Comparision Study On The Knowledge and Attitude Between Healthcare Workers Based On Educational materials of Nucleotie Based Vaccines

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Research

Keywords: COVID-19, Education, Gene therapy, Healthcare Workers, Nucleotide-based vaccine, Vaccine Safety.

Posted Date: September 17th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-871667/v1

Abstract

Background

With the implementation of nucleotide-based vaccines (NBVs) in the COVID-19 vaccination campaigns, a wide controversy surrounding NBVs has become a heated subject of debate, and it did not spare healthcare workers (HCW) and staff. HCW have a powerful influence on the acceptance of NBVs by the general public. Hence, the aim of this study was to assess the knowledge and attitude of healthcare workers regarding this new vaccine technology.

Methods

This is a cross-sectional study using an online survey involving health workers in Jordan. The survey assessed the participants' socio-demographic characteristics, knowledge, and attitude about the safety and efficacy if NBVs. The study population was divided into two groups, educated and uneducated groups, whereby the former received a small educational pamphlet on NBVs. The Mann-Whitney test was used to compare between the response of the two groups.

Results

A total of 330 health workers participated in this study. Respondents believed that RNA-based NBVs would be a safer option compared to DNA-based ones, with the educated group showing significant difference. The notion of NBVs being a form of gene therapy was more common among the educated group. The majority of the participants, particularly amongst the uneducated group, were concerned about undiscovered effects of NBVs. Respondents also agreed that NBVs must be reevaluated in phase 1 trials. As for efficacy, our study population agreed that these vaccines would prevent severe illness.

Conclusions

Although healthcare workers have positive knowledge and attitude towards NBVs, misconceptions and skepticism exist and must be addressed with more education efforts.

Statement Of Impact

This project could lead to developing better educational material for healthcare workers regarding NBVs. Healthcare workers are the most important players in combating stigma and controversies surrounding the COVID-19 vaccination campaign. Thus, correcting any knowledge gaps they have will help them better inform the public and raising vaccination turnout rates, which is the single most important factor in ending the pandemic.

Background

The Coronavirus Disease 2019 (COVID-19) is caused by the novel SARS-CoV-2 coronavirus and is characterized by pneumonia and respiratory failure [1] [2]. The first cases of COVID-19 were traced back to a popular seafood market in Wuhan city of the Hubei province in China [3] [4]. Despite strict measures mandated in the affected province to contain SARS-CoV-2, the virus spread dramatically outside of China and COVID-19 was designated as a pandemic in March of 2020 [5] [6]. By August of 2021, SARS-CoV-2 had infected more than 207 million people worldwide and was linked with the death of more than four million individuals [7].

Since the beginning of the pandemic, several medications have been proposed to manage COVID-19 [8] [9]. However, the use of these medications often stirs controversies amid conflicting reports regarding their efficacy and/or safety. Current treatment of COVID-19 involves the use of Remdesivir, an experimental antiviral drug previously tested for its clinical utility in controlling the Ebola virus, and dexamethasone [10]. However, the former has been approved for use in a small number of countries and both have yer to undergo further clinical trials to conclude their efficacy [11].

The scientific community worldwide quickly sensed the impact developing a vaccine against SARS-CoV-2 would have on ending the pandemic [12]. In addition, it appears that a safe, well-tolerated, and effective vaccine against SARS-CoV-2 may be the most cost-effective method to mitigate its spread[13]. Over 13 vaccines are currently in use worldwide. The bases of these vaccines are diverse and some of the approved ones are based on new technology platforms [14], specifically, they are nucleotide-based. Nucleotide-based vaccines (NBVs) offer a relatively quick production cycle [15] Their main strategy is to exploit the molecular machinery responsible for protein synthesis in the cells to produce a viral protein, which is presented on the cell surface and, in turn, stimulates an effective immune response [16] [17]. NBVs have a surprisingly high efficacy rate and are successful in preventing symptomatic COVID-19 disease as measured by negative PCR results in immunized individuals by nearly 95% as compared to non-vaccinated groups [18] [19] [20]. Importantly, NBVs are pathogen-free eliminating the possibility of infection among staff that administers the vaccine or among the patients receiving it.[21]

This is the first time in history that NBVs are used at this wide scale and there are disproportionate controversy and misinformation regarding this important subject [22]. Mounting controversy regarding their safety has been increasing in societies including among healthcare workers. For a vaccination program to succeed, public compliance and acceptance must prevail starting with healthcare workers [23] [24]. Therefore, it is important to elucidate the attitude and knowledge of healthcare workers in regards to vaccines[25]. This study aims to assess the attitude and knowledge among these workers in regards to the new NBVs and compare their knowledge when provided with a brief educational material versus when they are left without one, which would provide a successful base to improve the overall public attitude towards this new vaccine technology and asses the need for better education for HCWs about the matter.

Methods:

Study design and population:

This is a cross-sectional study conducted in Jordan through an online survey. The survey was prepared in Google Forms with a consent form appended as the first page. It was delivered to medical health professionals from different healthcare sectors including physicians, nurses, pharmacists, biomedical researchers, and medical, dental, and nursing students. The invitations were delivered to participants via closed groups on Facebook and WhatsApp, the most popular social media applications used in Jordan. All participants confirmed working or studying in Jordan. Study objectives were clearly explained at the beginning of the survey, and the participants were encouraged to distribute the survey to their colleagues. The study population was divided into two groups of similar numbers. One group was given a short description describing NBVs before the data collection sheet and after consenting to the form and, hence, named “the educated” group. The other group, labeled “the uneducated group” was not provided with the same educational material (see appendix 1).

Study instrument:

The tool was developed in the English language after a thorough search in the recent literature and based on the most recently available information from the World Health Organization (WHO) on emerging respiratory viruses, including COVID-19, and vaccines. A draft survey instrument was sent to a group of experts chosen according to their experience and expertise in the related fields to assess its readability, simplicity, and relevance. A pilot study was initially carried out by randomly selecting 20 participants at Jordan University Hospital (JUH) to assess clarity, readability, and acceptability and highlight issues that they deemed important on the subject of NBVs. Refinements were made accordingly before the final survey was distributed to the study population. The data of the pilot analysis were not used for the final sample of the study.

Contents of the survey instrument and scoring system:

The survey instrument consisted of 19 closed-ended questions with responses based on a three-point Likert scale composed of the options of agree, neutral, or disagree. This survey was divided into four main sections to assess the participants' socio-demographic characteristics, the safety of RNA- versus DNA-based NBVs, the safety of NBVs in general, and attitude of and knowledge towards NBVs efficacy. The first section covered the participants' demographic and professional attributes namely age, gender, educational degree, profession, and healthcare sector. The second section consisted of 6 questions assessing the attitude and knowledge towards the safety of DNA versus RNA-based NBVs. The third section consisted of 6 questions that assessed the knowledge and attitude of respondents towards the new technology of NBVs in general and relative to non-NBVs. The fourth section inquired about the basic knowledge NBVs.

Data analysis:

Descriptive and none parametric statistics were conducted by using the statistical package for social sciences (IBM, 25). Mann-Whitney test was used to compare between the two groups of the study on the

preference and safety of DNA vs RNA NBVs. We used the Mann-Whitney test because the dependent variables were measured in ordinal level (disagree, neutral, agree). Furthermore, the responses of the participants to the questions: Would DNA or RNA NBVs be more effective? Were depicted in themes in the result section. (IBMCorp Ibm, SPSS (2017). Statistics for Windows, version 25.0. Armonk, NY: IBM Corp.)

Results

Table 1 presents the descriptive statistics for the study sample. The study sample included 330 participants who were divided into two groups. The first group was composed of 157 (49.1%) participants who received educational materials of NBVs and the other group consisted of 163 (50.9%) participants who did not receive the educational materials. The ratio of males to females was almost equal in the study. The highest age group was the youngest (18–24 years), which constituted almost half of the study population. The medical students composed the highest percentage (41.3%) according to the profession of the participants. Most participants (64.7%) were associated with university hospitals. The comparision between groups showed that females received less education than males on COVID-19; and physicians are the least who get education on COVID-19.

Table 1
Descriptive statistics of the study sample (N = 320)

Variables	Uneducated N = 163	Educated N = 157	Chi-Square	Total sample
	Number (%)	Number (%)		Number (%)
Age in year				
18–24	79 (48.5)	84 (53.5)		163 (50.9)
25–34	34 (20.9)	36 (22.9)	2.49	70 (21.9)
35–44	28 (17.2)	18 (11.5)		46 (14.4)
≥45	22 (13.5)	19 (12.1)		41 (12.8)
Gender				
Male	92 (56.4)	65 (41.4)	7.24*	157 (49.1)
Female	71 (43.6)	92 (58.6)		163 (509.)
Profession				
Medical students	69 (42.3)	63 (40.1)		132 (41.3)
Physicians	55 (33.7)	34 (21.7)	12.17*	89 (27.8)
Healthcare fields other than physicians	39 (23.9)	60 (38.2)		99 (30.9)
Place of work				
Private sector	30 (18.4)	45 (28.7)		75 (23.4)
Public sector	21 (12.9)	17 (10.8)	4.71	38 (11.9)
University	112 (68.7)	95 (60.5)		207 (64.7)
*p ≤ .01				

Participants were then asked about their preference of the type of NBVs, that is DNA-based or RNA-based NBV, based on the molecular characteristics of RNA and DNA molecules, in association with the safety of the NBVs. The respondents within each group were given several statements and they would have to answer whether they agreed or disagreed with these statements, or if they had a neutral stance. Interestingly, there was good agreement among respondents that RNA-based NBVs could be safer than DNA-based NBVs since RNA cannot integrate into the human genome[26], whereas the latter can,[27] and that RNA molecules are degraded more easily (Table 2). In addition, whereas one-third of respondents thought that both types of vaccines are safe to be used, one-fourth of them thought that both could pose harm to humans and should not be used. The only difference between the educated and uneducated

groups was their preference towards RNA-based NBVs since RNA molecules cannot be integrated into the human genome whereby more respondent within the educated group thought that RNA-based NBVs were safer than DNA-based NBVs since RNA molecules cannot integrate into the human genome (66.9% vs. 55.2%).

Table 2
Comparisons between groups on the preference and safety of DNA vs RNA Nucleotide-Based Vaccines.

Items	Uneducated group Disagree N (%) Neutral N (%) Agree N (%)	Educated group Disagree N (%) Neutral N (%) Agree N (%)	Mann-Whitney test
Would RNA NBVs be preferred over DNA-based (or vice versa) for safety concerns? [RNA would be safer as it is degraded more easily]	13 (8.0) 62 (38.0) 88 (54.0)	14 (8.9) 60 (38.2) 83 (52.9)	12728.5
Would RNA NBVs be preferred over DNA-based (or vice versa) for safety concerns? [RNA would be safer as it is not incorporated in the genome]	14 (8.6) 59 (36.2) 90 (55.2)	10 (6.4) 42 (26.8) 105 (66.9)	11064.0*
Would RNA NBVs be preferred over DNA-based (or vice versa) for safety concerns? [DNA is safer as it only produces foreign particles]	37 (22.7) 87 (53.4) 38 (23.9)	42 (26.8) 78 (49.7) 37 (23.6)	12451.0
Would RNA NBVs be preferred over DNA-based (or vice versa) for safety concerns? [DNA is less safe as it may integrate with vital regions]	20 (12.3) 73 (44.8) 70 (42.9)	17 (10.8) 62 (39.5) 78 (49.7)	11690.0
Would RNA NBVs be preferred over DNA-based (or vice versa) for safety concerns? [Both DNA and RNA have concerning qualities and should be avoided]	43 (26.4) 80 (49.1) 40 (24.5)	50 (31.8) 67 (42.7) 40 (25.5)	12573.5
Would RNA NBVs be preferred over DNA-based (or vice versa) for safety concerns? [Both are safe to use]	22 (13.5) 88 (54.0) 53 (32.5)	22 (14.0) 77 (49.1) 58 (36.9)	12516.0

*$p \leq .05$

Although in the comparison between the study groups on their knowledge and attitude toward the safety of NBVs, no significant differences were found. However, the highest percentage in the two groups agreed

(71.8 & 67.5%) that NBVs full effect cannot be yet determined. Furthermore, the highest percentage of the participants in both groups agree that NBVs should be reevaluated in phase 1 trials (Table 3)

Table 3
Comparisons between groups on the safety of NBVs.

	Uneducated group	Educated group	Mann-Whitney test
Items	**Disagree N (%)** **Neutral N (%)** **Agree N (%)**	**Disagree N (%)** **Neutral N (%)** **Agree N (%)**	
How do you view the safety of NBVs? [NBVs full effect cannot be yet determined]	10 (6.1) 36 (22.1) 117 (71.8)	7 (4.5) 44 (28.0) 106 (67.5)	12479.5
How do you view the safety of NBVs? [NBVs should be reevaluated in phase 1 trials]	23 (14.1) 55 (33.7) 85 (52.1)	19 (12.1) 52 (33.1) 86 (54.8)	12752.0
How do you view the safety of NBVs? [NBVs are as safe as non NBV counterparts]	31 (19.0) 77 (47.2) 55 (33.7)	26 (16.6) 79 (50.3) 52 (33.1)	12711.0
How do you view the safety of NBVs? [NBVs are safer than non-NBVs]	32 (19.6) 89 (54.6) 42 (25.8)	24 (15.3) 83 (52.9) 50 (31.8)	11842.5
How do you view the safety of NBVs? [NBVs are harmful and should be reconsidered altogether]	65 (39.9) 74 (45.4) 24 (14.7)	67 (42.7) 62 (39.5) 28 (17.8)	12323.5
How do you view the safety of NBVs? [NBVs may cause new/more dangerous bacterial or viral strains]	41 (25.2) 78 (47.9) 44 (27.0)	47 (29.9) 57 (36.3) 53 (33.8)	12438.0

The participants in the education group showed significantly more agreement that ‘NBVs is a form of gene therapy’ [28] [29] than the group with no education ($p < .01$), as well as an agreement that ‘RNA based one is more effective ($p < .05$). Furthermore, the majority of the participants in both groups (52.1% & 56.1%) agree that ‘NBVs would prevent severe illness of COVID’[19] [30](Table 4).

Table 4
Comparisons between groups on their knowledge about DNA or RNA NBVs and their effectiveness.

	Uneducated group	Educated group	Mann-Whitney test
Items	**Disagree N (%)** **Neutral N (%)** **Agree N (%)**	**Disagree N (%)** **Neutral N (%)** **Agree N (%)**	
How well do you agree with the following statements? [NBVs should become the industry standard for vaccine development]	19 (11.7) 82 (50.3) 62 (38.0)	15 (9.6) 69 (43.9) 73 (46.5)	11847.0
How well do you agree with the following statements? [NBVs are a form of gene therapy]	31 (19.0) 72 (44.2) 60 (36.8)	22 (14.0) 49 (31.2) 86 (54.8)	10482.0**
How well do you agree with the following statements? [Nucleotide-based vaccines (NBV) are more effective than traditional non-nucleotide-based vaccines]	14 (8.6) 92 (56.4) 57 (35.0)	16 (10.2) 69 (43.9) 72 (45.9)	11563.0
How well do you agree with the following statements? [NBVs would prevent severe illness of COVID]	10 (6.1) 68 (41.7) 85 (52.1)	7 (4.5) 62 (39.5) 88 (56.1)	12516.0
How well do you agree with the following statements? [NBVs address concerns over transmission of the virus]	18 (11.0) 76 (46.6) 69 (42.3)	19 (12.2) 69 (43.9) 69 (43.9)	12402.5
Would DNA or RNA NBVs be more effective? [DNA-based ones are more effective.]	26 (16.0) 96 (58.9) 41 (25.2)	38 (24.2) 79 (50.3) 40 (25.5)	12030.5
Would DNA or RNA NBVs be more effective? [RNA-based ones are more effective.]	13 (8.0) 96 (58.9) 54 (33.1)	9 (5.9) 79 (50.3) 69 (43.9)	11322.0*

*p ≤ .05 **p ≤ .01

Discussion

While few other studies examined the attitude and behavior of healthcare workers and medical students towards the COVID-19 vaccines based on their personal experiences and past vaccination history [31] [32] [33] Medical Students and SARS-CoV-2 Vaccination: Attitude and Behaviors). To our knowledge, this is the first paper to provide a deeper view of the attitudes and knowledge of healthcare workers and students on the molecular mechanism of NBVs, predominantly the newly approved mRNA COVID-19 vaccines. Additionally, the study showcased the difference in attitudes between DNA-based and RNA-based vaccines, also a poorly covered area in literature.

The participants' demographics and their professional characteristics discussed in (Table 1) showed similar patterns in both the educated and uneducated groups. A higher percentage of female participants (59%) chose to fill the questionnaire with educational material attached than male participants (41%), suggesting that female healthcare workers show greater willingness to read educational materials than males. Noting that the study participants of both sexes had almost identical attributes concerning their level of education and other demographic factors. Surprisingly, physicians showed the least interest in being part of the "educated" group's sample than any other healthcare field which could be referred to them having confidence in their previous knowledge on the topic or due to their heavier workload.

In assessing the knowledge and attitude of healthcare workers, students, and researchers on their preferred type of NBVs, the analysis revealed the population to view RNA-based NBVs as a safer option as compared to DNA based ones as a whole (Table 2), which perhaps reveals an issue of skepticism towards the safety of DNA therapy as a whole.[34] [35]

Giving a brief educational material about NBVs yielded no difference when challenged by questions not solidly based on scientific theory (RNA being more readily degraded than DNA, or DNA producing foreign proteins only), which indicates a healthy scientific base among Jordans' healthcare workers regarding this topic (Table 2). On the other hand, the educational material proved significant in altering the participants' attitude on NBVs safety in favor of the RNA-based NBVs as opposed to DNA-based NBVs due to the reduced risk of genome incorporation (gene editing)[36], a very common theme in the controversy surrounding NBVs. Yet, about one third were still surprisingly skeptical of the possibility of this emerging type of vaccines being a form of gene therapy[37], despite that the educational material provided them with improved knowledge and agreement of the population as shown in (Table 2), and that RNA does not get incorporated into the genome[36], which shows a heightened concern against NBVs (perhaps more so of DNA based ones). It may be that healthcare workers view NBVs as a form of gene therapy merely due to the possible misconception that NBVs is a "therapeutic" module against a disease utilizing a "gene" albeit a viral gene. Other parameters of (Table 2) yielded no difference in attitudes regarding their safety when a comparison is made between the educated versus the uneducated groups.

When asked about the safety of NBVs in general (Table 3), only a mere third of the population across both groups (33%) considered NBVs as safe as their non-NBVs counterparts while as much as half of the total study population stayed neutral, pointing towards a clear alarm against NBVs in the population.

Educational material did not play any significant role in changing the knowledge base or attitude towards NBVs in healthcare workers. The majority of the population were concerned about possible undiscovered long-term effects of NBVs and agreed that phase 1 trials were not successful in adequately revealing any potential adverse effects of these vaccines. This could indicate a significant gap in knowledge regarding the components of NBVs or knowledge of their previous safety profile assessment in these components in vaccines and therapeutics years before SARS-CoV-2 vaccines such as flu, Zika, and CMV. Interestingly enough, the controversy on the safety of NBVs was not as pronounced as it is now with COVID-19, which could be due to the pandemic, aggressive and unprecedented nature of COVID-19 which was not experienced by most people alive today.

Table 3 also showed that more than two-thirds of the population agreed that the full safety effect of NBVs cannot yet be determined, which can be viewed in a very positive light as phase 4 trials only just begun, and healthcare workers are only adopting a healthy approach towards the safety of these vaccines. Moreover, the study's population agreed that these vaccines would be effective in preventing severe illness with COVID-19,[30] a very important result coming out of the phase 3 trials, which would effectively reshape the health emergency of COVID-19.

Table 4 dives deeper into the participants' knowledge about NBVs and their effectiveness[38]. The educated group showed noticeable agreement that NBVs should be the industry standard, although not significant. The most significant difference between the two study groups was, without surprises, the sharp increase amongst the educated group in declaring that "NBVs is a form of gene therapy" is a true statement when they faced it, confirming all of the previous points made about the skepticism surrounding "gene therapy". The belief that RNA-based NBVs are more effective than their DNA-based counterpart was also significantly elevated in the educational group. The remaining statements did not illustrate any significant difference between the two groups.

Assessing the impact of the provided educational material on changing the attitudes of the healthcare population in Jordan towards NBVs leaves us with interesting findings. To our surprise, barring eliminating the fear of participants regarding RNA-based NBVs being incorporated into the human genome, the educational material failed to drastically improve the attitudes of the study's population towards the safety of NBVs in general. This indicates the evident need for a clear, rich, and routinely updated educational material well integrated with the curriculum of various healthcare programs regarding NBVs and other modern techniques used in vaccinology. That shall aim to diminish fear arising from various misconceptions circulating around the topic, especially 'gene therapy', ultimately ensuring an elevated quality of knowledge and formulated opinions of healthcare workers towards NBVs.

The healthcare workers' knowledge and attitudes are of extreme importance for healthcare sectors to improve the success of vaccination programs [39]. The majority of controversy in the population relies in part on the opinion of healthcare workers or physicians (in or out of context). Thus, a well-educated front of vaccine providers (which are ultimately the healthcare workers themselves) would serve to paint an accurate picture to the patients to make a well-informed decision and consequently reduce the heated

controversy surrounding the topic. Efforts from different well reputable organizations (CDC, WHO…etc) have attempted to adopt this role with varying degrees of success however, with the unprecedented anti-vaccine sentiment that is mounting in the general masses and stemming from many political, social, and educational factors, healthcare workers are still touched by these sentiments. This may serve as fuel for further controversy with the current vaccine rollout and any possible future NBVs vaccination campaigns. In our view, a unified front that has a less governmental characteristic and more of a popular front would be essential in improving vaccine efforts and outcomes, both inpatients and the healthcare field staff.

Strengths And Limitations

This is the first paper to examine the attitudes of healthcare workers and medical students towards the safety of the recent technology of NBVs that has been utilized in several COVID-19 vaccines while offering a deeper insight at their reasoning in terms of their knowledge on the molecular mechanism of NBVs. The study population is representative to an extent as both genders were almost equally involved and healthcare workers of various professions, specialties, and workplaces took part.

As for limitations, firstly: data collection was performed through an online survey which limited access to the survey and made it impossible to confirm the inclusion criteria for each respondent, thus putting a dent in the accuracy. Secondly: students and healthcare workers with previous knowledge about NBVs may have been more inclined to fill the survey and thus are overrepresented. Finally, the educational material being in the written form and containing in-depth molecular mechanisms may have caused several participants to skip or skim through the material without fully comprehending it. We advise future studies on the topic to rather use an animated approach to describe the topic.

Conclusion

Fears and misconceptions regarding the concept of “gene therapy” and the ability of NBVs to incorporate within the human genome are not uncommon among the study’s participants [40]. While the provided educational material was deemed unsuccessful in reshaping the opinions of participants toward NBVs, it significantly lowered the notion of RNA-based NBVS being a form of “gene therapy” among the study participants.

Abbreviations

Nucleotide-based vaccines. (NBVs)

Coronavirus disease of 2019. (COVID-19)

Healthcare workers. (HCW)

Jordan university hospital. (JUH)

Severe acute respiratory syndrome coronavirus 2. (SARS-CoV-2)

Declarations

Ethics and consent to participate.

The survey was anonymous to maintain the privacy and confidentiality of all information collected in the study. Participation in this survey was voluntary and was not monetarily compensated. Informed consent was obtained from each participant before participation. Ethical approval was obtained from the Institutional Review Board at JUH (reference number: 221000013). The study was performed following the Helsinki Declaration as revised in 2013.

Consent for publication.

All authors gave their verbal consent to publish.

Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests.

There's no conflict of interest to report.

Funding.

This research did not receive any funding or grants from any party and there is no conflict of interest to declare.

Authors' contributions.

Dr. MEAM- Study design, data analysis, manuscript writing.

KEA, RR , NAS - Data collection, manuscript writing.

Dr. MaA - Manuscript writing.

Dr. SAD - Data collection.

Dr. MuA - Data analysis.

All authors have read and approved this paper in it's final form prior to submission.

Acknowledgment

We would like to express our deepest appreciation to IFMSA-JO for their help in data collection.

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Appendix

Appendix 1 is not available with this version.