the COVID-19 pandemic. Within this context, the study aims to determine the current uniform laundering practices of healthcare workers and enhance understanding of the potential barriers of healthcare workers to complying with uniform policies. Behaviors relating to changing out of uniforms on site versus travelling home in uniform and its link with the use of environmentally friendly travel methods are also explored.

## MATERIALS AND METHODS

### Design

Data from a cross-sectional survey was used to collect primarily quantitative data about healthcare workers knowledge and attitudes to home laundering of uniforms, with a qualitative component in the form of free-text comments at the end of the survey. Data collection was performed during the period of June to December 2020. This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (Supplementary File 1).

A section of the survey was developed to understand social psychological factors of laundering behavior. Utilizing relevant theory relating to preventive behaviors helps to identify modifiable factors that could later inform intervention design or policy change. The Capability, Opportunity Motivation-Behavior (COM-B) model of behavior change<sup>(27)</sup> is one such approach and has been found to predict hygienic practices of the general public in the early stages of the pandemic (Gibson Miller 2020<sup>(29)</sup>), with motivation as the strongest predictor. Considering the findings of both, we developed a section of the survey (15 items) to capture social psychological influences

utilizing the framework of the COM-B model, as well as acknowledging the potential role of subjective norms, behavioral control and self-efficacy, which have also showed some associations with COVID-19 preventative behaviours.<sup>30</sup> The findings of the survey and establishing the validity of these additional items can help further understanding of the influences on laundering behavior and related barriers and facilitators.

### Sample/Participants

Healthcare workers and nursing students who regularly wear uniforms as part of their current duties were included in the study across three phases of data collection. In phase one, convenience sampling of healthcare workers was performed using an online questionnaire advertised in healthcare worker trade bodies, publications and social media advertisements. In phase two, healthcare workers from three NHS hospitals within the East Midlands region of England were sampled by advertising the online survey via poster and by administering a paper-based survey in staff areas. In phase three, Nursing students enrolled at two universities in the East Midlands region were sampled using an online questionnaire. These phases aimed to obtain a representative sample.

There were no specific inclusion criteria based on gender, age, ethnicity, socioeconomic grouping or clinical condition. Exclusion criteria were healthcare workers and students that do not regularly wear uniforms, and for phases two and three of the study, those that had previously completed the online questionnaire at phase one of the study.

Convenience sampling was used to minimize disruption to healthcare workers and participation was on a voluntary basis. To obtain a representative sample of healthcare professionals, no upper limit on the sample size was determined. No similar research exists on the attitudes, opinions and knowledge questions; therefore, any power calculations were not possible.

### Data collection

#### Questionnaires

An anonymous questionnaire was designed to ascertain the current procedures used by healthcare workers to launder their uniforms, their attitudes towards washing their uniforms at home during the pandemic, and the availability of changing facilities to support environmentally friendly travel methods to work. The questionnaire was developed by a multi-disciplinary team of clinical, infection control and psychology specialists and piloted with 10 healthcare workers prior to the study. The questionnaire was comprised of four sections: Demographic Information, Knowledge Questions, Attitudes and Opinions, and Facilities to Support Walking, Running or Cycling to Work (see Supplementary File 2). Knowledge questions were based on key uniform laundering and changing practices mentioned in the NHS<sup>14</sup> uniform guidelines and previously published research on the laundering practices of nurses in the UK.<sup>18,31</sup> Healthcare workers who reported being offered industrially laundered scrubs were not required to answer knowledge questions and attitudes and opinions sections, and those who did not launder their uniforms at home were not required to answer knowledge questions. The attitudes section was generated using the framework of the COM-B method and other relevant psychological constructs.<sup>29,30</sup>

The data collection was split into three recruitment phases, conducted within June to December 2020. Participants were required to complete the survey only once. Within phase one, the questionnaire was available to complete online using Qualtrics software, and was advertised via healthcare worker trade bodies, publications and social media advertisements. In phase two, paper copies of the questionnaire were distributed to healthcare workers in three NHS hospitals

within the East Midlands region of England, as well as posters advertising the online version of the survey for those who may prefer to complete using this format. Convenience sampling was used to minimize disruption rather than selection of participants by the researchers; the questionnaires and a sealed collection box (to maintain anonymity) were placed within staff areas of wards alongside advertisements for a two-week collection period. For phase three, the online questionnaire was advertised to Nursing students within two universities in the East Midlands region of England for a 2 week collection period to investigate any differences in knowledge and attitudes of Nursing students.

### Ethical considerations

Ethical approval was received from the De Montfort University Faculty of Health and Life Sciences Faculty Research Ethics Committee. For distribution of paper surveys in phase two of the study, ethical approval was received from the NHS Health Research Authority and local site arrangements were approved.

The ethical issues attached to this research are minimal due the anonymous and descriptive nature of the questionnaire. All data generated from the study was anonymous at the point of collection and handled in accordance with university policies. A participant information sheet was used to inform participants of the purpose and details of the study. Informed consent was implied by completion and submission of the questionnaire as stated in the participation information sheet. Participation in the study was voluntary as outlined in the participant information sheet, and healthcare workers were not induced or persuaded to take part.

### Data Analysis

An Exploratory Factor Analysis was conducted using IBM (Armonk, New York, USA) SPSS Statistics for Windows (Version 26) to determine the validity and suitability of the items in the attitudes and opinions section of the survey. Missing items were not included in analysis. Significant differences ( $p \leq 0.05$ ) in the frequency of responses to quantitative questions were determined using Chi-squared tests or Fisher's Exact test where expected counts were less than 5. Blank responses were included as a category within the analysis.

Free-text sections of the survey containing short pieces of qualitative data were combined and analyzed using manifest content analysis.<sup>32</sup> Staying close to the raw text, comments were identified for their meaning and then coded and categorized to identify prominent areas where feedback were received. Each response was coded based on the source (phase one online survey: OL; phase two hospital A: A; phase two hospital B: B; phase two hospital C: C; phase three nursing students online survey: NS) and further numerically coded to each participants' response.

## RESULTS

### Respondents

In total 1277 responses were received, of which 888 were from phase one (online questionnaire), 298 from phase two (paper-based questionnaire) and 91 from phase three (online Nursing student questionnaire). Of the 1277 respondents, 219 left a free-text comment (17.1%). The demographic information for participants is displayed in Table 1.

The majority of respondents ( $n = 1277$ ) were nurses (63%,  $n = 807$ ), followed by students (10%,  $n = 127$ ), clinical support staff (8%,  $n = 107$ ), allied health professionals (6%,  $n = 74$ ), other professions (3%,  $n = 41$ ), medical associate professions (3%,  $n = 37$ ),

**Table 1**  
Demographic information for survey respondents (n=1277)

Demographic	Category	Frequency (%; n=1277)
Gender	Female	1151 (90)
	Male	97 (8)
	Other	2 (<1)
	Prefer not to say	4 (<1)
	Blank	23 (2)
Ethnicity	Asian or Asian British	54 (4)
	Black or Black British	41 (3)
	Mixed Race	10 (1)
	Other	24 (2)
	White or White British	1125 (88)
	Blank	23 (2)
Age	18-24	98 (8)
	25-34	237 (18)
	35-44	302 (24)
	45-54	347 (27)
	55-64	237 (19)
	65 or above	12 (1)
	Blank	44 (3)
	Blank	238 (20)
Working Experience	0-5	238 (20)
	10-Jun	175 (15)
	15-Nov	129 (11)
	16-20	178 (15)
	21-25	107 (9)
	26-30	103 (9)
	30+	236 (20)
	Blank	20 (2)
	Blank	20 (2)

midwives (2%, n = 28) care workers (2%, n = 20) doctors (1%, n = 6) and multiple occupations (1%, n = 14); 1% of respondents (n = 16) did not provide an occupation. Most respondents (59%, n = 757/1277) reported working in an area where patients were acutely unwell, while 38% were not (n = 482/1277) and 3% did not specify (n = 38/1277). With regards to specific area of work, 10.49% (n = 134/1277) were working in community care, 10.02% (n = 128/1277) worked in surgery, 6.97% worked in intensive care (n = 89/1277), 6.66% in medicine (n = 85/1277), 6.03% (n = 77/1277) in emergency medicine and 6.03% (n = 77/1277) on wards. In total, 2.19% (n = 28/1277) of respondents were working on COVID-19 patient wards. The majority of the remaining respondents (44.09%, n = 563/1277) worked in other areas, while 78 participants reported working in multiple areas (6.11%, n = 78/1277) and 1.25% (n = 16/1277) did not respond. Responses were received from 203 separate NHS trusts, clinical commissioning groups (CCGs) and health boards (84.89%, n = 1084/1277), whilst 59 participants (4.62%) work in care homes, 17 (1.33%) for private health care providers, 13 (1.02%) for other companies and/or organizations (such as charities or agencies) and seven (0.55%) for other NHS facilities; 97 (7.60%) did not respond.

### Laundering Practices

The results of the survey indicate that there is a limited number of healthcare workers (12%, n = 147/1277) being offered industrially laundered scrubs in place of their uniform in response to the COVID-19 pandemic, whereas most respondents were continuing to wear their normal uniform (87%, n = 1111/1277); 1% of participants did not respond to this question (n = 19/1277). There was a significant association ( $P \leq .05$ ;  $X^2 = 28.21$ ), between working in an area where patients were acutely unwell and being offered industrially laundered uniforms in response to the pandemic (16%; n = 111/692) compared to non-acute areas (6%; n = 26/458), however working on a COVID-19 ward was not significantly associated ( $P > .05$ ) with receiving industrially laundered scrubs. Furthermore, 86% (n = 1099/1277) continued to launder their uniforms at home, with few responses

indicating that in-house (1%, n = 13/1277) or industrial (<1%, n = 3/1277) laundering was being performed. Other laundering methods were used by 1% of respondents (n = 18/1277) while 11% (n = 142/1277) did not respond. Respondents who were issued industrially laundered scrubs were not required to answer further questions in the Knowledge or Attitudes and Opinions sections of the survey (n = 147/1277; 12%), accounting for the blank responses to the question (n = 142/1277); in addition participation in the study was voluntary and therefore it was not compulsory for respondents to answer all questions. There was no significant difference ( $P > .05$ ;  $X^2 = 1.36$ ) in laundering method between participants working on COVID-19 specific wards (n = 28/1277) and all other healthcare areas (n = 1249/1277), with 86% (n = 24/28) of participants working on COVID-19 wards laundering their uniforms domestically. Only 2% of all respondents (n = 27/1277) laundered their uniforms at home despite in-house or industrial laundering being offered to them and <1% did not know if laundering was being offered (n = 2/1277). There were 219 free-text survey responses, where 18.7% (n = 41/219) stated that the respondent would prefer laundry services to be provided (Table 2). Conversely, 5.5% of free-text comments (n = 9/219) mentioned that they prefer to launder their uniforms at home, which may be linked to items going missing (2.7%; n = 6/219) and/or slow turn-around of uniforms (5%, n = 11/219; Table 2). Respondents who reported that their uniforms were not laundered domestically were not required to answer further questions in the Knowledge section.

The NHS<sup>14</sup> workwear guidelines state that a fresh uniform should be worn at the start of each shift, yet 12% (n = 155/1277) of respondents stated that they did not have enough uniforms available to do so; the median number of uniforms issued to each nurse was three (Fig 1). There was no significant ( $P > .05$ ) association between not having enough uniforms and working on COVID-19 wards or with acutely unwell patients.

There were a number of free-text comments (n = 12/219, 5.5% of all free-text comments) stating that more uniforms are required (Table 2). The majority (64%, n = 811/1277) of participants changed out of their uniform at the hospital in accordance with NHS guidelines, however 16% (n = 210/1277) reported changing at home, either on the home doorstep, immediately upon entering the home or within 30 minutes of arrival (Table 3); 12% of respondents (n = 157/1277) did not respond. No significant differences in behavior were observed between participants working on COVID-19 wards and other areas ( $P > .05$ ;  $X^2 = 5.72$ ). The provision of changing facilities was also a major theme (n = 148/219) in free-text comments (Table 2), pertaining to issues such as a lack of changing areas (n = 30/219; 13.7% of all free-text comments), space in changing areas (n = 34/219; 15.5% of all free-text comments) and provision of showers (n = 20/219; 9.1% of all free-text comments). Cleanliness of changing areas was also mentioned in 12.8% of all free-text comments (n = 28/219; Table 2).

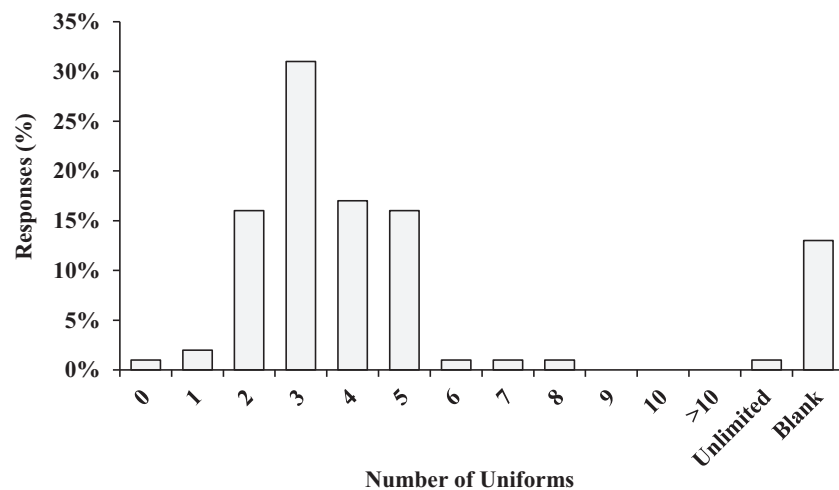
With regards to the laundering procedures, 19% (n = 247/1277) of respondents launder their uniforms with other household laundry and 68% (n = 872/1277) did not; NHS guidelines state that uniforms should be laundered separately if heavily soiled. Only <1% of respondents (n = 6/1277) did not use detergent in the wash, while 87% (n = 1112/1277) did report using detergent. There was a significant ( $P \leq .05$ ) association between washing at higher temperature and laundering separately from household items across all occupations. There were no significant differences ( $P > .05$ ) in the wash temperature, use of detergent and washing with household items between participants working in COVID-19 wards and other areas, with 61% (n = 17/28) of participants working on COVID-19 wards washing at 60°C, 86% (n = 24/28) washing with detergent and 79% (n = 22/28) washing their uniforms separately from other items. There was no significant association between occupation and washing temperature ( $P > .05$ ).

**Table 2**  
Thematic analysis of free-text survey responses (n=219) and number of comments within of each theme

Theme	Sub-category	Frequency (% of all free-text comments; n=219)
Laundering (n=187)	Request for in-house laundering	41 (18.7)
	Cost of washing things separately/ at high temperatures	25 (11.4)
	High temperature washing	12 (5.5)
	Use of additional antimicrobial supplements/detergents	12 (5.5)
	Prefer to launder at home	9 (5.5)
	Not aware of laundering policies	11 (5.0)
	Not wanting to bring uniform around family due to safety	11 (5.0)
	Request for faster turnaround of uniforms	11 (5.0)
	Having to do more wash cycles	9 (4.1)
	Comments about people washing at 30–40°C	8 (3.7)
	Feeling unsupported	8 (3.7)
	Washing uniform with other items	7 (3.2)
	Request for uniform laundering bags	6 (2.7)
	Items going missing in laundry services	6 (2.7)
	Difficulty with drying uniforms	6 (2.7)
Uniforms (n=95)	Comparison to European laundering policies / policies before 1980	5 (2.3)
	Requests specifically for scrubs to be readily available to all	40 (18.3)
	Comments about people being in uniform outside hospital grounds	17 (7.8)
	Request for more uniforms	12 (5.5)
	Requests for better quality scrubs	10 (4.6)
Changing Facilities (n=148)	Comments about out of date/inadequate PPE	10 (4.6)
	Request for better quality uniforms	6 (2.7)
	Request for more space in changing room	34 (15.5)
	Requests for more changing areas	30 (13.7)
	Request for more showers	20 (9.1)
	Request for more lockers in changing room	19 (8.7)
	Request for more discreet changing areas	11 (5.0)
	Time consuming to get to changing rooms	9 (4.1)
	Request for more space in lockers	7 (3.2)
	Need for gender separation	6 (2.7)
Cleanliness of Facilities (n=28)	Request for more toilets	6 (2.7)
	Request for a break room	6 (2.7)
	Request for cleaner facilities	16 (7.3)
Cycling Facilities (n=4)	Feeling unsafe in unclean environments	12 (5.5)
	Request for better cycling facilities	4 (1.8)
Community Nursing (n=25)	Community nurses feeling ignored	14 (6.4)
	Cleanliness of cars	6 (2.7)
	Cleanliness of patient's homes	5 (2.3)

The use of antimicrobial detergents or laundry supplements was stated by 12 participants in free-text comments (5.5%, n = 12/219; 2). The majority of participants (62%, n = 786/1277) reported washing their uniforms at 60°C in line with NHS guidance (Fig 2). The cost associated with washing items of clothing separately and/or at high temperatures (n = 25/219; 11.4% of free-text comments) and the

number of wash cycles required (n = 9/219; 4.1% of free-text comments) were raised as themes within free-text comments (Table 2). The survey revealed that 33% of respondents (n = 416/1277) laundered their uniforms in a specifically made bag or pillowcase while 55% (n = 703/1277) did not; six respondents commented that uniform laundering bags should be provided (2.7%, n = 6/219 of free-text



**Fig 1.** Number of uniforms issued to healthcare workers (n=1277).

**Table 3**  
Location for healthcare workers changing out of their uniform after a shift (n=1277)

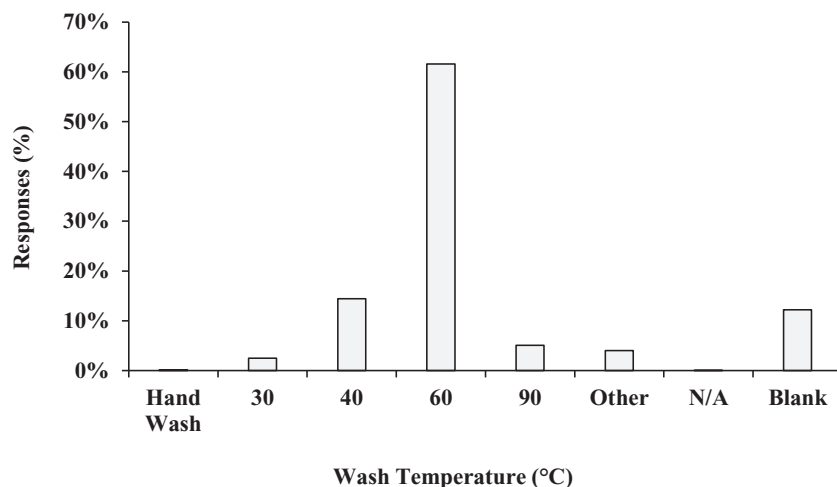
Response	Frequency (%)
At the hospital	811 (64)
On the home doorstep	28 (2)
Immediately on entering the home	167 (13)
Within 30 minutes of arrival at home	15 (1)
Multiple (hospital + home)	2 (<1)
Other	97 (8)
Blank	157 (12)

comments; Table 2). Respondents working in COVID-19 wards reported washing their uniforms within a pillowcase or bag more frequently ( $P \leq .05$ ;  $X^2 = 6.69$ ) than those working in other areas (54%;  $n = 15/28$ ). In total, 12% of respondents ( $n = 156-158/1277$ ) did not answer questions relating to laundering procedures. There were 11 participants that stated they were not aware of uniform laundering policies within free-text comments (5.0%, 11/219 of free-text comments; Table 2).

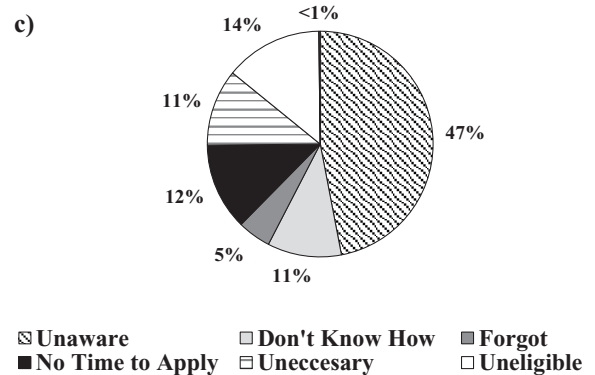
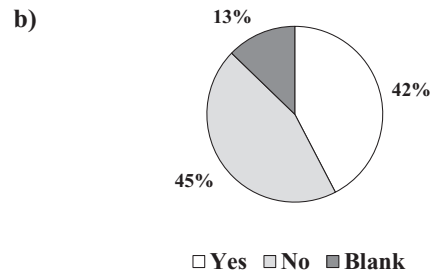
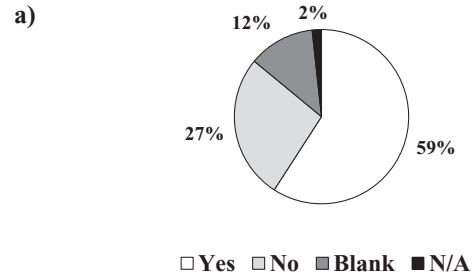
Healthcare workers in the UK are able to claim tax relief for the costs associated with laundering their uniforms at home.<sup>33</sup> The survey indicated that 27% ( $n = 343/1277$ ) of respondents were not aware of this tax relief while 59% ( $n = 755/1277$ ) reported being aware (Fig 3a) of the tax rebate; only 42% ( $n = 541/1277$ ) reported actually claiming this benefit (Fig 3b). 47% of healthcare workers did not claim because they were unaware, other reasons cited include not knowing how to claim and not having time to apply (Fig 3c). The tax question data may be skewed by the nursing student population, who were less likely to be aware of the tax relief compared to the other respondents (73%,  $n = 67/91$  vs 23%,  $n = 276/1186$ ) and less likely to claim tax relief compared to other respondents (89%,  $n = 81/91$  vs 45%,  $n = 538/1186$ ); there was a significant association ( $P \leq .05$ ,  $X^2 = 34.06$ ) between years of professional experience and awareness of tax relief.

*Facilities to Support Environmentally Friendly Travel Methods*

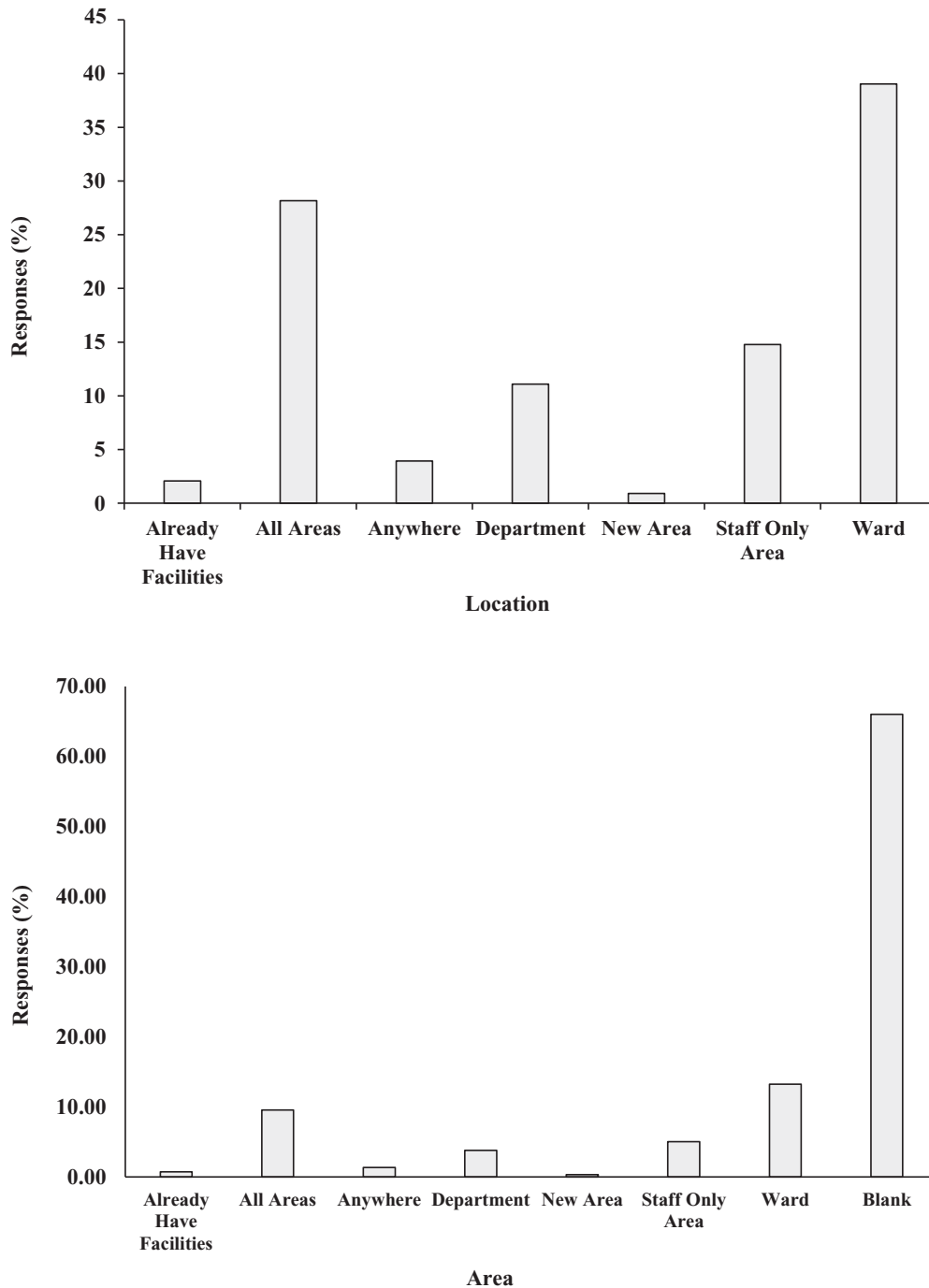
The majority of respondents reported that facilities to safely leave a bicycle were provided by their employer (52%,  $n = 663/1277$ ), 26% ( $n = 338/1277$ ) did not have access to such facilities, and 21% ( $n = 269/1277$ ) were unsure. In total four participants made requests for better cycling facilities in free-text comments (1.8% of free-text comments,  $n = 4/219$ ; Table 2).



**Fig 2.** Wash temperatures used for laundering healthcare worker uniforms (n=1277). 'Other' responses include 'don't know' and multiple temperatures. N/A, not applicable.



**Fig 3.** Claiming of tax relief for laundering uniforms at home. A) 'Are you aware of the tax relief (NHS only) you can claim for laundering your uniform at home?' (n=1277); b) 'Do you claim the tax relief (NHS only) offered to you for laundering your uniform at home?' (n=1277); c) 'If you answered 'no' to the previous question, please specify why you do not claim tax relief' (n=481).



**Fig 4.** Location that healthcare workers would like to see changing facilities added to (n=1277).

Only 19% of respondents (n = 239/1277) walked briskly, ran or cycled to work, whereas 40% (n = 515/1277) stated that they never did; this was not possible due to distance or other reasons for a further 39% (n = 495/1277) of respondents. Of the participants that did not travel via these methods, 16% (n = 84/515) would walk, run or cycle if appropriate changing and/or bicycle storage was provided, and 79% (n = 409/515) would not.

When questioned on where facilities should be added, 0.7% (n = 9/1277) of all respondents stated that there were sufficient facilities while 13.2% (n = 169/1277) would like to see facilities added to their ward (Fig 4). In accordance 67.6% of free-text comments (n = 148/219) mentioned the provision or improvements of changing facilities

and 1.8% (n = 4/219) requested better cycling facilities in free-text comments (Table 2).

*Attitudes Towards Laundering Practices*

An exploratory data analysis (EFA) was carried out on the data set. The KMO value (0.92) and Bartlett’s test ( $X^2 (105) = 7092.63$ ) confirmed suitability for EFA. Using Varimax rotation, a 3-factor solution was identified, based on Eigenvalues > 1. Statements related to *motivation* loaded onto Factor 1, with the second factor showing statements related to *knowledge and skills for laundering uniform at home* and the third factor showing statements related to *perceptions of*



*changing facilities at work.* Factor loadings were all acceptable. Where cross-loading occurred ( $n = 6$ ), these items loaded strongly to a single factor ( $>0.6$ ) and were therefore retained for this factor. All items in the final solution loaded  $> 0.4$  suggesting satisfactory construct validity. Responses to this section of the survey are considered according to these factors, with some illustrative quotes from the free-text comments provided where relevant.

### Motivation

The majority of respondents agreed it would be safer or more appropriate if their uniform was laundered at work (68%,  $n = 770/1137$ ). Only 40% ( $n = 454/1136$ ) felt it wasn't an issue laundered at home and 43% ( $n = 488/1135$ ) of the sample also stated they were happy to do so. This was further seen in comments, such as:

"I launder my uniform at home because there are no facilities to do this at work, but I am happy to do this at home, as I wash my uniform separately and on a high [temperature]. . ." (NS54).

Laundering at home did spark some emotions, in which 39% ( $n = 438/1136$ ) stated it worried them a lot to do so, compared with 38% ( $n = 440/1136$ ) that disagreed with this statement, and conversely 45% ( $n = 512/1134$ ) stated it did not cause them anxiety to do so. In accordance, this was reflected in the following comment:

"...The [COVID-19] situation has left me anxious, it has also affected my home life and I feel I don't want to see any of my family in case I am a carrier. . ." (B19)

When considering family concerns, 44% ( $n = 492/1132$ ) agreed that family members were concerned about laundering at home. However, the majority stated that, given a choice, they would prefer for this to be done at work (65%,  $n = 744/1139$ ). Interestingly 67% ( $n = 754/1129$ ) felt laundering at home was normal and expected.

### Knowledge and skills related to laundering at home

Many of the respondents expressed confidence about their knowledge of the laundering guidelines (71%,  $n = 810/1141$ ) and that they could take of their uniform safely at home (61%,  $n = 695/1136$ ), with the majority stating that they had no problems following the guidelines (57%,  $n = 644/1136$ ), that they had the resources to take care of their uniform at home (62%,  $n = 694/1119$ ). Only 29% ( $n = 332/1138$ ) felt that they were not certain how to launder their uniform at home without exposing themselves or family to risk.

Further related to laundering at home, the free-text comments showed the highest frequency ( $n = 187/219$ ; 85.4% of all free-text comments) related to the logistics of laundering uniforms (Table 2), with comments relating to requests for a return to in-house or industrial laundering of uniforms being a frequent theme ( $n = 41/219$ ; 18.7% of free-text comments).

"...we have no idea if [patients] are [COVID-19] positive... All staff should be having scrubs provided and washed for them now. I have to take my uniforms home and wash them. I hate that" (OL65).

These free-text comments may provide further insight into why, despite the majority feeling confident and knowledgeable, healthcare workers would prefer to see a return to in-house laundering. The cost associated with laundering uniforms at home, particularly with relation to high temperatures, washing items separately and the frequency of laundering was raised within this theme:

"...The tax rebate for washing uniforms does not cover the cost of the washing, I live in key worker [accommodation] and the cost of the laundry just for uniforms is over £40 per month." (OL835).

"As a student that lives in student accommodation, my washing costs £5.00 to wash and dry. Asking me to washing my uniform separately to my other linens costs a lot of money and therefore I have not been able to follow the guidelines. The trust couldn't provide washing facilities. This added additional stresses to life." (OL56).

There were also a number of comments regarding uniforms ( $n = 95/219$ ; 43.4% of all free-text comments), including requesting more or better-quality uniforms and/or scrubs ( $n = 28/219$ ; 12.8% of all free-text comments), or the issuing of scrubs to healthcare workers ( $n = 40/219$ ; 18.3% of all free-text comments)

"When I worked on [COVID-19] wards, we weren't allowed scrubs, even if we got some from outside of the trust (donated ones). Only scrubs allowed for ICU and AE. While this should be the case, those working in AE would not have same exposure as those working full time on [COVID-19] wards [ie] personal care, repositioning etc." (OL346).

### Adequacy of changing facilities

Slightly over half were dissatisfied with current changing facilities at their workplaces (51%;  $n = 574/1134$ ) compared to 37% ( $n = 421/1134$ ) who were satisfied) and 56% ( $n = 629/1123$ ) expressed the view that they had to launder at home due to a lack of appropriate changing facilities. This suggests that improved changing facilities could be important for improving where healthcare workers change out of their uniforms, which has implications for laundering practice and travel to and from work. This was one area commented upon in the free-text comments suggesting this is an important issue for healthcare workers. Comments suggested that changing facilities should be increased in number and that facilities need to offer more space, more lockers, toilets and showers, for example:

"Impossible to social distance in current staff locker rooms. One shower in [designated] male locker room for numerous staff meaning often [queues] of people waiting on a morning following walking, running or cycling to work!" (OL541).

"At the moment, the only private facility I have to change at work is a single staff Toilet cubicle used by approximately 25 people at the busiest time! People occasionally get changed in the staff room, but there is no lock on the door, so anyone, male or female can come in at any time." (OL879).

"...if I change at work we cannot socially distance and there is always the risk a member of staff of the opposite sex will come in while we are changing. [There] is no shower. (OL139).

"I use public transport so agree it is safer for me to change before and after work. However getting changed in the staff toilet or a box linen room that you can't move in is not nice. I would also like to leave my belongings in a secure place" (NS34).

"I worry about changing in the toilets. It does not seem hygienic." (OL465).

"Larger changing facilities & shower facilities are a must. to prevent further risk & spread of [multi-resistant] infections around hospital, communities & our homes" (B09).

There were also 25 comments relating to laundering facilities for community nurses (11.4% of free-text comments,  $n = 25/219$ ; Table 2).

It was expressed that there was a lack of facilities for changing and laundering of uniforms for community nurses and that they are not considered in guidelines, with community nurses commenting:

“As a community nurse we go into many people own homes[.] We look after [COVID-19] palliative and those recovering[.] We are discouraged from going to base and there are no changing washing facilities at work” (OL77).

“District nurses are visiting [COVID-19] positive patients in the community with insufficient PPE - we are then getting into our cars, contaminating the car and then entering other patients houses. District nurses are overlooked in these situations and we need a place at our office to change our uniform and to have it laundered.” (OL842).

## DISCUSSION

In this study, healthcare workers were surveyed for their knowledge, attitudes and beliefs relating to the laundering of healthcare uniforms during the COVID-19 pandemic. At the commencement of the study (June 2020), around 1049 COVID-19 cases were reported per day in the UK and 468 COVID-19 patients (7-day average, 7th June) were admitted to hospital daily, down from the initial peak in April 2020 of 4757 cases per day (7-day average, 21st April) and 3117 patients admitted daily (7-day average, 4th April). COVID-19 cases were increasing towards the end of the study (October 2020), with 16475 daily cases (7-day average, 31st October) and 1505 patients admitted daily (7-day average, 31st October) (UK Health Security Agency,<sup>34</sup>). This reflects the overall global trend in COVID-19 cases, with 128723 daily global cases reported in June (7-day average, 8th June 2020), rising to 499385 by October (7-day average, 31st October 2020) (World Health Organization,<sup>35</sup>).

The age distribution of survey participants (Table 1) was similar to that of the English NHS Trust and CCG workforce in general, where 6% are under 25, 25% are 25–34, 23% aged 35–44, 26% aged 45–54, 18% 55–64, and 2% over 65.<sup>36</sup> However, a higher proportion of female participants (90%) was sampled compared to the NHS England workforce (77%,<sup>36</sup>). There was also a marginally higher proportion of participants from White or White British groups in this survey (88% vs 74%) and lower proportion of other ethnicities compared to overall NHS England demographics (10% Asian or Asian British, 6% Black or Black British, 2% Mixed, 2% Other;<sup>36</sup>).

In 2020, 36% of NHS England healthcare workers were nurses and 0.38% were students,<sup>37</sup> compared to 63 and 10% in this survey, respectively, and therefore a limitation of this study is potential overrepresentation of these roles to other health care workers in the UK workforce, leading to underrepresentation of other workers, such as clinical support staff and medical and/or dental staff. However, while most clinical healthcare workers are required to wear a uniform personally issued to them by their employer, doctors either wear their own clothes or theatre scrubs which are not personally assigned to them,<sup>38,39</sup> and therefore are not classed as uniformed staff. This could account for a lower response rate from doctors due to regularly wearing a uniform being the key eligibility criteria for participation. Laundering behaviors may be influenced by variation in job role in addition to demographic factors including age and educational attainment, where older and/or retired people tend to use higher wash temperatures and people with higher education tend to use the correct amount of detergent in each wash.<sup>40</sup> Future investigations could sample for educational attainment to investigate its' effect on laundering behavior. The laundering behaviors and policy awareness of health care workers may also be related to the information given by their employer.

This study indicates that laundering procedures in the UK remain largely unchanged in response to the COVID-19 pandemic, with only

12% of respondents being offered industrially laundered scrubs and 86% continuing to launder their uniforms domestically. In accordance current PHE COVID-19 infection control policy does not call for special procedures for staff uniforms.<sup>41</sup> Although the infection risk associated with home laundering is debated, industrial laundering uses controlled disinfection systems, which may reduce the risk of SARS-CoV-2 and other pathogens surviving on textiles and subsequently transferring from contaminated textiles onto other surfaces (Owen et al., 2021<sup>5</sup>).

The majority (67%) of healthcare workers surveyed were laundering their uniforms at  $\geq 60^{\circ}\text{C}$ ; 17% laundered at  $\leq 40^{\circ}\text{C}$ , which may not completely remove microbial contamination.<sup>21</sup> Additionally 19% of respondents launder uniforms alongside household laundry which could present a risk of domestic items becoming contaminated with potential pathogens. Cross-contamination of microorganisms such as *Clostridioides difficile* spores onto textiles in the wash has been documented previously (Hellickson & Owens, 2007<sup>42</sup>). However, wash temperatures used tended to be higher and a smaller proportion laundered their uniforms with other household laundry than previously reported for healthcare workers.<sup>18,22</sup> Increased awareness of textile decontamination due to the COVID-19 pandemic across the healthcare worker population could lead to differing behaviour from previous studies as there was no significant difference between participants working on COVID-19 wards and other areas. However, there may be an increased feeling of safety for those staff in COVID-19 areas, who are less likely to be wearing their own personal uniform beneath and typically wear more extensive PPE compared to non-COVID-19 ward staff, who are still at risk from undiagnosed COVID-19 cases in the general patient population. The level of adherence to laundering guidelines (washing at  $\geq 60^{\circ}\text{C}$ , 67%, without other household laundry, 68%) correlated with the number of respondents that reported being confident in their knowledge of laundering guidelines (71%), suggesting that most healthcare workers had sufficient knowledge of laundering guidelines. It is not clear how guidelines are being communicated during the COVID-19 pandemic; 11 participants commented that they were not aware of uniform laundering policies (Table 2). Further, our survey identified other factors that could affect adherence to laundering guidelines, such as expense of domestic laundering and a lack of understanding about the associated tax rebates available. Although tax relief is available in the UK to cover costs of uniform laundering, the results suggest that costs are a driver in laundering behavior; this may apply in other countries where uniforms are domestically laundered.

One-third of participants reported washing their uniforms in a laundry bag or pillowcase, a practice that appears to have been adopted more readily in response to the COVID-19 pandemic to avoid handling contaminated clothing prior to laundering, and this practice was more frequent in participants working within COVID-19 wards. Some healthcare workers were using antimicrobial supplements in the wash process; while this could increase the efficacy of domestic laundering, free-text comments suggest that such products may be used in lieu of high temperature washing (Table 2).

The availability of uniforms and facilities may affect adherence to laundering policies. A minority of healthcare workers (12%) did not have enough uniforms to wear a fresh one for each shift, a key recommendation in the NHS<sup>14</sup> uniform guidelines, leading healthcare workers to rely on continuous cleaning and drying of their uniforms; this could be compounded if the uniform needs to be changed during the shift due to contamination.<sup>23</sup> Within this context, reusing worn and contaminated uniforms could post an infection control risk. A key theme raised was a lack of changing facilities, which could be a barrier to changing out of uniforms before leaving the healthcare facility, as highlighted by previous surveys of UK healthcare workers.<sup>18,23</sup> Wearing healthcare uniforms home is viewed as unhygienic by the general public<sup>14</sup> and could risk cross-contamination of

surfaces during transport. The limited availability of changing facilities may also affect how healthcare workers travel to work, with 17% of respondents stating that they would walk, run or cycle to work if facilities were available.

There was a mixed response about the negative emotions laundering at home could provoke (39% said it worried them a lot; 45% stated it did not make them feel anxious), which could be due to practices already adopted by healthcare workers (such as antimicrobial detergents; use of pillowcases) alleviating some concerns. Interestingly, in the early stage of the pandemic, risk perception did not predict hygienic practices.<sup>29</sup> Repeating this survey outside the immediate urgency of the pandemic may reveal different concerns and practices.

The COM-B model may help to understand laundering behaviors in HCWs. Our survey highlighted anxieties and a belief that laundering may be safer if carried out at work, suggesting motivational factors. Further free-text comments and items of the survey identified a dissatisfaction with current changing facilities and concerns about costs of laundering at home, highlighting opportunity factors. Finally, the majority suggested confidence in their knowledge of laundering requirements at home, with over half believing they could take care of their uniform safely, with the correct resources and according to the guidelines. This is not surprising considering the majority engage in this behavior regularly (the survey confirms that this is normal and expected behavior), however this does demonstrate the importance of knowledge and skills relating to the behavior and represents capability to engage in such.

Potential sample bias could be a limitation of this investigation. The survey was voluntary and conducted using convenience sampling to minimize disruption to healthcare staff, and therefore respondents were not required to answer every question. Individual decisions to take part may be due to a preference to see change in laundering practices, which may show a bias with concerns raised. However, it is valid for those who are concerned about infection control practices to engage and enable practice change. Although anonymity gave participants reassurance that their responses were confidential, completion of paper surveys on the worksite may have influenced responses, bringing a limitation of reporting bias; this was mitigated by advertising an online option for survey completion within the hospitals. Whilst free-text options gave some further background to some of the responses observed in the survey, it was not comprehensive (37.3%) and staff may have had limited time to complete this. Further phases of data collection may increase understanding of these concepts both in and outside of the pandemic and further qualitative data collection may provide more in-depth insight into some of the issues raised.

Further exploration of social psychological constructs alongside occurrence of behavior may increase understanding of the influences on laundering behavior. Previous studies focus on several preventive behaviors that serve a common behavioral outcome (ie reduce transmission of COVID-19;<sup>29</sup>), however, this study has a more focused context (healthcare workers) on a single action (laundering of uniform). It may be necessary to look at a wider range of behaviors that healthcare workers employ to reduce transmission risk. It may be important to consider healthcare workers' concerns relating to other aspects of infection control and the wider context of hygiene practices in healthcare settings during pandemics. Qualitative work could consider this in more depth to understand the factors that healthcare workers are most concerned about, e.g. incorrect use of PPE.<sup>26</sup>

## CONCLUSIONS

The majority of healthcare workers have continued to launder their uniforms at home during the COVID-19 pandemic, with few

uniformed staff being offered laundry services despite a preference for such facilities being expressed. This study also demonstrated that there were often limited and overcrowded changing facilities available, which is a barrier towards adhering with uniform policies. This suggests that there are often inadequate facilities to support UK healthcare workers following hygienic practices for the domestic laundering of their uniforms. Although most healthcare workers were confident that they were able to launder their uniforms appropriately; attitudes towards laundering could be considered by constructs of motivation, knowledge and/or skills and changing facilities; this relates to the COM-B model and further investigation of this could inform recommendations for changing practice. These findings could inform measures to improve adherence to laundering guidelines, and therefore reduce the infection control risk associated with domestic laundering of healthcare uniforms, particularly in a pandemic situation.

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## SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.ajic.2021.12.017>.

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