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A Review of Current Metaverse Applications as a Tool for Reshaping Human Behaviour in Health Communication

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ABSTRACT

In line with the objectives of Industry 4.0, the Health 4.0 initiative promotes the integration of cutting-edge technology into medical practice. The Health 4.0 concept includes virtual reality (VR) as a component that has the potential to play an important role. Even though VR in the medical field is a hot issue right now, there is still a lack of understanding about VR-assisted treatment from a broad viewpoint. The combination of healthcare with the metaverse will result in more efficient resource distribution and usage within the healthcare system. The data pertaining to healthcare in the metaverse are kept on a public server, and Artificial Intelligence (AI)-based devices are used to retrieve it. Through the use of metaverse's healthcare systems, patients get a diagnosis in a timely manner. Because the metaverse is meant to be used for specific things, its effects on society, the economy, and culture are also determined by those things. The main findings of this review are to highlight the metaverse's goal of encouraging connectivity, collaboration, and new experiences directly affects how people interact, work, and interact with digital environments and how important it is for responsible and ethical development to make sure that all of these elements work well together. This analysis is going to be broken down into two distinct categories, the first two of which are purpose and impact. In conclusion, the findings of this research will help to improve strategic decision-making as well as policy-making processes in order to pursue the creation of commercial opportunities via the deployment of a metaverse service in healthcare and other comparable contexts.

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1. Introduction

The phrase "virtual reality (VR) space" is used to describe the medium used in the field of anatomy education known as the "Metaverse" ("meta" meaning beyond, virtuality or transcendence as well as "verse" meaning world or universe). The most important goal in locating health information is to find information that can really be used. Health information identification has a critical function in the battle against disinformation and will be much improved by the ability to predict information usefulness. Because they provide a consistent, comprehensive, natural, as well as direct process of user cognitive processing, modal behaviours like gaze and gesture are encouraging signs of usefulness. Technological advancements in human bio-signal fusion are seen as crucial to allowing for cutting-edge, secure, and convenient metaverse-based digital health and wellness applications [1].

High-speed internet, Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Mixed Reality Experience (MRX) and Extended Reality (XR) blockchain, digital twins (DT), AI, and practically endless data all come together to create the metaverse, which allows actual people and their avatars to engage in a digitally enhanced version of the real world. The metaverse has just recently arisen as a social media and entertainment platform, but its application to healthcare has the potential to significantly alter both fields. We find new openings for metaverse methods in the healthcare sector as a group of academic, clinical, industrial, as well as regulatory researchers. For example, medical imaging-guided diagnosis and treatment are two areas where AI-based medical practice has the potential to greatly improve patient care. Here, a "metaverse" of "medical technology and AI" (MeTAI) may help speed up both processes [2].

The rise of the metaverse sports arena, which allows for a fully immersive virtual athletic experience through digital avatars, is a phenomenon that is attracting attention across the world [3]. The prevalence of ocular illnesses, including keratitis and dry eye, are strongly related to blink rate, a key physiological reaction in humans. In healthy eyes, the blinking rate is between 6 to 30 times per minute, and this range is consistent across all individuals [4]. Guidelines for safe content consumption (due to reduced blink rate) may be developed using this study's findings in the rapidly growing VR, head-mounted display (HMD) as well as AR goggles settings in the metaverse [4].

There is a lot of discussion on the ethical, legal, and sociological implications of DHTs, as well as the technical boundaries that have been reached in this field (ELSI). Unfortunately, the pace of regulation of innovations like medical devices is presently behind their rate of use. As the natural progression of such DHTs, DT provides us with the chance to foresee and respond to ELSI before adoption once again rushes ahead of the required assessment [5]. Having the ability to learn is crucial since it teaches others how to analytically identify the challenges and come up with acceptable solutions [6] and learn skills that will help in the future, like how to communicate well, work together, and solve problems in a way that makes sense in real life [7].

2. Purpose of Metaverse

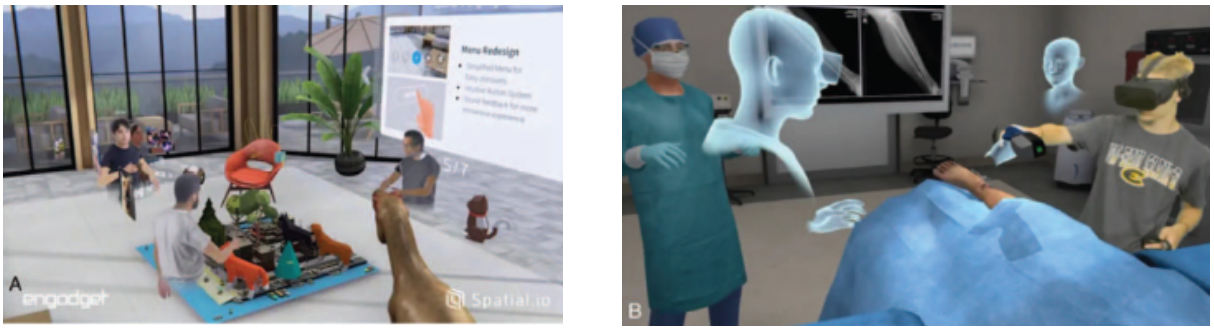
One of the most significant applications of the internet is the metaverse, a digital environment for the Fourth Industrial Revolution (IR 4.0). Internet growth improves people's lives and changes their spending habits. With the advent of technology that simplifies human existence, for instance, communication without regard to space, distance, or time, knowledge may be obtained rapidly.

In the reading phase, the most significant gesture and look characteristics were dwell duration and gaze entropy. A BP neural network was used to construct the gesture-based unimodal model, while a gradient-boosting decision tree was chosen to construct the gaze-based unimodal model and

the combined multimodal model. The F1 scores of these models were all higher than 77%, and they may be used in a variety of contexts, including the identification of health records. In addition, the gesture-based model could accommodate stringent technological or legal requirements; the gaze-based model was well-suited to AR, VR, and metaverse uses; and the combined model provided an option for multimodal human-computer interaction [8].

A significant number of these writers have interacted with or been exposed to a Metaverse in a therapeutic setting [9]. When using VR experience escapes, individuals can spend hours at a time in immersive virtual environments and interact with information in a world that provides solace and the impression of an alternate reality known as the metaverse. The psychological, social, as well as physical effects that this immersive technology reveals, as well as the factors that consumers and organisations need to take into account, have only been the subject of a small number of studies. Nevertheless, the great majority of conversations about potential threats have only addressed usability issues [10].

The 2019 coronavirus illness epidemic has highlighted the pressing need for digital transformation in healthcare settings via the use of technologies, including artificial intelligence (AI)/deep learning, telecommunication networks/virtual platforms, the internet of things (IoT), as well as blockchain. Recently, metaverse, an interconnected online universe, has emerged, bringing with it the synergistic combination of virtual, augmented, as well as mixed reality explained several years ago, ushering in a new era of immersive and real-time experiences that improve human-to-human connection and communication. The development of a 3D space as well as an avatar may prove especially beneficial in operational uses (e.g. meeting organisation), patient-fronting platforms (e.g. telemedicine platforms), diagnostics, digital education (e.g. simulated medical and surgical education), as well as therapies in the fields of healthcare and ophthalmology [11] as Figure 1.



(a) (b)

Fig. 1. Examples of the metaverse application in surgical education as well as clinical meetings. (A) Digital avatars in the metaverse, (B) Use of metaverse for surgical education [11]

As of 2021, 73.7% of Indonesia's population, or 202.6 million people, access the internet. E-commerce has been utilised by 138.2 million Indonesians aged 18-64, with 74.4% of those people using it to order meals from restaurants that deliver to their homes. Foods that are strong in carbohydrates and fat, but low in fruits and vegetables, are the most common kind of food offered via online apps. As a result, it is reasonable to infer that the food that is available to purchase has a great deal of calories but very few nutrients. Due to this, individuals are more likely to develop chronic illnesses, which include diabetes, high blood pressure, as well as cardiovascular disease. The purpose of this research is to use the health belief model to examine how individuals in Surabaya and Pasuruan, East Java, Indonesia, feel about the connection between their online food and drink ordering behaviours and their overall nutritional health [12].

Psychological counselling and online therapy are common methods of dealing with personality disorders (PD). However, schema therapy stands out among other therapeutic approaches because, unlike other approaches, it addresses not only the symptoms of PD but also the underlying cause by repairing the early maladaptive schema. This makes it particularly effective at calming emotional disturbances before implementing cognitive restructuring, which in turn leads to long-term success [13].

3. Impact of Metaverse

Fictional works like Ready Player and One Snow Crash introduced the notion of the metaverse, which is a VR world where users may engage with other users in a computer-generated social setting. The new "virtual internet" has caught the interest of futurists and visionaries because of the lofty aspirations and high expectations it has inspired. While the idea may be difficult to grasp, it's intriguing to consider the potential benefits to healthcare that the metaverse may provide. Research conducted in recent years has examined the potential of VR to enhance healthcare delivery. For example, pain is reduced, mental health is improved, and fears and PTSD are mitigated [14]. However, a number of issues arise when healthcare data from the metaverse is stored on public servers. These include the potential disclosure of sensitive patient information and the loss of important medical record data. Sharing medical records and other sensitive data in the metaverse may be done quickly and safely thanks to attribute-based encryption (ABE) [15].

The wide spread of COVID-19 has highlighted various holes in the healthcare system. As a result, new ideas and business models are springing up to offer an alternative healthcare system focusing on computer-mediated virtual worlds. Using metaverse technology, the healthcare industry's social network is being digitised as part of the ongoing digital revolution that goes well beyond virtual communication. Figure 2 is about the metaverse is an all-encompassing, fully immersive virtual environment made possible by VR and AR technology [16].

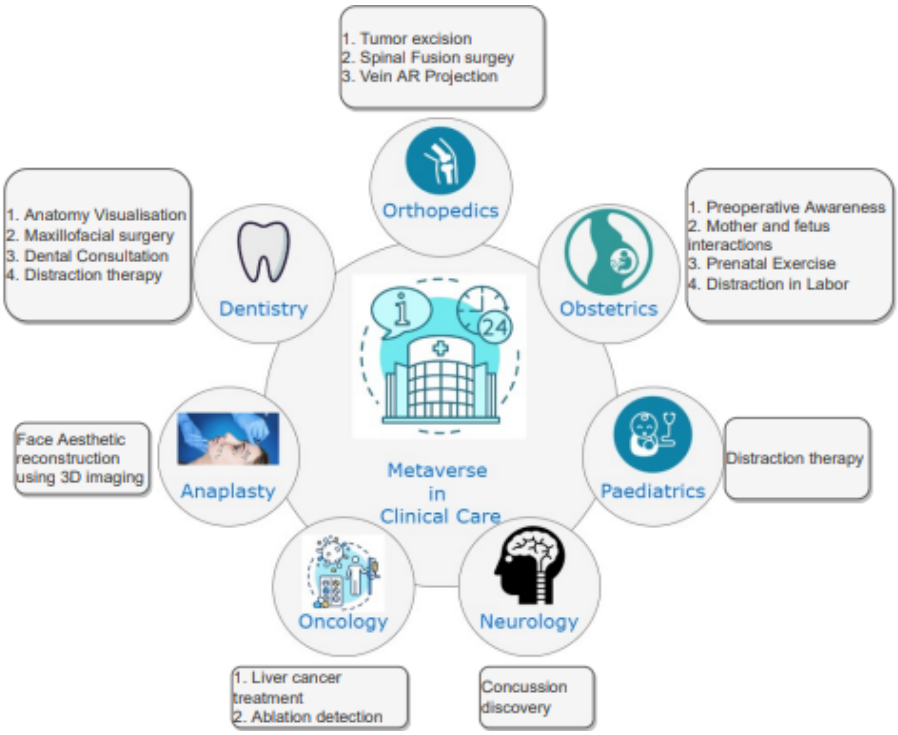


Fig. 2. Overview of metaverse applications in different divisions of clinical care [16]

In comparison to the results for "big data," "cloud," as well as "coronavirus," the RSV for "metaverse" showed an upward trend. There was an inverse relationship between the relative search volumes for DT-related terms and the newly emerged cases with respect to weekly COVID-19 cases. In this study, 78.1% of respondents believed that the good influence DT would have on future lives would surpass the damage it would cause. Experiential exposure to the metaverse (a factor of four), as well as education in AR and VR, were shown to be significant determinants of this favourable attitude (3.8-fold). After the fields of transportation and communication, respondents anticipated the most significant shifts to take place in the healthcare industry [17].

The results of this research provide strong statistical evidence that young Chinese athletes' performance anxiety as well as mental health completely moderate the direct relationships between VR sports experiences and their endurance performance. The mental health of young Chinese athletes has a stronger influence on their endurance performance than their performance anxiety. Findings from the current study advise young athletes on how to improve their VR sports skills and endurance performance [3]. There are a few different metaverses that can help us get to where we need to go sustainably in the transportation sector: testing algorithms for autonomous driving AI training, public transit safety and efficiency, traffic management, and the use of sharing economy apps [18].

The medical disorders, treatments, procedures, and results associated with four primary areas of VR-aided therapy were recognised and researched. These areas were anxiety and fear-related disorder (A&F), post-traumatic stress disorder (PTSD), diseases of the neurological system (DNS), as well as pain management. VOSviewer is a widely employed software programme for building and visualising bibliometric networks. However, this is the first research to use it. This paper's findings provide a road map for the development of the Health Metaverse during the last two decades (from the year 2000 to the year 2020), making it easier to realise the goal of Health 4.0 [19].

Table 1
A road map for the development of the Health Metaverse during the last two decades (from the year 2000 to the year 2020)

Author	Title	Year	Publisher	Method
[8]	Predicting information usefulness in health information identification from modal behaviours	2023	Elsevier Ltd	This research predicted health information identification usefulness using gaze and gesture patterns. In addition, 24 college students were enrolled to openly search for information about public health outbreaks using a smartphone. Participants reported their gestures, gaze, and information usefulness. User cognition divided information utility evaluation into two phases: skimming as well as reading. Each phase's modal behaviours yielded 31 characteristics. Random forest and Mann-Whitney U tests optimised features. The F1 score examined five standard techniques for information usefulness prediction models.

[15]	Multi-server assisted data sharing supporting secure deduplication for metaverse healthcare systems	2023	Elsevier B.V	A multi-server ABE-based Metaverse healthcare data-sharing strategy with constant encryption computation cost is proposed in this work. This system includes Metaverse healthcare ciphertext validity and equivalence detection to decrease invalid ciphertexts and ensure safe deduplication. In addition, for authority delegation following deduplication, a new attribute-based re-encryption is suggested.
[9]	Who really needs a Metaverse in anatomy education? A review of preliminary survey results		John Wiley and Sons Inc	At the 2022 American Association of Clinical Anatomists annual conference, we ran a brief survey to see how many anatomists know or use this adjunct in teaching (AACA). Only six responders (9.4%) utilised Metaverses to teach anatomy. Most participants were basic science academics or anatomy instructors, not practising surgeons/physicians or other health care professionals, who utilise this technology more often. Medical doctors, anatomists, dentists, physician assistants, physical therapists, occupational therapists, veterinarians, chiropractors, as well as medical students wrote this document. Thus, the research seeks to analyse Metaverse users in anatomy instruction and propose strategies to use this technology.
[1]	Towards a Machine Learning-Based Digital Twin for Non-Invasive Human Bio-Signal Fusion	2022	MDPI	We present a data-driven digital twin (DT) system to fuse three human physiological bio-signals: heart rate (HR), breathing rate (BR), and blood oxygen saturation (SpO2). To extract raw time-series bio-signal data from face video frames, we use photoplethysmography (PPG)-based computer vision technology. Machine learning (ML) is used to model and quantify bio signals. We properly model and measure HR, BR, and SpO2 using DT and obtain good performance relative to ground-truth values.
[10]	Virtual reality consumer experience escapes: preparing for the metaverse	2022	Springer Science and Business Media Deutschland GmbH	This article critically explores escapist literature to address VR consumer experience escape design and use. Consumer-centred research and design are examined in relation to VR experience escapes as well as consumer health and well-being. Purposeful creation of VR customer experience escapes. Moreover, a sequential research agenda combines VR experience escape antecedents that relate to three future research streams: complementing VR consumer experience research techniques, creating purpose-driven VR consumer experience escapes, as well as meaningful VR consumer experience escapes.

[2]	Development of metaverse for intelligent healthcare	2022	Nature Research	Metaverse application cases include raw data exchange, virtual comparative scanning, enhanced regulatory science, as well as metaverse medical intervention. We explore MeTAI metaverse ecosystem concerns which include security, privacy, as well as inequity. We also outline specific action items for coordinated efforts to establish the MeTAI metaverse to enhance accessibility, healthcare quality, cost-effectiveness, as well as patient happiness.
[12]	Food and Beverage Consumption Habits through the Perception of Health Belief Model (Grab Food or Go Food) in Surabaya and Pasuruan	2022	MDPI	A quantitative cross-sectional study was conducted. In addition, SPSS was used to analyse offline paper questionnaire data. Health attitudes were associated with age, married status, career, education level, income, and allowance.
[17]	Public interest in the digital transformation accelerated by the COVID-19 pandemic and the perception of its future impact	2022	Korean Association of Internal Medicine	COVID-19 has advanced digital transformation (DT). We examined the interest of the public in DT technologies and the view of Koreans with regard to their future influence. Google Trends showed the relative search volume (RSV) for "artificial intelligence," "coronavirus," "big data," "cloud," as well as "metaverse" from January 2020 to January 2022. In addition, DT knowledge, experience, and views were surveyed.
[13]	Metaverse as a possible tool for reshaping schema modes in treating personality disorders	2022	Frontiers Media S.A.	However, Piaget's genetic epistemology states that the schemata dictating adaptive behaviour may only be established in the patient's engagement with the actual world and reconsolidated by the object world's feedback on the patient's newly formed behaviour. Thus, to remodel the schema modes of the patient to promote adaptive behaviour and recover appropriate adult emotional regulation, one may have to recreate the patient's object world.
[3]	Metaverse-based virtual reality experience and endurance performance in sports economy: Mediating role of mental health and performance anxiety	2022	Frontiers Media S.A.	This research investigates how the metaverse-based VR athletic experience affects young Chinese athletes' endurance performance, using mental health and performance anxiety as mediators. Using convenience sampling, the participants of the study were mostly Chinese athletes, and the sample group accurately represented youthful athletes. For analysis and validation, SEM-AMOS statistical software was utilised.

[20]	Application of Metaverse Service to Healthcare Industry: A Strategic Perspective	2022	MDPI	This research examines a metaverse service problem in healthcare. This research provides strategic scenarios for metaverse service development and implementation in healthcare settings. Metaverse service is the business model of this research. Thus, metaverse service literature in healthcare is evaluated. An exploratory technique is utilised to assess current qualitative data describing the healthcare metaverse of service business positions and develop appropriate strategies from business patterns of present metaverse services.
[18]	A metaverse assessment model for sustainable transportation using ordinal priority approach and Aczel-Alsina norms	2022	Elsevier Inc.	Four metaverses are considered in this study: public transit operation and safety, auto-driving algorithm testing for training autonomous driving artificial intelligence, sharing economy applications for sustainable transportation and traffic operation. Operation efficiency, social and health, as well as law and regulation, are the thirteen sub-criteria used to assess these options. The assessment model uses a unique Rough Aczel–Alsa (RAA) function as well as the Ordinal Priority Approach (OPA).
[14]	The promise of the metaverse in cardiovascular health	2022	NLM (Medline)	Since Mark Zuckerberg rebranded Facebook Inc. as Meta Platforms to create a metaverse, there exists significant disagreement regarding its potential. In specific areas, evidence-based research has examined VR, but the metaverse provides more: a sophisticated, virtual universe in which individuals may interact and develop connections. Healthcare delivery should consider this.
[4]	Change in Blink Rate in the Metaverse VR HMD and AR Glasses Environment	2022	MDPI	Content having realism and high intensity lowered blink rate. Thus, we examined the change in blink rate while viewing material in VR HMD as well as AR glasses settings. We examined and studied blink rate in four environments: normal state, VR HMD, monitor, as well as AR glasses. In addition, 21 participants (26.87 ± 3.31 years) saw the information in four contexts for one minute. One-way repeated ANOVA was performed to examine blink rate variations. The research found that the blink rate was lower in the VR HMD, monitor, as well as AR glasses settings than in the real world. Compared to AR glasses, VR HMDs reduced blink rate.
[11]	Metaverse and Virtual Health Care in Ophthalmology: Opportunities and Challenges	2022	Lippincott Williams and Wilkins	Nevertheless, putting these cutting-edge virtual healthcare technologies into practice and ensuring their adoption will necessitate multifaceted strategies to guarantee interoperability with user-friendliness, actual virtual clinical settings, and clinical efficiencies while adhering to clinical, health economics, regulatory, as well as cybersecurity standards.

[19]	Virtual Reality-Aided Therapy towards Health 4.0: A Two-Decade Bibliometric Analysis	2022	MDPI	Thus, this article investigated VR's role in treatment to inform Health 4.0's therapeutic VR applications. This study used bibliometric analysis (a quantitative approach) to provide a macro summary with respect to VR-aided treatment, identified relevant research subjects and structures, and used a qualitative literature evaluation to get wider perspectives.
[5]	The Use and Ethics of Digital Twins in Medicine	2022	NLM(Medline)	This article discusses DT and their medical uses, frames the argument via ML and customised medicine and maps ethical issues arising from them. Finally, we discuss how DT may transform and challenge medicine.
[16]	Healthcare in Metaverse: A Survey on Current Metaverse Applications in Healthcare	2022	Institute of Electrical and Electronics Engineers Inc.	This article is the first to review metaverse advancements in seven healthcare domains: clinical care, telemedicine, mental health, education, veterinary, physical fitness, as well as pharmaceuticals. We evaluate metaverse applications and carefully explore technological difficulties and viable solutions in each discipline to design a self-sustaining, permanent, as well as future-proof medical healthcare system solution. Lastly, we discuss the healthcare industry's metaverse adoption hurdles.

4. Conclusion

The term "metaverse," derived from the term "meta-universe," describes a virtual world in which real and virtual worlds coexist. Metaverse technology will have a huge impact on how we move now. The transfer system is now getting ready to go to the metaverse. This study lays the groundwork and paves the way for developing a comprehensive DT model of human health and well-being for use in clinical practice [1]. Despite this, we found no correlation between health-related attitudes and the regularity with which people purchase from a web store. Finally, there was no statistically significant correlation between nutritional status and any of the reported dimensions of vulnerability, perceived benefit, perceived severity, perceived barrier, self-efficacy or signals to action. Consequently, the government should continue to emphasise the significance of education as well as socialisation about the relevance of a balanced diet as well as nutritional status in protecting citizens and preventing the emergence of degenerative illnesses [12].

During the COVID-19 epidemic, there was a rising trend in the number of online searches in which the term "metaverse" appeared. The Korean public generally expects DT to significantly alter medical practice. The majority of responders to this study had an optimistic view about DT's effects on the future, attributing their exposure to the metaverse or VR/AR in the classroom to this. There has to be a rapid uptake of DT in healthcare, including clinical practice, education, and training [17].

With a psychotherapist's guidance, the metaverse, the internet's anointed successor with the defining feature of "the sense of full presence," can emerge as an effective tool for reconstructing a new object world for the patient, thereby integrating the schema therapy treatment techniques into the patient's natural autobiographical experiences in the new object world. This paper details the theory, mechanism, method, as well as ethical implications of such a potential technology's near future [13].

In addition, policymakers have the ability, via the use of the metaverse, to construct systems that will dissolve physical as well as geographical obstacles, eliminate performance anxiety, and maintain

mental wellness in VR athletic events. This paper summarises the findings of previous research and makes recommendations about useful ways for implementing metaverse services in the healthcare sector [20]. Community observation must continue to develop, adapt, create, as well as sharpen its unique qualities concerning virtual healthcare technology to give improved eye care all over the globe to meet urgent needs.

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