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Evaluating the effect of using augmented reality (Metaverse) on improving the teaching and academic performance

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Abstract: This study aimed at evaluating the effect of employing the augmented reality (metaverse) on improving the process of teaching and academic performance. An electronic questionnaire containing five questions was distributed to the academic groups that received the lesson using augmented virtual reality (Metaverse). The aim of the questions was to evaluate their experience, and after they answered the questions, the answers were analyzed in the form of percentages and frequencies. The study sample consisted of (97) students from Al-Ain University enrolled in the programs of (special education, nutrition, and applied sociology), to whom the experiment was applied using augmented virtual reality in teaching during their academic course. The results revealed that (83%) of the respondents reported that the augmented virtual reality contributed to understanding the concepts of the lesson well, (79%) felt enjoyment in using this technique, (75%) suggested that the technique enhanced their involvement in the content well, (68%) suggested that augmented virtual reality could be a useful educational instrument in the future, and (77%) confirmed that the lesson's objectives were achieved by using metaverse technique in teaching. However, several challenges were faced by students, including the used language (only English) and the negative effects of bad quality of used glasses. Based on the findings, the study recommended addressing several key areas for optimizing the use of augmented virtual reality (AVR) in teaching. For example, diversifying language options for AVR content is crucial to accommodating the linguistic diversity among students, thereby enhancing accessibility and comprehension. Additionally, we should invest in high-quality equipment and implement regular maintenance protocols to enhance the quality of equipment, specifically addressing issues related to the negative effects of subpar AVR hardware.

Keywords: *Academic performance, Al Ain University, Metaverse, Teaching.*

1. Introduction

Educational technology is considered one of the most important innovations in the domain of education. In recent years, there has been a noticeable increase in the use of technology in classrooms, where virtual reality has been introduced as one of the creative methods for improving the educational process. Virtual reality enables students to interact with the educational content using new interesting methods, and contributes to improving the students' academic performance and enhancing their understanding of the academic subjects. Augmented virtual reality is a technique that combines the real world and the virtual world. It is an environment that augments the real basic environment by adding the virtual digital data and components, such as sound, images, videos, and information.

The augmented virtual reality (metaverse) aims to replace the traditional way of teaching by providing a comprehensive interactive environment that enhances innovation and interaction among

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students. This platform depends on the techniques of virtual reality and augmented reality to construct a three-dimensional educational content that allows students to participate in real educational environments and explore concepts by using new innovative methods. Metaverse provides a large set of educational materials and lessons, including science, history, mathematics, arts, design, and programming. Metaverse lessons are characterized by more creativity and motivating educational experiments that make the educational process more effective and interesting.

This technique also provides students with more creative educational opportunities, enabling them to interact more effectively with the educational material. Indeed, the scientific experiments and exploration allow students to engage in three-dimensional environments and interact with the existing elements, which, in turn, enhance cooperation among students. The educational opportunities in metaverse are not only limited to students, but they also include teachers and trainers, where metaverse provides teachers with innovative educational instruments that enable them to construct innovative educational content and introduce it to students in an attractive way. Metaverse also allows teachers to monitor students' progress and evaluate them using the available assessment tools. In short, metaverse is viewed as a new opportunity for learning and development in this digital era, where it provides an advanced educational environment that combines new technology with personal learning.

1.1. The Study Problem and Questions

The researcher faced difficulty finding sufficient or appropriate research about the effect of using the augmented virtual reality (metaverse) in education and its role in improving academic performance. This may highlight the necessity of conducting further studies and analyses in this domain.

The study seeks to evaluate the actual effect of using augmented virtual reality on education and academic performance, and whether it is a positive effect or not.

Therefore, the study problem lies in the way of assessing the effect and the actual value of using technology, such as augmented virtual reality (metaverse) in the domain of education, as well as the way of improving the experiment of education and academic performance using metaverse.

In light of the above-mentioned, the study aimed to answer the following main question: how does using the augmented virtual reality contribute to improving education and academic performance among the students of (special education, nutrition, and applied sociology) at Al-Ain University?

The study's main question gives rise to the following sub-questions:

1. What is the effect of using the augmented virtual reality on improving education and academic performance among the students of (special education, nutrition, and applied sociology) at Al-Ain University?
2. What are the most prominent challenges of using the augmented virtual reality (metaverse) in education from the perspective of the study sample individuals?
3. What are the most prominent recommendations and suggestions for improving the experiment of augmented virtual reality (metaverse) in education?

1.2. The Study Importance

The study's importance lies in identifying the extent of keeping pace with the modern global attitudes by employing the most prominent technological developments, particularly the technique of augmented reality in teaching students, which may, in turn, benefit experts and educational specialists in developing education by using the advanced technological methods. Also, the study results could be beneficial to curriculum developers, who should take this technique into account while planning and developing curricula. Furthermore, the results may be beneficial to faculty members, where conferences, workshops, and training meetings can be held to enable faculty members to employ this technique in the educational process and keep pace with the scientific and technological advancement.

Moreover, to the best of researcher's knowledge, this is one of the first studies to examine the extent of augmented reality use in higher education in the UAE. The study could open new horizons for

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other researchers to employ various models of augmented reality in different academic subjects and develop the various knowledge domains of science.

1.3. The Study Terms

Augmented virtual reality is a synchronous interactive technique that merges the real world with the virtual world by projecting the virtual objects and information (digital data) on the user's real environment in order to provide additional information that supports the real context by using the digital data and elements represented by sound, images, as well as three-dimensional interactive drawings and videos. Those elements promote perception, which, in turn, helps students interact with the digital content and remember it well. Academic performance is a multi-dimensional concept relating to the learner's characteristics, represented by the skills, attitudes, and behaviors affecting the individual's academic success. These skills and attitudes are manifested in two main domains; the simple and complex academic skills (such as memorization, understanding, and critical thinking) and the academic-assisting factors, represented by (intrapersonal skills, motivation, and academic-self-concept).

1.4. The Study Limits

- The spatial limits: the United Arab Emirates, particularly in Al-Ain University.
- The human limits: the students of the programs of special education, therapeutic nutrition, and applied sociology at Al-Ain University.
- Temporal limits: the first semester of the academic year (2022- 2024).

2. The Theoretical Framework

2.1. The Patterns of Augmented Reality

In his study, Obari [1] suggested that augmented reality technique is based on a system that combines the features of the real world already existing in the learner's mind, such as linking the geographical coordination with the virtual element information appropriate to it based on the requirements of the site, an introductory video, or any other information that augments the real world. Then, the content is analyzed in the program and the virtual elements are combined with it.

Attar and Kansara [2] and Qishta [3] suggested that there are two types of operating augmented reality:

The first type is AR Markerless

This type doesn't depend on using markers, but rather employs the camera's geographical location based on (GPS), or recognition of image programs, in order to display information. Examples of that include:

- Google Translate Application.
- Layer application.
- Aurasma application.
- Element 4D application.
- Anatomy 4D application.

The second type: (AR Markers). This type is based on using Markers, where the camera can take pictures and recognize them in order to display the related information. The researchers used the first type in this study. In their study, Kipper and Rampolla [4] suggested that the steps used in operating augmented reality techniques are identical regardless whether they are marker-or markerless augmented reality. If there is a marker, it is recognized and the three-dimensional figure is displayed on the marker's surface. In the event that there is no marker, the surrounding area is explored, and the digital data is assigned to a set of coordinates on the network.

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2.2. The Concept of Metaverse

The concept of metaverse was first used in the science fiction novel "Snow Crash" in 1992 to describe the virtual world. This term has two parts, "meta" and "verse," with reference to the universe. Currently, people use this term to describe the three-dimensional virtual world. Multiple world across various platforms that can provide users with attractive and thorough experiences based on interactive and cooperative activities also fall under this term. Several studies about metaverse suggested that there is a noticeable ambiguity in determining a clear definition of metaverse. We can attribute this to the necessity of further efforts to fully develop this technology [5]. However, we can say that metaverse is a large social network that includes a mixture of virtual reality, augmented reality, mixed reality, three-dimensional environments, and artificial intelligence, where these elements interact effectively with each other in real time. This interaction is shared by too many people throughout the world, where it provides a real communication environment with real sense for users. Virtual communication takes place in virtual environments that are similar to real-world environments, where various transactions, such as communication and payment, take place Lee, et al. [5]. Mystakidis [6] suggested that metaverse is a post-reality universe, where physical reality is merged with virtual environments across a connected network that encompasses continuous interactions and multiusers. The network features open gaming worlds based on virtual reality and augmented reality. Also, users are represented as symbolic images that interact in real time with full sensation and are referred to as "Avatar."

2.3. The Idea of Metaverse Environment and the Type of the used Technology

Metaverse is based on complex interrelated types of virtual reality (VR), augmented reality (AR), and mixed reality (MR), where all these techniques constitute a mixture, referred to as the extended reality (XR).

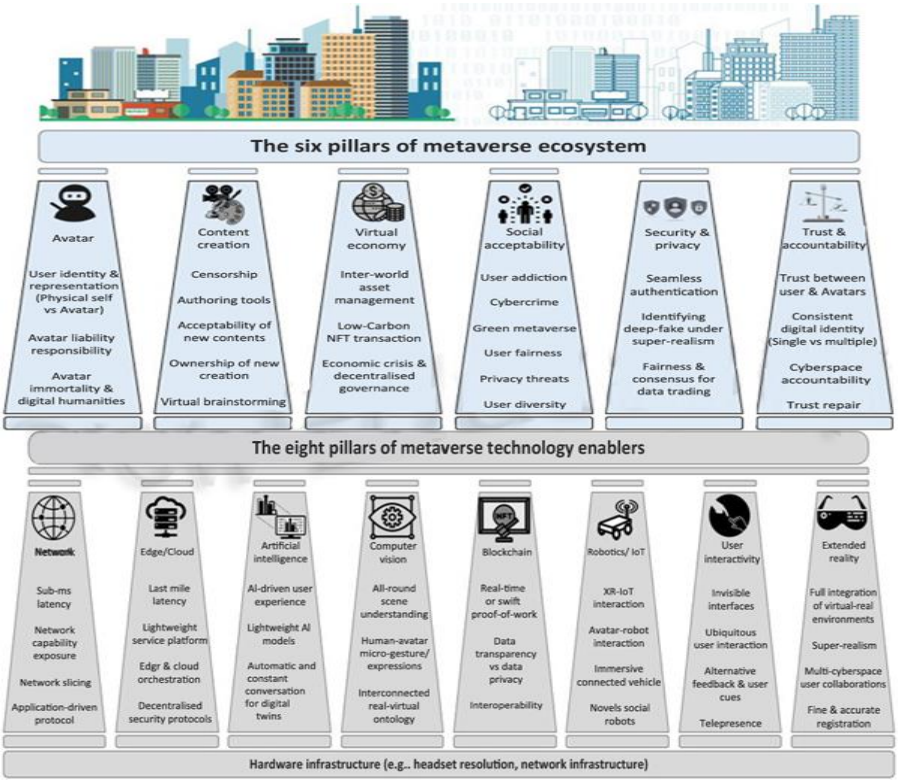

Figure 1.
8 basic techniques upon which metaverse is based.
Source: Lee, et al. [5].

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It depends on three-dimensional techniques to make virtual entities that merge closely with human and physical objects. Other techniques, such as artificial intelligence, the internet of things, computer vision, sensors, and blockchain, are used to ensure storing data and dealing with it in a way that guarantees user's protection and privacy. In their research on metaverse, Lee, et al. [5] mentioned (8) basic techniques upon which metaverse is based, including extended reality, users' interactivity, robotics, artificial intelligence, and other related techniques, as illustrated in the Figure 1.

Figure 1 illustrates (8) basic techniques upon which metaverse is based.

2.4. How Can Metaverse Environment Support Education

Researchers, teachers, policymakers, and digital designers have the opportunity lead the world by taking advantage of the three-dimensional, interrelated, real-time potential of metaverse. Indeed, this prompts us to look for new creative techniques to link the physical world with the experiments of augmented and virtual reality [7].

Some researchers suggested that we can take advantage of those innovative techniques in the domain of medicine, where they can provide users with more inclusive and interactive learning in the medical domains [8].

Also, metaverse has many advantages for aircraft, where it gives more opportunities for interaction with planes and provides semi-real aircraft experiences. It also provides innovative experiences in planes' maintenance and engineering based on smart glasses provided with virtual beings, units that process the passengers' various languages, in addition to creative plans to control skies and dominate the route of flights in an accurate and exciting way, which, in turn, urges us to take advantage of metaverse in the domain of aircraft and teach it [9].

As for the domain of science, metaverse can be used in chemistry to make chemical reactions and do experiments in an almost a realistic way, whether the used elements are radiant or contain a high ratio of uranium. Unlike real laboratory settings, experiments are done without fear of causing any harm to learners.

Metaverse also contributes to converting the abstract concepts, that are hardly understood, into three-dimensional figures. For example, learners can watch carbon atoms while they spread around them, or while forming various symmetric or asymmetric shapes in various compounds. Indeed, this allows learners to see the invisible side of the different elements and chemical compounds, and thus they can identify the number of carbon atoms in the various chemical structures and the safe ratio in each chemical compound, such as Co2. This, in turn, urges them to choose the safest compounds for the individual and the environment. In this way, it will be easier to realize the real danger imposed by the ozone hole and the harmful gas emissions causing it. In this vein, we can design a real metaverse structure about the earth's shape and show the effects of the real threats of climate change on the human beings and life in general. This will encourage students to make more efforts in the short run to protect their surrounding environment, and to protect earth in the long run [10].

Furthermore, metaverse can be employed in studying micro-sciences and organisms, studying the human body, identifying micro-details that can't be accessed in the human body, and exploring relationships that haven't been explored before. Scientists may also get to more achievements, such as controlling the human genes and hereditary diseases; therefore, they can prevent the emergence of those diseases gradually. However, this technique may be misused in this domain, where the human genes could be manipulated, and the unwanted genes may be aborted which may, in turn, result in preferring one gender to another, or even determining the number of humans, in addition to other scary scenarios that should be controlled by imposing strict laws that guarantee taking advantage of metaverse world without threatening humanity [8].

As for history, metaverse can be employed in displaying the history and culture of the previous nations as well as searching for the narrative events of the previous civilizations and assimilating them in a realistic way that enable learners to experience the lives of those civilizations.

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As for art, metaverse can provide a rich artistic environment, in terms of teaching art in its various types and explanations. In this vein, metaverse may enable us to solve the mysterious puzzles of Pablo Picasso's paintings and lay a new foundation of art by using metaverse, which provides us with unlimited artistic imagination, and allows each individual to participate in this domain without facing obstacles [11].

2.5. Provisions Studies

In a study, Qishta [3] aimed to identify the impact of using two types of augmented reality on developing the scientific skills and understanding in the subject of science among the students in the seventh grade in Gaza. The researcher developed a design based on Augmented Layer Reality application, D4 Element application, and an augmented-reality-based teacher's manual. The study used the analytical-descriptive approach and the experimental approach. The results revealed that there are statistically significant differences between the mean scores of the experimental group and the control group in the post application in favor of the students of the experimental group, and for testing the cognitive domains of scientific sensation in favor of the experimental group. The results showed that the two patterns of augmented reality were effective in developing the scientific concepts and cognitive domains among the students of the experimental group. In a similar vein, Jouda [12] investigated the effectiveness of using augmented reality in developing the skills of calculation, problem-solving and emotional intelligence among the students of the primary stage, who have difficulty in learning mathematics in Saudi Arabia. The experimental approach was used. The study sample consisted of (30) learning-difficulty students of the primary stage in Tabouk. The results revealed that there are statistically significant differences in favor of the experimental group, and differences in the post-application for the scale of emotional intelligence in favor of the experimental group. Furthermore, Jirjis [13] addressed the impact of the pattern of total and partial content shown using the technique of augmented reality on developing self regulation and learning efficacy among the students of the first preparatory class in Assiut. The results showed that there are statistically significant differences between the mean scores of the two experimental groups in the post-application for the scale of self-regulation in favor of the first experimental group and differences in learning-efficacy in the post-application in favor of the experimental groups. Moreover, Al-Dahasy, et al. [14] investigated the impact of using augmented reality to develop mathematical thinking. The results revealed that augmented reality in teaching mathematics contributed to increasing the student's cognitive abilities, overcame the individual differences between students and contributed to developing the love of knowledge among them. The results revealed that primary-stage teachers have positive attitudes towards using the technique of augmented reality on developing mathematical thinking. In his study, Ahmad [15] highlighted the impact of a program based on augmented reality on developing the skills of visual thinking in the subject of science among the ninth grade students in Gaza. The results revealed that there are statistically significant differences between the mean scores for the students in the pre- and post-applications in the test of visual thinking, and that the program is effective in developing the skills of visual thinking. Similarly, Al-Shatri and Al-Obaikan [16] examined the effect of using the technique of augmented reality on the academic achievement of secondary-stage students in computer studies and information technology. A positive effect was foundfor teaching by using augmented reality on the academic achievement in favor of the experimental group. Also, Zallio and Clarkson [17] suggested that employing metaverse in education provides us with more opportunities to overcome several difficulties faced by individuals in the real world, including the physical difficulties. Even though metaverse may cause social isolation due to the inability to communicate with others, it provides more opportunities related to new sensory experiences for those suffering from perceptual disabilities. Finally, Pimentel, et al. [18] revealed that many people may find difficulties in using (XR) techniques. For example, an individual suffering from difficulties in hand motion may find it difficult to use control tools or wear glasses. Also, using Head-Mounted Display (HMD) could be a challenge.

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3. Research Methodology and Procedures

3.1. Research methodology

In order to achieve the study objectives and answer its questions, the researchers used the analytical descriptive approach by asking all the individuals to describe the nature of the targeted phenomenon and the extent to which it exists.

3.2. The Study Population and Sample

The study population consisted of all the students in the programs of (special education, nutrition, and applied sociology) in the bachelor degree stage at Al-Ain University during the academic year (2023/2024). The study sample consisted of (97) male and female students from the three programs of (special education, nutrition, and applied sociology), selected by using a purposive sampling from the academic groups of students that received the lesson using augmented virtual reality (Metaverse).

3.3. The Study Instrument

The researchers developed a questionnaire to identify the effect of using augmented reality on improving education and academic performance. An electronic questionnaire containing five questions was distributed to a purposive sample consisting of academic groups that received the lesson using augmented virtual reality (Metaverse).and thus, (97) questionnaires were analyzed for the students who reported using metaverse in their learning during their academic study.

3.4. Results Analysis

3.4.1. The Characteristics of the Sample Individuals

Table 1 shows the characteristics of the sample individuals according to gender, program type, accumulative average, and job status.

Table 1.
The characteristics of the sample individuals.

Variable	Category	Frequency	Percentage (%)
Gender	Male	26	28
	Female	68	72
	Total	94	100
Program type	Special education	28	30
	Nutrition	18	19
	Applied sociology	48	51
	Total	94	100
Accumulative average	More than 3.5	24	26
	Less than 3.5	70	74
	Total	94	100
Job status	Work	35	37
	No work	59	63
	Total	94	100

Table 1 revealed that the highest percentage of the sample individuals were females (68%). The highest number was in applied sociology (51%), while those with an accumulative average above (3.5) represented (26%). Those working were (37%), while non-workers were (63%); this could be attributed to the fact that most working citizens in the UAE studied applied sociology, and thus we investigated their perspective about using metaverse in teaching and its effect on them as employees.

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3.4.2. Analyzing the First Question's Results

What is the effect of using augmented virtual reality on improving education and academic performance experiment?

Table 2 shows that (83%) of the respondents suggested that metaverse contributed to understanding the lesson's concepts well, and (79%) felt enjoyment while using this technique [14]. (75%) reported that metaverse increased their participation during the lesson, (68%) reported that metaverse can be a useful educational tool in the future of education, and (77%) suggested that the lesson's objectives were achieved by using metaverse technique [16].

Table 2.
The results of surveying students' opinions about the effect of using augmented virtual reality on improving the experiment of education and academic performance.

Number	Item	Frequency percentage		
		Yes	No	Don't know
1	Did you feel that using augmented reality (Metaverse) contributed to a better understanding of the concepts in the lesson well?	83%	7%	10%
2	Did you enjoy interacting with metaverse augmented technology during the lesson?	79%	13%	8%
3	Did you find that metaverse augmented technology useful for achieving the lesson objectives?	77%	10%	13%
4	Did you feel that the augmented reality (Metaverse) increased your engagement in the lesson and your interaction with the content?	75%	17%	%8
5	Do you think that the augmented virtual reality (Metaverse) can be a useful teaching tool in the future of your lessons?	68%	11%	21%

3.4.3. The Second Question

What are the most prominent challenges of using the augmented virtual reality (metaverse) in education from the perspective of the study sample individuals?

(39%) of the students reported that some challenges are represented by the used languages in metaverse applications (only English), while (18%) were concerned about the glasses used in metaverse and how they could adversely affect the skull and cause nausea after a certain time of usage [18]. (16%) reported that there were difficulties related to physical restrictions, where individuals could find difficulties in hand motion, using control tools, and wearing glasses [18].

3.4.4. The Third Question

What are the most prominent recommendations and suggestions for improving the experiment of augmented virtual reality (metaverse) in education?

(37%) of the respondents reported that using metaverse in education allowed users to overcome the challenges of physical environment of the real classrooms. (17%) reported that using metaverse in education allowed learners to overcome the obstacles of the real world, including the physical disabilities that could restrict reaching certain areas, in addition to the social exclusion resulting from lack of communication with others and the lack of new sensory experiences among those suffering from sensory or cognitive difficulties [17]. (44%) reported that metaverse contributed to cultural diversity, and (21%) reported that metaverse contributed to protecting the environment from pollution.

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4. Conclusion

The current study aimed at evaluating the impact of using metaverse in improving education and academic performance using an electronic questionnaire distributed to students from different programs at Al-Ain University who experienced the augmented virtual reality (metaverse) during their academic studies. The results revealed that (83%) of the respondents reported that metaverse contributed to a better understanding of the lesson's concepts, (79%) felt enjoyment while using this technique, (75%) reported that metaverse increased their engagement in the lesson, (68%) reported that metaverse could be a useful educational tool in the future of education, and (77%) reported that the lesson's objectives were achieved by using metaverse in education.

The results showed that the most prominent challenges were represented by the language used in metaverse applications (English only), the negative effects of some glasses used in metaverse on the skull, and the nausea resulting after a certain time of usage, in addition to the need for expensive infrastructure and the physical equipment, where the individuals with motion disabilities may find difficulties in using control tools and wearing glasses.

5. Recommendations

The study at Al-Ain University, which involved students from programs like special education, nutrition, and applied sociology recommends addressing several key areas to optimize use of augmented virtual reality (AVR) in teaching. Firstly, diversifying language options for AVR content is crucial to accommodating linguistic diversity among students, thereby enhancing accessibility and comprehension. Furthermore, by investing in high-quality equipment and implementing regular maintenance protocols, we should strive to enhance the quality of equipment, especially by addressing the negative effects of subpar AVR hardware. Providing comprehensive training and support to students will aid in familiarizing them with AVR technology and mitigating any challenges they may encounter during its use. Moreover, effectively integrating AVR techniques into the curriculum across disciplines requires collaborative efforts between educators and technology specialists to design tailored lesson plans that leverage AVR's potential for enhanced learning outcomes. Continuous evaluation and refinement of AVR applications through feedback mechanisms are essential for identifying areas for improvement and ensuring their effective integration into teaching practices. Exploring interdisciplinary applications of AVR in education and promoting further research and development initiatives will also contribute to maximizing its benefits across diverse academic programs. By implementing these recommendations, Al-Ain University can harness the potential of AVR to foster engagement, improve comprehension, and enhance educational experiences for students across various fields of study.

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Institutional Review Board Statement:

The Ethical Committee of the Al Ain University, Abu Dhabi, UAE has granted approval for this study (Ref. No. COP/AREC/AD/C/7).

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Competing Interests:

The authors declare that they have no competing interests.

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Authors' Contributions:

All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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