

# Appropriate Hand Drying - The Missed Step of Hand Hygiene: A Qualitative Evaluation of Hand Drying Practices among Indian Health Care Workers

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## Abstract

Hand hygiene remains one of the most effective methods of preventing healthcare-associated infections. Hand drying is the end point of hand hygiene. Hand drying after hand hygiene is less explored, and the practice varies in different facilities. This explorative study was done to know the various hand-drying methods and practices of healthcare workers in Indian settings. This was a descriptive cross-sectional questionnaire-based observational study initiated from a tertiary care setup in Uttarakhand. Healthcare workers over 18 years of age directly involved in patient care were enrolled. A semi-structured questionnaire with both open-ended and close-ended questions was used with snowballing sampling technique. Statistical analysis was done using Statistical Package for Social Sciences (SPSS). Out of the eligible 395 respondents, 62.8% were female. The mean age of the respondents was  $31.34 \pm 8.44$  years and average working hours were  $8.87 \pm 2.97$  (range 4–24) hours. Only 72.7% did hand hygiene always before touching a patient. Nurses were more compliant about hand hygiene than doctors ( $P < 0.0001$ ). A total of 82.8% were aware of appropriate hand-drying methods. Staff in the Intensive care unit (ICU) setup were more aware of hand drying practices ( $P = 0.033$ ). A total of 21.8% wiped their hands on their clothing to dry their hands. This was more in staff from paraclinical departments ( $P = 0.001$ ). A total of 35.7% used handkerchiefs to dry hands. Resident doctors used handkerchiefs more than senior doctors or nursing staff ( $P = 0.01$ ). A total of 49.9% of respondents spent less than 10 seconds in hand drying. Hand-hygiene knowledge is high among healthcare workers in India, but the knowledge of appropriate hand-drying practices is lacking. There is wide variation in the practice of hand drying. Better hand drying guidelines and incorporating hand drying as the essential endpoint of the hand hygiene ritual are warranted.

**Keywords:** Hand drying, hand hygiene, health care worker, hospital-acquired infection

## INTRODUCTION

Hand hygiene has been considered one of the most effective methods of preventing healthcare-associated infection.<sup>[1]</sup> Hand hygiene refers to any action of hand cleansing, which includes washing hands with medicated soap and water or using antiseptic solutions or wipes.<sup>[2]</sup> However, the practice varies considerably among healthcare workers and may range from quick rinsing of hands under water to extensive rubbing. Proper hand washing significantly reduces the transmission of infectious diseases in healthcare settings.<sup>[3]</sup> Many studies have focused on hand-washing techniques and improved adherence to hand-hygiene practices among healthcare workers.<sup>[4,5]</sup>

Hand drying after hand hygiene has remained a less explored area of research, and the knowledge about the role of hand drying after washing is less. Proper hand drying should be

considered an essential component of hand-hygiene practice.<sup>[6]</sup> Residual moisture in hand remains an important factor in touch or contact-associated contamination.<sup>[7]</sup> The importance of hand drying in infection control is often overlooked and, if not done correctly, may often undo the benefits of careful hand washing in healthcare settings. A systematic review of hand drying methods concluded that providing paper towels is superior to air dryers.<sup>[8]</sup> While for operating surgeons, autoclaved

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towels have been advocated,<sup>[2]</sup> the guidelines do not advocate any preferred technique for hand drying in other scenarios such as practice in critical care areas or indoor units. Studies comparing the effectiveness of various hand-drying practices remain inconclusive, and a practical guideline for hand-drying practice is still lacking.<sup>[9]</sup> This explorative study was done to know the various hand-drying methods and practices used by healthcare workers in Indian settings.

## MATERIALS AND METHODS

This descriptive cross-sectional questionnaire-based observational study was initiated from a tertiary care setup in Uttarakhand. Healthcare workers over 18 years of age directly involved in patient care were enrolled. A previous study<sup>[10]</sup> done on compliance with hand hygiene among healthcare workers reported a 66% compliance rate. A sample size of 345 was calculated with a power of 80%, an alpha error of 5%, and a compliance rate of 66% for hand hygiene based on a previous study.<sup>[10]</sup> Considering a 10% dropout rate, 380 responses were planned to be collected.

A semi-structured questionnaire with both open-ended and close-ended questions (a total of 24) divided into two main sections of demographic details (11 questions) and hand-drying practices (13 questions) was distributed online as Google Forms in February and March 2022. Form setting was done so that participants could answer the questionnaire only after consent. The questionnaire was pre-tested by providing links to the peers in the department for ease of administration and any difficulty in filling it out. The questionnaire required, on average, 5–10 minutes to fill out. The snowballing sampling technique was used for subject enrollment. The form was released on social media platforms (WhatsApp group, Facebook, or similar) in peer groups with a request to move forward to have wider publicity and larger reach. Data collected from the questionnaire was entered into Microsoft Excel sheets, checked for consistency and completeness, cleaned, and coded. All data were anonymized before analysis. Descriptive variables were expressed as frequency and percentage. Quantitative variables were expressed as mean and standard deviation. The association of demographic factors with hand-hygiene practice was checked using Chi-square and Fischer's exact test. SPSS version 25 was used for analysis. *P* value less than 0.05 was considered significant. Institutional ethical committee clearance for the study was taken.

## RESULTS

A total of 432 responses were received, and 38 were excluded from the analysis (10 were not healthcare workers, 4 were less than 18 years old, 3 did not provide consent, and 20 did not come in direct contact with patients).

The majority, 248 (62.8%) of respondents, were female with a mean age of  $31.34 \pm 8.44$  (range 19–73) years [Table 1]. 121 (21.8%) of respondents agreed to wipe their hands on their clothing to dry them. The average number of

**Table 1: Demographic parameters**

	Frequency <i>n</i> (%)
Gender	
Female	248 (62.8)
Male	147 (37.2)
Age, mean±SD (range)	31.34±8.44 (19–73)
Occupation	
Senior doctor	89 (22.5)
Junior doctor	101 (25.6)
Trainee doctor	55 (13.9)
Nursing and allied	150 (37.9)
Place of work	
Nursing home	16 (4.1)
Medical college	274 (69.4)
Private clinic	27 (6.8)
Corporate hospital	52 (13.2)
Primary health centre	5 (1.3)
Community health centre	21 (5.3)
Dominant hand	
Left	16 (4.1)
Right	379 (95.9)
Working in ICU setup	
Yes	209 (52.9)
No	186 (47.1)
Department	
Paraclinical	26 (6.6)
Medicine and allied	272 (68.9)
Surgery and allied	97 (24.6)
Average working hours per day, mean±SD (range)	8.87±2.97 (4–24)
Do you suffer from any hand condition that may impair effective hand hygiene?	
Yes	38 (9.6)
No	357 (90.4)

hand washing using soap and water was  $9.45 \pm 6.54$  times daily, and 287 (72.7%) always did hand hygiene before touching a patient [Table 2]. Items used for hand drying were mostly stored (44.81%) in the autoclaved container. 248 (62.78%) respondents used air drying. 137 (34.68%) respondents picked the drying item directly from the storage container with their hands [Table 3]. A significantly higher number of persons working in the ICU knew about hand drying practices than workers in non-ICU areas (86.6% vs 78.5%, *P* = 0.033) [Table 4]. A significantly higher number of persons in the paraclinical departments were wiping their hands on their clothes for drying compared to the clinical departments (50% vs 17.3%, *P* = 0.001). Trainee and resident doctors frequently used handkerchiefs to dry their hands as compared to senior doctors and nursing staff (*P* = 0.012) [Table 5].

As seen in Table 4, There was no difference in hand-drying knowledge based on gender, place of work, or experience. Supplementary Tables S1-S5 shows that nurses performed hand hygiene significantly higher time than doctors but less than nurses. The perceived knowledge of hand hygiene

**Table 2: Hand drying practices**

Attributes	Response	n (%)
Do you perform hand hygiene between patients?	Always	287 (72.7)
	Sometimes	108 (27.3)
Are you aware of hand hygiene steps?	Yes	393 (99.5)
	No	2 (0.5)
Are you aware of the hand-drying method?	Yes	327 (82.8)
	No	68 (17.2)
Do you wipe your hands on your own clothes after washing?	Never	309 (78.2)
	Sometimes	62 (15.7)
	Always	24 (6.1)
Do you use your own handkerchief for hand drying?	Never	258 (65.3)
	Sometimes	97 (24.6)
	Always	40 (10.1)
Hand position under a dryer	Rubbing hands while drying	50 (12.7)
	Hold hand stationary	312 (79.0)
	Do not exactly remember	33 (8.4)
Average time spent on hand drying	Less than 10	197 (49.9)
	11–30	141 (35.7)
	31–60	39 (9.9)
	>60	18 (4.6)
Average number of days you perform hand hygiene with soap and water for patient-related activity	Range 1–30	9.45±6.54

**Table 3: Infrastructure of hand drying**

Attribute	Infrastructure	n (%)
Storage of hand-drying item	Plastic container	51 (12.91)
	Autoclaved container	177 (44.81)
	Paper box	45 (11.39)
	Tissue rolls	104 (26.33)
	Other	25 (6.33)
Drying method used	Air dry	248 (62.78)
	Unsterilised paper/newspaper	36 (9.11)
	Sterilised paper/newspaper	136 (34.43)
	Washed cloth	46 (11.65)
	Reusable hand towel	60 (15.19)
	Hot air/jet blower	191 (48.35)
	Paper towel	45 (11.39)
	Tissue paper	15 (3.79)
	Other	41 (10.38)
How do you pick the item you use for hand drying?	Helper hands over	113 (28.60)
	Use your hands to pick directly	137 (34.68)
	Use forceps to pick	106 (26.83)
	Foot operated mechanism	64 (16.20)
	Other	24 (6.08)

was high irrespective of sex, place of work or working position. Para-clinical staff wiped their hands significantly higher times. Senior doctors and non clinical staff used handkerchief often,

and most of staff in non ICU areas spend less time in hand hygiene.

## DISCUSSION

Hand drying remains one of the critical end steps of hand washing. The benefits of doing appropriate hand hygiene may be undone if hand drying is not proper and aseptic.

In the present study, only 72% of respondents agreed to do hand hygiene at every patient contact, and nurses were more compliant in doing hand hygiene than clinicians. Various studies<sup>[11,12]</sup> have reported hand-hygiene compliance rates ranging from 50% to 89%. Noncompliance with hand hygiene may be because of a variety of reasons such as high patient load, lack of time, cold water, inaccessibility of infrastructure, etc.<sup>[13,14]</sup>

The present study found that self-perceived hand-hygiene knowledge was high in all the groups, but it did not culminate in practice. Novák *et al.*<sup>[13]</sup> showed that despite sufficient knowledge of hand hygiene among healthcare providers, they either did not follow or forgot in their practice. Regular education and practice sessions can circumvent this.

Many respondents lacked knowledge of appropriate hand-drying practices, and it was seen that those working in intensive care units had a better knowledge of hand-drying practices. This may be because people working in ICUs are regularly reinforced on hand-hygiene practices. In a quality improvement project done by Biswas *et al.*,<sup>[14]</sup> it was observed that hand drying after hand hygiene was neglected in 71.6% of invasive and 87.9% of non-invasive procedures in NICU.<sup>[14]</sup>

In this study, a significant number of respondents, 82 (21.8%), wiped their hands on their clothes or handkerchiefs for drying. Drying hands by wiping on own clothes and handkerchiefs can compromise the benefits of handwashing.<sup>[15]</sup> This may result in compromised hand hygiene as the clothes can be contaminated, especially when dirty.<sup>[16]</sup> Studies have shown that bacteria can survive on clothes for approximately 4 hours, and this survival can be prolonged up to 24 hours.<sup>[17]</sup> Also, trainee and junior resident doctors used handkerchiefs more frequently; this may be because of a lack of knowledge and less time available.

Many studies have tried to evaluate the superiority of one hand-drying method over another with contrasting results. Patrick *et al.*<sup>[18]</sup> compared the drying efficiency of cloth towels and hot air dryers. Water was more efficiently removed from the hands by cloth towels than hot air dryers. In the present study, it was observed that many different methods were used by respondents for drying their hands. The majority preferred drying hands in the air. Papers in several forms were used by 212 (53.6%) of respondents, while reusable hand towels were used by 60 (15.19%) of respondents. Most of the research on this subject has indicated that paper towels are better than air dryers. Most paper towels can efficiently dry hands,

effectively eliminate microbes, and reduce contamination of the washroom environments. Thus, paper towels must be strongly suggested when hygiene is crucial, such as in healthcare facilities.<sup>[8]</sup> Soft and absorbent paper towels are found to be more acceptable by users and may contribute to compliance with hand-hygiene recommendations.<sup>[19]</sup>

Reusable towels may contribute to the spread of healthcare-associated infections as they are a potential source of recontamination of hands, as reported in some studies.<sup>[8]</sup>

The storage infrastructure for items used for hand drying is also important as items kept in the open or in unhygienic or wet conditions may become breeding grounds for microorganisms and thus may contaminate the hands.<sup>[20]</sup> Maintenance of a clean environment around the dispenser is important. Also, the dispenser should allow ease of delivery, and one should be vigilant of the placement of the dispenser

near the sink and splash zones, which may be a source of microorganisms.

In the study by *et al.*,<sup>[14]</sup> it was seen that a significant number of participants contaminated their hands by touching unsterile surfaces after hand hygiene. In 17.8% of cases, it was by touching the paper towel dispenser lids.<sup>[16]</sup> A foot-operated mechanism to open the lids may circumvent this. Also, using forceps after hand hygiene may lead to cross-contamination. Thus, a helper should use the forceps to hand over the towel.

**Limitations**

This study has several limitations. As the data were self-reported, they are subject to social desirability bias (e.g., accepting that hand hygiene was always done and so may overestimate the amount of hand hygiene done and the opportunities for hand drying). Also, hand drying may change over time, as this cross-sectional study cannot access changes in practice and behavior. Also, as the study was done in Indian settings, it cannot be generalized to other settings.

**Strengths**

This study has incorporated multiple aspects of hand drying practices in Indian settings, including the practices and infrastructure, and brought out the gaps in the practice.

**CONCLUSIONS**

Effective hand hygiene remains one of the most useful tools to prevent healthcare-associated infections. Though hand-hygiene knowledge is high among healthcare workers in India, the knowledge of appropriate hand-drying practices is lacking. Hand drying is the end point of hand hygiene, but the benefits may be undone if hand-drying practices are improper. The findings of this study demonstrated that the practice of hand drying varies. Also, spending less time in hand drying implies wet hands, leading to the survival of organisms. Better hand-drying guidelines, incorporating hand drying as the essential endpoint of hand hygiene, and regular

**Table 4: Knowledge of appropriate hand drying method**

Are you aware of the hand-drying method?	Yes	No	$\chi^2$	$p$
Female	210 (84.7)	38 (15.3)	1.675	0.916
Male	117 (79.6)	30 (20.4)		
Nursing home	14 (87.5)	2 (12.5)		
Medical college	227 (82.8)	47 (17.2)	3.38	0.614
Private clinic	24 (88.9)	3 (11.1)		
Corporate hospital	41 (78.8)	11 (21.2)		
PHC	3 (60)	2 (40)		
CHC	18 (85.7)	3 (14.3)		
Senior doctor	68 (76.4)	21 (23.6)	28.414	<0.001
Trainee doctor	35 (63.6)	20 (36.4)		
Resident doctor	84 (83.2)	17 (16.8)		
Nursing and allied	140 (93.3)	10 (6.7)		
Works in ICU	181 (86.6)	28 (13.4)	4.54	0.033
Not in ICU	146 (78.5)	40 (21.5)		
Paraclinical	18 (69.2)	8 (30.8)	4.075	0.13
Medicine and allied	230 (84.6)	42 (15.4)		
Surgical and allied	79 (81.4)	18 (18.6)		

**Table 5: Significant group comparison findings of hand drying practices**

Practice	Never	Sometimes	Always	$\chi^2$	$p$
Rubs hands-on own cloth for hand drying					
Paraclinical	13 (50.0)	11 (42.3)	2 (7.7)	17.908	0.001
Medicine and allied	225 (82.7)	31 (11.4)	16 (5.9)		
Surgical and allied	71 (73.2)	20 (20.6)	6 (6.2)		
Use your own handkerchief for hand drying					
Senior doctor	66 (74.2)	19 (25.3)	4 (4.5)	16.51	0.012
Trainee doctor	26 (47.3)	20 (36.4)	9 (16.4)		
Resident doctor	61 (60.4)	30 (29.7)	10 (9.9)		
Nursing and allied	105 (70)	28 (18.7)	17 (11.3)		
Works in ICU	154 (73.7)	40 (19.1)	15 (7.2)	13.877	0.001
Not in ICU	104 (55.9)	57 (30.6)	25 (13.4)		
Paraclinical	13 (50.0)	11 (42.3)	2 (7.7)	14.608	0.006
Medicine and allied	193 (71.0)	56 (20.6)	23 (8.5)		
Surgical and allied	52 (53.6)	30 (30.9)	15 (15.5)		

training reinforcement will improve hand drying and, thus, the hand-hygiene practice.

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### Conflicts of interest

There are no conflicts of interest.

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**Supplementary Table S1: Performance of hand hygiene between patients**

<b>Do you perform hand hygiene between patients</b>	<b>Yes</b>	<b>No</b>	<b><math>\chi^2</math></b>	<b><i>p</i></b>
Female	183 (73.8)	65 (26.2)	0.43	0.512
Male	104 (70.7)	43 (29.3)		
Nursing Home	15 (93.8)	1 (6.3)	6.817	0.147
Medical college	192 (70.1)	82 (29.9)		
Private clinic	19 (70.4)	8 (29.6)		
Corporate Hospital	43 (82.7)	9 (17.3)		
PHC	4 (80.0)	1 (20)		
CHC	14 (66.7)	7 (33.3)		
Senior Doctor	55 (61.8)	34 (38.2)	46.76	<0.0000
Trainee Doctor	36 (65.5)	19 (34.5)		
Resident Doctor	58 (57.4)	43 (42.6)		
Nursing and allied	138 (92.0)	12 (8.0)		
Works in ICU	156 (74.6)	53(25.4)	0.878	0.349
Not in ICU	131 (70.4)	55 (29.6)		
Paraclinical	15 (57.7)	11 (42.3)	4.563	0.102
Medicine and allied	196 (72.1)	76 (27.9)		
Surgical and allied	76 (78.4)	21 (21.6)		

**Supplementary Table S2: Knowledge of Hand hygiene steps (\*Fischer exact test)**

<b>Are you aware of hand hygiene steps</b>	<b>Yes</b>	<b>NO</b>	<b><math>\chi^2</math></b>	<b><i>p</i></b>
Female	246 (99.2)	2 (0.8)	1.192*	0.275
Male	147 (100)	0 (0)		
Nursing Home	16 (100)	0 (0)	8.166*	0.238
Medical college	273 (99.6)	1 (0.4)		
Private clinic	27 (100)	0 (0)		
Corporate Hospital	52 (100)	0 (0)		
PHC	5 (100)	0 (0)		
CHC	20 (100)	1 (4.8)		
Senior Doctor	89 (100)	0 (0)	1.489*	1
Trainee Doctor	55 (100)	0 (0)		
Resident Doctor	100 (99.3)	1 (0.7)		
Nursing and allied	149 (99.3)	1 (0.7)		
Works in ICU	208 (99.5)	185 (95.5)		
Not in ICU	1 (0.5)	1 (0.5)		
Paraclinical	26 (100)	0 (0)	0.909*	0.663
Medicine and allied	270 (99.3)	2 (0.7)		
Surgical and allied	97 (100)	0 (0)		

**Supplementary Table S3: Rubs hands-on own clothes for drying**

<b>Rubs hands on own cloth for hand drying</b>	<b>Never</b>	<b>Sometimes</b>	<b>Always</b>	$\chi^2$	<b>p</b>
Female	194 (78.2)	39 (15.7)	15 (6.0)	0.001	0.999
Male	115 (78.2)	23 (15.6)	9 (6.1)		
Nursing Home	13 (81.3)	2 (12.5)	1 (6.3)	11.665	0.216
Medical college	209 (76.3)	50 (18.2)	15 (5.5)		
Private clinic	20 (74.1)	5 (18.5)	2 (7.4)		
Corporate Hospital	45 (86.5)	4 (7.7)	3 (5.8)		
PHC	49 (13.5)	1 (20)	0 (0)		
CHC	18 (85.7)	0 (0)	3((14.3)		
Senior Doctor	74 (83.1)	13 (14.6)	2 (2.2)	12.539	0.051
Trainee Doctor	44 (80)	11 (20)	0 (0)		
Resident Doctor	73 (72.3)	20 (19.8)	8 (7.9)		
Nursing and allied	118 (78.7)	18 (1.2)	14 (9.3)		
Works in ICU	173 (82.8)	25 (12.0)	11 (5.3)	5.599	0.61
Not in ICU	136 (73.1)	37 (19.9)	13 (7.0)		
Paraclinical	13 (50.0)	11 (42.3)	2 (7.7)	17.908	0.001
Medicine and allied	225 (82.7)	31 (11.4)	16 (5.9)		
Surgical and allied	71 (73.2)	20 (20.6)	6 (6.2)		

**Supplementary Table S4: Practice of using handkerchief for hand drying**

<b>Use own handkerchief for hand drying</b>	<b>Never</b>	<b>Sometimes</b>	<b>Always</b>	$\chi^2$	<b>p</b>
Female	163 (65.7)	59 (23.8)	26 (10.5)	0.261	0.878
Male	95 (64.6)	38 (25.9)	14 (9.5)		
Nursing Home	12 (75)	2 (12.5)	2 (12.5)	7.59	0.632
Medical college	173 (63.1)	75 (27.4)	26 (9.5)		
Private clinic	17 (63.0)	6 (22.2)	4 (14.8)		
Corporate Hospital	39 (75.0)	7 (13.5)	6 (11.5)		
PHC	4 (13.5)	1 (20.0)	0 (0)		
CHC	13 (61.9)	6 (28.6)	2 (28.9)		
Senior Doctor	66 (74.2)	19 (25.3)	4 (4.5)	16.51	0.012
Trainee Doctor	26 (47.3)	20 (36.4)	9 (16.4)		
Resident Doctor	61 (60.4)	30 (29.7)	10 (9.9)		
Nursing and allied	105 (70)	28 (18.7)	17 (11.3)		
Works in ICU	154 (73.7)	40 (19.1)	15 (7.2)	13.877	0.001
Not in ICU	104 (55.9)	57 (30.6)	25 (13.4)		
Paraclinical	13 (50.0)	11 (42.3)	2 (7.7)	14.608	0.006
Medicine and allied	193 (71.0)	56 (20.6)	23 (8.5)		
Surgical and allied	52 (53.6)	30 (30.9)	15 (15.5)		

**Supplementary Table S5: Average time spent on hand drying**

<b>Average time spent on hand drying</b>	<b>Less than 10</b>	<b>10-30 sec</b>	<b>31-60</b>	<b>&gt;60</b>	<b><math>\chi^2</math></b>	<b><i>p</i></b>
Female	133 (53.6)	85 (34.3)	20 (8.1)	10 (4.0)	4.873	0.181
Male	64 (43.5)	56 (38.1)	19 (12.9)	8 (5.4)		
Nursing Home	10 (62.5)	3 (18.8)	3 (18.8)	0 (0)	19.442	0.122
Medical college	138(50.4)	99 (36.1)	27 (9.9)	10 (3.6)		
Private clinic	12 (44.4)	13 (48.1)	1 (3.7)	1 (3.7)		
Corporate Hospital	22 (42.3)	21 (40.4)	5 (9.6)	4 (7.7)		
PHC	2 (40)	0 (0)	2 (40)	1 (20)		
CHC	13 (61.9)	5 (23.8)	1 (4.8)	2 (9.5)		
Senior Doctor	42 (47.2)	34 (38.2)	7 (9.9)	6 (6.7)	10.5	0.312
Trainee Doctor	33 (60.0)	15 (27.3)	7 (12.7)	0 (0)		
Resident Doctor	44 (43.6)	44 (43.6)	9 (8.9)	4 (4.0)		
Nursing and allied	78 (52.0)	48 (32.0)	16 (10.7)	8 (5.3)		
Works in ICU	87 (41.6)	84 (40.2)	24 (11.5)	14 (6.7)	14.197	0.003
Not in ICU	110 (59.4)	57 (30.6)	15 (8.1)	4 (2.2)		
Paraclinical	15 (57.7)	7 (26.9)	4 (15.4)	0 (0)	15.476	0.01
Medicine and allied	120 (44.1)	107 (39.3)	28 (10.3)	17 (6.3)		
Surgical and allied	62 (63.9)	27 (27.8)	7 (7.2)	1 (1.0)		