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CROSS-SECTIONAL STUDY OF THE KNOWLEDGE, ATTITUDE, PRACTICES AND CONCERNS (KAPC) ABOUT COVID-19 VACCINATION AMONG STUDENTS IN UNIVERSITY OF PAPUA NEW GUINEA

Running title: Covid-19 Vaccination Hesitancy Among University Students

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ABSTRACT:

After the declaration of the COVID-19 pandemic by the WHO in March 2020, the government of Papua New Guinea (PNG) took extraordinary measures to inform and educate the people about the ways of preventing the spread of the deadly virus. Massive awareness campaigns were carried out using most of the available media outlets in the country. The COVID-19 vaccination campaign was launched in March 2021 for healthcare and frontline workers, including medical and health science students. However, many eligible candidates for vaccination were hesitant to accept the vaccine. It was therefore necessary to determine the level of COVID-19 vaccine hesitancy by assessing the students' Knowledge, Attitudes, Practices and Concerns (KAPC) regarding the vaccine. The major aim of this study was to assess the KAPC of students in the University of Papua New Guinea (UPNG), using a questionnaire-based survey. This institutional-based cross-sectional observational descriptive study was carried out in both UPNG campuses, Taurama and Waigani. The study population included both residential and non-residential students. A validated, pretested, self-assessed questionnaire was used to collect information on socio-demographics, social interactions, information-seeking behavior and the KAPC about COVID-19 vaccines. A total of 768 questionnaires were distributed to students. However, based on the inclusion criteria, a total of 118 (15.4%) of the questionnaires collected were excluded. Of the 650 remaining questionnaires 300 were in Taurama and 350 in Waigani. The response rate for Taurama campus was 81.7% compared to 71.1% for the Waigani campus. Knowledge: 98% of students in Taurama, as opposed to 82.3% in Waigani, stated correctly that COVID-19 is caused by a virus. Only 51.8% in Taurama and 31.7% in Waigani said that the genetic material in the virus is RNA. 88.2% in Taurama and 78.3% in Waigani stated that COVID-19 cannot be transmitted by mosquito bites. Knowledge scores for students in Taurama and Waigani were 61.6% and 49.7% respectively. Binary logistic regression analysis showed a significant association between residence and students' Knowledge about the virus and the vaccine. Students in Taurama were about four times more likely to have good knowledge about the virus

and the vaccine than students in Waigani (OR 3.84, 95% CI: 2.64 - 5.58, p-value=<0.001). The low vaccination rate amongst UPNG students was seen as a consequence of their poor knowledge which, in turn, causes poor attitudes, practices, and concerns regarding the efficacy/safety of the vaccine.

INTRODUCTION:

In December 2019, an outbreak of pneumonia cases in Wuhan, China, was later linked to a new virus, 2019-nCoV, so called then [1, 2, 3]. The World Health Organization (WHO) declared 2019-nCoV a Public Health Emergency of International Concern (PHEIC) on 30 January 2020. On the 11 February 2020, the WHO named the disease COVID-19, short for "Coronavirus Disease 2019" [2, 3, 4]. On the 12 March 2020 COVID-19 was declared a pandemic by the WHO [4].

COVID-19 pandemic affected the day-to-day life in multiple ways, causing lockdowns to reduce the rapid spread of the virus [5]. The complexities of modern medicine and research were aggravated by the emerging variants of nCoV-2 which influenced the responses to the drugs and vaccines designed for disease management. These uncertainties and prolonged lockdowns affected people's mental health, causing serious psychological disturbances, such as, depression, anxiety, and inability to tackle negative emotions; these, in turn, led to an increase in suicidal behaviors which became a subject of concern, especially among the youths [6]. Some of the groups that were affected severely include school children, university students, youths, low-income earners, shop-owners, and health professionals.

The COVID-19 Treatment Guidelines Panel (the Panel) recommends COVID-19 vaccination as soon as possible for everyone who is eligible according to the Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices [7].

However, despite immense efforts made to develop safe and effective COVID-19 vaccines, many people including students were hesitant to accept the vaccines [8]. "COVID-19 Vaccine hesitance" can be defined as "low acceptance" or even "rejection" of COVID-19 vaccines by a population, despite the then ongoing vaccination drives. Vaccine hesitancy was listed among the top ten global threats of 2019 [8, 9].

Multiple factors, such as knowledge/perception of the likelihood of the COVID-19 spread, the perceived efficacy and safety of the new vaccines, the logistics of vaccine distribution – all have a bearing on the levels of public acceptance of the vaccine in general.

An assessment of the Knowledge, Attitude, Practices, and Concerns (KAPC) regarding COVID-19 vaccines, therefore, is a logical prerequisite for improving the vaccine acceptance levels among the population, especially in the resource limited countries [10].

Papua New Guinea (PNG) response to the COVID-19 pandemic:

On the 20 March 2020 the Prime Minister of PNG announced the first positive COVID-19 case in the country [11]. On 22 March 2020, a "State of Emergency" (SOE) for 14 days was declared. The entire country was put on a 14-day lockdown. PNG government established the National Emergency Operation Centre (NEOC) which was a multi-ministerial and inter-agency coordination body, to coordinate most of the strategic planning and operations of the health and non-health aspects of government [11]. The SOE was then extended for another two months, to enhance government preparedness measures to respond to COVID-19. The SOE enabled the whole-of-Government approach to the COVID-19 response. PNG Joint Agency Task Force National Control Centre (PNG

JATF NCC) for COVID-19 was established under the National Pandemic ACT 2020. On Tuesday, 9 March 2021, it was reported that the PNG Medical and Scientific Advisory Committee (MESAC), after studying the various COVID-19 vaccines available, had recommended that PNG source the AstraZeneca vaccine which was supplied through the COVID-19 Vaccine Global Access (COVAX) facility and approved by the WHO [11, 12]. On Thursday, 3 June 2021, "Directive No. 2" authorized a voluntary AstraZeneca vaccination to be administered in the vaccination roll-out program in PNG [11]. Approval was also given for the administration of a booster dose or second dose which was also optional. The vaccine was made available freely for those over 18 years of age. However, despite the massive awareness campaigns, only a small proportion of eligible candidates for vaccination, even among students, responded to the appeal to be vaccinated. A survey conducted by the World Bank reported that approximately 18% of PNG citizens were planning to get vaccinated, 26% did not want the vaccine, and 55% had not yet decided; 80% of respondents stated that they had concerns about the side effects of the vaccine, while 50% had no trust in the vaccine [13].

There are, however, no published studies yet on the KAPC among university students. Some studies conducted so far among the general

population have assessed public opinion regarding the COVID-19 vaccine before it was introduced in real time [10, 14]. These studies have used semi-structured questionnaires that had not been validated [10, 14]. Furthermore, these survey tools were administered in populations with vastly diverse socio-demographic and cultural backgrounds which influence the acceptance of COVID-19 vaccine. Some authors have emphasized the need to develop a standard questionnaire, certified or approved by the WHO, for a more uniform interpretation of the views of the target populations regarding the COVID-19 vaccines [15]. The assumption is that this will assist public health authorities in developing uniform advocacy and awareness messages to educate the population in the various countries regarding the need for the approved COVID-19 vaccination.

Vaccine hesitancy during the COVID-19 pandemic is caused by misinformation and lack of adequate knowledge about the COVID-19 vaccines. Thus, the need to assess people's KAPC about COVID-19 vaccines in resource limited countries with diverse cultures like PNG cannot be overemphasized.

The objective of the current study was to use an approved and validated questionnaire [16] to assess KAPC about the COVID-19 vaccines among students in the two campuses in the University of PNG (UPNG), in order to identify the barriers to the acceptance of the COVID-19 vaccine.

METHODOLOGY:

Study sites and subjects: This study was carried out in UPNG, the premier university in PNG. The university is made up of five schools. Four of the five schools (School of Natural and Physical Sciences, School of Humanities and Social Sciences, School of Business and Public Policy and School of Law) are located in the Waigani campus, while the School of Medicine and Health Sciences is located in the Taurama campus. Students in the Taurama campus complete their foundation year in the Waigani campus before moving over to Taurama to pursue the degree in medicine, dentistry or the health sciences. Post-basic nurses from various hospitals around the country are also enrolled in the Taurama campus to complete the nursing degree. The study subjects include students that are currently registered in both UPNG campuses. The study was conducted from May to August 2022.

Sample size: Currently, there is no published data on the prevalence of COVID-19 among students in the UPNG. To obtain the sample size an equation for computing sample size for unknown population size was used, where; Sample Size = (Z-score)^2 * StdDev*(1-StdDev) / (margin of error)^2.

Using the equation, a 95% confidence interval level (Z score =1.96), 0.5 standard deviation, and a margin of error (confidence interval) of +/- 5% was chosen.

The calculated sample size was 384 students in Taurama campus and 384 students in Waigani campus. The total sample size of 768 was considered to be adequate for a mini-survey with limited resources.

Study design and sampling: This was an institution-based cross-sectional observational descriptive study. The target population consisted of only registered students, whether residential or non-residential, in both UPNG campuses. All registered students in their second year or higher were eligible to participate in the study. Simple random sampling was used in the selection of survey participants.

Inclusion criteria: The students were informed about the nature of the study and that their participation was entirely voluntary. All consenting students above 18 years of age were eligible to participate in the study.

Data collection using a validated questionnaire: In the present study a reliable and validated questionnaire prepared by Kumari et al [16] was used for data collection. The questionnaire was modified to assess UPNG students' Knowledge, Attitude, Practices, and Concerns (KAPC) about COVID-19 vaccines. The modified questionnaire was pre-tested among 20 randomly selected students. Feedback and suggested changes were provided orally and in writing. The feedback was used to improve the questionnaire which was used in the present study.

The questionnaire contains two sections (A and B). Section-A probes the respondents' socio-demographic profile and acceptance of COVID-19 vaccines. Section-B seeks to elicit information about the respondent's Knowledge (as well as the sources of that knowledge) about COVID-19 and explores their Attitude, Perception and Concerns regarding the COVID-19 vaccines. In the analysis of the respondent's Knowledge, each correct answer was coded as "one", while each incorrect answer or "don't know" was given zero. A 5-point Likert scale was used to gauge the respondents' attitudes, practices and concerns: strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points) and strongly disagree (1 point).

Statistical analysis and interpretation of the data: Before the statistical analysis, completeness of the data was evaluated. The completed questionnaires were collected, coded and entered into Microsoft Excel Spreadsheets for analysis. Further statistical data analysis was performed using IBM SPSS version 22 (Statistical Package

for the Social Sciences). Descriptive and inferential statistics were used to analyse data, obtained samples, and make inferences about the study population. Descriptive statistics were used to analyse demographic characteristics such as, gender, and residence (campus). Inferential statistics such as Chi-square test were used for analysing categorical variables, such as gender and residence/campus. Chi-square tests were used to compare proportions at significance level $p \leqslant 0.05$, and also to assess the relationship and or association between the independent and dependent variables. T-test (Student's t-test) was used to compare knowledge, attitude, practice and concern scores of students in Taurama and Waigani campuses.

Primary outcome variable (dependent variable) were students' knowledge, attitudes, practices and concern independent variables of interest were gender, and residence. A binary logistic regression model was used to model students' knowledge, attitudes, practices and concerns related to COVID-19.

Interpretation of the KAPC scores: The numbers of correct answers for Q7 to Q12, Q15 to Q18, Q19 and Q20 to Q21 were used to calculate the Knowledge, Attitude, Practices and Concerns scores, respectively. The knowledge score for each participant was determined by allotting a score of '1' to correct responses and '0' (zero) to incorrect and 'don't know' responses.

Attitudes, Practices and Concerns toward COVID-19 vaccine were assessed using the 5-point Likert response scale (1 point for 'strongly disagree' to 5 points for 'strongly agree'). However, for the calculation of the Attitudes, Practices and Concerns scores, the 5-point Likert scale was modified to a 3-point scale. The 3 categories were Agree (strongly agree + agree), Neutral and Disagree (disagree + strongly disagree) [18].

To obtain the score for a section, the number of correct answers obtained was expressed as percentage of the total number of correct answers for the section. The criteria proposed by Hasan et al [23] were used for the categorization of the KAPC levels of the respondents. Score $\geqslant$ 75% was categorized as Good. Scores between 74 – 65% were categorized as Fair. Scores below 64% were categorized as Poor.

Ethical clearance: Ethical approval was obtained from the PNG National Department of Health Medical Research Advisory Committee (NDoH MRAC) and the Ethics and Research Grant committee in School of Medicine and Health Sciences (SMHS), University of Papua New Guinea (UPNG).

Written/Signed informed consent was obtained from each of the participants. The consent was documented on each participant interview form.

This consent procedure was approved by the ethics committees**.**

RESULTS:

Exclusion criteria: The total number of questionnaires distributed was 768. This was made up of 384 in Taurama campus and 384 in Waigani campus. For the exclusion criteria, questionnaires completed by students below 18 years of age were excluded. A total of 84 (21.9%) of the questionnaires from Taurama campus and 34 (8.9%) from Waigani campus were excluded because they were completed by students below 18 years of age.

Demographic characteristics:

Of the 300 questionnaires from Taurama campus, 245 were suitable for analysis (response rate of 81.7%). In Waigani campus, 249 of the 350 questionnaires were suitable for analysis (response rate of 71.1%).

In Taurama campus, 44.5% (109) of the participants were female and 55.5% (136) were male students. In Waigani campus, 53.8% (134) were female and 46.2% (115) were male students. Further detailed analysis of the data was not separated according to gender.

When asked if they had been vaccinated, 39.6% (97) in Taurama and 22.9% (57) in Waigani said they had been vaccinated. Thus, between 60 to 75%

of the students in Taurama and Waigani were unvaccinated at the time of this study.

The students were asked if it was legal to take the COVID-19 vaccination in PNG. Only 10.6% (26) and 11.3% (28) in Taurama and Waigani campuses respectively, responded in the affirmative.

Knowledge (K): The responses to the knowledge questions about the vaccine are presented in Table 1. In Taurama, 95.9% (235) of respondents, compared to 88.5% (221) in Waigani, said that people above 18 years of age were eligible {E} for vaccination in PNG. Majority of the respondents in Taurama (83.2%) and Waigani (89.6%) correctly stated that infants below one year of age were not eligible {NE} for the COVID-19 vaccination in PNG. About twice as many respondents in Taurama compared to Waigani (43.7% vs 22.9%) stated that patients with chronic diseases were eligible to take the COVID-19 vaccine in PNG.

The responses to Knowledge questions (Q8 to Q12) about the virus and the vaccine are presented in Table 2. When asked about the causative agent of COVID-19 infection, 98.0% (240) in Taurama and 82.3% (205) in Waigani correctly stated that it was a virus. The follow-up question was about the genetic material of the COVID-19 virus. In response, 51.8% (127) in

Taurama and 31.7% (79) in Waigani stated correctly that the genetic material is RNA. Malaria infection is very high in PNG; thus, the students were asked if COVID-19 can be transmitted by a mosquito bite. In Taurama, 88.2% (216) and 78.3% (195) in Waigani stated that it cannot be transmitted by mosquito bites. In response to Q 12 on how an infected person can spread the infection, 98.8% (242) in Taurama and 92.8% (231) in Waigani gave correct answers.

The next question (Q 13) was whether a second or booster dose of the vaccine was needed to increase the immunity against the virus. In Taurama 55.1% (135) of the students answered in the affirmative, compared to 34.5% (86) in Waigani.

Results obtained when the data for all the Knowledge questions (Q7 to Q 13) were further analyzed are summarized in Table 3.

Table 4 presents students' responses to the question (Q 14) about the sources of information that influenced their decisions and about the relative significance of those sources. In Taurama, 66.9% (164/245) and in Waigani, 59.4% (146/249) stated that "Health care providers – doctors, nurses and others" had a "very significant effect" on their opinion about COVID-19 vaccination. Second in significance came the News from National TV and FM Radio: Taurama 36.7% (90/245) and Waigani 44.6% (111/249).

Table 1: Responses (%) to questions on Knowledge {Taurama: N = 245; Waigani: N = 249} (K: Knowledge questions)

Q7	We have mentioned a group of people who may or may not be eligible for taking COVID-19 vaccine. Please indicate, in each case, the most appropriate option listed for each of the groups (Knowledge about COVID-19 and the vaccine)					
		Eligible %		Not eligible %		Don't know %	
	Group	Taurama	Waigani	Taurama	Waigani	Taurama	Waigani
(i)	Infants below one year of age	3.3	1.2	83.2	89.6	13.5	9.2
(ii)	People below 18 years old	28.2	27.3	47.8	53.0	24.0	19.7
(iii)	People above 18 years of age	95.9	88.8	0.40	4.4	3.7	6.8
(iv)	Pregnant and lactating women	35.9	20.5	32.3	52.6	31.8	26.9
(v)	Patients with chronic diseases, diabetes, hypertension, and heart disease	43.7	22.9	35.1	51.0	21.2	26.1
(vi)	Persons having active COVID-19 infection	57.1	75.1	25.7	8.4	17.2	16.5
(vii)	Persons recovered from COVID-19 infection	69.4	60.2	13.9	15.7	16.7	24.1
(viii)	Persons allergic to food items or drugs	28.6	14.1	31.4	49.4	40.0	36.5
(ix)	Immuno-compromised persons	45.7	17.3	26.9	38.1	27.4	44.6

Table 2: Responses (%) to Knowledge questions (Q8 to Q12) about the virus and vaccine: (Knowledge continues) {Taurama N = 245; Waigani N = 249}

			Taurama %	Waigani %
Q8	What is the cause of COVID-19 infection?	Bacteria	0.41	5.2
		Virus	98.0	82.3
		Not sure	1.6	12.5
Q9	What is the type of genetic material in COVID-19?	DNA	13.1	9.2
		RNA	51.8	31.7
		Not sure	35.1	59.1
Q10	Are antibiotics effective in treatment of COVID-19?	Yes	21.2	22.5
		No	48.6	36.1
		Don't know	30.2	41.4
Q11	Can COVID-19 be transmitted by mosquito bite? .	Yes	1.2	1.2
		No	88.2	78.3
		Don't know	10.6	20.5
Q12	COVID-19 infected person can spread the infection through droplets from coughing or sneezing and also through contaminated hands and surfaces	Yes	98.8	92.8
		No	0	2.0
		Don't know	1.2	5.2

Table 3. Summary of results for all the Knowledge questions (Q7-13): Correct and Incorrect responses among students in Taurama and Waigani, respectively

Questions of knowledge on COVID19	Correct answers				Incorrect answers				
	Taurama		Waigani		Taurama		Waigani		
	N	%	N	%	N	%	N	%	P-value
Q7.1 Infants below one year of age (NE)	204	83.3	223	89.6	41	16.7	26	10.4	0.041
Q7.2 Children and Adolescents below 18 years of age (NE)	117	47.8	132	53.0	128	52.2	117	47.0	0.243
Q7.3 Adults above 18 years of age (E)	235	95.9	221	88.8	10	4.1	28	11.2	0.003
Q7.4 Pregnant and lactating women (E)	88	35.9	51	20.5	157	64.1	198	79.5	<0.001
Q7.5 Patients with chronic diseases like diabetes, hypertension, heart disease (E)	107	43.7	57	22.9	138	56.3	192	77.1	<0.001
Q7.6 Persons having active COVID-19 infection (NE)	63	25.7	21	8.4	182	74.3	228	91.6	<0.001
Q7.7 Persons recovered from COVID-19 infection (E)	170	69.4	150	60.2	75	30.6	99	39.8	0.033
Q7.8 Persons allergic to food items or drugs (E)	70	28.6	35	14.1	175	71.4	214	85.9	<0.001
Q7.9 Immuno-compromised persons (E)	112	45.7	43	17.3	133	54.3	206	82.7	<0.001
Q8. What is the cause of COVID-19? (1) Bacteria; (2) Virus; (9) Not sure	240	98.0	205	82.3	5	2.0	44	17.7	<0.001
Q9. What is the type of generic material in COVID-19? (1) DNA; (2) RNA; (9) Not sure	127	51.8	79	31.7	118	48.2	170	68.3	<0.001
Q10. Are antibiotics effective in treatment of COVID-19? (1) Yes; (2) No; (9) Don't know	119	48.6	90	36.1	126	51.4	159	63.9	0.005
Q11. Can COVID-19 be transmitted by mosquito bite? (1) Yes; (2) No; (9) Don't	216	88.2	195	78.3	29	11.8	54	21.7	0.003

Q12. COVID-19 infected person can spread the infection through droplets from coughing or sneezing and also through contaminated hands and surfaces. (1) Yes; (2) No; (9) Don't know	242	98.8	231	92.8	3	1.2	18	7.2	0.001
Q13. 1 First dose of vaccination. (1) Yes; (2) No; (9) Don't know	72	29.4	73	29.3	173	70.6	176	70.7	0.986
Q13. 2 Second dose of vaccination: (1) Yes; (2) No; (9) Don't know	135	55.1	86	34.5	110	44.9	163	65.5	<0.001
Q13. 3 Fourteen days after first dose of vaccine (1) Yes; (2) No; (9) Don't know	43	17.6	22	8.8	202	82.4	227	91.2	0.004

Table 4: General assessment concerning influence from both media and interactions.
{Taurama campus N = 245; Waigani campus N = 249}

Q 14: In the present era there are multiple sources of information regarding a particular issue. How significantly the following sources of information have influenced your opinion about vaccination?

	Insignificant effect %		Somewhat significant effect %		Very significant effect %	
	Taurama	Waigani	Taurama	Waigani	Taurama	Waigani
(i) News from National TV / Radio	14.3	11.6	49.0	43.8	36.7	44.6
(ii) Government agencies	17.1	17.3	53.5	53.4	29.4	29.3
(iii) Social media (Facebook, Instagram, Whatsapp)	29.4	26.5	35.1	37.8	35.5	35.7
(iv) Discussion among friends and family	28.2	17.3	51.8	49.4	20.0	33.3
(v) Health care providers (Doctors, Nurses, others)	5.7	6.8	27.3	33.7	66.9	59.4

Attitude (A): Four statements (Q15 to Q18) were used to assess the attitude of the students towards the COVID-19 vaccine. The 5-point Likert Scale was used to interpret the responses (Table 5).

In response to Q15 about their willingness to take the vaccine, 21.2% (52/245) in Taurama compared to 10.4% (26/249) in Waigani said that they strongly agreed to take the vaccine. In response to Q16 about their preferred way of acquiring immunity to COVID, 19.6% (48/245) and 24.9% (62/249) in Taurama and Waigani, respectively, strongly agreed that acquiring immunity against COVID-19 naturally, by getting sick, was preferable to vaccination.

In Q17, the students were asked if they would still take the vaccine, even if they had to pay for it. Only 8.2% (20/245) and 2.8% (7/249) in Taurama and Waigani, respectively, said that they strongly agreed. In response to Q18 about whether they would recommend the vaccine to members of their families and friends, 22.9% (56/245) of students in Taurama strongly agreed, compared to only 6.4% (16/249) of their counterparts in Waigani. The detailed results are presented in Table 5.

Table 5: Attitude (A) towards COVID-19 vaccination: Q 15 to Q 18: {T = Taurama N = 245; W = Waigani N = 249)

In the next 4 questions there are certain statements regarding different aspects of COVID-19 vaccination. Please "tick" the response which best explains your opinion regarding a particular statement (Attitude towards the vaccine):

	Strongly agree %		Agree %		Neither agree nor disagree %		Disagree%		Strongly disagree %	
	T	W	T	W	T	W	T	W	T	W
Q 15: When it is (was) my turn for vaccination I am (was) willing to take the COVID-19 vaccine.	21.2	10.4	22.0	15.7	17.6	20.9	20.8	20.1	18.4	32.9
Q 16: I will prefer to acquire immunity against COVID-19 naturally (by having the disease / subclinical infection) rather than by vaccination.	19.6	24.9	20.8	26.9	25.3	25.7	22.0	15.7	12.2	6.8
Q 17: I am (was) willing to get the COVID-19 vaccine, even if I have/had to pay for it.	8.2	2.8	17.3	10.0	20.0	17.7	28.2	30.9	26.1	38.6
Q 18: I will recommend my family and friends to get vaccinated against COVID-19	22.9	6.4	20.8	16.1	30.6	30.5	14.7	21.3	11.0	25.7

Practices (P): Q19 consists of 10 statements (I to X) that were used to assess the Practices of the students towards the vaccine.

The 5-point Likert Scale was used to interpret the responses (Table 6).

In Taurama 15.5% (38/245) strongly agreed that there is no harm in taking the vaccine compared to 6.4% (16/249) in Waigani. In response to the next statement that the vaccine can provide protection against the infection, 24.1% (59/245) and 8.8% (22/249) in Taurama and Waigani respectively said that they strongly agreed. In

Taurama, 21.2% (52/245) compared to 7.2% (18/249) in Waigani strongly agreed that the benefits of taking the vaccine outweighed the risks. Only 11.4% (28/245) in Taurama and 6.8% (17/249) in Waigani strongly agreed with the statement that "*there is sufficient data regarding the vaccine's safety and efficacy released by the government*".

In Taurama 13.4% (33/245) compared to 8.0% (20/249) in Waigani strongly agreed with the statement "*My role models / political leaders / senior doctors / scientists have taken the vaccine*".

Table 6: Practice (P) section of the questionnaire:

Q19: If you have taken the vaccine certain factors may have motivated you to do so. If you are waiting for your turn to get vaccinated, then certain factors might be responsible for your decision to take the vaccine. There are certain statements regarding this below. Please "Tick" the response that best explains your opinion for each statement. Please put a tick against each of the statements.
 (**Practices regarding COVID-19 vaccine**) {T: Taurama N = 245; W: Waigani N = 249}

I have taken / will take the COVID-19 vaccine because:

	Strongly agree %		Agree %		Neither agree nor disagree %		Disagree %		Strongly disagree %	
	T	W	T	W	T	W	T	W	T	W
(i) I think there is no harm in taking it	15.5	6.4	22.5	17.7	27.3	28.5	22.5	27.3	12.2	20.1
(ii) I believe COVID-19 vaccine is useful to protect me against the infection.	24.1	8.8	36.7	25.3	22.9	34.9	9.4	18.1	6.9	12.9
(iii) COVID-19 vaccine is available for free.	36.7	23.7	40.8	43.8	13.5	13.3	5.7	10.0	3.3	9.2
(iv) My health care professional (doctor / nurse/ pharmacist) has recommended it to me.	19.6	11.2	43.7	32.1	20.8	25.7	11.4	18.9	4.5	12.1
(v) I feel the benefit of taking the COVID-19 vaccine outweighs the risk involved.	21.2	7.2	29.4	25.7	28.6	29.7	13.5	22.5	7.3	14.9
(vi) I believe that taking the COVID-19 vaccine is a societal responsibility	16.7	6.8	29.0	28.9	26.5	29.7	18.8	18.1	9.0	16.5
(vii) There is sufficient data regarding the vaccine's safety and efficacy released by the government.	11.4	6.8	24.1	22.1	23.7	22.1	24.9	29.3	15.9	19.7
(viii) Many people are taking the COVID-19 vaccine.	5.3	4.0	24.5	29.7	33.1	23.7	26.1	31.7	11.0	10.8
(ix) I think the vaccine will help in eradicating COVID-19 infection.	10.6	5.6	31.8	19.7	30.2	42.2	17.1	19.6	10.2	12.9
(x) My role models / political leaders / senior doctors / scientists have taken the vaccine	13.4	8.0	33.5	34.9	27.8	27.3	16.3	18.1	9.0	11.7

Concerns (C): Q 20, consisting of 7 statements (I to VI), and Q21 were used to assess students' Concerns regarding the vaccine. The 5-point Likert Scale was used to interpret the responses (Table 7).

23.7% (58/245) of respondents In Taurama and 35.3% (88/249) in Waigani strongly agreed that they believed they "*might have immediate serious side effects after taking COVID-19 vaccine*".

In response to the next statement, that "*COVID-19 vaccine was rapidly developed and approved* ",

28.2% (69/245) in Taurama and 22.5% (56/249) in Waigani said that they strongly agreed.

Another concern that was strongly agreed with by 13.9% (34/245) in Taurama and 15.7% (39/249) in Waigani was that the "*COVID-19 vaccine is being promoted for commercial gains by pharmaceutical companies*".

27.4% (67/245) of students in Taurama, as opposed to 41.4% (103/249) in Waigani, strongly agreed that "*Because of limited awareness done on COVID-19 vaccines to inform people properly, they are having fears of taking the vaccine*

because they are not really sure whether the vaccine will protect them or not '

Q21 relates to concerns about the need for precautionary measures after taking the vaccine:

"*After getting COVID-19 vaccine, I don't need to follow preventive measures wearing of mask, sanitation and social distancing*". In response, only 7.3% (18/245) in Taurama compared to 12.9% (32/249) in Waigani said that they strongly agree.

Table 7: The Concerns (C) section of the questionnaire.

Q20. There are still several concerns regarding the COVID-19 vaccine that may influence your decision (creating doubt in your mind) to get the COVID-19 vaccine. Give your opinion on how the following statements have influenced / will influence your decision to take the vaccine: (**Concerns about COVID19 vaccine**) {**T: Taurama** N = 245; **W: Waigani** N = 249}

I am concerned that:	Strongly agree %		Agree %		Neither agree nor disagree %		Disagree %		Strongly disagree %	
	T	**W**	**T**	**W**	**T**	**W**	**T**	**Wi**	**T**	**W**
(i) The vaccine might not be easily available to me	4.5	6.8	18.4	17.3	24.9	29.3	40.8	33.7	11.4	12.9
(ii) I might have immediate serious side effects after taking COVID-19 vaccine.	23.7	35.3	38.4	36.6	22.0	16.9	11.0	6.0	4.9	5.2
(iii) COVID-19 vaccine may be faulty or fake	12.3	21.3	31.4	37.4	31.4	26.9	16.7	9.2	8.2	5.2
(iv) COVID-19 vaccine was rapidly developed and approved.	28.2	22.5	43.7	38.2	19.2	26.5	5.3	5.2	3.6	7.6
(v) I might have some unforeseen future effects of the COVID-19 vaccine	26.9	33.7	39.2	44.6	23.3	13.7	6.1	3.2	4.5	4.8
(vi) COVID-19 vaccine is being promoted for commercial gains by pharmaceutical companies	13.9	15.7	25.7	24.1	40.8	48.6	12.7	5.2	6.9	6.4
(vii) Because of limited awareness done on Covid-19 vaccines to inform people properly, I am having fears of taking the vaccine because I am not really sure whether the vaccine will protect me or not	27.4	41.4	34.3	33.7	16.7	11.7	15.9	8.0	5.7	5.2
Q21. After getting COVID-19 vaccine, I don't need to follow preventive measures wearing of mask, sanitation and social distancing	7.3	12.9	8.6	9.6	14.7	26.1	34.7	27.7	34.7	23.7

Interpretation of KAPC scores:
The Knowledge scores for Taurama and Waigani were 61.6% and 49.7%, respectively, which indicated Poor knowledge about the COVID-19 vaccine. There was a statistically significant difference ($p < 0.05$) between the knowledge scores of students in Taurama and Waigani.

A two-sample t-test was performed to compare knowledge scores of students in Taurama and Waigani. There was a significant difference between knowledge scores of students in Taurama (M=9.6, SD=2.6) and Waigani (M=7.68, SD=2.33); t (492) = 8.690, p=0.008.

A chi-square test of independence showed that there was a statistically significant association between knowledge level (Good/Poor) and students in Taurama and Waigani, χ^2=51.837, df=1, p=<0.001).

A chi-square test of independence showed that there was no significant relationship between knowledge level of students in Taurama and Waigani, and gender (male/female) χ^2=1.815, df=1, p=0.18).

The Attitude score for Taurama was 36.7%, compared to 21.2% for Waigani. Both results indicated Poor attitude towards COVID-19 vaccination. The difference in attitude scores was statistically significant (p<0.05). A chi-square test of independence showed that there was a statistically significant relationship between the attitude towards the vaccine by students in Taurama and Waigani, χ^2=19.36, df=2, p=<0.001). About 60.6% (129) in Waigani disagree compared to 39.4% (84) in Taurama, suggesting a significant difference the students in both campuses have regarding their attitude towards the vaccine. There

was no significant association between attitude level (Good/Poor) and gender (p=>0.05)

The Practice score for Taurama was 49.8%, compared to Practice score of 37.8% for Waigani. The difference was statistically significant (p<0.05). The results indicated Poor practices which implies high risk for COVID-19 among respondents in both groups. A chi-square test of independence showed that there was a statistically significant relationship between the practice and students in Taurama and Waigani, χ^2=22.59, df=2, p=<0.001). About 43.7% in Taurama agree that they will take the COVID-19 vaccine compared to 26.9% in Waigani. There was no significant association between Practice level (Good/Poor) and gender (p=>0.05)

The Concern scores were 39.3% and 38.8% for Taurama and Waigani, respectively. There was no statistically significant difference between concern scores for Taurama and Waigani.

Factor(s) associated with Knowledge, Attitude, Practice of UPNG students:

A binary logistic regression was used to assess the strength of a relationship between one dependent variable and independent variable(s). The dependent variables (knowledge, attitude and practice) and independent variable (residence / campus) were modelled. A univariate analysis

was perform using one independent variable (residence / campus) and each of the dependent variable to assess how the factor (residence / campus) influence students' knowledge, attitude

and practice. Student's residence may influence on whether students have a good or poor knowledge, attitude or practice towards COVID-19 vaccination. The results are presented in Table 8.

Table 8. Binary logistic regression analysis of COVID-19, Knowledge, Attitude, Practice of UPNG students

Variables	Knowledge			Attitude			Practice		
	OR	95% CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value
Residence/Campus									
1 Taurama	3.84	2.64-5.58	<0.001	2.14	1.49-3.07	<0.001	2.37	1.49-3.07	<0.001
2 Waigani	1			1			1		

1=Reference group/category

Knowledge: Knowledge levels were classified as 1=Good knowledge, 0=Poor knowledge. A binary logistic regression analysis showed that there was a significant association between the residence / campus (1=Taurama, 2=Waigani) and the students' Knowledge about the virus and the vaccine. Students in Taurama were almost four times more likely to have good knowledge about the virus and the vaccine than students in Waigani (OR 3.84, 95% CI: 2.64 - 5.58, p-value=<0.001).

Attitude: Attitude level was classified as 1=Good attitude, 0=Poor attitude. In the binary logistic regression analysis, residence/campus was associated with attitude towards COVID-19

vaccination. Students who reside in Taurama campus were twice more likely to have good attitude towards COVID-19 vaccination than the students in Taurama (OR 2.14; 95% CI: 1.49 -3.07, p-value=<0.001).

Practice: Practice level were classified as 1=Good practice, 0=Poor practice. In the binary logistic regression analysis, residence/campus was associated with practices of students towards the vaccine. Students who reside in Taurama campus were two times more likely to have good practices towards the vaccine than students in Waigani (OR 2.37; 95% CI: 1.65 -3.41, p-value=<0.001).

DISCUSSION:

One of the recommended strategies for the control and elimination of an infectious disease, such as COVID-19, is the use of an approved vaccine for

mass vaccination of the affected population. This strategy was implemented in PNG after the WHO declaration of the COVID-19 pandemic. The focus of this study was to assess the KAPC of students in Taurama and Waigani campuses in UPNG

regarding the COVID-19 vaccination. This is because the students represent the community and have the potential to greatly influence the response of their parents, relatives, peers and friends towards the acceptance or rejection of the COVID-19 vaccine.

The response rates of students in the Taurama and Waigani campuses were 81.7% and 71.1% respectively. The low response rates on both campuses reflect the problem of doing research requiring voluntary participation. They also indicate the negative attitudes of students, especially of those in Waigani, to issues related to COVID-19. The 81.7% response rate on the Taurama campus was higher than the 78% response rate in a similar study by Raja et al. [19] in Sudan, but lower than the 100% response rate reported by Mose et al. [20] for students in Ethiopia.

At the time of this study, 39.6% of students in Taurama and 22.9% in Waigani had been vaccinated. The low vaccination rate may be due to the lack of knowledge about vaccination, as it is the main cause of vaccine hesitancy. The students in Taurama were 1.35 times more likely to take the vaccine, compared to students in the Waigani campus. Vaccine hesitancy is defined as a delay in the acceptance or the refusal of vaccination even when the vaccine is available. According to

some recent studies [19, 20, 21], vaccine hesitancy is one of the biggest global health risks, which existed even before the COVID-19 pandemic. The percentage of vaccine-hesitant students in Taurama (60.4%), unlike that in Waigani, was within the ranges (10.6 to 65.1%) reported for medical and health sciences students in Egypt, Uganda, India and Italy [19, 20, 21].

The government of PNG gave the regulatory approval needed to bring COVID-19 vaccines into the country in March 2021, resulting in the legalization of the COVID-19 vaccine [12, 17]. The very high percentages of students in Taurama and Waigani campuses (89.4% vs 88.7%) who did not know about the legality of the COVID-19 vaccines in PNG indicated students' lack of knowledge and interest in government efforts to mitigate the spread of the virus. Thus, lack of relevant information may be responsible for the poor response about the legality of the vaccination by students in both campuses. Most people, including students, were more concerned about the impact of the lockdown and its effect on their livelihoods than they were appreciative of the concerted efforts of the authorities to reduce the spread of the virus.

Students in Taurama were more knowledgeable than students in Waigani. The Knowledge scores for Taurama and Waigani were 61.6% and 49.7%, respectively, with an odds ratio of 3.84 (95% CI

2.64 – 5.58; p<0.001). One explanation is that the Taurama students study medical and health sciences which inform them of many diseases, including COVID-19. The 61.6% score obtained for students in Taurama was lower than the 78.6%, 72% and 70.2% obtained for medical students in Ethiopia [22], United Arab Emirate [23] and Egypt [24], but higher than the 40.8% to 57.0% scores reported by other authors respectively [22, 25, 26, 27]. Our result highlights the importance of knowledge about COVID-19 as well as that of community awareness regarding the available COVID-19 vaccines, because what people think, based on what they know, drives their behaviour.

Majority of the students in Taurama and Waigani campuses stated that their opinion about COVID-19 vaccines was greatly influenced by "Health care providers – doctors, nurses and others". This is contrary to the general assumption that social media significantly influence the opinion of students [28]. Our findings support the report by Venkatesan et al [21], which states that social media was not found to be significantly associated with vaccine hesitancy among medical students.

In the present study, students' attitude was assessed mainly based on their willingness to take the vaccine and to recommend the vaccine to family members. In Taurama, 21.2% of students, compared to 10.4% in Waigani, said that they strongly agreed with the need to take the vaccine. In addition, 22.9% of students in Taurama, compared with 6.4% in Waigani, strongly agreed that they would recommend the vaccine to members of their families and friends. The significant difference in attitude among the Taurama students might be, as has already been stated, due to better knowledge and awareness of vaccine-preventable diseases like COVID-19. These results are similar to those obtained for students in Uganda [28], India and Jordan [21, 27].

The Attitude score for students in Taurama was 36.7% compared to 21.2% for students in Waigani. These scores are lower than the 84.5%, 78.0% and 72.0% attitude scores reported for students in Uganda, Bangladesh and Jordan respectively [22, 24, 25]. The result suggests the need for effective awareness campaigns, to provide the students with a better understanding of the importance of vaccination against infectious diseases like COVID-19.

In the present study, Practices regarding the vaccine were assessed based on the responses to specific questions using the modified 3-point Likert scale. In Taurama 38.0% of students and 24.1% in Waigani agreed that there was no harm in taking the vaccine. That the vaccine is useful and can provide protection against the infection, was agreed upon by 60.8% of Taurama students,

compared with 34.1% in Waigani; odds ratio 3.37. In Taurama, 50.6% of students compared to 32.9% in Waigani, agreed that the benefits of taking the vaccine outweigh the risks involved. The statement that, "sufficient data regarding the vaccine safety and efficacy was released by the government" was accepted by 35.5% of students in Taurama and 28.9% in Waigani. Only 42.4% of student in Taurama and 25.3% in Waigani agreed that the vaccine will help in eradicating COVID-19 infection. The Practice score for Taurama was 49.8% compared to 37.8% for Waigani. The results indicate the knowledge about COVID-19 gap between the medical and health science students in Taurama campus, and students in the Waigani campus. The Taurama students' practice score with regard to COVID-19 vaccines was higher than the 41.0% obtained for students in Uganda but similar to the results (49.2%) for students in Egypt [20, 22, 25, 29].

Some of the responses to the practice questions by students in both campuses might have been influenced by the widespread misinformation about the side effects and ineffectiveness of the COVID-19 vaccines.

Students' Concerns regarding COVID-19 vaccines were also assessed, using the 3-point modified Likert Scale. Majority of the students in Taurama (62.1%) and Waigani (71.9%) believe that they might have immediate serious side effects after taking the COVID-19 vaccine. Similarly, 71.9% of students in Taurama and 60.7% in Waigani expressed the fear that COVID-19 vaccines had been developed too rapidly. Another concern expressed by 39.6% in Taurama and 39.8% in Waigani was that the COVID-19 vaccines are promoted for commercial gains by pharmaceutical companies. 61.7% of students in Taurama and 75.1% of students in Waigani indicated that their fear of taking the vaccine was mainly caused by not having been properly informed about COVID-19 vaccines; they were really not sure that the vaccines can protect them from getting sick. The calculated concern scores for Taurama and Waigani were 39.3%, and 38.8%, respectively.

Unlike reports by some studies [21, 28], the lack of trust in public health experts was not one of the concerns expressed by students in our study. However, there was a very weak correlation between trust in public health experts and willingness to accept the COVID-19 vaccine by students in Taurama and Waigani campuses (rho = 0.01, p >0.05).

These results indicate that Poor Knowledge is one of the main causes of vaccine hesitancy among students on both campuses. It is also directly related to the poor attitudes and practices on the part of the students, as well as to their concerns.

Some of the reasons for low vaccination rates, identified in this study, include lack of knowledge about COVID-19 and the vaccines against it, concerns about the possibility of serious side effects, uncertainty about the efficacy of the available vaccines, misinformation, and insufficient information about the safety of the vaccines. Our results indicate that the major barrier to UPNG students' acceptance of the COVID-19 vaccine is their insufficient knowledge about the safety and efficacy of the vaccine.

The limitations of the study:
The low response rate among students in both campuses and the use of the self-assessed questionnaire can be considered as the limitations of this study.

CONCLUSION:

Vaccination is one of the promising strategies for the control and elimination of the COVID-19 pandemic. Vaccine hesitancy is influenced by multiple factors. The response of the university students to the COVID-19 vaccination campaign in PNG was poor. At the time of this study, only 39.6% of students in Taurama and 22.9% in Waigani had received the first dose of the vaccine.

The Knowledge scores for students in Taurama and Waigani were 61.6% and 49.7%, respectively.

The Attitude score for Taurama students was 36.7%, compared to 21.2% for students in Waigani.

The Practice score for Taurama was 49.8%, compared with 37.8% for Waigani. These results indicate the knowledge gap about COVID-19 between the two groups of students. The barriers causing the low vaccination rates in this study include poor knowledge, which is directly related to poor attitudes and practices; concerns about serious side effects, lack of trust in the efficacy of the vaccines, misinformation, and insufficient information about vaccine safety.

There is a need for effective awareness campaigns, especially in the Waigani campus, to improve the students' knowledge about the COVID-19 virus and the role of vaccines in combating it.

official position of the UPNG. The authors declare

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