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Analysis of the Use of Optical Waves in the World of Health: Literature Study

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Abstract

Waves are vibrations that propagate at any time. Waves are divided into two, namely mechanical waves and electromagnetic waves. In the world of health, what we often encounter are tools whose use is accompanied by one of the physics concepts, namely optical waves. Optical waves in the world of health are very important to apply because they are the basis for learning in health science or in the sense that the concepts that are developed in health science use the concept of optical waves. Optical waves are known as electromagnetic waves, because these waves describe visible light rays, infrared, and ultraviolet rays, so these rays are used as materials for the use of optical instruments. There are many kinds of optical instruments, including loupes which are used to magnify small things, microscopes as a tool to see objects that are far away with the sense of sight, binoculars as a tool to see the distance of objects that are far from the surface of the earth, and the eye as a tool for our vision. Then scientists applied the wave concept with optical tools to serve as a reference in the world of health. Waves according to Prof. Yohanes Surya, Ph. in the title of the book Vibrations and Waves (2019), propagating vibrations produce energy and move at a certain speed, and do not drag the material they pass through. The use of optical waves is widely applied in medical science, including X-rays as a detector for internal body elements to clarify broken parts such as bones or other things. From the explanation above, it can be concluded that waves are the basis in the world of health, which are of course used in optical equipment, and are a reference for the health team and as a basic concept in physics learning. This underlies the fact that optical waves are not only used in the world of education, it is also needed in the world of health.

Keywords: Analysis, Optical Waves, Health World

Introduction

In everyday life we encounter many objects around us that move due to forces, for example, spiders that detect their prey based on the vibrations of their nests, as well as plucked guitar strings. Without us realizing it, this is a harmonic vibration. Simple harmonic motion is a movement that occurs repeatedly and regularly through the same trajectory and through the equilibrium point with the number of vibrations per second whose value is always the same or in other words constant. Vibrations that occur repeatedly in the same time interval are called harmonic motion (Rismawan & Aisiyah, 2023). Waves can be interpreted as propagating vibrations, in wave propagation, they will carry energy. In other words, waves are the propagation of vibrations while vibrations are the source of waves (Mapau, Helmi, & Haris, 2022). The concept of waves is very necessary (facilitator) for studying several other physics topics; such as light, mechanics of motion, electricity, magnetism, and sound. Therefore, mastery of wave concepts must be applied to students and students need to be guided by educators and researchers (Mapau, Helmi, & Haris, 2022).

Electromagnetic waves are waves that can propagate without the existence of an intermediary medium. There are two sources of electromagnetic waves, namely artificial and natural. X-rays, gamma rays, visible rays (light), ultraviolet and infrared rays are examples of natural sources of electromagnetic waves (Munawaroh & Sudarti, 2020). Light is an example of an electromagnetic wave where light can emit energy, and half of the light can be converted into visible light (Mukhlis, Lesmono, & Nuraini, 2021). Visible light itself is electromagnetic radiation that can be seen by the human eye and has a length ranging from 400 nanometers to 700 nanometers (Qadar, Haryanto, & Syam, 2019).

Optics, as a branch of physics, studies the behavior and properties of light, as well as the interaction of light with matter. The science of optics can be divided into three branches: geometric optics, quantum optics, and physical optics. Geometric optics discusses the behavior of light with a focus on straight propagation, studies refraction and reflection of light, and provides a basis for developing applications for optical devices. Quantum optics studies the phenomena related to light, as well as changes in energy and mass related to its quantum properties. Meanwhile, physical optics is a branch of optics that explains the behavior of light using wave theory, as well as studying diffraction, polarization, and light interference (Saprudin, 2018). Meanwhile, according to (Deswita & Saputri, 2021) geometric optics explains the propagation of light as vectors called rays. Physical optics refers to phenomena contained in geometric optics with mathematical explanations.

X-rays are an emission of electromagnetic waves, and these X-rays can be used in the world of health, one of which is in radiation therapy or radiotherapy for cancer sufferers. Wilhelm Conrad Roentgen discovered X-rays 100 years ago, which were later identified as radioactive by Marie Curie and Henry Becquerel, X-rays became the key to treating cancer through radiotherapy, which is a therapeutic approach that utilizes ionizing rays. These ionizing rays can be X-rays and gamma rays or involve groups of particles such as beta, alpha, and neutrons (Mayarani, Hidayat, Apriantoro, Kristian, & Irsal, 2018). This treatment aims to damage tumor cells by giving maximum and minimum doses to healthy organs or protected organs around the tumor, where the cancer treatment process is generally carried out in a closed

manner (Daniartie, Wardani, Putri, Stevenly, & Suryaningsih, 2022). In the world of health, X-rays are not only used in the rehabilitation of malignant tumors, but are also used in the world of health to photograph broken bones, lungs, kidney stones, and others (Fuadi, Jusli, & Harmini, 2022). So the use of X-ray optics in the world of health is very important, one of which is in radiodiagnosis where the aim is to improve the quality of radiographic images, facilitate better interpretation, and ultimately support correct medical diagnosis. Radiodiagnosis is a branch of radiology that uses X-rays, a type of pegion radiation, which can provide benefits (diagnosis) with radiation, a disease or abnormality in a body organ can be identified earlier and can be detected more thoroughly (Sari, Surahmi, Della, & Supriyanti, 2022).

Based on the description above, an analysis of the use of optical waves in the world of health was carried out: A literature study to find out the meaning of optical waves and their various types, and be able to find out the benefits of optical waves in the world of health. Without us realizing it, it turns out that optical waves also play a role in the world of health, this article will discuss them more extensively in this article.

Research Method

In this descriptive research, researchers adopt the literature study method to find, observe, identify, assess, and interpret information related to the research topic (Hamilton, McKechnie, Edgerton, & Wilson, 2021). Analysis of the use of optical waves in the world of health was obtained from several sources, including journals and books. Several methods in literature study involve identification, analysis, interpretation, and evaluation of research that has been conducted previously (Nistrina, 2021). As well as being relevant to the established topic, this research aims to answer research questions by providing additional learning materials and identifying gaps in previous research, so that it can contribute to further research (A, Fatichah, & Arifin, 2021). A total of 15 publications articles and books obtained from several domestic sources were investigated in this investigation. The journals and texts used were released between 2018 and 2023. Researchers collected information and concluded the results of qualitative research using the literature study research methodology shown in Figure 1.

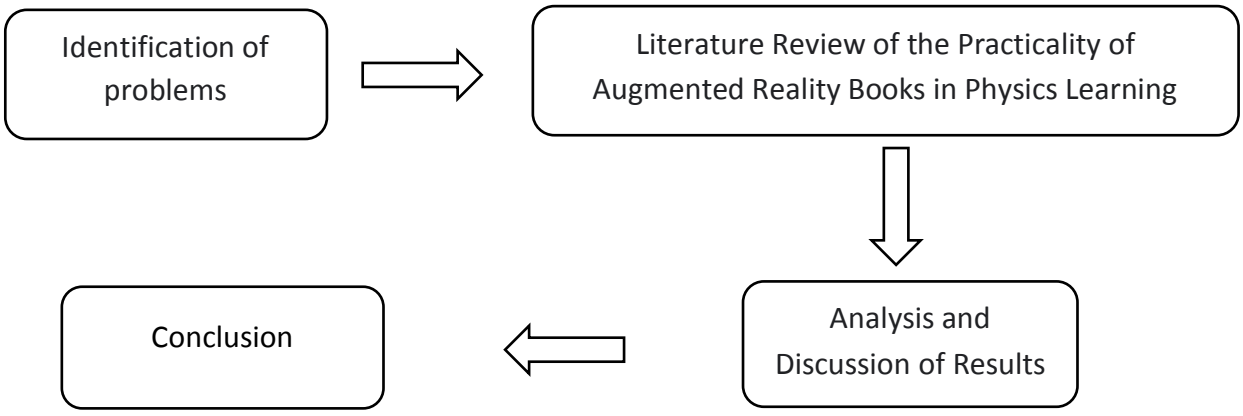

Figure 1. Research Flow

The initial part of this research focuses on identifying a problem that occurs. The second stage included reviewing up to 15 national and international article publications as well as several books related to the use of optical waves in the world of health which were published between 2018 and 2023. The third stage of the research was analysis, and the researchers carried out this after reading several articles and books that had been published. there is, then proceed with a discussion of the results. Researchers make conclusions based on the findings and analysis in the fourth step of reading related articles and books (Arzak & Prahani, Practicality Of Augmented Reality Books In Physics Learning: A Literature Review, 2023).

Literature Review

In the article entitled "Analysis of the Use of Waves and Optics in the World of Health; "Literature Study," there are several references that we found in journals and articles that are still related to wave and optics articles, also in one of these journals there are references that have interesting discussions. Below are references taken from several journals in the table below;

Table 1. Literature Review

No	Tahun	Judul jurnal / buku	Nama penulis	Nama jurnal / penerbit
1	2023	Menentukan Nilai Periode, Amplitudo, Frekuensi Dan Menfisualisasi Getaran Harmonik Pada Pegas Dalam Bentuk Gelombang	*Heri Rismawan, Muktamar Cholifah Aisiyah*	Journal Fisika
2	2023	*Practicality of Augmented Reality Books in Physics Learning: A Literature Review*	*Kirana Aureola Arzak , Binar Kurnia Prahani*	JPPS (Jurnal Penelitian Pendidikan Sains)
3	2022	Analisis Penguasan Gelombang Peserta Didik MAN 2 Kota Makasar DI Masa Pandemi Covid 19	*Oktaviana Beverly Mapau, Helmi, Abdul Haris*	Jurnal Sains Dan Pendidikan Fisika
4	2022	Analisis Treatment Planning System Dengan Menggunakan Teknik Box Dan Teknik Antero Posterior-Postero Anterior Pada Kasus Kanker Serviks	*Yasinta E. Daniartie, Pratiwi S. Wardani, Devina R.P.S. Putri, Robert J.Stevenly, dan Suryaningsih*	*Progressive Physics Journal*
5	2022	Pemanfaatan Dosis Perorangan Menggunakan Thermoluminescence Dosimeter (TLD) Di Wilayah Papua Dan Papua Barat Tahun 2020-2021	*Nurul Fuadi, Nurlinda Jusli, Harmini*	Jurnal Sains Fisika

6	2022	Analisis Tingkat Kepatuhan Radiografer Terhadap Pemakaian Apron Kepada Pasien Di Rumah Sakit Pertamedika Ummi Rosnati Banda Aceh	*Kartika Sari, Nadia Surahmi, Cul Alya Della, Supriyanti*	Jurnal Perisai
7	2021	Analisis Hubungan Indeks Bias Dan Intensitas Cahaya Pada Berbagai Fluida	*M. Akbar Mukhlis, Albertus Djoko Lesmono, Lailatul Nuraini*	Jurnal Pembelajaran Fisika
8	2021	Revolusi Saintifik Dalam Perkembangan Ilmu Optika	*Pipi Deswita, Ririn Hustia Saputri*	Jurnal Penelitian Bidang IPA Dan Pendidikan IPA
9	2021	*Immersive Virtual Reality As A Pedagogical Tool In Education: A Systematic Literature Review Of Quantitative Learning Outcomes And Experimental Design*	*D. Hamilton, J. McKechnie, E. Edgerton, C. Wilson*	J. Comput. Educ.
10	2021	Penerapan Augmented Reality Dalam Media Pembelajaran	*Khilda Nistrina*	Jurnal Sistem Informasi, J-SIKA
11	2021	Analisis Metode Representasi Teks Untuk Deteksi Interelasi Kitab Hadis: *Systematic Literature Review*	*Amelia Devi Putri A, Chastine Fatichah, Agus Zainal Arifin*	Jurnal Resti
12	2020	Potensi Paparan Gelombang Elektromagnetik Extremely Low Frequency (ELF) Dalam Meningkatkan Ketahanan Pangan	*Wahdiyatun Munawaroh, Sudarti*	Jurnal Tegnologi Pangan Dan Hasil Pertanian
13	2019	Optika	*Riskan Qadar, Zeni Haryanto, Muliati Syam*	Mulawarman University Press
14	2018	Analisis Kesiapan Dan Strategi Monitoring Evaluasi Program Pengembangan Perkuliahan Gelombang Dan Optik Berbasis Game	*Saprudin*	JIPFRI (Jurnal Inovasi Pendidikan Fisika Dan Riset Ilmiah)
15	2018	*Analysis Of Rooftop Skyshine Radiation Exposure With Angel Of Gantry Linear Accelerator 180□ In Radiotherapy*	*Maryani, Eka Putra Syarif Hidayat, Nursama Heru Apriantoro, Robert Kristian, Muhammad Irsal*	Jurnal Teknologi Dan Seni Kesehatan

		Unit Of Pertamina Central Hospital Jakarta		

Results

In Table 1, the first column contains the journal title "Determining Period Values, Amplitude, Frequency and Visualizing Harmonic Vibrations in Springs in Wave Form" which includes physics journals written by Heri Rismawan and his friends, this journal discusses how to determine values period, amplitude, frequency in the waveform contained in the introduction. Meanwhile, in the second column of the research results of Kirana Aureola Arzak and Binar Kurnia Prahani, there is the title "Practicality of Augmented Reality Books in Physics Learning: A Literature Review" where this article is a reference in the methods section which discusses descriptive research that uses reviews. literature to find out, identify, assess, and interpret related research topics, where these references include the JPPS journal (Journal of Science Education Research).

In Table 3 there is a reference titled "Analysis of Wave Mastery of MAN 2 Makasar City Students During the Covid-19 Pandemic" which states that various basic wave concepts include frequency, wavelength, superposition amplitude, and others. including in the Journal of Science and Physics Education.

Table 4 in Yasinta E. Daniartie et al.'s research entitled "Analysis of the Treatment Planning System Using the Box Technique and the Antero Posterior-Postero Anterior Technique in Cervical Cancer Cases" explains the use of electromagnetic waves in various fields, for example in the health, agriculture and food sectors. and this reference is included in the Progressive Physics Journal. Furthermore, in table number 5 there is a reference titled "Utilization of Individual Doses Using Thermoluminescence Dosimeter (TLD) in the Papua and West Papua Regions 2020-2021" which explains electromagnetic waves in X-rays, where these X-rays have very high energy so is often used in the world of health, one of which is to photograph broken bones by doctors, and this reference is included in the Journal of Physical Science. In table number 6 there is a reference titled "Analysis of Radiographer Compliance Levels with the Use of Aprons for Patients in Hospitals Pertamedika Ummi Rosnati Banda Aceh "explains electromagnetic waves in X-rays, where X-rays are used by radiology for diagnostic purposes. Apart from that, radiology has an effect that makes a person when carrying out a radiological examination and this effect cannot be felt immediately but will appear in the future so that radiographers when carrying out examinations must wear something called PPE, where PPE is one way to avoid the effects of examining patients.

Table 7 in M. Akbar Mukhlis et al's research entitled "Analysis of the Relationship between Refractive Index and Light Intensity in Various Fluids" explains that light emits energy that is converted into visible light which has a wavelength ranging from 340 nm to 700 nm. Next, table number 8 "Scientific Revolution in the Development of Optical Science" explains optics as a branch of physics that investigates the properties of light and its interaction with matter. Optics is divided into 2, namely geometric optics which explains the propagation of light as vectors called rays, and physical optics which explains phenomena that occur in

geometric optics with mathematical explanations. In Table 9 of the research results of D. Hamilton et al. there is a reference title "Immersive Virtual Reality As A Pedagogical Tool In Education: A Systematic Literature Review Of Quantitative Learning Outcomes And Experimental Design" where this article is a reference in the methods section which discusses systematic reviews used in literature studies in the form of observing, knowing, identifying, assessing, and interpreting a topic from related research. Furthermore, in table number 10 there is the title "Application of Augmented Reality in Learning Media" where this article is a reference in the method section which explains the application of augmented reality in the field of education which has the advantage of being an educational medium that has quite a large influence on students who study wave material. easier to understand than those who don't use augmented reality.

In table number 11 there is a journal written by Amelia Devi Putri A and her friends entitled Analysis of Text Representation Methods for Detecting Interrelation in Hadith Books: Systematic Literature Review published by the public in 2021 which explains the research by providing learning materials by looking for gaps. from the results of research that has been carried out previously so that it can be useful or can be used as a reference in further research. In Table number 12 there is a journal entitled Potential Exposure to Extremely Low Frequency (ELF) Electromagnetic Waves in Increasing Food Security which was published in 2020 and written by Wahdiyatun Munawaroh and Sudarti which explains electromagnetic waves and the source of the electromagnetic waves themselves, this journal is a journal of Food Technology and Agricultural Products. In table number 13 there is a Mulawarman University Press book entitled Optics published by Riskan Qadar and his friends their book discusses visible light itself, which is electromagnetic radiation that can be seen by the human eye, and has a length ranging from 400 nanometers to 700 nanometers, this book was published in 2020.

Table number 14 entitled Analysis of Readiness and Evaluation Monitoring Strategy for Game-Based Wave and Optics Lecture Development Program which was published in 2018 includes the journal JIPFRI (Journal of Innovation in Physics Education and Scientific Research) which discusses light and how light works and the symptoms that it causes. experienced by light, this journal was written by Zapruder. In table number 15 there is a Journal of Health Technology and Arts published by Maryani and her friends entitled Analysis of Rooftop Skyshine Radiation Exposure With Angel Of Gantry Linear Accelerator 180^{o} In Radiotherapy Unit Of Pertamina Central Hospital Jakarta, in the discussion X-rays are radiation from electromagnetic waves, where X-rays can be used in the world of health, one of which is in radiation therapy or radiotherapy for cancer sufferers, this journal was published in 2018.

Discussion

Waves are a type of electromagnetic radiation, waves and optics can also be used in the health sector, especially in the medical sector, light waves can be used as a method of examination and treatment for certain conditions or diseases. In the use of optical waves in the world of health, we use X-rays and radiation, where X-rays are a form of image in electromagnetic waves similar to sound or sound channels through the air, and heat waves,

where X-rays have very high energy produced by Free electrons are accelerated through a high potential difference, because a large amount of energy and radiation causes the path length of the atmosphere, and therefore, this radiation is called X-ray ionizing radiation, which appears when electrons react to directed particles.

Science in the field of electrical technology is currently experiencing very rapid development, creating a significant impact on health equipment, where the transition from analog to digital systems, as well as from digital to microcontrollers or computerized systems, has produced more effective, efficient, and accurate health equipment. , so this contributes to improving the quality of health services by providing better support for medical personnel in carrying out their duties (Priyono & Idris, 2020). Light waves are also used to treat various medical conditions, such as:

A. Treating Jaundice

Jaundice often appears in neonates as a condition. Where bilirubin encephalopathy is the most severe complication of neonatal icterus, which is one of the causes of death in newborn babies. Icterus is a clinical condition characterized by yellow staining of the skin and mucosa due to high levels of unconjugated bilirubin. Phototherapy is a method of light treatment that aims to reduce bilirubin levels in the blood by facilitating the excretion of conjugated tan bilirubin so that it is more easily broken down and soluble in water, where the processes of photoisomerization and structural isomerization are the mechanisms involved in reducing hyperbilirubinemia through phototherapy. The effectiveness of phototherapy depends on the quality of the light emitted by the lamp (wavelength), the intensity of the light (irradiation), the surface area of the body affected, and the distance between the phototherapy lamp and the body.

Figure 2. Babies with Hyperbilirubinemia

Figure 3. Phototherapy

To develop and improve the function of phototherapy equipment in a medical context, the author designed the placement of phototherapy lamps at the right distance from neonates, and in addition, implemented a new prototype for newborns that can control temperature exposure and adjust lamp removal automatically (Priyono & Idris, 2020).

Factors that need to be inspected in determining and implementing phototherapy are various emissions from light sources, light intensity (irradiance), and body surface area being phototherapy. The effective wavelength of light in the blue-green region is 430-490 nm. The closer the phototherapy is to the baby's body, the more effective it is. The phototherapy method can help treat jaundice in babies. Phototherapy is a common and very effective treatment method that uses light to help break down the bilirubin in your baby's body. Changing the color

of a baby's skin to yellow is often caused by an increase in bilirubin levels. Phototherapy or therapy using ultraviolet light, is the most common treatment used to reduce high bilirubin levels in newborns who have jaundice or yellow babies. The effectiveness of phototherapy is influenced by various things, one of which is the distance between the phototherapy and the baby (Wati, Handoko, & Suhartin, 2023).

B. As a cancer treatment

With the ever-increasing development of science and technology, it plays an important role in the evolution of medical equipment, including beams in treating malignant tumors using radiation. Although X-rays in medicine are used in the treatment of malignant tumors, they are a problem in scanning various conditions, such as fractures, kidney stones, lungs, and so on.

Figure 4. TLD and TLD Reader

The image above is a TLD and TLD Reader tool used in individual dose monitoring laboratories in 2021. The equipment and materials used involve ultrahigh pressure with 90% authenticity, air temperature and air humidity measuring equipment, cartridges, key openers, extensions of a domain of the Harshaw 8800 plus model, as well as computers and devices that display printed data (Harmini, Fuadi, & Jusli, 2022).

One use of light in cervical cancer radiotherapy is through the use of a Linear Accelerator (Linac). Radiotherapy is a medical treatment that is carried out using ionizing radiation to kill the cancer cells suffered by the patient by carrying out therapy to damage the cancer cells as much as possible. This cancer treatment procedure is closed. A form of radiation treatment where the radiation source is at a distance from the intended target or outside the body is called external radiation/teletherapy. The source used is X-rays or photons. One type of external radiotherapy aircraft is the Linear Accelerator (Linac). Radiotherapy has been accepted as an important modality in the treatment of cancer not long after the discovery of X-rays in addition to other modalities such as surgery and chemotherapy (Winarno, Nurmansya, & Miskiyah, 2021).

LINAC (Linear Accelerator), also known as a linear accelerator, is an external radiation therapy device that is most commonly used for people who have cancer. This tool is used to treat cancer-affected bodies with the help of X-rays of the same dose to the area of a person's tumor. LINAC was originally used to accelerate particles that have a positive charge such as protons, with developments over time and various modifications, this tool can be used to accelerate particles that have a negative charge such as electrons. These electrons can be

accelerated and the high-energy electrons are collided with heavy metal targets, then the LINAC will emit high-energy X-rays.

Figure 5. LINAC at the Radiotherapy Installation at Dr. SOETOMO

C. Reduces pain in muscles and joints

Entering old age means experiencing decline, both psychologically and physically. Physical decline involves dysfunction of vital organs, loss of passion, increased emotional sensitivity, slowed movement, impaired hearing, and decreased vision, as well as changing hair color to white and losing elasticity or looseness. on the skin (Horne, et al., 2018). These changes in the elderly include physiological aspects, such as a decrease in skin sensitivity at certain temperatures. Apart from that, they also often face health problems, including disorders of the musculoskeletal system which can cause pain in the joint area, where these changes become a significant challenge. in living everyday life. Elderly people often experience joint complaints, and if not treated quickly, it can hurt their quality of life. Apart from that, this condition can add to the burden on families and Indonesian society in providing adequate care to the elderly, so it is important to implement effective prevention and care efforts for the elderly population to maintain their well-being (Untari, Subijanto, Mirawati, Probandari, & Sanusi, 2019). The application of infrared therapy (TIR) is an effective technique in reducing pain in the elderly. This therapy can help improve blood circulation, relieve muscle tension, and provide relief to affected joints, so by using infrared therapy in routine care, elderly people can feel the benefits of increasing daily comfort and supporting a better quality of life (Putra, Muryani, & Daryaswanti, 2021).

Figure 6. Patient during infrared therapy

Figure 7. Infrared therapy device

Infrared therapy involves the application of often invisible electromagnetic wave energy with wavelengths longer than visible light as a form of intervention. This therapy is

designed to treat pain complaints caused by inflammation of the musculoskeletal and neuro systems in the elderly (Arianto & Widodo, 2022). Infrared radiation is distributed in three categories, namely near-infrared (NIR) with a wavelength of 0.8-1.5mm, middle infrared (MIR) with a range of 1.5-5.6mm, and far infrared (FIR) with a wavelength of 5.6-1000mm. Infrared radiation can penetrate subcutaneous tissue to a depth of 3 cm without causing movement. Indications include 1) pain in the joints, muscles, and soft tissue around the joints. 2) joint stiffness caused by various factors. 3) muscle tension. 4) chronic inflammation with swelling. 5) healing wounds on the skin. Infrared therapy provides heating that induces important physiological effects to support the healing process, which involves activating heat receptors on the surface of the skin, thereby changing the conduction or transmission of sensory nerves, which in turn can reduce the sensation of pain. The heating process is also responsible for eliminating unused metabolic waste, as well as accelerating tissue healing, and increasing the activity of enzymes that support metabolic processes. What's more, heating also increases blood flow through vasodilation, which creates a feeling of comfort and relaxation. This effect also increases elasticity in the soft tissue around the joints, allowing wider movement, especially in surface joints such as the feet and hands (Untari, Prasojo, Sarifah, & Nugroho, 2023).

Conclusion

From the article above, it can be concluded that waves are included in the category of electromagnetic radiation which is used in the world of health, especially in medicine. In the world of medicine, there is a lot of use of the concept of waves and optics, where the use of this concept can help facilitate treatment, examination, and data collection on various diseases. In this case, actual evidence on optical waves that can facilitate treatment in the medical world includes being able to treat jaundice, as a tool for treating cancer, and reducing muscle and joint pain, in terms of examinations usually when the disease experienced by a person is a disease. which was very difficult to detect before the existence of sophisticated medical equipment, so experts created the concept of waves as a sophisticated tool to make human work easier, such as electromagnetic waves known as X-rays which can be used to visualize images of broken bones, lungs, etc. lungs, kidney stones, heart, and others. From the results above, we support technological advances, especially in the medical field, which currently uses optical waves as a detection tool in the world of health, and can be felt by everyone.

Recommendation

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