ORIGINAL ARTICLE

Knowledge, attitude, and practice (KAP) survey regarding COVID-19 and factors associated with intention to receive a vaccine in kidney transplant recipients: A cross-sectional study

Tomohiro Takayama[1*], Kohei Unagami[2,4], Kazuya Omoto[3,4], Satoshi Miyata[1], Kenzo Takahashi[1]

[1]Teikyo University Graduate School of Public Health, Tokyo, Japan
[2]Department of Organ Transplant Medicine, Tokyo Women's Medical University, Tokyo, Japan
[3]Department of Urology, Tokyo Women's Medical University, Tokyo, Japan
[4]Yocho-machi Clinic, Tokyo, Japan

Corresponding Author: Tomohiro Takayama **Email:** tmhr.takayama@gmail.com

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ABSTRACT

Post-kidney transplant recipients were recommended to take appropriate infection control measures and receive the third or additional doses of COVID-19 vaccines to reduce the risk of severe COVID-19. However, it remained unclear whether prevention of infection was being adequately implemented and what factors were related to vaccination intention. A cross-sectional questionnaire survey was conducted in March 2022 at Yochomachi Clinic in Tokyo, Japan. The purpose of this study was to identify factors associated with vaccine intentions based on the Knowledge, Attitude, and Practice (KAP) survey regarding COVID-19 and how to promote vaccine acceptance to reduce mortality not only during the COVID-19 pandemic but also in future emerging infectious disease pandemics. Of the 497 participants, 435 intended to receive the third dose of COVID-19 vaccines (including those who actually got it), and 62 did not have such intention. Multivariate logistic regression analysis revealed that male sex (OR: 2.856, 95% CI: 1.377-5.921), positive attitude toward COVID-19 (OR: 1.950, 95% CI: 1.399-2.718), and television as a source of information (OR: 4.165, 95% CI: 1.964-8.831) were associated with vaccination intention, whereas patients who trusted family and friends (OR: 0.343, 95% CI: 0.121-0.968) and those who trusted no-one (OR: 0.173, 95% CI: 0.049-0.613) had no vaccination intention. When considering vaccination policies, media outreach to patients should be given high priority, especially for people at higher risk of developing severe symptoms. This approach can promote vaccine acceptance to reduce mortality not only during the COVID-19 pandemic but also in future emerging infectious disease pandemics.

Key words:
vaccine promotion strategy; COVID-19 vaccination; vaccine hesitancy; COVID-19 prevention

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INTRODUCTION

New coronavirus infection (COVID-19) spread rapidly around the world from late 2019 and became a major public health concern.[1,2] Countermeasures were particularly important for post-organ transplant patients who required lifelong immunosuppressive medications. Although various treatment methods for COVID-19 were established,[3-7] the prevention of infection and exacerbation, including non-pharmaceutical interventions such as wearing masks, hand washing and disinfection, avoiding crowded places and minimizing direct contact with others, and vaccination remained important.[8-18]

In patients with end-stage renal disease, kidney transplantation is known to reduce mortality and improve quality of life compared to dialysis,[19-21] In addition, post-kidney transplant recipients are free from the time constraints of dialysis because they no longer have to undergo it, and are more socially active and involved in society compared to dialysis patients. Thus, they may face a heightened risk of being infected with COVID-19.

Previous reports indicate that the mortality rate from COVID-19 infection among post-kidney transplant patients in situations where vaccination against COVID-19 was not yet available was 21.3%.[22] Other studies reported a mortality rate of 32%,[23] which may be considered alarmingly high.

Because of this high mortality rate, prevention of infection and exacerbation is important, but there have been no reports evaluating whether the prevention of infection and development of severe disease are being adequately implemented in post-kidney transplant patients. In addition, it has been suggested that in post-kidney transplant patients taking oral immunosuppressive drugs, the second dose of COVID-19 vaccines is not adequately effective and that a third dose or more is required to achieve adequate efficacy[24]. However, there are also no studies that report the factors associated with the intention to receive a vaccine for COVID-19 in post-kidney transplant recipients and whether these factors differ from those in the general population.

Therefore, we evaluated whether post-kidney transplant recipients have correct knowledge and information about COVID-19, including information sources the patients trust, what attitude they have toward COVID-19, and whether they actually practice infection control measures through a Knowledge, Attitude, and Practice (KAP) survey to assess which factors were associated with intention to receive a vaccine and to identify problems that inhibit infection control behavior toward COVID-19.

MATERIALS AND METHODS

Ethical approval

This study was approved by the Teikyo University Clinical Research and Clinical Trials Review Committee (control code 21-202). After the participants were given a written explanation of the study, written informed consent was obtained from all participants before their participation in the study.

Study design, setting, and participants

This cross-sectional, questionnaire-based survey was conducted in March 2022. At the time of the survey, vaccinations with the third dose of COVID-19 vaccines, which began in December 2021, were still being administered in Japan. The study participants were patients attending the Yochomachi Clinic, a follow-up clinic for kidney transplant patients located in Shinjuku-ku, Tokyo, Japan, which covers nearly 15% of post-kidney transplant patients nationwide. From March 1 to 31, 2022, we explained the study in writing to the patients in the order in which they arrived at the clinic and obtained their

informed consent to participate in the study. The target number of subjects was set at approximately 500, and the survey was completed when the target number was reached. The rationale for this target was based on previous studies at the facility and the number of outpatients visiting per month.[25] Participants completed this survey in about 10 minutes and with no incentives. If there were any omissions, we requested participants to provide responses to avoid data gaps.

Questionnaire and data collection

There are four main categories of questions: patient background, KAP survey, intention to receive COVID-19 vaccination, and trusted sources of information. When we conducted our study, there were no KAP surveys regarding COVID-19 for post-kidney transplant recipients, so we referenced several previous studies of the general population.[26-36] We developed a questionnaire for kidney transplant recipients based on the advice of two physicians specializing in kidney transplantation to have specificity for post-kidney transplant recipients. The authors initially developed the questionnaire referring to the English questionnaire, and then the co-researchers checked the content. A pilot test was conducted among medical professionals. These steps were taken to ensure validity. As for reliability, this is a limitation of this study because the responses may vary depending on trends in the number of infected patients nationwide and the timing of testing. The first part of the questions asked about participant characteristics.

The next part of the survey included five questions each on knowledge, attitude, and practice related to COVID-19. The knowledge section assessed how much people knew about COVID-19. Specifically, respondents were asked to identify the incubation/latent period of COVID-19 and its characteristic symptoms. It was formatted to be answered with "Yes", "No", or "Unsure" or by multiple choice selection. To calculate the score, a completely correct answer was scored as 1 point, and an incorrect answer was scored as 0 points. "Unsure" was also scored as 0 points. The attitude section was formatted to be answered with "Yes", "No", or "Undecided/Unsure or Neither". Specifically, we asked whether they feared being infected with COVID-19 and whether they were confident that they would not be infected. To calculate the score, desirable answers were scored as 1 point and undesirable or undecided/unsure answers were scored as 0 points. The practice section assessed the extent to which people practiced infection control in relation to COVID-19 and was formatted to be answered with "Yes", "No", or "Neither". Specifically, we asked whether they wash their hands/disinfect with alcohol frequently and whether they make sure to wear a mask when going out. In the third part, we included a question about whether the patient had been vaccinated with the second dose of COVID-19 vaccine. To calculate the score, desirable answers and those vaccinated with the second dose of COVID-19 vaccine were scored as 1 point, and undesirable or "Neither" answers were scored as 0 points.

We also asked about their intention to receive the third dose of COVID-19 vaccines (including those who actually got it). In the last part, we also asked where they obtained their information and who they relied on for that information.

For term definition, we defined "full vaccination" as receiving or trying to receive the third dose of COVID-19 vaccines because at the time of the survey, the third dose of COVID-19 vaccines was being administered in Japan. It has been suggested that for post-kidney transplant

patients taking oral immunosuppressive drugs, a second dose of COVID-19 vaccines was not adequately effective. Therefore, a third dose of COVID-19 vaccines or more was required to achieve adequate efficacy.[24] Similarly, "vaccine intention" was defined as whether the participant intended to receive the third dose of COVID-19 vaccines. To investigate factors influencing the intention to receive the third dose of COVID-19 vaccines, we decided to analyze the results with the participants divided into two groups: those who had received or who were willing to receive the third dose of COVID-19 vaccines, and others who did not intend to receive the third dose of COVID-19 vaccines (two doses or less).

Statistical analysis

The primary outcome of this survey was the patients' intention to fully receive COVID-19 vaccination (third dose) and it was treated as the dependent variable.

Age, time passed since transplantation (months), duration of pre-transplant renal replacement therapy (months), and scores for knowledge, attitude, and practice were treated as continuous variables. We did not convert them to interval scales. The reason for treating them as continuous variables is that categorization inevitably reduces the predictive power of the prediction equation in the logistic regression analysis. Other factors were treated as categorical variables. Regarding pre-transplant renal replacement therapy, the analysis was divided into two groups: those who had undergone hemodialysis or peritoneal dialysis and those who did not. The sources of information and sources the participants trusted were also analyzed as explanatory variables. These were treated as independent variables.

A logistic regression analysis was conducted to investigate factors influencing the intention to receive the third dose of COVID-19 vaccines. Variables with a p-value of <0.2 in the single regression analysis were entered into a multivariate regression model. Because one of the five questions in the practice section of the KAP survey asked about the second dose of COVID-19 vaccines and was judged to have a significant impact on the present results, univariate and multivariate logistic regression analyses were conducted using the total scores of the other four questions, excluding the above question.

P-values of <0.05 were considered to be statistically significant. There were no missing data in this study. All statistical analyses were conducted using SAS (version 9.4).

RESULTS

Participant characteristics

Of the 500 patients who were approached, 497 participants completed the questionnaire. Two patients returned home without submitting the questionnaire, and another one refused to participate in the study. Among the participants, 305 (61.4%) were male, and the mean age was 53.3 (SD 13.3) years old. Thirty-four participants (6.9%) had a history of COVID-19 infection. Of the 497 participants, 435 (87.5%) had an intention to receive the third dose of COVID-19 vaccines (including those who actually got it), and 62 (12.5%) had no such intention (two doses or less). This latter group had a larger proportion of women (56.5% vs 36.1%) and a younger average age (45.7 vs 54.4 years) than the third-dose vaccination group. The participant characteristics are shown in Table 1.

Table 1. Patient Characteristics

Characteristics	All	Vaccination with third dose	Vaccination with second dose or less
	N = 497	N = 435 (87.5%)	N = 62 (12.5%)
Sex - No. (%)			
Female	192 (38.6)	157 (36.1)	35 (56.5)
Male	305 (61.4)	278 (63.9)	27 (43.5)
Age - mean (SD)	53.3 (13.3)	54.4 (12.9)	45.7 (13.5)
Area of residence - No. (%)			
Living in the Greater Tokyo Area (including Saitama, Chiba, Kanagawa)	457 (91.9)	399 (91.7)	58 (93.6)
Other	40 (8.1)	36 (8.3)	4 (6.4)
Level of education - No. (%)			
Junior/Senior High School	135 (27.2)	118 (27.1)	17 (27.4)
Vocational, technical school/University Short Course	107 (21.5)	86 (19.8)	21 (33.9)
University Undergraduate/Postgraduate	251 (50.5)	228 (52.4)	23 (37.1)
Other	4 (0.8)	3 (0.7)	1 (1.6)
Time passed since transplantation (months) - median (IQR)	78.0 (29.0-137.0)	81.0 (31.0-139.0)	58.5 (10.0-111.0)
Pre-transplant renal replacement therapy - No. (%)			
HD and/or PD	397 (79.9)	348 (80.0)	49 (79.0)
Preemptive	100 (20.1)	87 (20.0)	13 (21.0)
Duration of pre-transplant renal replacement therapy (months) - median (IQR)	12.0 (3.0-42.0)	15.0 (3.0-48.0)	12.0 (2.0-28.0)
Donor - No. (%)			
Parents	230 (46.3)	189 (43.4)	41 (66.1)
Spouse	165 (33.2)	154 (35.4)	11 (17.7)
Sibling	53 (10.7)	49 (11.3)	4 (6.5)
Children	5 (1.0)	4 (0.9)	1 (1.6)
Other family member	15 (3.0)	10 (2.3)	5 (8.1)
Other donor (Deceased)	29 (5.8)	29 (6.7)	0 (0.0)
Co-inhabitants - No. (%)			
Family	419 (84.3)	368 (84.6)	51 (82.3)
Alone	72 (14.5)	63 (14.5)	9 (14.5)
Other	6 (1.2)	4 (0.9)	2 (3.2)
Living with Donor - No. (%)			
YES	226 (45.5)	199 (45.8)	27 (43.6)
NO	271 (54.5)	236 (54.2)	35 (56.4)
History of COVID-19 Infection - No. (%)			
YES	34 (6.8)	26 (6.0)	8 (12.9)
NO	463 (93.2)	409 (94.0)	54 (87.1)
History of COVID-19 Infection (Housemate) - No. (%)			
YES	30 (6.0)	26 (6.0)	4 (6.5)
NO	467 (94.0)	409 (94.0)	58 (93.5)

Abbreviations: SD, standard deviation; IQR, interquartile range; HD, hemodialysis; PD, peritoneal dialysis

KAP survey and intention to vaccinate

The results of the questionnaire content and vaccination intentions are shown in Table 2. The average knowledge section score was 3.46. More than 95% of the participants correctly answered the questions about the incubation/latent period of COVID-19. The average score of the attitude section was 3.0. Regarding the safety and effectiveness of vaccines, 200 participants (40.2%) answered "Don't believe" or "Neither". The average practice section score was 4.61. Of the 497 participants, 435 expressed an intention to get the third dose of COVID-19 vaccines (including those who actually got it), and 62 did not have such an intention.

Table 2. KAP Survey and Intention to Vaccinate

Question	Response	No. (%) (N = 497)
K1. How long is the incubation/latent period of COVID-19?	Correct	473 (95.2)
	Incorrect	24 (4.8)
K2. What are the symptoms of COVID-19?	Correct	339 (68.2)
	Incorrect	158 (31.8)
K3. Are elderly people and those with underlying health conditions at higher risk of developing severe symptoms?	Correct	475 (95.6)
	Incorrect	22 (4.4)
K4. Which is effective for sterilization/disinfection for COVID-19?	Correct	218 (44.9)
	Incorrect	279 (56.1)
K5. What are the characteristics of COVID-19 variants?	Correct	216 (43.5)
	Incorrect	281 (56.5)
A1. Are you afraid of getting infected with COVID-19?	Yes	445 (89.5)
	No	36 (7.3)
	Undecided/Unsure	16 (3.2)
A2. Are you confident you won't be infected with COVID-19?	Yes	14 (2.8)
	No	348 (70.0)
	Undecided/Unsure	135 (27.2)
A3. Do you think you would develop severe symptoms if you were infected?	Yes	352 (70.8)
	No	14 (2.8)
	Unsure	131 (26.4)
A4. Do you actively seek out the latest information regarding COVID-19?	Yes	390 (78.5)
	No	15 (3.0)
	Neither	92 (18.5)
A5. Do you believe the vaccine is safe and effective?	Yes	297 (59.8)
	No	37 (7.4)
	Neither	163 (32.8)
P1. Do you wash your hands/disinfect with alcohol frequently?	Yes	489 (98.4)
	No	3 (0.6)
	Neither	5 (1.0)
P2. Do you make sure to wear a mask when going out?	Yes	493 (99.2)
	No	0 (0.0)
	Neither	4 (0.8)
P3. Do you avoid crowded places?	Yes	444 (89.3)
	No	16 (3.2)
	Neither	37 (7.5)
P4. Do you avoid having meals with people other than your family?	Yes	416 (83.7)

Question	Response	No. (%) (N = 497)
P5. Did you get vaccinated for COVID-19?	No	39 (7.8)
	Neither	42 (8.5)
	Twice	453 (91.1)
	Once	3 (0.6)
	None	41 (8.3)
		No. (%) (N = 497)
Final results of vaccination intention	Full (third dose) vaccination	435 (87.5)
	Second dose or less	62 (12.5)

Sources of information related to COVID-19 and trusted sources

Table 3 shows the results of the overall sources of information related to COVID-19 and trusted sources. Most people reported television (82.1%) as a source of information. Regarding trusted sources, 13 participants (2.6%) reported that they did not trust anyone.

Table 3. Sources of Information Related to COVID-19 and Trusted Sources

Sources of Information Related to COVID-19 (Multiple Answers Allowed)	**No. (%)**
Television	408 (82.1)
Internet	390 (78.5)
Attending physician/Family doctor	190 (38.2)
Radio	170 (34.2)
Family/Friends	133 (26.8)
Ministry of Health, Labor and Welfare, Japan	101 (20.3)
Medical papers/Journal	32 (6.4)
Newspaper/Magazines	24 (4.8)
WHO (World Health Organization)	15 (3.0)
Other	11 (2.2)
Trusted sources (Multiple Answers Allowed)	**No. (%)**
Attending Physician/Family doctor	307 (61.8)
Infectious disease specialist	210 (42.3)
Ministry of Health, Labor and Welfare, Japan	50 (10.1)
Family/Friends	42 (8.5)
WHO (World Health Organization)	27 (5.4)
Other	23 (4.6)
Nobody	13 (2.6)

Factors associated with intention to receive the third dose of COVID-19 vaccines

Table 4 shows the results of the univariate and multivariate logistic regression analysis. The results of the multivariate logistic regression analysis showed that men were more willing to receive the third dose of COVID-19 vaccines than women (OR: 2.856, 95% CI: 1.377-5.921). In addition, a higher average score for attitude toward COVID-19 (OR: 1.950, 95% CI: 1.399-2.718) and television as a source of information (OR: 4.165, 95% CI: 1.964-8.831) were associated with receiving the third dose of COVID-19

vaccines. In contrast, participants who trusted family and friends regarding COVID-19 information (OR: 0.343, 95% CI: 0.121-0.968) and those who trusted no one (OR: 0.173, 95% CI: 0.049-0.613) were less willing to receive the COVID-19 vaccination.

Table 4. Logistic Regression Analysis of Factors Associated with Intention to Receive a Third Dose of COVID-19 Vaccines among Kidney Transplant Recipients

Factors	Univariate Analysis OR (95% CI)	Multivariate Analysis OR (95% CI)
Sex		
Female	Ref.	
Male	2.295 (1.339-3.934)	2.856 (1.377-5.921)
Age	1.051 (1.030-1.074)	1.011 (0.976-1.047)
Area of residence		
Living in the Greater Tokyo Area (including Saitama, Chiba, Kanagawa)	Ref.	
Other	1.308 (0.449-3.810)	
Level of education		
Junior/Senior High School	Ref.	
Vocational, technical school/University Short Course	0.590 (0.294-1.185)	0.752 (0.304-1.859)
University undergraduate/Postgraduate	1.428 (0.734-2.777)	1.147 (0.465-2.825)
Other	0.432 (0.042-4.396)	0.966 (0.054-17.407)
Time passed since transplantation (months)	1.003 (0.999-1.006)	1.002 (0.997-1.006)
Pre-transplant renal replacement therapy		
Preemptive	Ref.	
HD or/and PD	1.061 (0.551-2.043)	
Duration of pre-transplant renal replacement therapy (months)	1.008 (1.001-1.016)	1.003 (0.994-1.013)
Donor		
Parents	Ref.	
Spouse	3.037 (1.510-6.108)	1.602 (0.567-4.521)
Sibling	2.657 (0.908-7.776)	1.864 (0.475-7.310)
Children	0.868 (0.095-7.967)	1.662 (0.064-43.10)
Other family member	0.434 (0.141-1.337)	0.227 (0.049-1.051)
Other donor (deceased)	N/A[a]	N/A [c]
Co-inhabitants		
Family	Ref.	
Alone	0.970 (0.455-2.069)	
Other	0.277 (0.05-1.551)	
Living with Donor		
No	Ref.	
Yes	1.093 (0.639-1.869)	
History of COVID-19 Infection		
No	Ref.	
Yes	0.429 (0.185-0.996)	0.744 (0.242-2.292)
History of COVID-19 Infection (Housemate)		
No	Ref.	
Yes	0.922 (0.311-2.736)	

Factors	Univariate Analysis OR (95% CI)	Multivariate Analysis OR (95% CI)
Knowledge regarding COVID-19	0.952 (0.723-1.252)	
Attitude toward COVID-19	2.346 (1.825-3.014)	1.950 (1.399-2.718)
Practice related to COVID-19	1.573 (1.071-2.310)	0.816 (0.485-1.372)
Source of information related to COVID-19		
Television	4.265 (2.41-7.548)	4.165 (1.964-8.831)
Internet	0.67 (0.328-1.368)	
Newspaper/Magazines	2.995 (1.481-6.058)	1.853 (0.752-4.565)
Radio	N/A[b]	
Medical papers/Journal	0.593 (0.234-1.505)	
Attending physician/Family doctor	1.917 (1.052-3.494)	1.084 (0.509-2.311)
Family/Friends	0.804 (0.45-1.436)	
Ministry of Health, Labor and Welfare, Japan	1.375 (0.673-2.811)	
WHO (World Health Organization)	0.924 (0.204-4.196)	
Other	1.288 (0.16-10.346)	
Trusted source (COVID-19)		
Attending Physician/Family doctor	2.172 (1.269-3.716)	1.198 (0.573-2.504)
Infectious disease specialist	1.931 (1.081-3.45)	0.805 (0.384-1.688)
Family/Friends	0.413 (0.192-0.889)	0.343 (0.121-0.968)
Ministry of Health, Labor and Welfare, Japan	1.315 (0.501-3.451)	
WHO (World Health Organization)	1.829 (0.422-7.920)	
Nobody	0.132 (0.055-0.313)	0.173 (0.049-0.613)
Other	0.778 (0.168-3.596)	

Abbreviations: OR, odds ratio; CI, confidence interval; Ref., Reference; N/A, not available; HD, hemodialysis; PD, peritoneal dialysis

[a,b,c] For kidney transplant recipients from deceased donors and participants who used radio as a source of information, the odds ratio could not be calculated, and the result was not available because all were willing to receive the third vaccination.

DISCUSSION

In this study, 497 post-kidney transplant patients were surveyed to determine factors related to their intention to receive a third dose of COVID-19 vaccine through a KAP survey on COVID-19. A statistical analysis revealed that male sex, positive attitude toward COVID-19, and television as a source of information were associated with COVID-19 vaccination intentions, whereas trusting family and friends and trusting no one were associated with COVID-19 vaccine hesitancy.

Although there have been many previous KAP surveys on COVID-19 and reports on vaccination intentions, most were conducted in the general population or with healthy subjects. To our knowledge, this is the first report on post-kidney transplant patients. Previous studies conducted abroad have reported that various factors (e.g., sociodemographic factors, attitudes and beliefs about COVID-19 infection and vaccination, and political views) influence vaccine acceptance in the general population.[37-44] We found that women tend to avoid vaccination more than men among post-kidney transplant recipients. These results were similar to those of the general population.[38,39,41] Other reports suggest that women in the general population are more likely to have more knowledge about the health hazards of vaccines than men or to refuse vaccination because of pregnancy and/or reliability issues.[43] In the present study, it is possible

that the tendency to be more cautious about one's own physical condition and consequently to be more evasive was more pronounced among the post-kidney transplant women. Although further research is needed to determine the reasons for vaccination avoidance among post-kidney transplant women, changing the approach of interventions to encourage vaccination by gender may contribute to improving vaccination coverage.

The most common source of information about COVID-19 in this survey was television. The results of the analysis strongly indicated that the use of television as a source of information was associated with intention to receive the third dose of COVID-19 vaccines. The results of this study also showed that many post-kidney transplant patients practiced infection control and severe disease prevention behaviors based on information from the media. However, there is excessive media coverage of post-vaccination side effects, and it is important for us as medical professionals to encourage the media to disseminate correct scientific data. Conversely, receiving information from family and friends was associated with vaccine hesitancy. While other reports for the general population indicate that people who trust their friends as a source of information are more willing to be vaccinated,[27] we found the opposite in the post-kidney transplant recipients. We speculate that this may be because the post-kidney transplant recipients were more sensitive and afraid of the occurrence of adverse reactions following COVID-19 vaccination and were more likely to be strongly influenced by the experiences with adverse reactions of those close to them than the general population. A further problem is the fact that a certain number of people reported that they do not trust anyone. Previous reports have shown that the conventional second dose of COVID-19 vaccines are not sufficient to produce antibodies in patients taking immunosuppressive drugs after organ transplantation and that a third or fourth dose of COVID-19 vaccine is necessary.[24,45,46] Therefore, it is necessary to strongly recommend booster vaccination for transplant recipients to ensure sufficient immunity. It is known that health beliefs (e.g., health susceptibility and perception of severity) can be modified by interventions.[47] The results of this study suggest that to improve COVID-19 vaccination rates among post-renal transplant patients at risk of severe disease, it is important to actively reach out not only to the patient population with low intention to vaccinate but also to their families and friends.

The main purpose of our KAP survey was to determine how knowledge, attitude, and practice toward COVID-19 affect vaccination intentions in order to reduce mortality among post-kidney transplant recipients. The results of the multivariate logistic regression analysis showed that knowledge and practice were not associated with intention to receive the third dose of COVID-19 vaccines, and that attitude was the most influential factor. A statistical analysis also revealed that trusting family and friends and trusting no one were associated with COVID-19 vaccine hesitancy, and may be factors that inhibit infection control behavior toward COVID-19. From these results, we were able to reaffirm the limitations of changing behavior by providing knowledge, which has been the conventional approach. Providing information alone is not enough to promote vaccination, and we need to consider what we can do to positively change attitudes toward vaccines. For this reason, we believe it will continue to be important to approach indifferent and information-weak groups and their friends and family who have no intention of receiving vaccination, and because such patients regularly visit clinics, we can approach their attitudes through regular

communication to improve the quality of immunization awareness.

The present study was associated with several limitations. As this study is a cross-sectional study, it is possible that reverse causation might have occurred, and thus, we plan to continue to conduct additional surveys and investigate longitudinal results. We conducted this study in March 2022. The possibility that results may vary depending on the timing of the survey cannot be ruled out. Furthermore, as the survey was conducted at a single facility in Tokyo, there is a possibility of single-center or regional bias. To secure a sufficient number of cases, we investigated the number of patients who already received the third dose of vaccine and the number who will receive the third dose of vaccine without separating them. However, even if a patient indicates an intention to receive a third dose of vaccine, it is not known whether the patient will actually receive it, which could be a limitation. Further, also to secure a sufficient number of cases, the analysis was conducted by grouping together individuals who had received ≤2 vaccinations. However, the reasons for not proceeding with vaccination differ in essential aspects between those who have not received any COVID-19 vaccination and those who have received the second vaccination dose, and it may not be appropriate to analyze them in the same group. In addition, some participants might not have been vaccinated due to concerns about side effects, and thus additional research should be conducted to determine the specific reasons why they avoided COVID-19 vaccination. However, it has been suggested that in post-kidney transplant patients taking oral immunosuppressive drugs, the second dose of COVID-19 vaccines is not adequately effective and that a third dose or more is required to achieve adequate efficacy.[24] Therefore, from the perspective of the prophylactic efficacy of the vaccine, the 0–2 vaccination groups were grouped together. Furthermore, the survey did not confirm the patients' income or the presence or absence of adverse reactions after receiving COVID-19 vaccination.

RECOMMENDATIONS

This study showed that reaching out to kidney transplant recipients to influence their attitudes toward vaccination through media outreach and regular outpatient communication can lead to vaccination promotion activities in these recipients. When considering vaccination policies, media outreach to patients should be given high priority, especially for people at higher risk of developing severe symptoms, to promote vaccine acceptance to reduce mortality not only during the COVID-19 pandemic but also in future emerging infectious disease pandemics.

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REFERENCES

1. Finelli L, Gupta V, Petigara T, Yu K, Bauer KA, Puzniak LA. Mortality Among US Patients Hospitalized With SARS-CoV-2 Infection in 2020. JAMA Netw Open. 2021;4(4):e216556. doi: 10.1001/jamanetworkopen.2021.6556\
2. Zhang Y, Luo W, Li Q, Wang X, Chen J, Song Q, et al. Risk Factors for Death Among the First 80 543 Coronavirus Disease 2019 (COVID-19) Cases in China: Relationships Between Age, Underlying Disease, Case Severity, and Region. Clin Infect Dis. 2022;74(4): 630-638. doi: 10.1093/cid/ciab493

3. Baraniuk C. Where are we with drug treatments for covid-19? BMJ. 2021;373:n1109. doi: 10.1136/bmj.n1109
4. Avni T, Leibovici L, Cohen I, Atamna A, Guz D, Paul M, Gafter-Gvili A, Yahav D. Tocilizumab in the treatment of COVID-19-a meta-analysis. QJM. 2021;114(8):577-586. doi: 10.1093/qjmed/hcab142
5. RECOVERY Collaborative Group; Horby P, Lim WS, Emberson JR, Mafham M, Bell JL, et al. Dexamethasone in Hospitalized Patients with Covid-19. N Engl J Med. 2021;384(8):693-704. doi: 10.1056/NEJMoa2021436
6. REMAP-CAP Investigators; Gordon AC, Mouncey PR, Al-Beidh F, Rowan KM, Nichol AD, et al. Interleukin-6 Receptor Antagonists in Critically Ill Patients with Covid-19. N Engl J Med. 2021;384(16):1491-1502. doi: 10.1056/NEJMoa2100433
7. O'Brien MP, Forleo-Neto E, Musser BJ, Isa F, Chan KC, Sarkar N, et al. Subcutaneous REGEN-COV Antibody Combination to Prevent Covid-19. N Engl J Med. 2021;385(13):1184-1195. doi: 10.1056/NEJMoa2109682
8. Abaluck J, Kwong LH, Styczynski A, Haque A, Kabir MA, Bates-Jefferys E, et al. Impact of community masking on COVID-19: A cluster-randomized trial in Bangladesh. Science. 2022;375(6577):eabi9069. doi: 10.1126/science.abi9069
9. Abu-Raddad LJ, Chemaitelly H, Ayoub HH, AlMukdad S, Yassine HM, Al-Khatib HA, et al. Effect of mRNA Vaccine Boosters against SARS-CoV-2 Omicron Infection in Qatar. N Engl J Med. 2022;386(19):1804-1816. doi: 10.1056/NEJMoa2200797
10. Brooks JT, Butler JC. Effectiveness of Mask Wearing to Control Community Spread of SARS-CoV-2. JAMA. 2021;325(10):998-999. doi: 10.1001/jama.2021.1505
11. Dagan N, Barda N, Kepten E, Miron O, Perchik S, Katz MA, et al. BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Mass Vaccination Setting. N Engl J Med. 2021;384(15):1412-1423. doi: 10.1056/NEJMoa2101765
12. Gonçalves MR, Dos Reis RCP, Tólio RP, Pellanda LC, Schmidt MI, Katz N,et al. Social Distancing, Mask Use, and Transmission of Severe Acute Respiratory Syndrome Coronavirus 2, Brazil, April-June 2020. Emerg Infect Dis. 2021;27(8):2135-2143. doi: 10.3201/eid2708.204757
13. Greenhalgh T, Jimenez JL, Prather KA, Tufekci Z, Fisman D, Schooley R. Ten scientific reasons in support of airborne transmission of SARS-CoV-2. Lancet. 2021;397(10285):1603-1605. doi: 10.1016/S0140-6736(21)00869-2
14. Haas EJ, Angulo FJ, McLaughlin JM, Anis E, Singer SR, Khan F, et al. Impact and effectiveness of mRNA BNT162b2 vaccine against SARS-CoV-2 infections and COVID-19 cases, hospitalisations, and deaths following a nationwide vaccination campaign in Israel: an observational study using national surveillance data. Lancet. 2021;397(10287):1819-1829. doi: 10.1016/S0140-6736(21)00947-8
15. Mayr FB, Talisa VB, Shaikh O, Yende S, Butt AA. Effectiveness of Homologous or Heterologous Covid-19 Boosters in Veterans. N Engl J Med. 2022;386(14):1375-1377. doi: 10.1056/NEJMc2200415
16. Moreira ED Jr, Kitchin N, Xu X, Dychter SS, Lockhart S, Gurtman A, et al. Safety and Efficacy of a Third Dose of BNT162b2 Covid-19 Vaccine. N Engl J Med. 2022;386(20):1910-1921. doi: 10.1056/NEJMoa2200674
17. Viana Martins CP, Xavier CSF, Cobrado L. Disinfection methods against SARS-CoV-2: a systematic review. J Hosp Infect. 2022;119:84-117. doi: 10.1016/j.jhin.2021.07.014

18. Wellenius GA, Vispute S, Espinosa V, Fabrikant A, Tsai TC, Hennessy J, et al. Impacts of social distancing policies on mobility and COVID-19 case growth in the US. Nat Commun. 2021;12(1): 3118. doi: 10.1038/s41467-021-23404-5.
19. Purnell TS, Auguste P, Crews DC, Lamprea-Montealegre J, Olufade T, Greer R, et al. Comparison of life participation activities among adults treated by hemodialysis, peritoneal dialysis, and kidney transplantation: a systematic review. Am J Kidney Dis. 2013;62(5):953-973. doi: 10.1053/j.ajkd.2013.03.022
20. Wolfe RA, Ashby VB, Milford EL, Ojo AO, Ettenger RE, Agodoa LY, et al. Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. N Engl J Med. 1999; 341:1725-1730. doi: 10.1056/NEJM199912023412303
21. Von der Lippe N, Waldum B, Brekke FB, Amro AA, Reisaeter AV, Os I. From dialysis to transplantation: a 5-year longitudinal study on self- reported quality of life. BMC Nephrol. 2014; 15:191. doi: 10.1186/1471-2369-15-191.
22. Hilbrands LB, Duivenvoorden R, Vart P, Franssen CFM, Hemmelder MH, Jager KJ, et al. COVID-19-related mortality in kidney transplant and dialysis patients: results of the ERACODA collaboration. Nephrol Dial Transplant. 2020;35(11):1973-1983. doi: 10.1093/ndt/gfaa261
23. Cravedi P, Mothi SS, Azzi Y, Haverly M, Farouk SS, Pérez-Sáez MJ, et al. COVID-19 and kidney transplantation: Results from the TANGO International Transplant Consortium. Am J Transplant. 2020;20(11):3140-3148. doi: 10.1111/ajt.16185
24. Rozen-Zvi B, Yahav D, Agur T, Zingerman B, Ben-Zvi H, Atamna A, et al. Antibody response to SARS-CoV-2 mRNA vaccine among kidney transplant recipients: a prospective cohort study. Clin Microbiol Infect. 2021;27(8):1173.e1-1173.e4. doi: 10.1016/j.cmi.2021.04.028
25. Miyake K, Endo M, Okumi M, Unagami K, Kakuta Y, Furusawa M, et al. Predictors of return to work after kidney transplantation: a 12-month cohort of the Japan Academic Consortium of Kidney Transplantation study. BMJ Open. 2019;9(10):e031231. doi: 10.1136/bmjopen-2019-031231
26. World Health Organization. Survey tool and guidance: rapid, simple, flexible behavioural insights on COVID-19 2020. [Internet]. [Cited 2023 February 11]. Available from: https://apps.who.int/iris/handle/10665/333549.
27. Al-Marshoudi S, Al-Balushi H, Al-Wahaibi A, Al-Khalili S, Al-Maani A, Al-Farsi N, et al. Knowledge, Attitudes, and Practices (KAP) toward the COVID-19 Vaccine in Oman: A Pre-Campaign Cross-Sectional Study. Vaccines (Basel). 2021;9(6):602. doi: 10.3390/vaccines9060602
28. Ferdous MZ, Islam MS, Sikder MT, Mosaddek ASM, Zegarra-Valdivia JA, Gozal D. Knowledge, attitude, and practice regarding COVID-19 outbreak in Bangladesh: An online-based cross-sectional study. PLoS One. 2020; 15(10):e0239254. doi: 10.1371/journal.pone.0239254
29. Kasemy ZA, Bahbah WA, Zewain SK, Haggag MG, Alkalash SH, Zahran E, et al. Knowledge, Attitude and Practice toward COVID-19 among Egyptians. J Epidemiol Glob Health. 2020; 10(4):378-385. doi: 10.2991/jegh.k.200909.001

30. Lau LL, Hung N, Go DJ, Ferma J, Choi M, Dodd W, et al. Knowledge, attitudes and practices of COVID-19 among income-poor households in the Philippines: A cross-sectional study. J Glob Health. 2020;10(1):011007. doi: 10.7189/jogh.10.011007
31. Noreen K, Rubab ZE, Umar M, Rehman R, Baig M, Baig F. Knowledge, attitudes, and practices against the growing threat of COVID-19 among medical students of Pakistan. PLoS One. 2020;15(12):e0243696. doi: 10.1371/journal.pone.0243696
32. Park DI. Development and Validation of a Knowledge, Attitudes and Practices Questionnaire on COVID-19 (KAP COVID-19). Int J Environ Res Public Health. 2021;18(14):7493. doi: 10.3390/ijerph18147493
33. Peng Y, Pei C, Zheng Y, Wang J, Zhang K, Zheng Z, et al. A cross-sectional survey of knowledge, attitude and practice associated with COVID-19 among undergraduate students in China. BMC Public Health. 2020; 20(1):1292. doi: 10.1186/s12889-020-09392-z
34. Reuben RC, Danladi MMA, Saleh DA, Ejembi PE. Knowledge, Attitudes and Practices Towards COVID-19: An Epidemiological Survey in North-Central Nigeria. J Community Health. 2021;46(3):457-470. doi: 10.1007/s10900-020-00881-1
35. Siddiquea BN, Shetty A, Bhattacharya O, Afroz A, Billah B. Global epidemiology of COVID-19 knowledge, attitude and practice: a systematic review and meta-analysis. BMJ Open. 2021;11(9):e051447. doi: 10.1136/bmjopen-2021-051447
36. Zhong BL, Luo W, Li HM, Zhang QQ, Liu XG, Li WT, Li Y. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. Int J Biol Sci. 2020;16(10):1745-1752. doi: 10.7150/ijbs.45221
37. Sakamoto M, Ishizuka R, Ozawa C, Fukuda Y. Health information and COVID-19 vaccination: Beliefs and attitudes among Japanese university students. PLoS One. 2022;17(11): e0277435. doi: 10.1371/journal.pone.0277435
38. Latkin CA, Dayton L, Yi G, Colon B, Kong X. Mask usage, social distancing, racial, and gender correlates of COVID-19 vaccine intentions among adults in the US. PLoS One. 2021;16(2): e0246970. doi: 10.1371/journal.pone.0246970
39. Kessels R, Luyten J, Tubeuf S. Willingness to get vaccinated against Covid-19 and attitudes toward vaccination in general. Vaccine. 2021;39(33):4716-4722. doi: 10.1016/j.vaccine.2021.05.069
40. Yoda T, Katsuyama H. Willingness to Receive COVID-19 Vaccination in Japan. Vaccines (Basel). 2021;9(1):48. doi: 10.3390/vaccines9010048
41. Ward JK, Alleaume C, Peretti-Watel P; COCONEL Group. The French public's attitudes to a future COVID-19 vaccine: The politicization of a public health issue. Soc Sci Med. 2020;265:113414. doi: 10.1016/j.socscimed.2020.113414
42. Wang J, Jing R, Lai X, Zhang H, Lyu Y, Knoll MD, et al. Acceptance of COVID-19 Vaccination during the COVID-19 Pandemic in China. Vaccines (Basel). 2020;8(3):482. doi: 10.3390/vaccines8030482
43. Neumann-Bohme S, Varghese NE, Sabat I, Barros PP, Brouwer W, van Exel J, Schreyögg J, Stargardt T. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. Eur J Health Econ. 2020;21(7):977-982. doi: 10.1007/s10198-020-01208-6
44. Troiano G, Nardi A. Vaccine hesitancy in the era of COVID-19. Public Health.

2021;194:245-251. doi: 10.1016/j.puhe.2021.02.025
45. Stumpf J, Siepmann T, Lindner T, Karger C, Schwobel J, Anders L, et al. Humoral and cellular immunity to SARS-CoV-2 vaccination in renal transplant versus dialysis patients: A prospective, multicenter observational study using mRNA-1273 or BNT162b2 mRNA vaccine. Lancet Reg Health Eur. 2021;9:100178. doi: 10.1016/j.lanepe.2021.100178
46. Benotmane I, Gautier G, Perrin P, Olagne J, Cognard N, Fafi-Kremer S, et al. Antibody Response After a Third Dose of the mRNA-1273 SARS-CoV-2 Vaccine in Kidney Transplant Recipients With Minimal Serologic Response to 2 Doses. JAMA. 2021;326(11):1063-1065. doi: 10.1001/jama.2021.12339
47. Machida M, Nakamura I, Kojima T, Saito R, Nakaya T, Hanibuchi T, et al. Acceptance of a COVID-19 Vaccine in Japan during the COVID-19 Pandemic. Vaccines (Basel). 2021;9(3):210. doi: 10.3390/vaccines9030210