Effectiveness of a Health Intervention using theory of planned behavior on Hand Washing Among residents receiving the COVID-19 vaccine: Randomized Controlled Trial

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Research

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Abstract

Introduction

Hand washing is of key importance among residents to prevent life-threatening infections such as severe pneumonia or other microbial infection. Residents received coronavirus disease 2019 (COVID-19) vaccine at vaccination station are obliged to stay in the vaccination station at least 30 minutes. The period of post-vaccination observation is an ideal time for hand washing intervention. This study aimed to determine the effectiveness of a health intervention on hand washing among residents, who received the COVID-19 vaccine, by using the theory of planned behavior (TPB).

Methods:

This randomized controlled trial was carried out between March 2021 and May 2021 in Wuhan, China. Participants were recruited using randomized cluster sampling and divided into intervention group and control group by random allocation. Data were collected using a self-administered researcher-made questionnaire based on TPB and Hand washing Questionnaire. Validity (content validity index = 0.87; content validity ratio = 0.89) and reliability of the questionnaires were confirmed ($\alpha = 0.96$). Intervention was implemented during the observation period post-vaccinated (lasting 15 min) using videos and live training based on TPB constructs.

Results:

A total of 448 residents were participated with a response rate of 71.9% (322). The mean age of the participants was 46 (53% females). Compared with the control group, the scores of subjective norm ($P = 0.009$) and perceived behavioral control ($P < 0.001$) in intervention group were higher after one time intervention. Mean scores of attitudes, subjective norms, perceived behavior control and intention of intervention group was significantly higher than the control group after twice intervention ($P < 0.001$). Moreover, participants in the intervention group performed better than those in the control group on daily hand-washing times ($P = 0.044$), hand sanitizer use ($P = 0.003$), rub time ($P < 0.001$), following the six-step technique ($P < 0.001$) after intervention.

Conclusions:

The findings suggested that applying TPB based intervention is suggested to improve hand washing behavior in residents.

Contributions To The Literature

- Theory of planned behavior (TPB) integrates internal and external factors that affect behavior, which explores, explains and predicts the behavior of the subject from the perspective of the relationship between behavior and willingness.

- Intervention of hand washing after COVID-19 pandemic gained more attention. The innovation of TPB-based intervention plan improved the effect of hand washing.
- These findings contribute to new method of health intervention in residents.

Background

Hand washing is especially important because it helps prevent the spread of infections such as COVID-19, colds, the flu and gastroenteritis, which widely accepted as a key strategy of infection prevention and control (IPC) in the knowledge of relevant studies[1, 2]. After the COVID-19 pandemic, the national and international health agencies, including the Centers for Disease Control and Prevention (CDC) and the WHO, have provided multiple guidelines and mentioned the importance of hand hygiene[3, 4].

Additionally, certain cutting edge articles mentioned that wet hands are at high risk for infection, the released amount of microbial flora from wet hands is more than 10 times that from dry hands, increasing the potential for microbial transmission and dispersion, which warning people to dry their hands after washing. By drying the hands thoroughly, the number of microbes transferring by direct contact to skin, food or objects can be reduced by the order of 99%[5]. As the most simple protection for personal hand hygiene, hand washing is also the cornerstone of preventing the diseases of respiratory tract and gastrointestinal tract. A systematic review referred that hand washing interventions resulted in a reduction in respiratory conditions, gastrointestinal problems, seven studies found that hand washing had decreased the incidence of diarrhea (53–73%), three studies found a decrease in acute respiratory infection (RR = 0.77; CI = 0.62–0.95; EDM (Exploratory Data Mining) – 2%; 90% CI = – 3% to – 1%)[6]. Another article reported the incidence of pneumonia in children younger than 5 years in households that received plain soap and hand washing promotion was 50% lower than controls (no intervention) (95% CI; -65% to -34%). Compared with controls, incidence of diarrhea and impetigo in children younger than 15 years in households with plain soap were 53% (95% CI; -65% to -41%) and 34% (95% CI; -52% to -16%) lower respectively[7].

The theory of planned behavior (TPB) started in 1980 to predict an individual's intention to engage in a behavior at a specific time and place. The TPB theory takes behavior intention as an important indicator to understand and explain human social behavior, and also provides an important logical framework for predicting human behavior, that is, the motivation of behavior comes from people's rational evaluation of the consequences of their behavior and the behavior controllability they perceive. The TPB theory points out that behavioral intention is affected by three factors: attitude, subjective norms and perceived behavioral control. Behavioral intention is the key variable of behavior, and perceived behavioral control variables may also explain human behaviors. The TPB theory has been used widely to predict and explain a wide range of health behaviors and intentions including smoking, drinking, health services utilization, breastfeeding, and sleep, etc.[8] It can serve as a useful heuristic tool for understanding the personal motivational components of breastfeeding behavior and what factors influence exclusive breastfeeding[9, 10].

Previous studies regarding health intervention is an important part of promoting the health management of community behavior[11]. Public health intervention in China has undergone many years of development[12], and current digital development makes the dissemination of health education media more convenient[13]. During the COVID-19 pandemic, the mainly method to prevent the disease transmission is wearing masks and hand washing[14]. However, studies on hand washing intervention experiments are rare, the compliance of hand hygiene also needs to be improved[15]. In addition, the Chinese Health Commission specifically mentioned hand hygiene in its guidelines on infection prevention and control issued on February 4, 2020[4]. Furthermore, there has been massive surge in the demand for hand sanitizer due to the COVID-19 pandemic. The data from the on-line shopping mall showed that sales of hand sanitizer in SuNing increased by 2315%, while in Taobao on-line mall nearly 11times than the same time in 2019[16]. All of these indicate the public concern on thorough hand washing with sanitizer to prevent the spread of the germs (like bacteria and viruses) that cause these diseases. Therefore, the objective of this research is to determine the effectiveness of health intervention on hand washing by TPB in the residents received COVID-19 vaccine.

Study Design And Population

Residents received two-dosed COVID-19 vaccine (Corona Vac. supplied by Sinovac or Sinopharm by China National Biotec Group) in a community health service center in Wuhan from March 1, 2021 to May 25, 2021 were recruited as the observation subjects.

2.1 Inclusion and exclusion criteria

Inclusion criteria: (1) Residents who have received COVID-19 vaccination in the Community Health Service Center from March to May, 2021, (2) aged 18-69, (3) are willing to participate in the study and complete the questionnaire; exclusion criteria: (1) who received only one vaccination, (2) residents who are not willing to complete the questionnaire, (3)who was reported post-injection adverse events (AEFI).

2.2 Methods

A total of 448 residents were recruited using randomized cluster sampling and divided into intervention (n = 236) and control (n = 212) groups by random allocation. At last,

a total of 322 residents finished the whole project (intervention group, n=169; control group, n=153). After received the COVID-19 vaccine, AEFI were observed in observation room at least 30 minutes. During this period, all of participants filled out a questionnaire before the intervention started (Time 1, T1). All of the participants have the opportunity to take an education booklet at the station. Then the intervention group accepted video guidance and live presentation of six-step washing technique by doctors. The video followed WHO's hand-washing guidelines with Mandarin dubbing [17]. The doctors was trained on six-step washing technique at least three times and certificated by Hospital Infection Prevention Center. The whole intervention was lasted at least 15 minutes. The control group did not accept intervention. All the participants vaccinated the second dose and filled out the second questionnaire (Time 2, T2). The second

dose of vaccine was 21-56 days after the first dose. Then the intervention group accepted the second intervention. Follow-up survey and the questionnaire was conducted one month after Time 2 (Time 3, T3).

2.3 Measuring tools: validity and reliability

Data were collected using a self-administered researcher-made questionnaire based on TPB and Hand washing Questionnaire. Validity (content validity index = 0.87; content validity ratio = 0.89) and reliability of the questionnaires were confirmed ($\alpha = 0.96$). Intervention was implemented during the observation period post-vaccinated (lasting 15 min) using videos and live training based on TPB constructs.

In part one, we evaluated the demographic characteristics of the participants including age, sex, educational level of the participant, employment and marital status, annual family income, injection interval, on-line time and whether they learned how to wash their hands properly.

In part two, the constructs of TPB related to hand washing was assessed through 18 questions. The items are presented in **Table 1**. The TPB based questions included attitude (6 items), subjective norms (6 items), perceived behavioral control (3 items), and intention (3 items).

In part three, one-month follow-up on hand washing behavior was performed by on-line or phone call questionnaire. The questionnaire including daily hand-washing times, hand sanitizer use, rub time, following the six-step technique, judgement of hand washing step and the willingness of sharing hand washing method with family members.

2.4 Data Analyses

Data were analyzed using the Statistical Package for the Social Sciences (ver 25.0) or GraphPad Prism 9 (GraphPad Software), and P values < 0.05 were determined statistically significant. Continuous parameters were presented as median with interquartile ranges (IQR) and analyzed by the Mann-Whitney U test to determine significance. Gender and death before day 28 were presented as frequency and percentages. These data were analyzed by the chi-square (χ^2) test to determine significance between the cohorts for categorical variables.

Results

3.1 Demographics of participants

This prospective study screened a total of 448 residents who were vaccinated with COVID-19 vaccine, 322 of them enrolled the final study (Figure 1). The median age of the participants was 46 and 45 years in the intervention and control groups, respectively (Table 2). One-hundred fifty-one participants (46.9%) were male. There were no significant difference between both groups in the terms of age ($P = 0.988$),

gender ($P = 0.078$), marital status ($P = 0.242$), education ($P = 0.850$), employment ($P = 0.344$), annual household income ($P = 0.201$), injection interval ($P = 0.276$), and on-line time ($P = 0.704$).

3.2 TPB-based hand washing intervention

As shown in Table 2, there was no significant difference of the TPB scores between the intervention group and control group at the baseline (Time 1). After one time intervention (Time 2), the mean scores of attitude ($P = 0.017$), perceived behavioral control ($P = 0.006$), and intention ($P = 0.016$) of hand washing behavior in intervention group were much higher than baseline (Time 1). After twice intervention (Time 3), all the four scores (attitude, subjective norm, perceived behavioral control and intention) are significantly higher than baseline (Time 1) ($P < 0.001$). Comparing with the control group, the scores of subjective norm ($P = 0.009$) and perceived behavioral control ($P < 0.001$) in intervention group were higher at Time 2. Moreover, all the four scores (attitude, subjective norm, perceived behavioral control and intention) are significantly higher than control group at Time 3 ($P < 0.001$) (Table 3).

3.3 Follow-up after the intervention

Participants in the intervention group performed better than those in the control group on daily hand-washing times ($P = 0.044$), hand sanitizer use ($P = 0.003$), rub time ($P < 0.001$), following the six-step technique ($P < 0.001$) after intervention. The accuracy of right six-step technique in intervention group was higher than that in the control group (73.9% vs. 19.0%, $P < 0.001$). Moreover, more participants in intervention group had sharing hand washing method with family members than the control group (73.4% vs. 13.7%, $P < 0.001$, Table 4).

Discussion

Based on our known knowledge, this study is one of a few theoretical-based interventions on hand washing behavior in community vaccination populations. According to our results, residents' attitude, subjective norm, perceived behavioral control, intention regarding hand washing behaviors of the intervention group was found to be significantly increased as compared with the control group after the intervention. Hence, it can be verified that theory-based intervention was effective in improving and maintaining the hand washing behavior of residents. According to the theory of planned behavior, intention of residents' hand washing behavioral improving and perceived behavioral control directly affect behavior. At the same time, the attitude of residents, subjective norms and perceived behavioral control directly affect the resident's behavioral intention[8]. This project introduced the theory of planned behavior in the healthy intervention on citizens, to explore its impact on behavioral intention of hand washing improving. Behavioral intention reflects expected future behavior, and the measurement of actual behavior should lag behind behavioral intention for a period of time. Thus, one-month follow-up after intervention showed that participants in the intervention group performed better than those in the control group on daily hand-washing times, hand sanitizer use, rub time, following the six-step technique, the accuracy of six-step technique and willingness sharing the intervention contents with family members.

Hand washing is rigorously rub together of two hands with soap or sanitizers, followed by a brief rinse with clean water. It is the basic hygiene procedure aimed to achieve disease control and prevent spread of microbial infection. As an effective means of infection control, hand washing has been shown to have an impact on the prevalence of respiratory diseases[18, 19], and appropriate hand washing interventions can break the transmission cycle. A systemic review including eight interventional studies reported that handwashing lowered risks of respiratory infection, with risk reductions ranging from 6% to 44% [pooled value 24% (95% CI 6-40%)] [20].

Hand washing knowledge was strongly associated with positive attitudes toward hand washing and correct hand washing practice. A research including 1323 adults from all regions of Saudi Arabia, revealed that sex, educational level, family income, and HW knowledge were associated with negative and neutral attitude, whereas age, sex, family income, and HW knowledge were associated with practice[21]. This prompts us to conduct healthy intervention to improve citizens' hand washing behavior. Another study suggested that hand hygiene interventions can help control the risk of infection in nursing homes[22]. A survey comprised 222,599 individuals among Korean adults during the year of the Middle East respiratory syndrome (MERS) outbreak, revealed that individuals who received hand-washing education or saw promotional materials related to hand washing had significantly higher scores for self-reported use of soap or sanitizer and self-reported frequency of hand washing than those who did not have such experiences[23]. It can be speculated that the health education intervention in this study may indirectly help to control the infection risk of community residents. Especially in the community of the elderly or young population of the import should be more obvious. Of course, this conjecture has yet to be proved.

Previous studies have shown that the majority of the population is not optimistic about the compliance of hand washing behavior[24]. Unfamiliarity with hand washing methods and forgetting to wash hands are important reasons for the low compliance[24, 25]. We recommend that enhanced educational surveillance measures, particularly in heavily staffed facilities, can improve compliance with hand-washing behaviors and thus improve or reduce the risk of disease transmission[26, 27]. Surveys showed that medical students (Medicine/Nursing) had a 6.3% higher median hand washing knowledge score when compared with the rest of the students ($P = 0.029$), in addition, students who wash their hands ≥ 6 times a day had a 18.7% higher median hand washing knowledge score when compared with those who wash their hands ≤ 2 times a day ($P = 0.008$), these students also had a higher median hand washing skills score[24]. The results suggested that medical education can improve people's attention to hand hygiene, which suggests healthy education can have a similar effect on health promotion. Although the study has only demonstrated that the implementation of monitoring measures during medical procedures can improve compliance with hand washing behavior so far[27], it can be used as a reference for improving hand washing compliance in other situations. Previous studies have found that individual experience is of greater important than formal education in explaining hand hygiene behavior[28], we can regard the vivid vicarious experience as a potential means to increasing the propensity for instilling sustainable adequate hand hygiene habits to residents. In this way, the habit of hand washing and hand hygiene can be improved imperceptibly.

It is worth noting that high frequency of hand washing or high sensitizing and irritancy hand sanitizers may lead to contact dermatitis, we remind the need to pay attention to keep the appropriate frequency, do not wash your hands for a long time and cause skin damage. The study said alcohol-based hand sanitizers with moisturizers have the least sensitizing and irritancy potential when compared to soaps and synthetic detergents[29]. Since hand washing is an important way of health care and preventing the spread of COVID-19 in society, we recommend to use right and suitable hand products[30] and wash our hands correctly for residents' daily health care and maintain hand hygiene.

This study can be used as a reference for the hand health situation of some local people in Wuhan, and it can play an important role in promoting the implementation of hand health education. As the TPB is adopted in this study, and this theory predict behavior quite well in comparison to the ceiling imposed by behavioral reliability[8], we believe our research can be used as a sample for other studies. However, there are some limitations to the study. First, the questionnaire is self-reported and may be subject to recall bias and social desirability bias. Second, the outcome variable (hand washing behavior) had no clinical data to examine. Moreover, due to the limitations of our sample size, the results of the study only looked at the effects of current interventions on adults in community groups, so we were unable to determine the effects of interventions on adolescents.

Conclusions

Finally, the results of this study showed that residents who accepted the TPB-based hand washing intervention program, which is for hand washing attitude, subjective norm, perceived behavioral control, intention have been improved. Therefore, applying TPB based education is suggested to maintain and improve self-care behaviors and health literacy in residents. And it can be generalized to other applicable situations.

List of abbreviations

TPB, theory of planned behavior; COVID-19, coronavirus disease 2019.

Trial registration

Not applicable.

Authors' contributions

LW, ZG, and LZ conceptualized this study. LW, HW and ZG conducted the literature search and initial item selection. ZS, BW, WW and WS reviewed the items. LW and WX extracted the data and ZG and ZS conducted the data analyses. All authors drafted and edited the manuscript. The authors read and approved the final manuscript.

Abbreviations

TPB, theory of planned behavior; COVID-19, coronavirus disease 2019.

Declarations

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Not applicable.

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LW, ZG , and LZ conceptualized this study. LW, HW and ZG conducted the literature search and initial item selection. ZS, BW, WW and WS reviewed the items. LW and WX extracted the data and ZG and ZS conducted the data analyses. All authors drafted and edited the manuscript. The authors read and approved the final manuscript.

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Availability of data and materials

Available upon request of the principal of each of the studies that provided data for the measure development.

The study protocol was approved by the ethics review board of Renmin Hospital of Wuhan University(No.WDRY2020-K219). We have obtained written informed consent from all study participants .All of the procedures were performed in accordance with the Declaration of Helsinki and relevant policies in China.

Consent for publication

Not applicable.

Competing interests

No conflicting relationship exists for any author.

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Populated checklist

The TIDieR (Template for Intervention Description and Replication) Checklist has been completed (Additional file).

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Tables

Table 1. Number of items, range and Cranach's Alpha based on the TPB (Theory of Planned Behavior) constructs

TPB constructs Variables	Items example	Options	Number of items	Range score	Cranach's Alpha
Attitude	In my opinion, hand washing can lead to better infection control	1=completely disagree 2=disagree 3=No idea 4=Agree 5=Completely agree	6	6-30	0.91
Subjective Norms	Most people who are important to me (e.g. family, doctors, health nurses) think that I must wash my hands thoroughly, doing the proper procedure for 2 minutes	1=completely disagree 2=disagree 3=No idea 4=Agree 5=Completely agree	6	6-30	0.85
Perceived Behavioral Control	I am confident that I could perform right hand washing procedure	1=completely disagree 2=disagree 3=No idea 4=Agree 5=Completely agree	3	3-15	0.87
Intention	I intend to learn right hand washing procedure	1=completely disagree 2=disagree 3=No idea 4=Agree 5=Completely agree	3	3-15	0.89

Table 2. Demographic and behavioral data of the study population. Data are presented as median with interquartile ranges (IQR) where specified.

Characteristics		Intervention (n=169)	Control (n=153)	<i>P</i> value
Age (y), median (IQR)☐		46 (35-56)	45 (36-53)	0.988
Gender	Male, n	78	73	0.078
	Female, n	91	80	
Marital status	Never married, n	63	53	0.242
	Married/staying with partner, n	106	100	
Education	None, n	1	0	0.850
	Primary, n	23	25	
	Secondary, n	110	98	
	Tertiary/university, n	35	30	
Employment	Unemployed/retired, n	48	42	0.344
	Self-employed, n	61	60	
	Formal employment, n	60	51	
Annual household income	< 8,000 dollars, n	50	26	0.201
	8,000-15,000 dollars, n	97	83	
	>15,000, n	58	44	
Injection interval (d), median (IQR)☐		40 (35-45)	38 (33-45)	0.276
On-line time	<1h	38	29	0.704
	1-3h	89	82	
	>3h	42	42	

Table 3. Comparing of mean and standard deviation of TPB (Theory of Planned Behavior) structures and the hand-washing between the intervention group and the control group at different time points. * $P < 0.05$.

		Intervention	Control	<i>P</i>	<i>P</i>
		Mean(SD)	Mean(SD)	Group	Time
Attitude	Time 1	19.93 (3.72)	20.25 (3.96)	0.449	
	Time 2	20.89 (3.64)	20.41 (3.88)	0.253	0.017*
	Time 3	21.87 (3.84)	20.08 (3.72)	<0.001*	<0.001*
Subjective norm	Time 1	20.44 (3.71)	19.88 (3.66)	0.175	
	Time 2	21.07 (3.59)	20.00 (3.70)	0.009*	0.119
	Time 3	21.93 (3.90)	20.41 (3.87)	<0.001*	<0.001*
Perceived behavioral control	Time 1	9.91 (1.69)	9.69 (2.13)	0.307	
	Time 2	10.49 (2.17)	9.63 (1.91)	<0.001*	0.006*
	Time 3	11.06 (2.40)	9.95 (1.49)	<0.001*	<0.001*
Intention	Time 1	9.62 (2.01)	9.72 (2.09)	0.670	
	Time 2	10.12 (1.76)	10.05 (1.85)	0.743	0.016*
	Time 3	10.76 (2.97)	10.04 (1.83)	0.001*	<0.001*

Table 4. Hand washing behaviors of the participants after intervention. * $P < 0.05$.

Behaviors		Intervention (n=169)	Control (n=153)	<i>P</i> value
Daily hand-washing Times	<2	34	48	0.044*
	2-5	82	70	
	>5	53	35	
Hand sanitizer use	always	113	72	0.003*
	usual	42	58	
	seldom	11	21	
	never	3	2	
Rub time	<15s	57	80	<0.001*
	≥15s	112	73	
Follow the six-step technique	always	22	5	<0.001*
	usual	78	10	
	seldom	51	24	
	never	18	114	
Judgement of hand washing step	right	125	29	<0.001*
	wrong	44	124	
Share hand washing methods with family	did	124	21	<0.001*
	didn't	32	125	
	will but not yet	13	7	

Figures

Figure 1

Flow diagram and outcome of the study participants.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TIDieRChecklistWord.docx](#)