Assessing the impact of advanced vaccine education on students' understanding, confidence and preparedness in becoming future immunization providers

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Introduction: With community pharmacists emerging as prominent immunization providers, there is an increased need for additional training in this area. The primary objective of this pre-post questionnaire study was to evaluate the impact of a series of webinars on advanced vaccine education on the understanding, confidence, and knowledge of undergraduate PharmD students.

Methods: A 7 question, web-based survey was administered to third year PharmD students at the University of British Columbia, prior to and immediately after attending the 6-part webinar education series from November 2021 to March 2022. The pre- and post- survey data were analyzed using SPSS 26. A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of each question before and after the educational intervention was significantly different from zero.

Results: In group of predominantly third year pharmacy students **63** completed the pre-survey questionnaire, **27** students completed the post-survey questionnaire, and **12** students completed the vaccine education series and post-survey. Pre-survey questionnaire results showed significant knowledge gaps in the areas of patient assessment, scope of practice, immunization assessment, and public vaccine programs. After the educational webinar series, students showed significantly higher knowledge and confidence across all domains pertaining to community vaccination practice.

Conclusions: Considerable knowledge gaps exist for graduating community pharmacists in vaccine education. Canadian pharmacy school curriculums currently address only technical administration of vaccinations and module type therapeutics on vaccine preventable diseases. Pharmacy students will benefit from integrated education focusing on addressing vaccine hesitancy, immunization status assessment, jurisdictional routine immunization programs, navigating scope of practice, coverage and reimbursement. Furthermore, communities may also benefit from frontline healthcare providers who are highly trained to address their vaccination status and related concerns.

Introduction

Pharmacists have played a large role in the delivery of recommended immunizations in an accessible community setting. Expansion in scope of practice has allowed for pharmacists to provide all recommended vaccinations to at risk populations based on assessment and best practice guidelines. This role has been further personified with the participation of community pharmacists in the delivery of COVID-19 vaccinations across the country.

After surveying the educational needs of 15 UBC pharmacy students in 2020-2021, we identified critical gaps in the training and education of future pharmacist's needed to provide comprehensive immunization services in a community practice setting. These learning gaps existed between student's "technical" immunization administration training and their education in the infectious disease therapeutic's module. Specific learning objectives pertaining to vaccine hesitancy, scope of practice, immunization assessment, and public vaccine programs formed the basis of a 6-part monthly education series **(Figure 1).**

The learning objectives were addressed across key vaccine preventable disease areas important for pharmacists in community practice. The specific topics and their respective session descriptions are shown in **(Table 1).** The educational sessions were presented in both virtual and in person formats. For live events, a virtual stream was provided for students to attend if they were not on campus that day. All presentations featured a pharmacist immunization subject matter expert, with the final event having three pharmacist experts across Canada. Presentations also included a discussion portion where students could actively participate and engage with the subject matter expert.

Figure 1: Learning Objectives for the Vaccine Education Series

1. Understand the true "burden" of vaccine preventable diseases
2. Develop communication skills around "vaccine hesitancy"
3. Discuss how to properly assess patient vaccination records
4. Evaluate the scope of practice for BC pharmacists when dispensing and administering a vaccine
5. Review the "evolving landscape" of both public health and individual vaccine recommendations
6. Appreciate the pharmacist's role in "recommended unfunded" vaccinations

Table 1: Vaccine Education Series

Topic	Description
Influenza: The Unfolding Story	The 2009 H1N1 pandemic brought pharmacists to the forefront of delivering vaccination services. Since then, pharmacists have been the largest provider of seasonal influenza vaccinations across the provinces! But is administering publicly funded influenza vaccinations the full extent of the pharmacist's role? Find out more about how the story continued to "unfold".
Pharmacists' Role in Pneumococcal Disease	Understanding the true "burden" of pneumococcal disease on both patients and the healthcare system highlights the power of prevention. "Comprehensive" vaccination against vaccine preventable strains of community acquired pneumonia is a critical patient intervention for community pharmacists. Learn about practice opportunities where pharmacists can close the "information access gap" and protect their patients against pneumococcal disease.
HPV Vaccination	We have very few tools in medicine which can "prevent disease". We have even fewer which can prevent cancer. Persistent infection with Human Papilloma Virus (HPV) can lead to devastating cancers which affect both males and females. Vaccination against HPV is a powerful intervention pharmacists can make for their patients across the lifespan. Learn about the burden of HPV disease, how the virus causes cancer, and opportunities to prevent it.

Meningitis: Protecting adolescent patients before it's too late	Invasive Meningococcal Disease (IMD) is a devastating neurological infection which can disproportionately affect adolescents and young adults. Albeit a rare infection, once it manifests, there is a high mortality risk and life-changing sequelae for survivors. Pharmacists can help identify at-risk groups and address the vaccination gaps that exist in the current routine vaccination program for IMD.
Shingles disease and vaccination	The reactivation of dormant varicella zoster infection as herpes zoster (shingles) can lead to devastating consequences. Vaccination for adults over the age of 50 is nationally recommended for protection against herpes zoster infection and its complications. Despite this national recommendation, vaccination rates among those at risk remains low. Learn about how pharmacists can “take the lead” on closing the gap on shingles prevention in community practice.
Pharmacist's awareness about Vaccine Hesitancy (Panel Discussion)	The vaccine education series concludes with a panel discussion moderated by Ajit Johal, featuring prominent vaccinating pharmacists on the topic of vaccine hesitancy. Identified in 2019 by the WHO as a serious global health concern, this issue of vaccine hesitancy has made its way further to the forefront with the COVID-19 pandemic. Learn from experienced pharmacists about how to address vaccine hesitancy in your practice.

Methods

Students participating in the webinar and presentation events were asked to complete a vaccine learning "needs assessment" questionnaire to help shape future learning and training for pharmacy students on the topic of vaccinations. The questionnaire was administered prior to the educational presentations in November 2021 and repeated following the completion of educational events in April 2022. To increase response rate and engagement, students were eligible to enter a draw for an ipad if they had completed the pre- and post-program surveys.

Data Analysis

The pre- and post-survey data were analyzed using SPSS version 26. A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of each of the seven questions before and after the educational program as was significantly different from zero. The result of the two-tailed paired samples *t*-test was significant, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean scores of all pre-survey questions and the mean scores of post survey questions was significantly different from zero. The mean of all presurvey questions (1 to 7) was significantly lower than the mean of post survey questions. Sub-group analysis of the above statistical test was preformed on both the 27 student group who completed at least one educational event, along with the 12 student group who completed all six events **(Appendix A).** For the students who completed all six events even greater differences in mean scores between all pre and post-survey questions was observed.

Results

Demographics

Out of the total class of 220 third year PharmD students, 63 students completed the survey prior to program delivery, 27 students completed the post survey, 12 students completed both pre- and post-surveys, as well as attended all six events.

Burden of Disease

Students scored their self-assessed knowledge and comfort on the "burden" of vaccine preventable diseases as low (<5 on a 10-point scale). For those students who attended all 6 educational events, post-survey results showed considerable improvement in knowledge and comfort in educating patients on this topic.

Vaccine Hesitancy

Students scored their self-assessed skills to address patient "vaccine hesitancy" in community practice. For those students who attended all 6 educational events, post-survey results showed considerable improvement in knowledge and comfort in educating patients on this topic.

Immunization "Assessment"

When it came to patient vaccine status assessment, students self-assessed their ability and comfort as low. This included making guideline-based recommendations in the context of individual risk factors and vaccination history. For those students who attended all 6 educational events, post-survey results showed considerable improvement in confidence when performing these patient assessments.

Scope of Practice

Students naturally scored low in this domain, given they have yet to practice as a full-pharmacists and are therefore not yet aware of their professional scope upon licensure. For those students who attended all 6 educational events, post-survey results showed improvement in their understanding of pharmacy immunization scope of practice.

Routine vs Recommended Vaccinations

Students scored the lowest in the final two self-assessment questions pertaining to both routine immunization programs and recommended unfunded vaccinations. As a result, post-survey results for students who attended all 6 educational events, showed the highest changes of increased self-assessed competency.

Discussion

Table 2: Confidence of pharmacy students Pre-Survey Vaccination Topics

Question	Average Confidence % (/100)
How comfortable are you in educating patients on the evidence based "burden" of vaccine preventable diseases? (This includes discussion of case fatality ratio, complications, long-term sequelae, and impact on quality of life)	**48.73**
How confident are you is addressing "vaccine hesitancy" in a patient across all three domains? This refers to (complacency, confidence, convenience)	**51.76**

How comfortable are you in assessing patient immunization records? This includes locating records, identifying “gaps” and making guideline-based recommendations based of age and lifestyle risk factors.	**49.82**
How would you rate your understanding of the current scope of practice in BC for pharmacists in “dispensing and administering” vaccinations? This includes recommending and administering vaccines independent of a physician prescription based on your patient assessment and any national or international immunization guideline.	**55.23**
How comfortable are you in dispensing and administering a recommended vaccine (schedule 2) for patients who have coverage under third-party plans?	**52.77**
How would you rate your understanding of the difference between public health vaccine recommendations and those for individual patients? This includes understanding of economic decisions to include a vaccine in the public program, the difference between relative and absolute risk reduction, and changing epidemiology of vaccine preventable disease.	**45.84**
How confident are you in engaging patients on the topic of “recommended unfunded vaccines? This includes in-depth understanding of which vaccines are “publicly funded” and which are recommended (based on evidence-based guidelines) but must be purchased out of pocket. It also includes how to address which populations would benefit from these vaccines and how to communicate the value of these vaccinations to patients.	**46.44**

Table 3: Confidence, Knowledge, Understanding of pharmacy students on Vaccination Topics pre- and post- vaccine education series students who completed at least 1 event (n=27)

Question	Mean Average Confidence % (/100) **Before**	Mean Average Confidence % (/100) **After (Attending at least one event)**
How comfortable are you in educating patients on the evidence based "burden" of vaccine preventable diseases? (This includes discussion of case fatality ratio, complications, long-term sequelae, and impact on quality of life)	**47.59**	**77.30**
How confident are you is addressing "vaccine hesitancy" in a patient across all three domains? This refers to (complacency, confidence, convenience)	**52.52**	**80.30**
How comfortable are you in assessing patient immunization records? This includes locating records, identifying "gaps" and making guideline-based recommendations based of age and lifestyle risk factors.	**47.58**	**75.35**
How would you rate your understanding of the current scope of practice in BC for pharmacists in "dispensing and administering" vaccinations? This includes recommending and administering vaccines independent of a physician	**50.65**	**82.08**

prescription based on your patient assessment and any national or international immunization guideline.		
How comfortable are you in dispensing and administering a recommended vaccine (schedule 2) for patients who have coverage under third-party plans?	**51.52**	**78.62**
How would you rate your understanding of the difference between public health vaccine recommendations and those for individual patients? This includes understanding of economic decisions to include a vaccine in the public program, the difference between relative and absolute risk reduction, and changing epidemiology of vaccine preventable disease.	**41.54**	**79.46**
How confident are you in engaging patients on the topic of “recommended unfunded vaccines? This includes in-depth understanding of which vaccines are “publicly funded” and which are recommended (based on evidence-based guidelines) but must be purchased out of pocket. It also includes how to address which populations would benefit from these vaccines and how to communicate the	**45.54**	**78.73**

value of these vaccinations to patients.		

Table 4: Confidence, Knowledge, Understanding of pharmacy students on Vaccination Topics pre- and post- vaccine education series students who completed all 6 events (n=12)

Question	Mean Average Confidence % (/100) **Before**	Mean Average Confidence % (/100) **After (Attended all 6 events)**
How comfortable are you in educating patients on the evidence based "burden" of vaccine preventable diseases? (This includes discussion of case fatality ratio, complications, long-term sequelae, and impact on quality of life)	**40.25**	**79.16**
How confident are you is addressing "vaccine hesitancy" in a patient across all three domains? This refers to (complacency, confidence, convenience)	**53**	**86.83**
How comfortable are you in assessing patient immunization records? This includes locating records, identifying "gaps" and making guideline-based recommendations based of age and lifestyle risk factors.	**43.75**	**80.25**
How would you rate your understanding of the current scope of practice in BC for pharmacists in	**50.25**	**87.58**

"dispensing and administering" vaccinations? This includes recommending and administering vaccines independent of a physician prescription based on your patient assessment and any national or international immunization guideline.		
How comfortable are you in dispensing and administering a recommended vaccine (schedule 2) for patients who have coverage under third-party plans?	**50.25**	**78.58**
How would you rate your understanding of the difference between public health vaccine recommendations and those for individual patients? This includes understanding of economic decisions to include a vaccine in the public program, the difference between relative and absolute risk reduction, and changing epidemiology of vaccine preventable disease.	**44.41**	**84.83**
How confident are you in engaging patients on the topic of "recommended unfunded vaccines? This includes in-depth understanding of which vaccines are "publicly funded" and which are recommended (based on evidence-based guidelines) but must be purchased out	**47.66**	**84.16**

of pocket. It also includes how to address which populations would benefit from these vaccines and how to communicate the value of these vaccinations to patients.		

Discussion

This educational initiative was inspired by informal anecdotal accounts from UBC pharmacy students regarding "gaps" in their vaccine education. As pharmacy students made their way from the classroom to administering immunizations in practice, what additional training could make them more confident? Key learning objectives were created along with corresponding needs assessment questions to determine knowledge and confidence pre-and post-educational intervention.

Students scored low across all domains of the needs assessment. Following the educational program, significant increases for all learning objectives was observed for students after completion of the education series. Students who partially attended the educational events scored higher in their post self-assessment, but not as high as those who attended all six events. Rationale for significant changes in student vaccine confidence is discussed below.

A key issue with current pharmacy school curriculums is that although the "burden" of infectious diseases is discussed, it is not discussed in the context of prevention. Furthermore, pharmacy students do not do often do practicum rotations in hospital emergency rooms, intensive care units, and cancer clinics to see first-hand the burden of vaccine preventable diseases. Highlighting the burden of disease illustrates the value of vaccination in preventing or mitigating adverse patient outcomes.

Pharmacists have been classified as the most "accessible" healthcare provider which addresses a key domain of vaccine hesitancy, convenience. Students who attended the educational intervention scored higher in their understanding of vaccine hesitancy which consists of convenience, complacency, and confidence. A better understanding of the complacency domain was addressed with a higher-level understanding of the burden of vaccine preventable disease. Confident immunization providers can also be successful in addressing patient concerns of vaccine safety.

A greater understanding of their scope of practice can enable new pharmacy graduates to have an immediate impact on supporting their patients. Community pharmacists should embrace vaccinations as perhaps the most powerful tool at their disposal in order to improve the health of their patients and communities. This is clearly reflected in the scope of practice for

pharmacists across the country, where in most jurisdictions, pharmacists can administer vaccinations but not prescribe medications for their patients.

Current pharmacy school curriculums do not address the expanding role of pharmacists in the immunization "assessment" domain. A patient immunization assessment consists of reviewing their vaccination history, relevant risk factors and administering evidence-based vaccinations to improve their health status. Current training for pharmacists consists of education on each area separately but there is a lack of application to real world practice settings.

Finally, pharmacists play a critical role in facilitating access to all recommended vaccinations including both routine and recommended "unfunded" vaccinations. A greater understanding of the jurisdictional public vaccination programs would better equip pharmacists to deliver comprehensive immunization assessments. Immunizing pharmacists would better address routine immunization gaps, especially in adults, but also determine all guideline-based vaccination recommendations regardless of funding status. The 2013 paper written by Scheifele et al "Approved but non-funded vaccines: accessing individual protection", clearly outlines the role of pharmacists in making these important vaccinations available for patients (1).

There were several limitations of this survey. The uptake rate was low due to the educational program not being part of the regular academic program. The drop-out rate from session to session was also high. Despite 63 students completing the initial survey, only 27 students completed the post-survey, with 12 students attending the complete program and completing the final post-program survey. The questionnaire, although only 7 questions, does require careful reading and self-assessment. Given that at least two students indicated a 10/10 self-assessed confidence in the area of scope of practice (despite not ever practicing as a licensed pharmacist) indicates that some students may not have read the questions carefully. The questionnaire itself is not validated, so the results may not reliably predict the confidence regarding immunization practice amongst this sampled group of students.

Current pharmacy students at the University of British Columbia are certainly keen to adopt and become experts in the immunization space. Given that this educational initiative was outside the current curriculum, and there was no academic obligation, 79 total students attended at least 1 educational event. Unfortunately, only 12 students were able to receive the full educational training. Justifying an urgent need to integrate more training on immunization in Canadian pharmacy school curriculums.

Conclusion

Canada leads the way when it comes to mobilizing pharmacists as immunization providers, with other jurisdictions recently expanding the scope of practice for pharmacists to provide routine vaccinations (2). Most jurisdictions in Canada allow for the administration of vaccinations by pharmacists. Provinces, British Columbia, Alberta, Saskatchewan allow for further expanded scope to independently recommend and administer vaccinations based on patient assessment (3).

Increasing the pharmacist's role in the provision of immunization services begins at a "grassroots level" with comprehensive education for pharmacy students. Addressing learning gaps pertaining to patient assessment, vaccine hesitancy, jurisdictional programs and scope of practice within the pharmacy school curriculum will improve knowledge and confidence of pharmacy graduates.

The COVID-19 pandemic has highlighted the need to deliver accessible adult immunization programs in a sustainable fashion. The annual need for seasonal influenza, and possibly COVID-19 vaccinations requires additional immunization provider capacity in the community. Disruptions to routine immunization programs has also led to an increased need for community immunization providers in order to help patients "catch up" on their routine immunizations. Finally, age, lifestyle and medical risk factors increase an individual's risk in suffering morbidity secondary to vaccine preventable diseases. An enhanced capacity to identify and address "immunization gaps" in a convenient setting with a knowledgeable healthcare provider will prevent downstream healthcare utilization costs. Community pharmacists can certainly become this accessible and knowledgeable provider with additional training added to current pharmacy school curriculums.

References:

1. Scheifele DW, Ward BJ, Halperin SA, McNeil SA, Crowcroft NS, Bjornson G. Approved but non-funded vaccines: accessing individual protection. Vaccine. 2014 Feb 7;32(7):766-70. doi: 10.1016/j.vaccine.2013.12.027. Epub 2013 Dec 25. PMID: 24374500.

2. Ecarnot F, Crepaldi G, Juvin P, Grabenstein J, Del Giudice G, Tan L, O'Dwyer S, Esposito S, Bosch X, Gavazzi G, Papastergiou J, Gaillat J, Johnson R, Fonzo M, Rossanese A, Suitner C, Barratt J, di Pasquale A, Maggi S, Michel JP. Pharmacy-based interventions to increase vaccine uptake: report of a multidisciplinary stakeholders meeting. BMC Public Health. 2019 Dec 18;19(1):1698. doi: 10.1186/s12889-019-8044-y. PMID: 31852470; PMCID: PMC6921486.
3. What Pharmacists Can do across Canada URL = Scope of Practice - English (pharmacists.ca) accessed April 26th 2022

Appendix A: Statistical Analysis

Group 1: Confidence, Knowledge, Understanding of pharmacy students on Vaccination Topics pre- and post- vaccine education series students who completed at least 1 event (n=27)

Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q1_1 and Q1_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(26) = -6.00$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q1_1 and the mean of Q1_2 was significantly different from zero. The mean of Q1_1 was significantly lower than the mean of Q1_2. The results are presented in Table 1. A bar plot of the means is presented in Figure 1.

Table 1

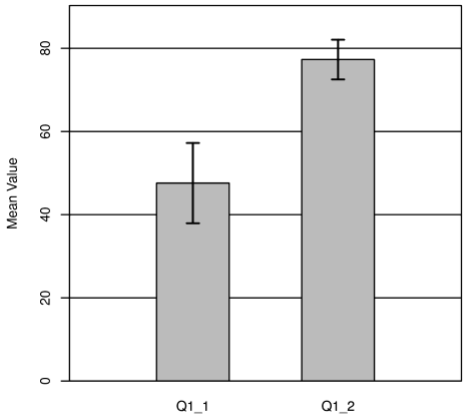
Two-Tailed Paired Samples t-Test for the Difference Between Q1_1 and Q1_2

Q1_1		Q1_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
47.59	25.58	77.30	12.67	-6.00	< .001	1.16

Note. N = 27. Degrees of Freedom for the *t*-statistic = 26. *d* represents Cohen's *d.*

Figure 1

The means of Q1_1 and Q1_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q2_1 and Q2_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(26) = -5.60$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q2_1 and the mean of Q2_2 was significantly different from zero. The mean of Q2_1 was significantly lower than the mean of Q2_2. The results are presented in Table 2. A bar plot of the means is presented in Figure 2.

Table 2

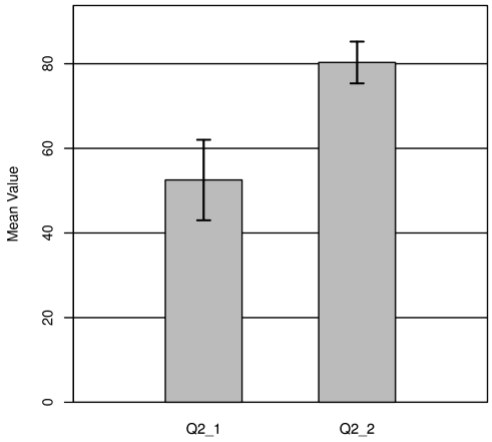
Two-Tailed Paired Samples t-Test for the Difference Between Q2_1 and Q2_2

Q2_1		Q2_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
52.52	25.20	80.30	13.08	-5.60	< .001	1.08

Note. N = 27. Degrees of Freedom for the *t*-statistic = 26. *d* represents Cohen's *d.*

Figure 2

The means of Q2_1 and Q2_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q3_1 and Q3_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(25) = -4.64$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q3_1 and the mean of Q3_2 was significantly different from zero. The mean of Q3_1 was significantly lower than the mean of Q3_2. The results are presented in Table 3. A bar plot of the means is presented in Figure 3.

Table 3

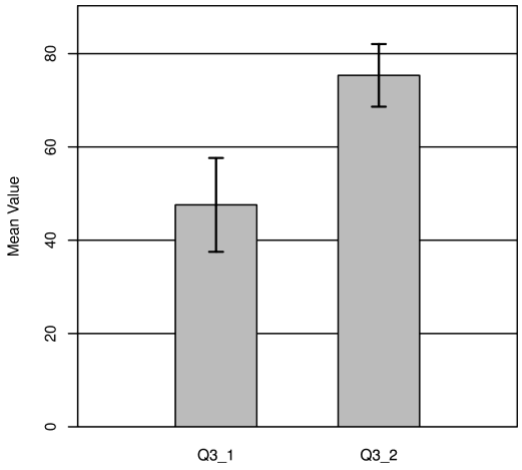
Two-Tailed Paired Samples t-Test for the Difference Between Q3_1 and Q3_2

Q3_1		Q3_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
47.58	26.18	75.35	17.48	-4.64	< .001	0.91

Note. N = 26. Degrees of Freedom for the *t*-statistic = 25. *d* represents Cohen's *d.*

Figure 3

The means of Q3_1 and Q3_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q4_1 and Q4_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(25) = -7.32$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q4_1 and the mean of Q4_2 was significantly different from zero. The mean of Q4_1 was significantly lower than the mean of Q4_2. The results are presented in Table 4. A bar plot of the means is presented in Figure 4.

Table 4

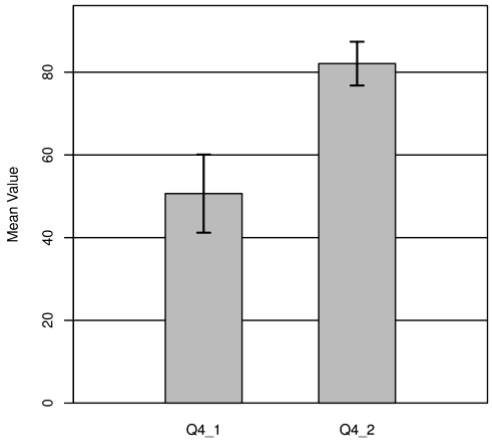
Two-Tailed Paired Samples t-Test for the Difference Between Q4_1 and Q4_2

Q4_1		Q4_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
50.65	24.58	82.08	13.77	-7.32	< .001	1.43

Note. N = 26. Degrees of Freedom for the *t*-statistic = 25. *d* represents Cohen's *d.*

Figure 4

The means of Q4_1 and Q4_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q5_1 and Q5_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(25) = -4.59$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q5_1 and the mean of Q5_2 was significantly different from zero. The mean of Q5_1 was significantly lower than the mean of Q5_2. The results are presented in Table 5. A bar plot of the means is presented in Figure 5.

Table 5

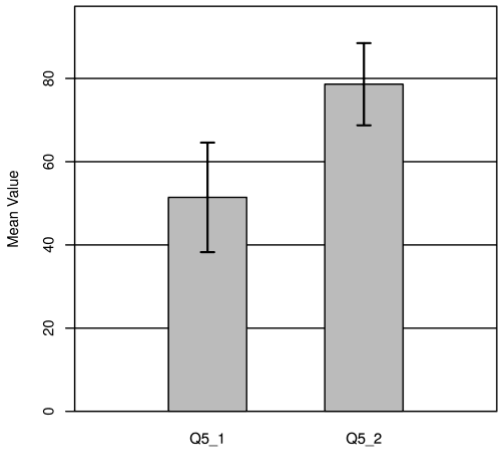
Two-Tailed Paired Samples t-Test for the Difference Between Q5_1 and Q5_2

Q5_1		Q5_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
51.42	34.25	78.62	25.69	-4.59	< .001	0.90

Note. N = 26. Degrees of Freedom for the *t*-statistic = 25. *d* represents Cohen's *d.*

Figure 5

The means of Q5_1 and Q5_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q6_1 and Q6_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(25) = -8.46$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q6_1 and the mean of Q6_2 was significantly different from zero. The mean of Q6_1 was significantly lower than the mean of Q6_2. The results are presented in Table 6. A bar plot of the means is presented in Figure 6.

Table 6

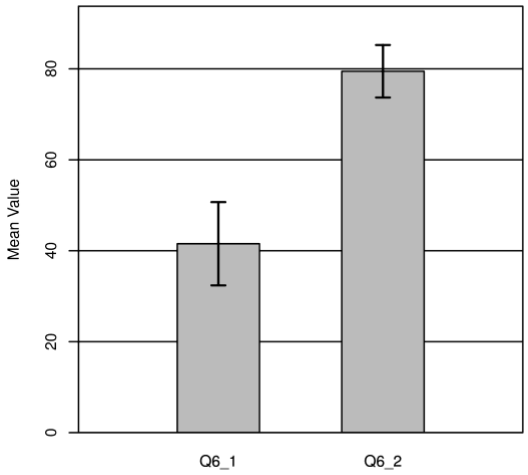
Two-Tailed Paired Samples t-Test for the Difference Between Q6_1 and Q6_2

Q6_1		Q6_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
41.54	23.84	79.46	15.03	-8.46	< .001	1.66

Note. N = 26. Degrees of Freedom for the *t*-statistic = 25. *d* represents Cohen's *d.*

Figure 6

The means of Q6_1 and Q6_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q7_1 and Q7_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant, $t(25) = -7.66$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q7_1 and the mean of Q7_2 was significantly different from zero. The mean of Q7_1 was significantly lower than the mean of Q7_2. The results are presented in Table 7. A bar plot of the means is presented in Figure 7.

Table 7

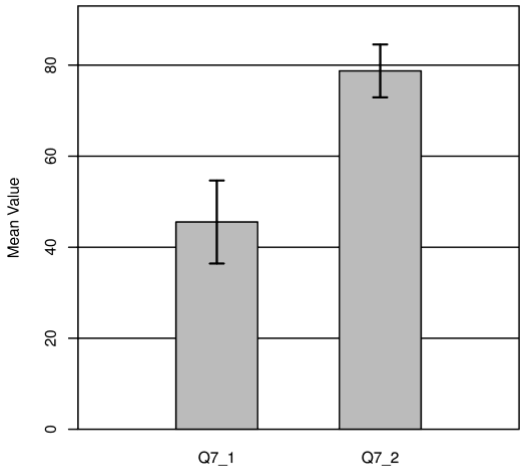
Two-Tailed Paired Samples t-Test for the Difference Between Q7_1 and Q7_2

Q7_1		Q7_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
45.54	23.73	78.73	15.12	-7.66	< .001	1.50

Note. N = 26. Degrees of Freedom for the *t*-statistic = 25. *d* represents Cohen's *d.*

Figure 7

The means of Q7_1 and Q7_2 with 95.00% CI Error Bars



Group 2: Confidence, Knowledge, Understanding of pharmacy students on Vaccination Topics pre- and post- vaccine education series students who completed all 6 events (n=12)

Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q1_1 and Q1_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -5.62$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q1_1 and the mean of Q1_2 was significantly different from zero. The mean of Q1_1 was significantly lower than the mean of Q1_2. The results are presented in Table 1. A bar plot of the means is presented in Figure 1.

Table 1

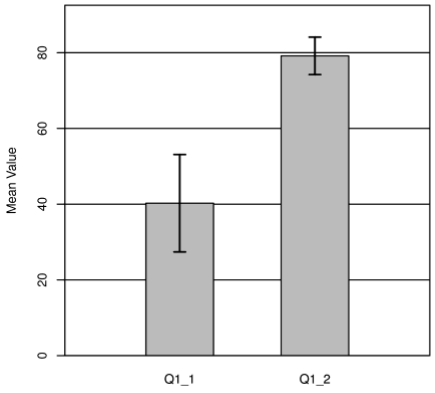
Two-Tailed Paired Samples t-Test for the Difference Between Q1_1 and Q1_2

Q1_1		Q1_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
40.25	22.73	79.17	8.75	-5.62	< .001	1.62

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 1

The means of Q1_1 and Q1_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q2_1 and Q2_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -5.20$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q2_1 and the mean of Q2_2 was significantly different from zero. The mean of Q2_1 was significantly lower than the mean of Q2_2. The results are presented in Table 2. A bar plot of the means is presented in Figure 2.

Table 2

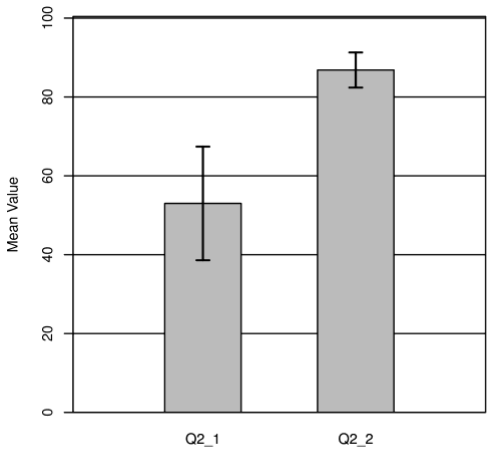
Two-Tailed Paired Samples t-Test for the Difference Between Q2_1 and Q2_2

Q2_1		Q2_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
53.00	25.47	86.83	7.87	-5.20	< .001	1.50

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 2

The means of Q2_1 and Q2_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q3_1 and Q3_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -4.56$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q3_1 and the mean of Q3_2 was significantly different from zero. The mean of Q3_1 was significantly lower than the mean of Q3_2. The results are presented in Table 3. A bar plot of the means is presented in Figure 3.

Table 3

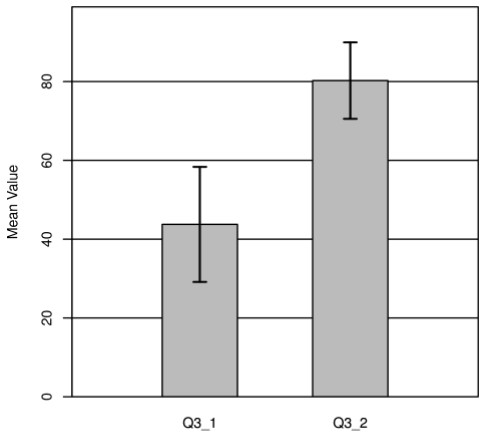
Two-Tailed Paired Samples t-Test for the Difference Between Q3_1 and Q3_2

Q3_1		Q3_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
43.75	25.80	80.25	17.16	-4.56	< .001	1.32

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 3

The means of Q3_1 and Q3_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q4_1 and Q4_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -5.13$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q4_1 and the mean of Q4_2 was significantly different from zero. The mean of Q4_1 was significantly lower than the mean of Q4_2. The results are presented in Table 4. A bar plot of the means is presented in Figure 4.

Table 4

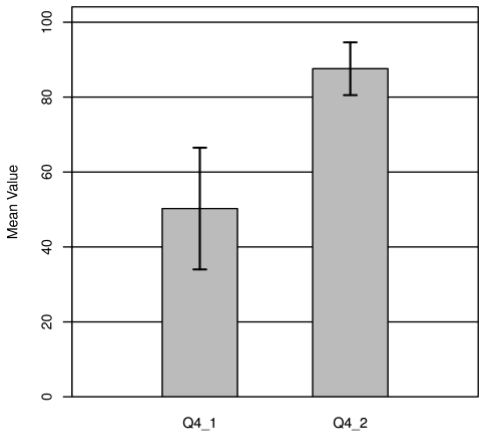
Two-Tailed Paired Samples t-Test for the Difference Between Q4_1 and Q4_2

Q4_1		Q4_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
50.25	28.72	87.58	12.45	-5.13	< .001	1.48

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 4

The means of Q4_1 and Q4_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q5_1 and Q5_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -4.04$, $p = .002$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q5_1 and the mean of Q5_2 was significantly different from zero. The mean of Q5_1 was significantly lower than the mean of Q5_2. The results are presented in Table 5. A bar plot of the means is presented in Figure 5.

Table 5

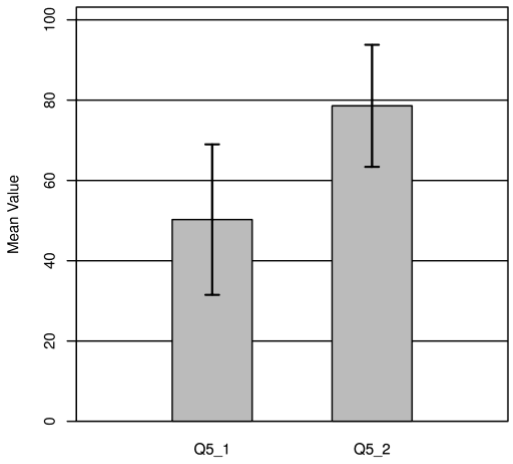
Two-Tailed Paired Samples t-Test for the Difference Between Q5_1 and Q5_2

Q5_1		Q5_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
50.25	33.13	78.58	26.87	-4.04	.002	1.16

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 5

The means of Q5_1 and Q5_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q6_1 and Q6_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -6.13$, $p < .001$, indicating the null hypothesis can be rejected. This finding suggests the difference in the mean of Q6_1 and the mean of Q6_2 was significantly different

from zero. The mean of Q6_1 was significantly lower than the mean of Q6_2. The results are presented in Table 6. A bar plot of the means is presented in Figure 6.

Table 6

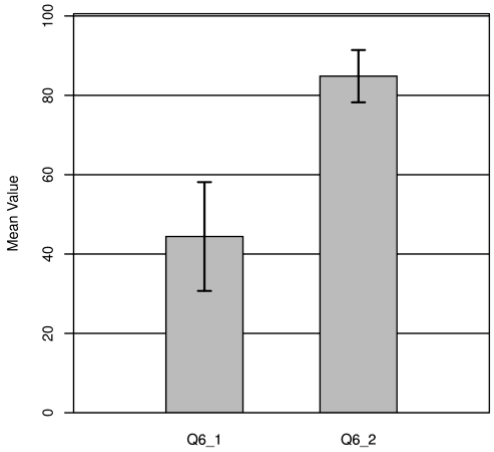
Two-Tailed Paired Samples t-Test for the Difference Between Q6_1 and Q6_2

Q6_1		Q6_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
44.42	24.23	84.83	11.65	-6.13	< .001	1.77

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 6

The means of Q6_1 and Q6_2 with 95.00% CI Error Bars



Two-Tailed Paired Samples *t*-Test

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of Q7_1 and Q7_2 was significantly different from zero.

The result of the two-tailed paired samples *t*-test was significant based on an alpha value of .05, $t(11) = -4.87$, $p < .001$, indicating the null hypothesis can be rejected. This finding

suggests the difference in the mean of Q7_1 and the mean of Q7_2 was significantly different from zero. The mean of Q7_1 was significantly lower than the mean of Q7_2. The results are presented in Table 7. A bar plot of the means is presented in Figure 7.

Table 7

Two-Tailed Paired Samples t-Test for the Difference Between Q7_1 and Q7_2

Q7_1		Q7_2				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
47.67	27.70	84.17	7.48	-4.87	< .001	1.41

Note. N = 12. Degrees of Freedom for the *t*-statistic = 11. *d* represents Cohen's *d.*

Figure 7

The means of Q7_1 and Q7_2 with 95.00% CI Error Bars