ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

ASSESSMENT OF THE LEVEL OF AWARENESS AND PREPAREDNESS OF MEDICAL TECHNOLOGISTS IN MOLECULAR DIAGNOSIS

Dhon Aldous D. Castro, Mary Rose M. Cruz, Maria Luisa R. Olano, Lea Mei P. Agcaoili, Nathalie Mae P. De Jesus, Glenn L. Tan, Ahmed Khan H. Cayongcat, Ma. Beth Giel O. Munda
Department of Medical Technology, Faculty of Pharmacy
University of Santo Tomas
Manila, Philippines
dhonaldous.castro.pharma@ust.edu.ph

Abstract The emergence of molecular diagnostics is a growing trend in the Philippine healthcare systems. The molecular techniques applied to diagnosing infectious diseases have been more appreciated in the COVID-19 pandemic, wherein Real-Time Polymerase Chain Reaction (RT- PCR) has become the gold standard in detecting SARS-COV2. As a result, there has been an increasing demand for molecular techniques in the clinical laboratory. The purpose of this study was to assess the level of awareness and preparedness of medical technologies on molecular diagnostic techniques in the National Capital Region and to determine the relationship between the level of awareness and level of preparedness. A descriptive-correlational study was conducted using an online survey through Google forms, sent to 67 medical technologists trained on molecular diagnosis and working in a hospital or clinical laboratory in the National Capital Region. Data analysis utilized SPSS software; results were analyzed using frequencies and percentages. A weighted mean value of 3.07 was computed for the overall awareness and overall preparedness interpreted as "moderately aware" and "moderately prepared," respectively. The Pearson r correlation coefficient is 0.755 with a p-value of less than 0.05, indicating a strong correlation. There is a significant relationship between the level of awareness and the level of preparedness of the respondents. The emergence of new molecular diagnostic procedures requires medical technologists to have relevant training programs and refresher courses to reinforce their awareness and improve their preparedness in terms of practical application in the clinical setting.

Keywords—*medical technologists, molecular biology, molecular diagnostics, awareness, preparedness*

I. INTRODUCTION

A growing trend in the Philippine healthcare systems is the emergence of molecular diagnostics. The molecular techniques applied to the diagnosis of infectious diseases have been more appreciated in the coronavirus disease (COVID-19) pandemic, wherein Real-Time Polymerase Chain Reaction (RT-PCR), a molecular technique, has been used as a gold standard in detecting the SARS-COV2, the causative agent of COVID-19. As a result, there has been an increasing demand for molecular techniques in the clinical laboratory.

Most of the current generation of medical technologists in the Philippines have no formal education in molecular diagnostics. It was only in 2017 that Molecular Biology and Diagnostics was included in the curriculum of B.S. Medical Technology. Current medical technologists must undergo training for two to five days only from accredited laboratories to operate molecular diagnostic laboratories such as COVID-19 laboratories. Lack of knowledge and preparedness could be a barrier in correctly diagnosing important deadly diseases. A similar study in 2014 found some medical students who administer HIV treatment also lack basic knowledge and awareness of HIV, the world’s leading killer infection. Therefore, an optimal plan of educating and preparing medical students was deemed needed (Verma, Wong, Chakravarthi, & Barua, 2014).

At present, most existing literature covers practices in other countries, while only very few research studies in the Philippines can answer this question. It is not unknown that medical technologists play a crucial role in aiding physicians in diagnosing diseases. For this reason, medical technologists should have enough knowledge and preparedness in diagnosing various diseases, including COVID-19. It is essential to gauge the level of awareness and preparedness of medical technologists in molecular diagnosis to prevent misdiagnosis. Therefore, an optimal plan for educating and preparing medical technologists might be needed, wherein specific educational training programs in the field of molecular diagnostics could assist in assessing the knowledge and awareness of medical laboratory practitioners.

The study aimed to assess the level of awareness and preparedness of medical technologies on molecular diagnostic techniques in the National Capital Region. Specifically, this study sought to determine the relationship between the level of awareness and level of preparedness of medical technologists in molecular diagnosis. Additionally, this study will supplement the lacking literature and help assess if medical technologists are prepared during the COVID-19 pandemic. This research intended to help the medical technology profession in determining if there is adequate training in molecular diagnostics.

II. METHODOLOGY

In order to assess the level of awareness and preparedness of medical technologists with regards to molecular diagnostic technologies, the researcher utilized a descriptive-correlational study to describe their awareness and preparedness as well as their significant relationship. The researcher utilizes the purposive sampling technique. The inclusion criteria for the respondents are limited to medical technologists trained on molecular diagnosis of infectious diseases and those who work in a hospital or clinical laboratory in the National Capital Region (NCR) as a front liner of the COVID-19 pandemic regardless of age and gender. The researchers based their hospital and laboratory list on the updated COVID-19 testing laboratories in the Philippines by the Department of Health (DOH) as of November 2020, a total of one hundred seven (107) health facilities. The calculated sample size is sixty-seven (67) registered medical technologists with a 10% margin of error and 95% confidence level. The researchers obtained approval from the Faculty of Pharmacy Research Ethics Committee (FOPREC) to conduct the study. Each participant was given a consent form before the data gathering procedure.

A. *Data Measure/Instrumentation*

This study used a standardized questionnaire derived from a pre-existing research instrument employed in a study conducted by Olumide Odeyemi and Joseph Oyelami in 2010 that can be accessed online. The researchers structured the survey questionnaire into three sections: [A] basic information sheet, [B] level of awareness, and [C] level of preparedness. The first portion of the survey included a basic information sheet to obtain the respondents' basic demographic profile. The next part assessed the level of awareness through a series of level-based questions on a four-point Likert scale. Another set of four-point Likert scale survey questions was included in the third portion, which assessed the respondents' level of preparedness through a series of level-based questions. Thus, a total of 20 questions were included in the last two parts— 11 items for part 2 and 9 items for part 3. Before proceeding in the data gathering, a pilot study was conducted among twenty (20) medical technologists to check the validity of the survey tool. The respondents of the pilot study were not allowed to be part of the actual study. Using the Cronbach's Alpha, the following values were obtained: 0.835 for awareness on information on molecular biology, interpreted as "good"; 0.731 for awareness

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

on general information on molecular diagnosis, interpreted as "acceptable"; 0.712 for awareness on information on applications of molecular diagnostic assays, interpreted as "acceptable"; 0.711 for awareness on information on the procedures involved in molecular diagnostic assays, interpreted as "acceptable; 0.887 for preparedness on operation and calibration of machines used in molecular diagnostic assays, interpreted as "good"; and 0.830 for preparedness on the interpretation of results in molecular diagnostic assays, interpreted as "good." With these results computed, the questionnaire was certified reliable, and the researchers were recommended to conduct the actual survey.

B. *Data Analysis*

The respondents' answers were tallied to observe the frequency distribution manually. Meanwhile, the average score obtained from the administered test results was then used to determine the respondents' level of preparedness. These results were then plotted using the Pearson's Product-Moment Correlation Test, which measured the strength of linear correlation between two different variables. Furthermore, the square of the Pearson correlation coefficient r was used to explain the extent of variation of one variable that significantly causes the variance of the other variable.

III. RESULTS AND DISCUSSION

A. *Respondents Profile*

Table 1 shows the demographic profile of the respondents based on their gender and age. Of the 67 respondents, 39 (58.21%) are female, 24 (35.82%) are male, and 4 (5.97%) preferred not to state their gender. Moreover, most of the respondents are between 21-25 years old (61.19%). In addition, the number of years of practice as a medical technologist are summarized in Table 1, indicating that the majority of respondents had fewer than five years of experience (70.15%).

TABLE I. Demographic Profile and Years of Practice of the Respondents

	f	%
Gender		
Male	24	35.82
Female	39	58.21
Prefer not to say	4	5.97
Age		
21- 25 years old	41	61.19
26-30 years old	25	37.31
31 years old and above	1	1.49
Years of practice		
Less than 5 years	47	70.15
5 to 10 years	19	28.36
More than 10 years	1	1.49

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

Globally, more than 50% of the health and social care sector are women (Boniol et al., 2019). In the Philippines, the demographic studies of the University of the Philippines Population Institute (UPPI) and Demographic Research and Development Foundation Inc. (DRDF) (2020) shows that women dominate the healthcare sector. Additionally, the 1919 board passers of the March 2021 Medical Technologist Licensure Board Exam (MTLE) are predominantly female (Professional Regulation Commission, 2021). Furthermore, as the pandemic continues to hit our country, the medical field is in dire need of new personnel. Fresh graduates of various medical professions were immediately called out in the area (CNN Philippines, 2021). Lastly, more medical technologists are aged 21-25. This finding is supported by the UPPI and DRDF (2020) data, which concluded that most of the health workers in the Philippines fall under the age group 20 -29 years old. The same study also found that 70% of the respondents have less than five years of work experience. This could be related to the increased demand for medical technologists due to the rapid increase in the number of licensed molecular laboratories (Lo et al., 2020), resulting in the mass hiring of Registered Medical Technologists. As a result, 1,356 new medical technologists were hired as of September 2020 (DOH, 2020).

B. *Level of Awareness*

Study participants were asked to assess their awareness about chromosomal DNA extraction and molecular diagnosis. The respondents were extremely aware of the information on molecular biology, having an average weighted mean of 3.38 (Table 2).

TABLE II. Level of awareness on information on molecular biology

Statement/ Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
How aware are you about molecular diagnosis?	4 3 2 1	30 37 0 0	44.78 55.22 0.00 0.00	3.45	Extremely aware
How aware are you about chromosomal DNA extraction?	4 3 2 1	28 32 7 0	41.79 47.76 10.45 0.00	3.31	Extremely aware
AVERAGE ($\bar{x}$)				3.38	**Extremely aware**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

Interestingly, the respondents were only moderately aware of the general information on molecular diagnostic assays, although they were extremely aware regarding polymerase chain reactions (PCR) and moderately aware of protein extraction and purification and agarose gel electrophoresis (AGE) (Table 3).

TABLE III. Level of awareness on the general information on molecular diagnostic assays

Statement/ Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
How aware are you about polymerase chain reactions?	4 3	22 45	32.84 67.16	3.33	Extremely aware

	2 1	0 0	0.00 0.00		
How aware are you about protein extraction and purification?	4 3 2 1	17 41 9 0	25.37 61.19 13.43 0.00	3.12	Moderately aware
How aware are you about agarose gel electrophoresis?	4 3 2 1	5 26 35 1	7.46 38.81 52.24 1.49	2.52	Moderately aware
AVERAGE ($\bar{x}$)				**2.99**	**Moderately aware**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

The average weighted mean for the level of awareness regarding applications of molecular diagnostic assays is shown in Table 4. The lowest level of awareness was manifested in AGE procedures(X_W= 2.48), followed by protein extraction and purification (X_W= 3.12), whereas extreme awareness was observed with PCR procedures (X_W=3.27). In general, the respondents were moderately aware towards the applications of molecular diagnostic assays ($\bar{x}$=2.96).

TABLE IV. Level of awareness on the information on the applications of molecular diagnostic assays

Statement/ Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
At what level is your knowledge on what PCR is used for?	4 3 2 1	19 47 1 0	28.36 70.15 1.49 0.00	3.27	Extremely aware
At what level is your knowledge on what protein extraction and purification is used for?	4 3 2 1	16 43 8 0	23.88 64.18 11.94 0.00	3.12	Moderately aware
At what level is your knowledge on what agarose gel electrophoresis is used for?	4 3 2 1	4 26 35 2	5.97 38.81 52.24 2.99	2.48	Slightly aware
AVERAGE ($\bar{x}$)				**2.96**	**Moderately Aware**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

The respondents are extremely aware of PCR techniques (X_W=3.31) but just moderately aware of protein extraction and purification (X_W=3.16), and only slightly aware of AGE procedures (X_W=2.36). With an average weighted mean of 2.95, these data show that the

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

respondents are only moderately aware of the methods involved in molecular diagnostic tests (Table 5).

TABLE II. Level of awareness on the information on the procedures involved in molecular diagnostic assays

Statement /Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
How aware are you of the procedures involved in polymerase chain reaction?	4 3 2 1	23 42 2 0	34.33 62.69 2.99 0.00	3.31	Extremely aware
How aware are you of the procedures involved in protein extraction and purification?	4 3 2 1	18 42 7 0	26.87 62.69 10.45 0.00	3.16	Moderately aware
How aware are you of the procedures involved in agarose gel electrophoresis?	4 3 2 1	5 21 34 7	7.46 31.34 50.75 10.45	2.36	Slightly aware
AVERAGE ($\bar{x}$)				**2.95**	**Moderately Aware**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

As part of the study's aim to assess the level of awareness of medical technologists on molecular diagnosis in our country, the researchers' questionnaire focused on different aspects of awareness of medical technologists. Specifically, when it comes to molecular diagnosis, namely, the awareness of the information on molecular biology, the general information on molecular diagnostic assays, applications of molecular diagnostic assays, and the procedures involved in conducting molecular diagnostic assays.

According to the official publication of the Philippine Association of Medical Technologists, Inc., "The PAMET Link," online seminars with approved CPD units were conducted by the organization last May and June of 2020 to improve the competency of medical technologists in the country. Discussed in the free webinar are topics that include an introduction to molecular biology, molecular biology in Action (RT-PCR), and an online demonstration of COVID-19 testing. About 1000 PAMET members were able to attend per session based on zoom registrations, and the discussions were streamed live on the official Facebook page of PAMET (Philippine Association of Medical Technologists, Inc., 2020). Furthermore, training programs are provided through the collaboration of various universities and the DOH to ensure that the medical technologists working in the laboratories are prepared and skilled enough to perform molecular diagnostic procedures. One example is the Molecular Diagnostic training offered by the DOH-RITM, which primarily aims to provide basic theoretical background on molecular biology and provide a further understanding of PCR and other related molecular diagnostic techniques employed in the diagnosis of infectious diseases (RITM, 2020). Because of the accessibility of the webinars offered and public live streaming on social media, a good number of medical technologists in the country were able to view and

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

listen to the speakers. The effective dissemination of information explains why medical technologists are extremely aware of molecular biology, as presented in Table 2.

Tables 3, 4, and 5 show a moderate overall level of awareness regarding general information, applications, and procedures on molecular diagnostic assays. As discussed previously in the review of related literature of this study, CHED recently added Molecular Biology and Diagnostics as a course in the curriculum of third-year students undertaking the Medical Technology program as provided in the CHED memorandum No. 13 Series of 2017 (CHED, 2017). Therefore, the recent implementation of the new curriculum can be a factor that contributed to the generated results of the level of awareness of the respondents.

Noticeably, among the three tables, the respondents have extreme awareness of the general information, application, and procedures related to polymerase chain reaction (PCR). Over the last few decades, advancements in molecular diagnostic assays have made it possible to detect and identify clinical samples and microbes rapidly and precisely (Buckingham, 2019). These assays were used globally, with PCR as one of the most commonly employed techniques for nucleic acid amplification due to its remarkable advantage as an end-point assay to confirm the presence of a specific DNA sequence in a sample (Shen, 2019). Although the Philippines had extremely limited capacity to perform Nucleic Acid Amplification Tests (NAATs) such as PCR before the COVID-19 pandemic (Fetalco, 2020), the demand for SARS-CoV-2 testing made it possible to drastically increase the number of licensed COVID-19 molecular laboratories and other healthcare systems to offer PCR (Lo et al., 2020). Hence, there is also an increase in demand for molecular biologists and registered medical technologists with training in molecular diagnosis. In this study, most of the training programs undertaken by the respondents focused mainly on the fundamental concepts in molecular biology, particularly PCR. These training programs include Training on Molecular Techniques (RNA Extraction and rRT-PCR), Mol Dx: PCR Applications in Infectious Disease Diagnostics, Molecular detection of SARS CoV 2 using PCR, and UP COLLab: COVID-19 Online Learning Lab for RT-PCR Testing, to name a few. This explains why the respondents were extremely aware of PCR compared to the other biotechniques.

Before any molecular methods, a process of nucleic acid extraction has to be done. Afterward, it is essential to determine the purity and yield of the obtained nucleic acid extract (Ali, Rampazzo, Costa, & Krieger, 2017). It is necessary to measure the quality and quantity of DNA or RNA for various molecular applications (Buckingham, 2019). One of the commonly used methods of DNA concentration measurements is through agarose gel electrophoresis (AGE). AGE is cost-effective and convenient to use, but it takes time and has limited precision. Thus, it is rarely utilized to study viral genomes (Cook, Luo, Guttman, & Thompson, 2020). This can be inferred as a factor that resulted in the slight awareness of the respondents on the general information, application, and procedures related to AGE.

C. *Level of Preparedness*

Table 6 shows the level of preparedness of the respondents on the extraction of nucleic acids from bacteria, viruses, and human biological samples. The respondents were moderately prepared to extract DNA or RNA on the given organisms, with an average weighted mean of 2.93.

TABLE VI. Level of preparedness on the extraction from specimens used in molecular diagnostic assays

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

Statement/ Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
How prepared are you in extracting DNA/RNA from bacteria?	4 3 2 1	9 37 16 5	13.43 55.22 23.88 7.46	2.75	Moderately prepared
How prepared are you in extracting DNA/RNA from viruses?	4 3 2 1	11 36 17 3	16.42 53.73 25.37 4.48	2.82	Moderately prepared
How prepared are you in extracting DNA/RNA from human biological samples?	4 3 2 1	22 37 8 0	32.84 55.22 11.94 0.00	3.21	Moderately prepared
AVERAGE ($\bar{x}$)				**2.93**	**Moderately prepared**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

Table 7 presents the level of preparedness on operation and calibration of machines used in molecular diagnostic assays. The lowest level of preparedness was manifested in AGE (X_W=2.27), whereas extreme preparedness was observed with a spectrophotometer (X_W=3.60) and PCR operation (X_W=3.40). Overall, the respondents were moderately prepared on operation and calibration on these machines ($\bar{x}$=2.96).

TABLE VII. Level of preparedness on operation and calibration of machines used in molecular diagnostic assays

Statement/ Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
How prepared are you to operate a spectrophotometer?	4 3 2 1	43 21 3 0	64.18 31.34 4.48 0.00	3.60	Extremely prepared
How prepared are you to operate a PCR machine?	4 3 2 1	30 34 3 0	44.78 50.75 4.48 0.00	3.40	Extremely prepared
How prepared are you to operate an agarose gel electrophoresis equipment?	4 3 2 1	4 19 35 9	5.97 28.36 52.24 13.43	2.27	Slightly prepared
AVERAGE ($\bar{x}$)				3.09	**Moderately prepared**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

The respondents were extremely prepared on interpreting PCR and spectrophotometer results but moderately prepared in interpreting the results from AGE. With an average weighted mean of 3.21, these data show that the respondents were only moderately prepared on the interpretation of results in molecular diagnostic assays (Table 8).

TABLE VIII. Level of preparedness on the interpretation of results in molecular diagnostic assays

Statement/ Question	**Scale**	**f**	**%**	Weighted mean (X_W)	**Verbal Interpretation**
How prepared are you to interpret the results from a PCR machine?	4 3 2 1	40 24 3 0	59.70 35.82 4.48 0.00	3.55	Extremely prepared
How prepared are you to interpret the results from a spectrophotometer?	4 3 2 1	36 28 3 0	53.73 41.79 4.48 0.00	3.49	Extremely prepared
How prepared are you to interpret the result of an agarose gel electrophoresis equipment?	4 3 2 1	7 26 33 1	10.45 38.81 49.25 1.49	2.58	Moderately prepared
AVERAGE ($\bar{x}$)				**3.21**	**Moderately prepared**

Legend: 1.00 to 1.74 — Not aware at all; 1.75 to 2.49 — Slightly aware; 2.50 to 3.24 — Moderately aware; 3.25 to 4.00 — Extremely aware

New techniques in molecular diagnosis require limited education and training of laboratory staff. Medical laboratory scientists must understand molecular-based technologies' principles to ensure appropriate interpretation and significance of results. With this, specific training must be given and must be a priority (Sarkinfada, Auwal, & Manu, 2014). Training workshops on molecular biology techniques are effective in imparting knowledge to those who underwent training. Participants who also underwent training showed greater confidence and positive feedback on the impact of training on knowledge and skill acquisition (Yisau et al., 2017). Given that these respondents underwent training, their training experiences contributed to their level of preparedness in the different applications and techniques in molecular diagnostic assays.

Based on Table 2 and 6, the pattern of difference between the two data ratings appeared paradoxical, as the medical technologist is extremely knowledgeable in chromosomal DNA extraction but only moderately prepared in the actual work setting. This can be explained by the Dunning-Kruger effect, which states that individuals with less understanding of a specific topic tend to overestimate their actual performance in tests (Weisman, 2019). The most plausible explanation for this psychological phenomenon is that such individuals lack understanding and ability and the metacognition necessary to evaluate their performance as unsatisfactory. Furthermore, less experienced personnel compared to professionals have less metacognitive skills to assess their performance (Rahmani, 2020). Given that 70.15% of the respondents have less than five years of work experience, low metacognition is plausible,

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

increasing the possibility of the Dunning Kruger effect. The data gathered by Ganni et al. (2016), who compared the assessments of 150 medical residents to professional evaluations of laparoscopic cholecystectomy operations, support Rahmani's claim. Except for "tissue handling," the researchers discovered a significant association ($r2 > 0.5$; p 0.001) in all assessment areas.

Tables 7 and 8 show a clear distinction between which instruments the medical technologists are prepared to use. The results show they are extremely prepared to operate, calibrate and interpret results from the PCR machine and spectrophotometer. At the same time, there is a dip in preparedness when it comes to AGE. Most of the molecular diagnostic training for medical technologists focuses on RT-PCR testing workflow, real-time PCR, and RT-PCR troubleshooting. There is no clear highlight on methods for AGE. Although molecular techniques can diagnose an array of infections, the type of training most medical technologists have is limited to SARS- CoV2. In addition, most molecular diagnostic laboratories only have instruments for COVID-19 testing. Real-time reverse transcription-polymerase chain reaction (RT-qPCR) is widely accepted as the "gold standard" for directly detecting and diagnosing SARS-CoV-2 infections (Silva Júnior et al., 2021). In this method, the PCR product is already measured during the exponential phase (Rao, Lai, & Huang, 2013), removing the need to use AGE instead of endpoint PCR, which needs an electrophoresis step. The training provided and equipment available for medical technologists are only for RT-qPCR and not endpoint PCR, which would explain the dip in awareness and preparedness for AGE methods. Thus, lack of preparedness in some aspects of molecular techniques is unsurprising due to prioritizing the pandemic first rather than other diseases.

D. Correlation

Table 9 shows that there is a significant, strong correlation between the level of awareness and level of preparedness of medical technologists with molecular diagnosis ($r = 0.755$; $p < .05$). This implies that as the level of awareness of medical technologists increases, the level of preparedness of medical technologists also increases. Therefore, given the results, the null hypothesis of the study is rejected, which states that there is no significant relationship between the level of awareness and the level of preparedness of medical technologists with molecular diagnosis.

TABLE IX. Correlation between the level of awareness and preparedness of medical technologists with molecular diagnosis

Variables being correlated:	**Pearson r Correlation Coefficient**	**Interpretation**	**p-value**	**Decision** $\alpha=0.05$
Overall level of awareness & level of preparedness of medical technologist in molecular diagnosis	0.755	Strong Correlation	.000	Reject H_0, significant

These results are consistent with the findings of the study conducted by Groves (2013) on knowledge, involvement, and emergency preparedness, wherein knowledge was implied to have a significant relationship to the perceived level of personal emergency preparedness. It was also implied that the higher the perceived knowledge, the higher the perceived level of personal emergency preparedness. In addition, another study conducted by Odeyemi and Oyelami (2010) revealed that participants who underwent training had increased their ability to perform molecular diagnosis. The success or failure of molecular diagnosis is determined by medical laboratory scientists' knowledge, awareness, and application. Hence, the relationship between the level of awareness and the level of preparedness of medical technologists with molecular diagnosis is significantly based on their knowledge, training, and other factors that may affect one's awareness and preparedness.

IV. CONCLUSION AND RECOMMENDATIONS

Data collected from this study shows extreme awareness of medical technologists on molecular biology. However, there was a moderate overall level of awareness regarding general information, applications, and procedures on molecular diagnostic assays. On the level of preparedness survey, collected data shows a moderate overall preparedness on the extraction, operation, calibration, and interpretation of results in molecular diagnostic assays. In a study conducted by Odeyami and Oyelami (2010), it revealed that participants who underwent training had increased their ability to perform molecular diagnosis. Therefore, the success or failure of molecular diagnosis is determined by medical laboratory scientists' knowledge, awareness, and application. Hence, the relationship between the level of awareness and the level of preparedness of medical technologists with the emerging technologies in molecular diagnosis is significantly based on their knowledge, training, and other factors that may affect one's awareness and preparedness. As intervention to the moderate level of awareness and preparedness of the respondents, the proponents encourage the provision of relevant training programs and refresher courses would be imperative to let registered medical technologists learn up to date information and enhance skills in emerging diagnostic techniques and practices relevant to the medical field. Such training programs can reinforce their awareness and improve their preparedness in terms of practical application in the clinical setting. Additionally, to better comprehend their answers and explain the matter, an in-depth interview with the respondents is recommended to be added in the methods of future studies. Moreover, future researchers should attain a larger sample size and widen the scope of the study.

Acknowledgment

The authors would like to express their sincerest gratitude to the Department of Science and Technology Science Education and Institute (DOST-SEI) and DOST Regional Office No. V - Bicol for the financial grants. Above all, to our Almighty God, who guided the researchers every step of the way to the right path, and for intellect, patience, persistence, and guidance until the study was completed.

References

[1] Ali, N., Rampazzo, R. D., Costa, A. D., & Krieger, M. A. (2017). Current nucleic acid extraction methods and their implications to point-of-care diagnostics. BioMed Research International, 2017, 1-13. doi:10.1155/2017/9306564

[2] Boniol, M., McIsaac, M., Xu, L., Wuliji, T., Diallo, K. et al. (2019). Gender equity in the health workforce: analysis of 104 countries. World Health Organization. https://apps.who.int/iris/handle/10665/311314. License: CC BY-NC-SA 3.0 IGO

[3] Buckingham, L. (2019). Molecular diagnostics: Fundamentals, methods, and clinical applications (3rd ed.). F.A. Davis Company.

[4] CNN Philippines. (2021, April 14). New medicine graduates may enter COVID-19 battlefield as a last resort. CNN. Retrieved June 05, 2021, from https://cnnphilippines.com/news/2020/4/14/medicine-graduates-hospitals-coronavirus-.html.

[5] Commission on Higher Education. (2017). CHED Memorandum Order No. 13 Series of 2017. Commission on Higher Education [PDF]. Available at: https://ched.gov.ph/wp-content/uploads/2017/10/CMO-13-s-2017.pdf
[6] Cook, K. S., Luo, J., Guttman, A., & Thompson, L. (2020). Vaccine Plasmid Topology Monitoring by Capillary Gel Electrophoresis. Current molecular medicine, 20(10), 798–805. https://doi.org/10.2174/1566524020666200427110452
[7] Department of Health. (2020, August 7). Philippines now has 100 licensed testing labs. Retrieved October 3, 2020, from https://www.doh.gov.ph/doh-press%20release/PHILIPPINES-NOW-HAS-100-LICENSED-TESTING-LABS-%E2%80%93-DOH
[8] Fetalco, M. (2020, May 25). DOH confirms 32,000 estimated testing capacity. Retrieved May 28, 2021, from https://ptvnews.ph/doh-confirms-32000-estimated-testing-capacity/
[9] Ganni, S., Chmarra, M. K., Goossens, R. H., & Jakimowicz, J. J. (2016). Self-assessment in laparoscopic surgical skills training: Is it reliable? Surgical Endoscopy, 31(6), 2451-2456. doi:10.1007/s00464-016-5246-6
[10] Lo, R., Barrientos, A., Espiritu, B., Santiago, F. K., Tandoc, A., III, Velasco, J., & Yanez, S. (2020, December 20). An Evaluation of Pooling Strategies for RT-qPCR testing for SARS-CoV-2 Infection: A Pragmatic Multi-site Parallel Operational Study. Philippine Journal of Pathology, 5(2), 12-33. doi:10.21141/pjp.2020.12
[11] Odeyemi, O. A., & Oyelami, J. O. (2011). Knowledge, awareness and usage of molecular biology techniques as medical diagnostic tools among medical laboratory practitioners in Nigeria. International Journal of Biological & Medical Research, 2(4), 1051–1054.
[12] Philippine Association of Medical Technologists, Inc. (2020, January). The PAMET Link, VII.
[13] Professional Regulation Commission. (2021, March 25). March 2021 medical technologist Licensure examination results released in five (5) WORKING DAYS: Professional Regulation Commission. Retrieved September 06, 2021, from https://www.prc.gov.ph/article/march-2021-medical-technologist-licensure-examination-results-released-five-5-working-days
[14] Rahmani, M. (2020). Medical Trainees and the Dunning–Kruger Effect: When They Don't Know What They Don't Know. Journal of Graduate Medical Education, 12(5), 532–534. https://doi.org/10.4300/jgme-d-20-00134.1
[15] Rao, X., Lai, D., & Huang, X. (2013). A New Method for Quantitative Real-Time Polymerase Chain Reaction Data Analysis. Journal of Computational Biology, 20(9), 703–711. https://doi.org/10.1089/cmb.2012.0279
[16] Research Institute for Tropical Medicine. (2020). Training workshop on Molecular Diagnosis of Infectious diseases by PCR. Retrieved October 3, 2020, from https://ritm.gov.ph/training/laboratory-training/training-workshop-on-molecular-diagnosis-of-infectious-diseases-by-pcr/
[17] Sarkinfada, F., Auwal, I., & Manu, A. (2014). Applications of Molecular Diagnostic Techniques for Infectious Diseases. Bayero Journal of Pure and Applied Sciences, 7(1), 37. doi:10.4314/bajopas.v7i1.8
[18] Silva Júnior, J. V. J., Merchioratto, I., de Oliveira, P. S. B., Rocha Lopes, T. R., Brites, P. C., de Oliveira, E. M., … Flores, E. F. (2021). End-point RT-PCR: A potential alternative for diagnosing coronavirus disease 2019 (COVID-19). Journal of Virological Methods, 288, 114007. https://doi.org/10.1016/j.jviromet.2020.114007
[19] Shen, C. H. (2019). Amplification of Nucleic Acids. In Diagnostic Molecular Biology (1st ed., pp. 215-247). MA, Cambridge: Elsevier.
[20] The University of the Philippines Population Institute & Demographic Research and Development Foundation. (2020). Human Resource for Health in the Time of the COVID-

ISSN: 2799 - 1091
Volume 1 Issue 3 | October 2021
Page 43-55

19 Pandemic: Does the Philippines Have Enough?. Retrieved November 7, 2020, from www.drdf.org.ph/sites/default/files/pdf/COVID-19-Research-Brief-08.pdf?fbclid=IwAR3F4Mz0HfqgdFru7W5tzjfOpIslOEpfM3drgvdJj87XnfWqM0s5lt6ghks

[21] Verma, R. K., Wong, S., Chakravarthi, S., & Barua, A. (2014). An assessment of the level of awareness, attitudes, and opinions of the medical students concerning HIV and AIDS in Malaysia. Journal of Clinical and Diagnostic Research. https://doi.org/10.7860/JCDR/2014/7829.4286

[22] Weisman, J. (2019). A Systematic Review of Medical Students' and Professionals' Attitudes and Knowledge regarding Medical Cannabis as a Proxy for Forecasting Trends in the Medical Community's Acceptance of Therapeutic Hallucinogens. Pitzer Senior Theses. 101. Retrived from https://scholarship.claremont.edu/pitzer_theses/101

[23] Yisau, J. I., Adagbada, A. O., Bamidele, T., Fowora, M., Brai, B. I., Adebesin, O., . . . Smith, S. I. (2017). Assessment of knowledge of participants on basic molecular biology techniques after 5-day intensive molecular biology training workshops in Nigeria. Biochemistry and Molecular Biology Education, 45(4), 313-317. doi:10.1002/bmb.21039