

## **Factors influencing the use of N95 Respirator among Healthcare Professionals at Nyangabgwe Hospital in Botswana**

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### **Abstract**

*Transmission of communicable respiratory infections within health care settings to healthcare workers has emerged as a major public health problem. The N95 respirator has been reported as the most efficient and effective protective equipment in preventing respiratory infections amongst the healthcare workers in healthcare facilities. Although the use of respiratory protective equipment is vital, there have been reported cases of non-compliance to usage by healthcare workers. Thus, this cross-sectional survey was undertaken with the aim of investigating the factors influencing the use of N95 respirator among healthcare professionals working in medical and acute care wards at Nyangabgwe Hospital in Botswana. A total of 165 participants completed the questionnaires used to collect data for the study. Although the majority of the participants (154 of 165, 93%) were aware of the protective nature of the N95 respirator, less than 60% reported adherence to its recommended use. Moreover, 165 (82%) of them reported personal barriers as well as organizational factors that influenced the usage of N95 respirator.*

*In conclusion, this study has shown that healthcare personnel acknowledged the importance of N95 respirator as a means of providing protection against occupational transmission of respiratory infections. It was found that some individual and organizational factors are the main barriers to usage adherence. These factors need to be addressed in order to strengthen the usage adherence to N95 respirator and consequently curbing occupational transmission of respiratory infections among the health care workers in Botswana.*

**Keywords:** Adherence, N95 respirator, healthcare workers, respiratory disease, prevention

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## **Introduction**

Transmission of communicable respiratory infections within healthcare settings has emerged as a major public health problem (Mahomed et al., 2007; Kuruuzum et al., 2008; Kermode et al., 2005). Hazardous biological risks have become more significant in recent decades, including newly emergent infectious diseases such as severe acute respiratory syndrome (SARS) (Park et al, 2004; Tang et al., 2004) and influenza A (Mahomed et al., 2004, Galton and McLaws, 2010). There have also been reports of escalating number of tuberculosis (TB) cases including multi-drug resistant TB (MDR-TB) and extensively drug resistant TB (XDR-TB) elsewhere including Botswana, which puts health care workers at higher risk for nosocomial TB transmission (Ministry of Health Botswana, 2004; Biscotto et al., 2005).

The use of respiratory protective equipment has been found to be an important strategy to prevent occupational transmission of nosocomial infections. Several previous studies have shown that the N95 respirator is the best choice among those available in offering respiratory protection (Galton and McLaws, 2010; Li et al., 2006; Loeb et al., 2009). Although the use of respiratory protective equipment is so important, there have been reported cases of non-compliance to their use by healthcare workers. For example, a study done in two hospitals in Toronto found that nurses' adherence to the N95 recommended facial protective equipment remains suboptimal (Nichol et al., 2012). This is observed in South African reports showing that despite the knowledge of the high tuberculosis incidence and the likelihood of tuberculosis infection, healthcare workers were still not using facial protective equipment optimally (Zungu and Malotle, 2011).

However, some factors that contribute to usage or non-compliance include lack of knowledge, lack of means, negative influence of the equipment, healthcare workers' skills, healthcare workers' reported discomfort with the equipment, skin irritation, lack of training, conflict between the need to provide care and self-protection, and distance to necessary equipment or facility (Efstathiou et al., 2011).

In the case of health care workers in Botswana, it is not well established whether they comply with regard to the use of N95 respirator. Thus, this study was conducted to investigate the factors influencing the usage of N95 respirator among the healthcare workers at Nyangabgwe Hospital in Botswana.

## **Methodology**

This was a cross-sectional study conducted among the health care professionals from Nyangabgwe Hospital, Francistown, Botswana. This hospital is the second biggest referral hospital in Botswana in terms of patient admission capacity, staffing, and the catchment area. The study population comprised all healthcare professionals in Nyangabgwe hospital at medical and acute care wards. The targeted wards have a staff complement of 212 healthcare professionals. These included medical doctors, nurses, social workers, occupational therapists, physiotherapists, and dieticians. All these health care professionals attending to patients in these wards are expected to wear the N95 respirators.

The data were collected using a self-administered questionnaire from June to August 2013. The protocol of the study was reviewed and approved by Medunsa Research Ethics

Committee (MREC) of the then University of Limpopo -Medunsa Campus. In Botswana, the protocol was approved by Ministry of Health, Health Research and Development Committee. Furthermore, permission to collect data was obtained from institutional managers. Upon obtaining permission to conduct the study, an outline of the study was presented to staff members during departmental meetings to inform them that participation was voluntary.

Staff members were then approached individually; at this stage, the study details were explained to them, and they were then requested to participate. Those who consented to participate were enrolled in the study.

### **Data analysis**

STATA software version 10.0 was used for data analysis. Descriptive statistics was used to summarize data and determine the frequencies of events. Inferential statistics were carried out to describe healthcare professionals' adherence to the use of the N95 respirator.

Pearson Chi-square test of association was used to determine adherence and the constructs of Moore's theoretical framework (individual, environmental and organizational factors). P-values less than 0.05 were considered significant.

### **Results**

In total, 165 health professionals gave consent and completed the self-administered questionnaire. The majority (61.8%) of respondents were female; their age ranged from 23 to 58 years; their mean age was 34.5 years. Almost two-thirds of the respondents (67.3%) were nurses. Half of the respondents (51.5%) had attained a diploma level of qualification; while 5 (3.0%) had a doctorate.

More than half of the respondents had been working for between 1 to 5 years, while 32 (19.4%) had worked in the unit for less than 1 year, 19 (11.5%) had been working for 6 to 10 years. The socio-demographic details are shown in Table 1.

**Table 1: Demographic characteristics of respondents (n=165)**

<b>Variables</b>	<b>Level</b>	<b>Frequency</b>	<b>Percentage</b>
<b>Gender</b>	Male	63	38.2
	Female	102	61.8
<b>Age (years)</b>	20 - 30	74	44.8
	31 - 40	52	31.5
	41 - 50	28	17.0
	>50	11	6.7
<b>Professional category</b>	Doctor	36	21.8
	Nurse	111	67.3
	Social worker	6	3.6
	Dietician	5	3.0
	Physiotherapist	5	3.0
	Occupational therapist	2	1.2
<b>Educational level</b>	Diploma	85	51.5
	Undergraduate degree	52	31.5
	Master degree	23	13.9
	Doctoral degree	5	3.0
<b>Number of years in unit (years)</b>	< 1year	32	19.4
	1 - 5 years	97	58.8
	6 – 10 years	19	11.5
	> 10 years	17	10.3

**Knowledge on the use of N95 respirator**

More than half (57/6%) of the respondents knew that fit testing of the respirator is done to ensure the right size required for use by individuals. The majority (over 90%) of respondents knew that wearing an N95 respirator would help protect from contracting a communicable respiratory disease. Although there is a recommended way to remove the N95 respirator, only a few (26.1%) of the respondents knew about it. Less than half of the respondents knew that a seal check is to be conducted each time a respirator is put on. Most of the respondents (70.3%) correctly responded that wearing a surgical mask does not protect one from contracting communicable respiratory diseases. The details of the responses are shown in Table 2.

**Table 2: Summary of responses to knowledge on the use of N95 respirator (n=165)**

<b>Statement</b>	<b>Yes n (%)</b>	<b>No n (%)</b>	<b>I don't know n (%)</b>
Fit testing of N95 respirators is done to ensure size of the respirator seals to my face.	95 (57.6)	67 (40.6)	3 (1.8)
Wearing N95 respirator will help protect me from contracting a communicable respiratory disease	154 (93.3)	10 (6.7)	1(0.6)
There is no recommended way to remove an N95 respirator	101 (61.2)	43 (26.1)	21 (12.7)
I have to conduct a seal check each time I put on an N95 respirator.	77 (46.6)	79 (47.9)	9 (5.5)
Wearing a surgical mask will help protect me from catching communicable respiratory disease.	49 (29.7)	116 (70.3)	0 (0)

**N95 respirator usage pattern**

A 5-point Likert scale ranging from never to always was used to assess the N95 respirator usage pattern. Although, a mere 7.3% respondents stated “always using” the N95 respirator when attending to patients; the majority of respondents stated that they used an N95 respirator when they suspect the patient of suffering from an infectious disease and they knew the patient had been diagnosed with a communicable disease. Table 3 presents the details of responses to items reflecting respondents’ usage patterns.

**Table 3: Details of the responses to items reflecting N95 respirator usage pattern (n = 165)**

<b>Statements assessed</b>	<b>Usage pattern</b>				
	<b>Never n (%)</b>	<b>Rarely n (%)</b>	<b>Sometimes n (%)</b>	<b>Mostly n (%)</b>	<b>Always n (%)</b>
I wear N95 respirator for every patient in the ward	48 (29.1)	34 (20.6)	38 (23)	33 (20)	12 (7.3)
I wear an N95 respirator when caring for a patient that I suspect may have an airborne disease	5 (3)	5 (3)	20 (12.1)	46 (27.9)	89 (53.9)
I wear an N95 respirator when caring for a patient that has been diagnosed with an airborne spread disease	5 (3)	1 (0.6)	6 (3.6)	27 (16.4)	126 (76.4)

**Association between adherence to usage and Moore theoretical framework**

For this analysis, the Pearson Chi-square test of association was used to test the strength of usage adherence and the constructs of Moore’s theoretical framework (individual, environmental and organizational factors). Table 4 shows the details of association between adherence and Moore’s theoretical framework constructs.

Results show a statistically significant association between adherence and a history of contracting an occupational communicable respiratory illness ( $p = 0.009$ ). Those who have never suffered from a communicable infection were less likely to be compliant in using the N95 device. On contrast, those who had access to respiratory protection guidelines and those who were in wards where the wearing of N95 respirators was enforced were more likely and significantly to comply ( $p=0.05$ ). None of the environmental assessed showed any statistical significance between those who were adherent versus those who were less adherent.

**Table 4: Association between individual factors and Moore’s theoretical framework constructs (n= 165).**

Variable category	Variable	Level of adherence		Statistic	
		Adherent n (%)	Non-adherent n (%)	P-value	Odds Ratio (95% CI)
Individual	Knowledge (Adequate vs. inadequate)	32 (19.4)	16(9.7)	0.188	1.60 (0.75,3.43)
	Past experience with communicable respiratory infection (had been infected vs. not)	17(10.3)	24(14.5)	<b>0.009</b>	0.39 (0.18, 0.85)
	Personal barriers to use of N95 Respirator (Yes vs. No)	75 (45.5)	60(39.4)	0.074	0.45 (0.17, 1.17)
Environmental	Accessibility of N95 respirator (has access vs. not)	61(37)	38(23)	0.366	1.34 (0.68, 2.64)
	Proper storage (Yes vs. No)	9(5.5)	10(6.1)	0.246	0.57 (0.20, 1.64)
Organizational	Trained on use of N95 respirator (Yes vs. No)	18(10.9)	6(3.6)	0.147	2.53 (1.03, 6.32)
	Respiratory protection guidelines accessible (Yes or No)	27(16.4)	9(5.5)	<b>0.025</b>	2.53 (1.03, 6.32)
	Workplace enforcing compliance (Applied vs. Not)	35(21.2)	12(7.3)	<b>0.011</b>	2.59 (1.16, 5.88)

## Discussion

The findings from the study show that the majority of respondents were females and nurses. This can be explained by the fact that nurses constitute a larger proportion of the health care workforce in hospital settings. The finding that half of the participants had attained a diploma level of qualification is consistent with the fact that most of the nursing institutions in the country train nurses only as far as a diploma level.

The findings from this study confirm that health professionals know that wearing an N95 respirator would help protect them from contracting communicable respiratory diseases. However, almost half of the respondents were not aware that a fit testing should be done to ensure that the respirator properly seals to the face. These findings concur with results from another study where 49% of respondents reported not receiving adequate training and fit testing within the last two years on the use of N95 respirator (Nichol et al., 2012). Also, almost three-quarters of respondents were not aware that there was a recommended way to remove the N95 respirator and to perform a seal check. Published data recommend that the respirator should be removed by pulling the bottom strap over the back of the head, followed by the top strap, without touching the respirator (Center for Disease Control and Prevention, 2010; OSHA, 2004). It is important that healthcare workers know how to verify that there are no leaks around their masks. Strikingly, the respondents were aware of the protective nature of the N95 respirator in comparison to that of the surgical mask. This awareness may be because there have been wellness campaigns on the use of the N95 respirator in control of TB in Botswana (Botswana Ministry of Health, 2009). It should be noted that the surgical masks are primarily designed to protect the environment from the wearer, whereas the respirators are meant to protect the wearer from the environment (Balazy et al., 2006).

In this study, about half of the respondents were adherent to the usage of the N95 respirator. However, poor adherence to usage in almost half of the respondents is worrisome given the fact that non-adherence to usage leads to high risk for occupational infections during disease outbreaks. This could have a more severe impact and result in extensive disease transmissions to health care workers. Health care workers compliance with standard precautions to prevent the spread of infectious disease is historically poor. Several studies have demonstrated that healthcare workers are generally poorly compliant with respiratory protection guidelines, especially when N95 respirator is recommended, yet it is an important barrier against contracting respiratory illnesses (Kermode et al., 2005; Baig et al., 2010; Efstathiou et al., 2011; Okechukwu et al., 2012; Nichol et al., 2008).

Usage of N95 respirator in this study by healthcare workers was enhanced by the knowledge of the patient's diagnosis as many of them never used the device at all times when they attended to patients. For example, wearing an N95 respirator when caring for a patient that is suspected to have an airborne spread disease and diagnosed with an airborne spread disease had high usage adherence rates of over 80% in both cases. This finding was also observed in other studies where healthcare worker's adherence to self-protection guidelines was most closely associated with whether they provided care to patients who had received a

definite diagnosis or not. For example, a study on SARS outbreak in Toronto, Canada reported that consistent adherence rate to recommended barrier precautions varied depending on the diagnosis. In the same study, usage adherence was higher (84.6%) when confirmed diagnoses of SARS had been made and lower when patients were not thought to have SARS (Shigayeva et al., 2007). Similarly, another study showed adherence to respirator use to be less (57%) when the diagnosis of tuberculosis was unconfirmed and more (84%) when it was confirmed (Kellerman et al., 2001). The N95 respirator is the recommended respiratory protective equipment in government health facilities in Botswana. Thus, the finding that it is not being used at all times is not supporting that policy. This also does not augur well with the reviewed literature on universal precautions, which recommend the use of PPE when attending to every patient, regardless of their presumed infection status (Ministry of Health Botswana, 2009; Efstathiou et al., 2011; Beltrami et al., 2000).

In this study, most of the respondents (over 80%) reported personal barriers to using the N95 respirator. These barriers were physical discomfort, difficulty in breathing, communication breakdown, excessive heat, adverse skin reactions (rash/skin eruptions, dryness of mouth, itchiness and sneezing), inability to express facial expression, N95 respirator smells bad and that when wearing N95 respirator clients with hearing problems are not able to read the health care workers lips. These findings are consistent with literature reports that factors contributing to non-compliance with standard precautions include lack of knowledge, forgetfulness, lack of means, negative influence of the equipment on nursing skills, skin irritation (Efstathiou et al., 2011), uncomfortable equipment (Nichol et al., 2008), overall discomfort, diminished visual, vocal or auditory acuity, excessive humidity or heat; headaches; facial pressure; skin irritation or itchiness; excessive fatigue or exertion (Baig et al., 2010), increased breathing resistance as less air is drawn through the respirator, and communication difficulties during the mask's use (Roberge, 2008).

There was a significant relationship between adherence to usage and past experience or history of having contacted communicable respiratory disease in this study. However, this finding is not consistent with findings of another study, showing no relationship between adherence to usage and past experience of a disease (Nichol et al., 2012). Other individual factors such as knowledge, the perception of risk to occupational respiratory illness and personal barriers to the use of the N95 respirator did not significantly influence adherence to usage.

This study did not find any significant association between adherence to usage and accessibility to N95 respirator. This is not consistent with previous studies that reported significant associations between adherence to usage and availability and accessibility of the N95 respirator (Nichol et al., 2008; Nichol et al., 2012; Efstathiou et al., 2011; Stone et al., 2004). The inconsistency in findings could be due to the type and age of the population in the different studies. The study also found a significant association between adherence to usage, availability, and accessibility of respiratory protection guidelines and work place enforcing compliance to respirator protective equipment. This finding is consistent with reports in other



studies that organizational factors positively correlated with adherence to usage (Nichol et al., 2012; Nichol et al., 2008; Mukwato et al., 2007).

It is acknowledged that the sample size is small and the data was collected in one hospital setting; thus, the findings may not be generalizable to the whole country. Larger scale studies are recommended to further corroborate the findings of this study.

### Conclusion

This study has shown that healthcare personnel acknowledged the importance of N95 respirator as a means of providing protection against occupational transmission of communicable respiratory diseases. It was found that some individual and organizational factors are the main barriers to usage adherence. These factors need to be addressed in order to strengthen the usage adherence to N95 respirator and consequently curbing occupational transmission of respiratory infections among the health care workers in Botswana.

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