AJMB
eISSN: 2600-8173
https://doi.org/10.37231/ajmb.2023.1.S.684
https://journal.unisza.edu.my/ajmb
PENERBIT Universiti Sultan Zainal Abidin
Asian Journal of Medicine and Biomedicine

Evaluation of Knowledge and Practice of Radiation Safety among Nursing Students at Universiti Sultan Zainal Abidin (UniSZA)

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Received: 2nd August 2023 **Accepted: 6th November 2023** **Published: 24th December 2023**

Abstract

Excessive exposure to unnecessary radiation may cause long-term effects to human beings. Thus, nursing students should be knowledgeable about radiation protection and safety before starting their clinical placement at the hospital to minimize the risk of radiation. This research aims to determine the level of knowledge and practice among nursing students in UniSZA toward radiation safety and to identify whether the duration of clinical training influences their level of knowledge and practice. A cross-sectional study questionnaire-based was carried out among nursing students at Universiti Sultan Zainal Abidin (UniSZA) from March 2022 to June 2023. All nursing students including degree and diploma students were eligible to participate in the study. The questionnaires consisted of a section for socio-demographic information and two (2) sections for 5-point Likert scale questions, which were radiation knowledge and radiation protection practice. A total of 108 nursing students consented and participated in the study. Majority of the participants were female (86.1%). Among the participants, 35.2% were enrolled as bachelor's degree students, while the remaining 64.8% were pursuing a diploma. The results showed that nursing students have a high level of radiation knowledge with a mean score 3.67±0.68 and a high level of radiation protection practice with mean score 3.98±0.73. Furthermore, the findings indicated that the mean score of knowledge and practice among respondents with a clinical training duration of more than 8 weeks were 47.29±8.09 and 33.23±5.56, respectively. The participants who had a longer duration of clinical training had a significantly higher mean score in their knowledge and practise of radiation safety, in comparison to those with a shorter duration of clinical training ($p<0.005$). In conclusion, nursing students at UniSZA, possess a high level of knowledge regarding radiation safety and radiation protection practices. The duration of clinical training may also be a factor that can improve the radiation protection and safety and awareness among them. Overall, it is essential to prioritize the development of a strong awareness of radiation safety among nurses as it plays a critical role in upholding a secure working environment and minimizing radiation exposure for healthcare professionals.

Keywords

Awareness, knowledge, radiation protection, clinical training, nursing students

https://doi.org/10.37231/ajmb.2023.1.S.684
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Introduction

There are variety of imaging modalities that use ionizing radiation. Among the imaging modalities often used in diagnosis are x-ray, computed tomography (CT), fluoroscopy and mammography. Ionizing radiation is energy emitted either natural or man-made sources that is more energetic than non-ionizing radiation and can induce chemical alterations by breaking chemical bonds. Cellular damage caused by radiation severely affects living things, endangering both healthy and diseased tissues [1]. According to Algohani et al. ionizing radiation is continuously being applied for diagnostic and therapeutic purposes, which benefits millions of people worldwide [2]. However, any exposure to radiation poses a danger to both patients and healthcare professionals [3]. This statement is supported by Hao et al. who report a case of radiation accident in which a worker suffered from acute radiation disease and resulted in decreased white blood cell level, zero sperm count and complete loss of libido [4]. The consequence led to his death from acute lymphoblastic leukaemia about 34 years after the exposure.

Patients are exposed to direct radiation exposure due to the requirement for imaging, whereas medical professionals are largely exposed due to a process called scatter which is the radiation that spreads in diverse directions from the beam when it interacts with body tissues. This can result in excessive levels of exposure, which gradually and potentially result in negative effects [5]. Nurses are the backbone of the healthcare industry whose role is as patient advocates and professional care providers. They are mostly involved in the healthcare environment by accompanying patients throughout examinations. Alzubaidi et al. stated that nurses are generally present in the radiology wards and operation theatres since they provide health care to patients during and after radiological exams [6]. Nurses are important in the healthcare industry since they spend the majority of their time with patients [7]. However, they can also be exposed to radiation when working behind protective barriers during inward. For instance, X-rays examinations are necessary to be performed in the ward for those patients who are unable to go to the x-ray room. As a result, nurses are frequently exposed during inward X-ray examinations, needing them to follow the safety of radiation use.

Particularly nurses working in clinical environments where radiation is used only undergo specific training before they take up the role [8]. Nurses who had completed radiation protection training were more knowledgeable than those who did not receive training [9]. In general, nursing students commonly learn about radiation protection indirectly during their clinical placements. Clinical placements provide students with opportunities to experience the clinical environment and also develop professional knowledge in practice [10].

Nurses who are unaware of the dangers of ionizing radiation may not be able to adequately protect themselves or their patients. Medical workers including nurses represent the largest group of radiation exposed workers in the world [11]. Medical staff exposed to radiation are at higher risks of cancer, particularly any medical workers who perform fluoroscopically guided interventional procedures or radionuclide procedures [12]. Thus, it is important to identify the deficiencies and analyze existing levels to ensure that nurses have an appropriate understanding of radiation. Radiation knowledge and radiation protection practice are essential to ensure nurses have the necessary skills to perform duties in radiation areas where there is a high risk of exposure. Therefore, this study was undertaken in order to evaluate the level of awareness toward radiation safety among nursing students at UniSZA.

Materials and Methods

Study design

A cross-sectional study questionnaire-based using the Likert scale was carried out among nursing students at Universiti Sultan Zainal Abidin (UniSZA). This study was carried out specifically at the

https://doi.org/10.37231/ajmb.2023.1.S.684
https://journal.unisza.edu.my/ajmb

University of Sultan Zainal Abidin (UniSZA) campus of Gong Badak, Kuala Terengganu, Terengganu Darul Iman. This study was carried out from March 2022 to June 2023, a total of 16 months.

Ethical statement

The survey followed the study protocol that was approved by the UniSZA Human Research Ethics Committee (UHREC), with the protocol code UniSZA/UHREC/2022/426. The research was conducted according to the ethics committee's regulations and standards. Each participant was provided with a consent form and had complete freedom to participate.

Study participants

The sample selected for this study was specifically the nursing students at Universiti Sultan Zainal Abidin (UniSZA). All the nursing students including male and female from all races and religions at UniSZA were eligible to be recruited for this study. Students who were not able to read in English were excluded from this survey. The sampling method used in this study was probability sampling, simple random sampling. It means each person in the population has an equal chance of being included in the sample.

Instruments

The questionnaires adapted from previous study had been modified and validated to match the parameters and objectives in this study [13]. This study utilized Google form to distribute the questionnaire. A pilot survey was conducted to ensure the reliability and validity of the questionnaires. Questionnaires were distributed randomly among radiography students (n=44) within a week. The resultant Cronbach's alpha is 0.67. This indicates a high level of internal consistency for the measured scale. In addition, minor modifications were made based on the feedback of the pilot study participants. The questionnaires consisted of 20 Likert scale questions and were divided into three sections which were socio-demographic information, radiation knowledge and radiation protection practice. In the first section, the question contains the socio-demographic information of each respondent, such as gender, age, education level, year of study and duration of clinical training attended. The second section consists of 12 items regarding radiation knowledge and the third section contains 8 items about radiation protection practice. The Likert scale has the following responses: Strongly Disagree - Disagree - Neutral - Agree - Strongly Agree. The mean scores 1.00 – 2.49 were taken as low knowledge/practice level, 2.50 – 3.49 as moderate level and 3.50 – 5.00 as high knowledge/practice level [9].

Data collection

A set of questionnaires had been distributed online via the link provided, enabling individuals who meet the inclusion requirements access to the Google forms. Informed written consents were obtained from the respondents, and they were required to complete the questionnaire without any references. The return date was further reminded by follow-up emails and social media posts. This survey was optional, and the researchers had no influence over who chose to participate. Data collected were only accessible to the research team. Data obtained were kept private and confidential under all circumstances. The information gathered was only used for this study. Participants had the option of contacting the researcher in charge for any clarifications or to quit at any time for any reason.

Data Analysis

Frequency and percentages were provided for the demographic characteristics, i.e., age and gender. Descriptive summaries (mean and standard deviation) were provided for the radiation safety knowledge and practice score. Comparisons of radiation safety knowledge and practice scores between clinical practice duration was assessed using an independent t-test. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were carried out using the statistical package for the social sciences (SPSS), version 21.0 (SPSS Inc., Chicago, IL, USA).

AJMB
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Results

Demographic characteristics

A total of 108 nursing students at UniSZA consented to participate in the survey. The study participants comprised of 13.9% male and 86.1% female, as shown in Table 1. Among the participants, 57.4% were aged between 18 to 20, while 42.6% were aged between 21 to 23. According to the data, a total of 35.2% participants held a degree level of education, while 64.8% held a diploma level of education. First-year students consist of most of the sample which is 42.6%, followed by second-year students 33.3%, and third-year students 24.1%. It was found that 48.1% of the participants experienced clinical training for a duration of 1 to 8 weeks, while 51.9% of them received clinical training for a period of more than 8 weeks.

Table 1: Socio-demographic information of nursing students

Socio-demographic information	Frequency and percentage, n (%) Total of respondents: 108
Gender	
Male	15 (13.9)
Female	93 (86.1)
Age	
18-20	62 (57.4)
21-23	46 (42.6)
Education Level	
Degree	38 (35.2)
Diploma	70 (64.8)
Year of study	
Year 1	46 (42.6)
Year 2	36 (33.3)
Year 3	26 (24.1)
Duration of clinical training attended	
1 – 8 weeks	52 (48.1)
More than 8 weeks	56 (51.9)

Assessment of knowledge towards radiation safety

Table 2 presents the findings from respondents in the radiation knowledge survey. A total of 48.2% respondents who answer strongly agree (24.1%) and agree (24.1%) believe that ionizing radiation can harm the normal process of cell division, while non-ionizing radiations do not affect molecular levels. However, 43.5% of the respondents neither agreed nor disagreed, 5.6% disagreed and 2.8% strongly disagreed which led the results of mean score 3.61. The respondents were 35.2% agree and 25.9% strongly agreed that the eyes, thyroid and gonad are the most sensitive organs when exposed to radiation. However, 29.6% answer neutral, 7.4% disagree and 1.9% strongly disagree with that statement. The mean score for this statement was 3.76.

Among the 108 respondents, 46.3% conveyed uncertainty regarding whether ultrasound and Magnetic Resonance Imaging (MRI) examinations involved the use of ionizing radiation or not. This was followed by 20.4% of the respondents who agreed, 15.7% who strongly agreed, 13.9% who disagreed, and 3.7% who strongly disagreed, making the mean score 3.31. Regarding the statement about the scatter radiation is the most common type of exposure that healthcare personnel received in diagnostic radiology, half of the respondents (50.0%) remain neutral, 27.8% agree, 18.5% strongly agree and 3.7 disagree. The mean score calculated for this statement was 3.61. Besides that, there were 42.6% of respondents who strongly agree that pregnant woman should not undergo an x-ray examination. 25.9% of them agree, 26.9% neutral and

https://doi.org/10.37231/ajmb.2023.1.S.684
https://journal.unisza.edu.my/ajmb

4.6% disagree which make the mean score 4.06. In general, these results show the overall mean score for radiation knowledge was 3.67±0.68 which indicates a high level of knowledge among nursing students in considering the principle and effect of radiation.

Assessment of practice towards radiation safety

The practice towards radiation safety were assessed by asking 8 questions as shown in Table 3. A total of 34.3% respondents strongly agrees and 29.6% respondents agree that they will wear a lead apron and thyroid shield when working with radiation. But 28.7% remain neutral, 4.6% disagree and 2.8% strongly disagree about that statement making the mean score derived from this statement was 3.88. When not directly involved in holding the patient or attending to nearby patients, 41.7% respondents strongly agree that they will leave the room until the X-ray procedure is completed. Followed by 26.9% agree, 25.9% unsure, 4.6% disagree and 0.9% strongly disagree with the statement. The mean score calculated for this statement was 4.04.

In terms of maintaining distance at least 2 meters from the beam during an x-ray procedure, it was found that both agree and neutral had same percentage which were 33.3%. The balance respondents were 29.6% strongly agree and 3.7% disagree that they would step back at least 2 meters from the beam which make the mean score was 3.89. Furthermore, the respondents were 47.2% strongly agree, 25.9% neutral, 20.4% agree, 4.6% disagree and 1.9% strongly disagree that they will minimize their time spent near radiation sources. The mean score obtained for this statement was 4.06. In summary, these results show the overall mean score for radiation protection practices with 3.98±0.73 which indicate high level of practice among nursing students in considering radiation safety.

Influence of clinical training experiences on radiation protection awareness

Regarding radiation knowledge, participants with a clinical training duration of more than 8 weeks had a higher mean score of 47.29±8.09, compared to those with a duration of 1 to 8 weeks, who had a mean score of 40.44±6.58, as depicted in Table 4. The mean difference between the two groups was 6.84, with a 95% confidence interval (CI) ranging from 4.02 to 9.67. The t-statistic value was 4.80 with 106 degrees of freedom, and the p-value was 0.001 which is less than 0.05. These findings indicate a significant difference in radiation knowledge between the two groups, which shows that participants with a longer duration of clinical training have higher levels of radiation knowledge.

Meanwhile, regarding radiation protection practice, participants with a clinical training duration of more than 8 weeks had a higher mean score of 33.23±5.56 compared to those with a duration of 1 to 8 weeks, who had a mean score of 30.13±5.77. The mean difference between the two groups was 3.10, with a 95% confidence interval (CI) ranging from 0.94 to 5.26. The t-statistic value was 2.84 with 106 degrees of freedom, and the p-value was 0.005 which is less than 0.05, indicating a significant difference in radiation protection practice between the two groups. These results show that participants with a longer duration of clinical training tend to exhibit better radiation protection practices.

AJMB
eISSN: 2600-8173
https://doi.org/10.37231/ajmb.2023.1.S.684
https://journal.unisza.edu.my/ajmb
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Table 2: Responses to radiation protection knowledge.

Radiation Protection Knowledge Items	Frequency and Percentage, n (%)					Mean score
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Ionizing radiations can damage the process of normal cell division while non-ionizing radiations do not affect molecular levels.	3 (2.8)	6 (5.6)	47 (43.5)	26 (24.1)	26 (24.1)	3.61
The stochastic effect is those effects which occur when a person receives a high dose of radiation.	2 (1.9)	1 (0.9)	47 (43.5)	38 (35.2)	20 (18.5)	3.68
Radiation-induced skin burns and cataracts are examples of deterministic effects.	2 (1.9)	7 (6.5)	38 (35.2)	38 (35.2)	23 (21.3)	3.68
Justification, optimization and dose limitation are the three general principles of radiation protection.	1 (0.9)	5 (4.6)	53 (49.1)	27 (25.0)	22 (20.4)	3.59
As Low As Reasonably Achievable (ALARA) principle consist of time, distance and shielding.	2 (1.9)	5 (4.6)	47 (43.5)	30 (27.8)	24 (22.2)	3.64
The eyes, thyroid and gonad are the most sensitive organ when exposed to radiation.	2 (1.9)	8 (7.4)	32 (29.6)	38 (35.2)	28 (25.9)	3.76
X-ray, computed tomography (CT) scan and fluoroscopy examinations are using ionizing radiation.	0 (0.0)	11 (10.2)	41 (38.0)	32 (29.6)	24 (22.2)	3.64
Ultrasound and Magnetic Resonance Imaging (MRI) examinations are not using ionizing radiation.	4 (3.7)	15 (13.9)	50 (46.3)	22 (20.4)	17 (15.7)	3.31
Scatter radiation is the most common type of exposure that healthcare personnel will receive in diagnostic radiology.	0 (0.0)	4 (3.7)	54 (50.0)	30 (27.8)	20 (18.5)	3.61
As the distance from the source increases, the intensity of radiation decreases.	1 (0.9)	11 (10.2)	44 (40.7)	19 (17.6)	33 (30.6)	3.67
Barriers of lead and concrete provide protection from penetrating gamma rays and x-rays.	0 (0.0)	7 (6.5)	40 (37.0)	34 (31.5)	27 (25.0)	3.75
Pregnant woman should not undergo an x-ray examination.	0 (0.0)	5 (4.6)	29 (26.9)	28 (25.9)	46 (42.6)	4.06

Note: The mean score 1.00 – 2.49 were taken as low knowledge level, 2.50 – 3.49 as moderate level and 3.50 – 5.00 as high knowledge level [14] *. Mean knowledge was 3.67±0.68.*

AJMB
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https://doi.org/10.37231/ajmb.2023.1.S.684
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Table 3: Responses to practice related to radiation safety.

Radiation Safety Practice Items	Frequency and Percentage, n (%)					Mean Score
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
I will not undergo an x-ray examination if I am suspected of pregnancy.	2 (1.9)	4 (3.7)	30 (27.8)	27 (25.0)	45 (41.7)	4.01
I wear a lead apron and thyroid shield when working with radiation.	3 (2.8)	5 (4.6)	31 (28.7)	32 (29.6)	37 (34.3)	3.88
If not holding the patient or required for nearby patients, I will leave the room until the x-ray procedure has been completed.	1 (0.9)	5 (4.6)	28 (25.9)	29 (26.9)	45 (41.7)	4.04
During the x-ray procedure, if I must remain in the room for some reason, I will step back at least 2 meters from the beam.	0 (0.0)	4 (3.7)	36 (33.3)	36 (33.3)	32 (29.6)	3.89
During fluoroscopic exposures, I wear a lead apron and thyroid shield.	0 (0.0)	5 (4.6)	42 (38.9)	29 (26.9)	32 (29.6)	3.81
When the x-ray room warning sign is light on, I do not enter the room.	0 (0.0)	3 (2.8)	27 (25.0)	27 (25.0)	51 (47.2)	4.17
I will spend less time near radiation sources.	2 (1.9)	5 (4.6)	28 (25.9)	22 (20.4)	51 (47.2)	4.06
I will use the ALARA principle to minimize the radiation exposure.	0 (0.0)	3 (2.8)	43 (39.8)	26 (24.1)	36 (33.3)	3.88

Note: The mean score 1.00 – 2.49 were taken as low practice level, 2.50 – 3.49 as moderate level and 3.50 – 5.00 as high practice level [14]. Mean practice was 3.98±0.73

AJMB
eISSN: 2600-8173
https://doi.org/10.37231/ajmb.2023.1.S.684
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Table 4: The comparison between radiation knowledge and radiation protection practice based on duration of clinical training

	Duration of clinical training	Mean (SD)	Mean difference (95% CI)	t-statistic (df)	p-value
Radiation knowledge	More than 8 weeks	47.29 (8.09)	6.84 (4.02, 9.67)	4.80 (106)	<0.001
	1 to 8 weeks	40.44 (6.58)			
Radiation protection practice	More than 8 weeks	33.23 (5.56)	3.10 (0.94, 5.26)	2.84 (106)	<0.005
	1 to 8 weeks	30.13 (5.77)			

Discussion

The knowledge level of radiation safety among nursing students

This study aims to determine the knowledge level of radiation safety among nursing students in UniSZA. The mean score obtained from each question in radiation knowledge were above 3.50, indicate high level except the question "ultrasound and MRI examinations are not using ionizing radiation" which the mean score was 3.31, indicate moderate level. Most of the respondents unsure about the statement may cause by the limited exposure to these non-ionizing radiation examination as their clinical rotations may not always include placements in radiology departments where they can observe or participate in ultrasound and MRI procedures. This confusion may also arise from the misconception that all modalities within the radiology department, including ultrasound and MRI, utilize ionizing radiation. Furthermore, medical radiation topics were not covered in their syllabus. The results show the overall mean score for radiation knowledge was 3.67±0.68 which indicate high level of knowledge among nursing students in considering the principle and effect of radiation. These findings are somewhat surprising given that a previous study from the literature review found that nursing students lacked basic knowledge of radiation safety principles [15,16]. However, a study from Watmode et al. that investigated nursing students' attitudes and understanding of radiation concerns found that both were high, and the knowledge of radiation hazards was well-understood [17].

There are a variety of ways for students to increase their knowledge, including engaging in self-learning through the use of the internet and going to clinical training. It has been demonstrated through research that utilizing the internet as a learning resource while participating in the educational process can considerably increase learning results [18] . E-learning has recently developed as an efficient method that can meet the specific requirements of each student [19]. Individuals are able to leverage the internet as a beneficial tool to improve their knowledge, gain new skills within a relatively short amount of time, and frequently at a more inexpensive cost, and build collaborations with leading experts in their respective industries [20]. Furthermore, the integration of radiation protection into the nursing curriculum and the undertaking of Continuing Professional Development (CPD) regarding medical radiation may improve the knowledge, awareness and also a good practice of radiation safety among nurses. Nurses acquiring knowledge through education can result in a shift in their attitudes and greater adherence to radiation protection control measures [8].

The radiation protection practice among nursing students during working in radiation areas

Regarding radiation protection practices among nursing students, the findings indicate an overall mean score of 3.98±0.73, reflecting a high level of adherence to radiation safety practices among nursing students. Radiation protection practices among nursing students may increase because of clinical experience and resources from the internet. Nursing students gain clinical experience through rotations in

https://doi.org/10.37231/ajmb.2023.1.S.684
https://journal.unisza.edu.my/ajmb

different health care settings. During this rotation, they may observe and participate in radiation-related procedures, which can improve their practical skills and radiation protection practices. Participants emphasized that clinical practice placements offer invaluable opportunities to gain practical experience, develop knowledge, engage in community interactions, achieve educational objectives and receive important clinical guidance [21]. Learning in the practice or hands on setting is essential to prepare nursing students for the challenges of professional practice [22]. In addition, the use of social media has been proven beneficial in improving knowledge, education, training, teaching ability, professional skills, learning environment, and the overall performance of health care professionals [23]. Incorporating e-learning into the educational process not only improves the quality of practical training but also improves the understanding of course material [24].

The comparison of radiation knowledge and radiation protection practices among nursing students based on their duration of clinical training

The goal of this study was to assess the radiation knowledge and radiation protection practice of nursing students UniSZA based on their duration of clinical training. This study found that participating nursing students with duration of clinical training more than 8 weeks have higher radiation knowledge and radiation protection practice than participants who attend only 1 to 8 weeks of clinical training. The study conducted by Osakwe et al. reveals that respondents who underwent training exhibited enhanced knowledge and practice, with the researchers themselves concurring that training was indeed linked to improved knowledge and practice [25]. There is also a study indicated that the students were more confident about their knowledge after following the training, and that this knowledge can be used in practice [26]. As nursing students progress through their clinical training, they are likely to gain more exposure to radiation-based procedures. This increased exposure provides them with opportunities to enhance their knowledge and understanding of radiation and its associated risks.

Nursing students who undergo clinical training are likely to encounter situations involving radiation exposure. It was discovered that the training had an advantageous impact on the maintenance of clinical practice [27]. Recent study concluded that implementing a training program for internship nursing students effectively increased their knowledge and skills, with significant differences observed between pre-training and post-training performance, especially in terms of overall knowledge, fundamental nursing, and generative skills [28]. Nursing students with longer clinical placement durations were more satisfied with clinical training as a result of both their satisfaction with their supervisor and their perceptions of good learning environment [29]. Study from Phang et al. showed that the longer the industrial training duration, the more confident and ready the students are in pursuing future career [30]. They also recommended that universities should consider lengthen the industrial training duration to boost students' confidence in future career and increase their readiness to join the workforce.

Conclusion

The study reveals that nursing students at UniSZA, possess a high level of knowledge regarding radiation safety and radiation protection practices. This study also highlights that the duration of clinical training contributes to the improvement in the knowledge and practice of radiation protection among nursing students. The awareness of radiation safety among nursing students is crucial for assuring the health and safety of both patients and healthcare professionals. Through education and training, nursing students gain the knowledge and skills necessary to effectively handle and minimise the risks associated with radiation exposure in healthcare settings. By prioritizing radiation protection, nursing students can contribute to the overall improvement of patient outcomes and the promotion of a safe healthcare environment.

Funding
The author(s) received no specific funding for this work.

Acknowledgements
We would like to thanks to all nursing students in UniSZA who participated in this study.

Conflict of Interest Disclosure
None to declare

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