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THE IMPACT OF COVID-19 VACCINE ADMINISTRATION ON BALANCE AND COORDINATION IN COVID-19-NAÏVE, HEALTHY MEN

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ABSTRACT

The study investigated the effects of COVID-19 vaccination on the balance and coordination of 60 healthy men aged 55 to 60, with no previous COVID-19 history. Participants were chosen from a diverse population and evaluated for static/dynamic balance and eye-foot coordination two weeks before vaccination. Data collection adhered to standard pre-test conditions. Following vaccination, participants were stratified based on vaccine type (AstraZeneca, Sputnik, Sinopharm, Cov Iran Barkat) using random sampling. Assessments occurred one- and seven-days post-vaccination, emphasizing balance and static/dynamic coordination. Repeated measures analysis of variance revealed significant differences in static and dynamic balance across the phases, highlighting the impact of COVID-19 vaccination on these aspects of physical health. Notably, the AstraZeneca group exhibited distinctive differences in static balance compared to the Cov Iran Barkat group. While eye-foot coordination scores remained consistent, the AstraZeneca group differed from the other three groups. The findings suggest that COVID-19 vaccination may influence balance and coordination, particularly in standing balance. Prioritizing monitoring and addressing potential side effects related to these physical functions is crucial in the vaccination context.

Keywords - COVID-19 vaccination, statistical analysis, adverse effects, balance and coordination, vaccine, evaluation.

INTRODUCTION

The COVID-19, caused by the new SARS-CoV-2 coronavirus, is a global challenge. It primarily affects the respiratory system, but various clinical symptoms can be presented [1]. The pandemic caused rapid scientific and medical advances that resulted in diagnostics, treatments, and vaccines [1, 2]. The emergence of COVID-19, first reported in Wuhan, China in mid-December 2019, was officially declared a pandemic by China on December 30, 2019. This new coronavirus, named "Covid-19," has since caused a global pandemic [3, 4]. In addition, according to data provided by the World Health Organization (WHO), the widespread human-to-human transmission of this virus has infected approximately 443 million people, with a high mortality rate of nearly 6 million [5]. Due to its high contagiousness, long incubation period, and the symptoms it can cause, COVID-19 poses a serious threat to the health of human society [6, 7]. The virus has been declared one of the deadliest pandemics of the last century, necessitating many measures, including quarantines, social distancing, healthcare interventions, and the closure of educational institutions and businesses. All measures have been taken with the aim of reducing the transmission rate and limiting humans [8]. The COVID-19 vaccines serve the important purpose of targeting the immune system to recognize the virus and, once infected, effectively neutralize the onset of the disease [9, 10]. Before widespread distribution, COVID-19 vaccines undergo an extensive validation process, prioritizing efficacy and safety. This process requires randomized, controlled clinical trials. These comprehensive measures, while time-consuming to establish vaccine efficacy and safety, lead to vital public health improvements [9]. The intensification of the global crisis during the COVID-19 pandemic has accelerated the need for expediting the vaccine development process. By December 2020, the United Kingdom and the United States had issued initial emergency approvals, setting a precedent that was soon followed by Europe [11].

BACKGROUND

As per Iran's national COVID-19 vaccination program, the country, in line with the global trend, initiated coronavirus vaccination in February 2019, commencing with the administration of the Russian Sputnik vaccine [12]. This vaccination effort commenced with priority given to at-risk groups, including the elderly and individuals with underlying health conditions, and it is ongoing [9]. Since the initiation of public vaccination in the country, the available vaccine portfolio has included AstraZeneca, Sputnik V, Chinese Sinopharm, and Indian Bharat vaccines, offering a range of options to the population [13]. Meanwhile, it is notable that a substantial portion of the population has received vaccines such as AstraZeneca, Sinopharm, Sputnik, and Cov Iran Barkat. An important question arises regarding the relative safety profiles of these vaccines and their associated risks. COVID-19 vaccines administered in Iran, akin to those worldwide, may induce varying degrees of local and systemic reactions, typically resolving spontaneously within a week following administration. Comprehensive assessment of these vaccines' safety profiles is essential for informed public health decision-making [14]. Despite numerous studies conducted on COVID-19 vaccines and the administration of approximately 10 billion vaccine doses globally to date (17), the accelerated pace of vaccination has led to an increase in reported complications following vaccine administration, raising concerns about vaccine-related adverse events [15]. While there have been no documented cases of severe complications or fatalities resulting from COVID-19 vaccine injections, a substantial number of vaccine recipients have reported various complications, including issues like imbalance and dizziness [16]. According to research findings, approximately 11.8% of the reports within the Vaccine Adverse Event Reporting System (VAERS) concerning COVID-19 vaccines include mentions of dizziness as a potential side effect. Moreover, an additional 80% of these reports specifically cite dizziness as a reported complaint [17]. According to the Centers for Disease Control and Prevention (CDC), dizziness and unsteadiness following a Covid-19 vaccination can sometimes be a sign of an allergic reaction, but according to the CDC, it is more common within the first 15 to 30 minutes of vaccination [18]. Kadali et al. (2021) aimed to explore non-severe side effects of the mRNA-1273 COVID-19 vaccine in healthcare workers. They utilized surveys and found dizziness (14%) and pseudo-vertigo (47.3%) prevalent, with incoherence being the most reported symptom post-vaccination [19]. Moradian et al. (2021) examined the frequency of COVID-19 vaccine complications among emergency responders. Their study revealed that 12% of participants reported experiencing headaches and dizziness as side effects [20].

Vertigo encompasses various sensations, including lightheadedness, a lack of balance, diminished concentration, and instability. Balance, within the context of this study, is the ability to maintain the center of gravity within the range of support provided. It can be categorized into static, involving maintaining a stable position, and dynamic, related to performing tasks in a stable position [21]. Balance is a fundamental aspect of daily physical activities and plays a pivotal role in overall performance and coordination; its impairment can lead to reduced performance and coordination, increasing the risk of injury [22]. Achieving balance control is a complex process involving the coordination and interaction of multiple systems, including the nervous system, skeletal-muscular system, proprioception, vestibular system, basal ganglia, cerebellum, and visual system [23]. These systems collectively contribute to the regulation of balance and contribute to sensory stimulation within the skin and joints, enhancing coordination and proprioceptive feedback [24]. Additionally, movement coordination involves the integration of various processes governing how muscles interact with the skeletal system and the neural processes that control these interactions within the spine and brain. When these components work harmoniously, overall bodily coordination improves [25]. Therefore, understanding balance and coordination as attributes of neuromuscular circuits can provide valuable insights into movement control [26].

Moreover, considering the potential impact of COVID-19 vaccines on balance and coordination, investigating these variables in this study holds significant importance. Reports of vaccine side effects, collected by pharmaceutical agencies through online questionnaires without clinical validation, are susceptible to various biases. Thus, this research assumes the possibility of vaccine effects on balance and coordination, potentially leading to effective interventions to prevent injuries like falls due to balance and coordination issues. Such interventions could yield multiple benefits, including cost reduction and performance improvement. Consequently, understanding the broader implications of balance and coordination in everyday life and the paucity of studies on the impact of COVID-19 vaccine administration on the balance and coordination of healthy men with no history of COVID-19 motivate our research, aiming to compare the effects of different anti-corona vaccines on the balance and coordination of this specific population.

MATERIALS AND METHODS

Procedural visualization stands as a valuable method for in this semi-experimental research study, a cohort of 60 male participants, aged between 55 and 60, hailing from Ardabil city, were meticulously chosen from the larger statistical population, in accordance with a pre-defined questionnaire aimed at capturing individual-specific information, based on specific inclusion and exclusion criteria. The ethics committee at Physical Education and Sport Sciences-Sports, identified by the reference code IR.SSRI.REC.1401.1622. The inclusion criteria for the vaccinated subjects were as follows: individuals falling within the age bracket of 55-60 years, absence of a positive PCR test prior to the administration of the initial vaccine dose, overall physical and mental well-being, and satisfactory hearing and visual acuity, with vision close to 6.60. Additionally, all subjects had received their first vaccine dose within the initial two weeks of August. Exclusion criteria encompassed a history of surgical procedures, presence of lower limb and spinal abnormalities, neurological disorders, and inadequate cooperation. It is noteworthy that stringent adherence to all prescribed health protocols was observed throughout the course of this research. Two weeks prior to vaccination commencement, participants underwent a preliminary session at the laboratory. During this session, the procedure for the subsequent tests was elucidated, and participants were requested to complete informed consent forms and questionnaires. Subsequently, anthropometric measurements were obtained for all participants, and assessments of both static and dynamic balance as well as eye-foot coordination were conducted under pre-test conditions, with corresponding data meticulously documented. Following the vaccination process, participants were categorized into four distinct groups, each consisting of 15 individuals, based on the specific vaccine type administered. These groups comprised individuals inoculated with AstraZeneca, Sputnik V, Sinopharm, and the Iranian-made Barkat vaccines, respectively. It should be noted that all participants in these four vaccine groups shared similar mean ages, heights, and weights, and were selected in accordance with the test's predefined criteria. Post-test assessments were conducted on all subjects, both one day and seven days after vaccination, and relevant data pertaining to static and dynamic balance as well as coordination were diligently recorded.

EVALUATION OF STATIC AND DYNAMIC BALANCE

To assess static balance, we employed the Sharpendromberg test, a standardized evaluation method. During this assessment, subjects were instructed to stand barefoot on a level surface and adopt a static position wherein their dominant foot was positioned in front of their non-dominant foot, with the heel of the front foot aligned with the toe of the back foot. The subject's arms were crossed over their chest, and the palm rested on the shoulder of the opposite side. Importantly, this test was conducted with the subject's eyes closed, and their ability to maintain this position with closed eyes determined their score. The reliability of this assessment, when conducted with eyes closed, was found to be within the range of 0.76 to 0.77 [27].

For the evaluation of dynamic balance, the standing and walking time test was administered. To perform this test, a chair was initially placed at a distance of 3 meters from a designated obstacle, representing the endpoint of the path. Participants were then instructed to rise from the chair without the assistance of their hands and proceed to traverse a three-meter distance. Upon reaching the endpoint, participants were required to make a controlled turn and sit back down on the chair. It was emphasized that this sequence should be completed as quickly as possible, without resorting to running. Each participant performed this test three times, and the average time taken across these three attempts was recorded as their final score. The reliability of this test was found to be impressively high at 0.96 [28].

ASSESSMENT OF EYE-FOOT COORDINATION

To assess eye-foot coordination, we implemented the tandem gate walking test, a validated measure widely employed in the context of evaluating motor skills and coordination. During this assessment, participants were instructed to walk along a straight path spanning 15 steps, executing each step with precision by placing the heel of one foot directly in front of the toes of the other, all while maintaining a shoeless state. Throughout the test, participants were allowed to move their hands freely alongside their body. The maximum attainable score in this test was 15 steps. Should a subject veer off the designated path before successfully completing the 15 steps, the test was promptly halted, and the number of steps completed up to that point was meticulously recorded as the individual's performance score. The reliability of this assessment measure was established at a commendable 0.80 [29], highlighting its consistency and effectiveness in appraising eye-foot coordination in various contexts, including those relevant to the assessment of COVID-19-related motor function and physical performance.

Figure 1. Tandem gait walking test for eye-foot coordination assessment.

RESULT AND DISCUSSION

In this comprehensive research study, various research variables underwent a thorough analysis, employing SPSS software version 25, which encompassed both descriptive and inferential components. The analysis included a one-way analysis of variance test with repeated measurements, scrutinizing intra-group factors (pre-test, post-test, and a follow-up seven days later) and inter-group factors related to the administered COVID-19 vaccines (Astrazenka, Sputnik V, Sinopharm, and Cov Iran Barkat). The primary objective was to discern the impact of these vaccine injections on the balance and coordination abilities of 60 healthy male participants aged 55 to 60, none of whom had a history of COVID-19 infection. The significance level was set at 0.05. Table 1 presented a comprehensive overview of participant characteristics, including age, height, weight, and body mass index. Meanwhile, Table 2 presented data on static balance, dynamic balance, and eye-foot coordination in both pre-test and post-test phases, along with a follow-up assessment. Levene's Test was employed to evaluate normality and equality of variance, revealing that assumptions of equality of variances were met. This study emphasized evaluating the impact of COVID-19 vaccine injections on balance and coordination, utilizing a rigorous methodology that included baseline measurements, stratified random sampling, and multiple assessments before and after vaccination.

Table 1. Average and standard deviation and the general characteristic of participants in four groups including age, height, weight, and body mass index.

Group variable	Age (year)	Mass (KG)	Height (CM)	BMI
	57.21±2.16	72.50±7.94	175.00±3.74	23.5

AstraZeneca				
Sputnik	58.3±2.00	73.25±6.23	178.40±4.79	23.00
Sinopharm	57.15±1.2	73.36±6.01	175.18 ±3.32	23.8
Barkat	58.01±1.32	74.13±8.15	177.73±5.78	23.6

Table 2. The mean and standard deviation of static balance, dynamic balance, and eye-foot coordination in the pre-test, post-test, and a follow-up testing.

Group variable	**Time variable**	**Static balance** Mean & SD	**Dynamic balance** Mean & SD	**Coordination** Mean & SD
AstraZeneca	Pre-test Post-test Follow-up testing	33.46±13.5 16.74±6.40 30.95±10.0	7.09±0.71 8.13±1.14 7.76±1.16	±2.31 10.48 9.67±3.67 ±2.26 11.13
Sputnik	Pre-test Post-test Follow-up testing	23.08±8.62 17.31±4.23 24.30±8.99	7.29±0.69 8.04±0.69 7.30±0.51	±1.10 13.73 13.00±1.3 ±1.74 13.20
Sinopharm	Pre-test Post-test Follow-up testing	25.99±8.45 15.92±6.27 24.69±9.53	7.39±0.53 7.56±0.53 7.19±0.57	±2.61 12.67 ±2.59 13.20 ±2.12 13.33
Barkat	Pre-test Post-test Follow-up testing	19.04±7.87 19.07±5.77 19.41±6.19	7.30±0.66 7.95±0.62 7.36±0.58	±1.59 13.13 ±2.28 12.67 ±1.45 12.87

In Table 3, the results of the analysis of variance for repeated measurements are presented to assess the differences in the research sample across three stages: pre-test, post-test, and follow-up one week later. The measurements pertain to static balance, dynamic balance, and eye-foot coordination. As indicated in Table 3, the impact of measurement time on static balance is statistically significant ($\eta 2 = 0.312$, $P \leq 0.001$, $F(101.341, 1.81) = 25.425$). Thus, it can be concluded that there is a significant difference in average static balance among the pre-test, post-test, and follow-up periods, irrespective of the test groups. Furthermore, the interaction effect between time and group is also significant ($\eta 2 = 0.190$, $P \leq 0.001$, $F(101.341, 5.429) = 4.378$), indicating that the change in average static balance at different times varies across different group levels. Additionally, the effect of the group on static balance is statistically significant (η2=0.191, P≤0.007, F (3,56) = 4.408). This suggests that, regardless of the measurement time, there is a significant difference in the average static balance among the test groups. In Table 3, it is observed that the effect of measurement time on dynamic balance is also statistically significant (η2 = 0.212, P ≤ 0.001, F (2.112) = 15.041). Thus, it can be concluded that there is a significant difference in average dynamic balance among the pre-test, post-test, and follow-up periods, regardless of the test groups. However, the interaction effect between time and group is not statistically significant (η2=0.080, P ≤ 0.458, F (112, 6) = 1.622), indicating that the difference in average dynamic balance at different times does not vary significantly among the different group levels. Similarly, the effect of the group on dynamic balance is not statistically significant (η2=0.045, P≤0.007, F (3,56) = 0.878). This implies that, regardless of the measurement time, there is no significant difference in the average dynamic balance among the test groups. According to the results presented in the table above, the effect of measurement time on eye-foot coordination is not statistically significant (η2=0.025, P≤0.236, F (2,112) = 1.463). Consequently, it can be inferred that there is no significant difference in average eye-foot coordination among the pre-test, post-test, and follow-up periods, irrespective of the groups. However, the interaction effect between time and group is statistically significant (η2= 0.054, P ≤ 0.382, F (6,112) = 1.074), indicating that the difference in the average eye and foot coordination at different times varies across different group levels. Additionally, the effect of the group on eye-foot coordination is statistically significant (η2=0.326, P≤0.001, F (3,56) = 9.040). This suggests that, regardless of the measurement time, there is a significant difference in the average eye and foot coordination among the test groups.

Table 3. Analysis of variance for repeated measurements: static balance, dynamic balance, and eye-foot coordination across pre-test, post-test, and one-week follow-up stages.

Scale	Group type	References	df	Mean square	F	Sig	eta squared
Static balance	Within group	Time Time * Group error	1.8	1369	25.43	000. * 0	312
	Between group-	Between -group	5.4	235.9	4.38	001. * 0	190
Dynamic balance	Within group	Time Time * Group error	101	53.9	…	…	…
	Between group-	Group error	3	491.4	4.41	007. * 0	191
Coordination	Within group	Time * Group error	56	111.5	…	…	…
	Between group-	Group error	2	7.1	15.04	000. *0	212

* Significant sign

Based on the findings extracted from Table 4 and Figure 2, the Sidak follow-up test was employed to conduct pairwise comparisons among the test groups concerning static balance, dynamic balance, and eye-foot coordination. The analysis revealed a noteworthy difference between the Astrazenka group and the Barkat group specifically in the domain of static balance. However, in the context of static balance, no significant differences were observed when comparing the Astrazenka group with the other groups. Turning to the results pertaining to dynamic balance, the analysis did not uncover any statistically significant disparities among the various groups, indicating a uniform performance across this particular metric. In contrast, when assessing eye-foot coordination among the test groups, a notable divergence was observed. The Astrazenka group exhibited a substantial difference in comparison to the other three groups in terms of eye and foot coordination. Conversely, no statistically significant distinctions were identified among the remaining groups in this regard. These findings underscore the importance of considering not only the vaccine type but also individual attributes and interventions when evaluating the impact of COVID-19 vaccinations on physical aspects such as balance and coordination.

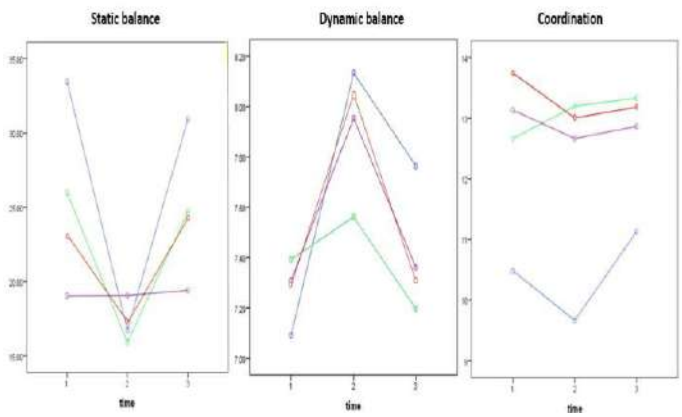

Figure 2. Trend graph of mean changes in repeated measure variance analysis.

Table 4. Comparative analysis of static balance, dynamic balance, and eye-foot coordination across test groups using the sidak follow-up test.

Groups	Static balance	Dynamic balance	Follow up after a week
AstraZeneca	33.46 16.74 30.95	7.09 8.13 7.76	10.48 9.67 11.13
Sinopharm	25.99 15.92 24.69	7.39 7.56 7.19	12.67 13.20 13.33
Sputnik	23.08 17.31 24.30	7.29 8.04 7.30	13.73 13.00 13.20
Barkat	19.04 19.07 19.41	19.04 19.07 19.41	13.13 12.67 12.87

The line diagram, presented in Figure 2, provides a visual representation of our analysis. The results clearly indicate that in the one-way repeated measure variance analysis, the null hypothesis was rejected, signifying a significant impact of vaccine type on both static balance and eye-foot coordination. On the other hand, when we examine the outputs obtained from the dynamic balance section, the one-way repeated measure variance analysis did not lead to the rejection of the null hypothesis. Consequently, it can be confidently stated that the type of vaccine has no discernible effect on dynamic balance. These findings underscore the differential impact of vaccine types on various facets of physical health and highlight the importance of tailored approaches in evaluating the physiological effects of COVID-19 vaccinations.

CONCLUSION

In conclusion, this study has meticulously examined the effects of COVID-19 vaccine injections on balance and coordination among a cohort of 60 healthy male participants aged 55 to 60, all free from prior COVID-19 infection. The research adopted a rigorous methodology encompassing baseline measurements, stratified random sampling, and multiple assessments conducted both before and after vaccination. The analysis employed SPSS software version 25 and included descriptive and inferential components, such as one-way analysis of variance tests with repeated measurements, scrutinizing intra-group factors (pre-test, post-test, and a follow-up seven days later) and inter-group factors related to the administered COVID-19 vaccines (Astrazenka, Sputnik V, Sinopharm, and Cov Iran Barkat).

The findings have revealed several crucial insights. Firstly, the research has shown a significant impact of vaccine type on static balance, as evidenced by the rejection of the null hypothesis. Additionally, the interaction effect between time and group further elucidates the differential effects of vaccine types on static balance at various time points. Conversely, no statistically significant differences were identified in dynamic balance across the different vaccine groups or time points, indicating the limited impact of vaccine type on this aspect of physical health. In contrast, a noteworthy divergence in eye-foot coordination was observed, particularly with the Astrazenka group, highlighting the importance of considering individual attributes and interventions when assessing the effects of COVID-19 vaccinations on physical attributes.

In summary, this study underscores the importance of tailored approaches in evaluating the physiological effects of COVID-19 vaccinations. While vaccine type plays a significant role in static balance and eye-foot coordination, dynamic balance appears to be unaffected by the type of vaccine administered. These findings contribute to the growing body of knowledge concerning the broader impact of vaccination campaigns on individual health, ultimately assisting in the development of more informed public health policies and recommendations.

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This study was carried out with official approval from the ethics committee at Physical Education and Sport Sciences-Sports, identified by the reference code IR.SSRI.REC.1401.1622.

CONFLICT OF INTEREST

The authors declare, they don’t have any conflict with this article.

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