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ORIGINAL ARTICLE

Students' level of knowledge about the application of nanoscience in dentistry

Nivel de conocimiento de estudiantes sobre la aplicación de la nanociencia en la odontología

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RESUMEN

Introducción: la nanotecnología consiste en el uso de materiales de tipo sintético o natural formado por estructuras menores a 100 nm, así también los granos con un tamaño inferior a 100 nm, las fibras con un diámetro menor a 100 nm, películas con un espesor menor a 100 nm, y así también los nano agujeros y compuestos formados por la combinación de estos. **Objetivo:** determinar el nivel de conocimiento en estudiantes de la carrera de Odontología de la Universidad Regional Autónoma de los Andes Santo Domingo, centrado en los principales desarrollos tecnológicos de la nanociencia. **Método:** se realizó un estudio observacional, descriptivo de corte transversal en la Universidad Regional Autónoma de Los Andes, sede Santo Domingo perteneciente al país de Ecuador en el período del año 2022, el universo estuvo constituido por 160 estudiantes matriculados en la carrera de odontología. **Resultados:** de acuerdo con la información que se recopilo el 77 % de los estudiantes demuestran un conocimiento o idea del concepto básico de nanociencia, Al respecto de si esta nueva ciencia debería ser tomada en cuenta en la práctica profesional la muestra demostró que un 68 % de la misma, afirmar usar esta tecnología en la práctica profesional. **Conclusiones:** dentro del estudio se determinó que la falta de interés por parte de los estudiantes sumado a la desinformación con las nuevas tecnologías del tema en el ámbito educativo son los principales problemas dentro del estudio que determina que esta práctica de la nanotecnología en odontología este en niveles teóricos.

Palabras clave: Nanociencia; Nanotecnología; biomateriales; Odontología.

ABSTRACT

Introduction: nanotechnology consists of the use of synthetic or natural materials formed by structures smaller than 100 nm, as well as grains with a size smaller than 100 nm, fibers with a diameter smaller than 100 nm, films with a smaller thickness at 100 nm, and also the nanoholes and compounds formed by the combination of these. **Objective:** determine the level of knowledge in students of the Dentistry program at the Regional Autonomous University of the Andes Santo Domingo, focused on the main technological developments of nanoscience. **Method:** an observational, descriptive, cross-sectional study was carried out at the Regional Autonomous University of Los Andes, Santo Domingo campus belonging to the country of Ecuador in the period of 2022, the universe was composed of 160 students enrolled in the dentistry career. **Results:** according to the information collected, 77 % of the students demonstrate knowledge or idea of the basic concept of nanoscience. Regarding whether this new science should be taken into account in professional practice, the sample showed that 68 % of the same claim to use this technology in professional practice. **Conclusions:** within the study it is required that the lack of interest on the part of the students added to the misinformation with the new technologies of the subject in the educational field are the main problems within the study that determines that this practice of nanotechnology in dentistry is in theoretical levels.

Keywords: Nanoscience; Nanotechnology; Biomaterials; Dentistry.

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INTRODUCTION

The Nobel Prize in Physics, Richard Feynman, in 1959 makes public reference for the first time to the use of nanotechnology and nanoscience, in his meritorious speech "At the bottom there is plenty of room", he describes the possible uses and feasibility of matter in nanometric size, in which he proposes the feasibility of using atoms for the development of structures in reduced dimensions, focusing on health care through the use of this new technology, described as nanomedicine.[1]

In the same way, the precursor of this new science or technology is Norio Taniguchi, at the Tokyo University of Science in a study carried out in 1974, in which he indicates or idealizes nanotechnology as a technology that focuses on the processing, separation, consolidation and formation of material by an atom or a molecule.[2]

Nanotechnology consists in the use of synthetic or natural materials formed by structures smaller than 100 nm, as well as grains with a size smaller than 100 nm, fibers with a diameter smaller than 100 nm, films with a thickness smaller than 100 nm, as well as nanoholes and composites formed by the combination of these. Due to this characteristic, nanomaterials have a larger contact surface per unit mass. A large part of nanotechnology has been used in medicine over the last few decades. Thus was born the concept of "Nanomedicine" which was given by Freites in 1993, in which he defines it as "the observation, control and treatment of the biological systems of the human body at the molecular level using nanostructures and nanodevices".[3]

Dentistry has benefited from improvements in the prevention, diagnosis and treatment of oral diseases. Over the last few years, multiple journal articles have described the potential of this technology in dentistry.[3]

Nanoparticles have been used by biological nature since the beginning of evolution, the joint and functional performance of the respective receptors and enzymes, both inside and outside the cell is a simple and concrete example of the use that mother nature has made of nanoscience.[2]

In spite of being a new technology, "nanotechnology" is being used as a political object, and it is taken as a tool for public relations campaigns. That is why the average Ecuadorian, when hearing something about nanotechnology or nanoparticles, takes it as something insignificant or of little interest. However, in first world countries such as the United States, Japan, China, and part of the countries of the European Union, new technologies are already being studied and developed in this regard.[4]

The idea of this study is to identify the possible areas in which nanotechnology can influence dentistry, and thus clarify the doubts of those interested in dentistry.

In the approach to "nano dentistry" we find the bottom-up approach that means integrating particles of volume less than 100 nm to achieve structural and stable assembly with practical and improved features. It focuses on complex design to achieve high-order mesoscale/microscale assembly and self-organization. A basic example is that of DNA "the fabrication of DNA by joining nucleic acids in the nanometer dimension.[5]

The top-down approach is given in an easy and understandable way, it means creating smaller nanometer-sized particles from complex structures with enhanced functional properties. As you modify the particle size to minimum level in a system, there is an increase in surface area resulting in a pronounced increase in physical phenomena or properties due to statistical and mechanical effects.[6]

Nanotechnology scaffolds is the reconstruction and augmentation of alveolar bone is a complex and challenging field for the maxillofacial and periodontal surgeon. The fundamental goal of therapies in this field is primarily to increase bone mass in patients

who have lost tissue as a result of various conditions such as periodontal disease, aging, osteoporosis, trauma, neoplastic pathology and reconstructive surgery or as a result of congenital defects.(7)

Biopolymers that come from natural sources such as: collagen, hyaluronate, gelatin, chitosan and cellulose are being explored every day in dentistry since their properties are assimilated in one way or another to the conditions of native tissues.

Photodynamic therapy (PDT) has attracted much attention as an alternative approach to combat microorganisms that live despite the use of drugs. An example is the enrichment of biopolymers with nanoparticles that significantly improve the surfaces in contact with the oral cavity in order to avoid bacterial colonization.(8) In this way, using biomaterials, new photosensitizing techniques were developed to improve water solubility, mitigate high concentrations, easy binding and assimilation by the bacteria present and improve their performance.(9)

It is given by the use of particles that recombine, using proteins as active principle, improving their domain conditions. In the same way there are some nano drug carriers which are made of metal, a simple example is that of magnetic nanoparticles of silver, gold and iron oxides which have verified antimicrobial characteristics, offering a great window to the development of modern medicines.(10)

For the success of a dental implant it is necessary to take into account the peri-implant healing, which clearly depends on the bone development from the blood coagulation, until it conforms or contacts with the implant in its superficial part, in concrete words it is in the osseointegration point, in the bone renewal, it depends on two factors.(2)

1. Deep relationship between the gingival tissues and the implant neck area, thus achieving gingival development.

2. To achieve root fusion with the nearby bone for the fusion of the same in a structural way.

To develop these processes it is necessary to perform the orographic modification at a nanometric level, thus, the development of ion implantation, lithography, use of radiofrequency plasma and anodization, used to control in a nanometric way the surface of the dental implant.(11) On the other hand, from the chemical point of view at the nanometric level, it takes into account the biofunctionality of the exterior of the implant, using biomolecules as a support factor in the ossification "calcium phosphate, extracellular proteins, addition lipids and proteins that cover the bone".(5)

Nanotechnology in local anesthesia consists in the use of thousands of nanorobots which are in charge of distributing the analgesic inside the receptor body; these are found inside a colloidal substance. It also allows the use of a computer on board which will allow us to

monitor at all times the anesthetic measure and also to terminate or reverse the anesthesia at the moment the treatment is completed.[2]

Nanotechnology in dental structure restorations is the easiest way to understand the benefits of nanotechnology within the restoration, the materials used are more transparent which gives an aesthetic appearance of another level, (Leinen, 2020) as well as with these materials is achieved greater resistance and hardness to wear structures; However, these types of advances are overshadowed by the difficulties, since due to their relationship of contact area with the environment they can be affected by minimal changes, either by dust particles which when in contact with the materials alter the resistance of the same, thus being more fragile and brittle, reaching to have fractures after healing.[13]

Among the common materials for this type of treatment we have nanofillers and nanohybrids, in which the former consist of particulate material of 100 nm and the latter uses larger particles ranging from 0, 4 to 5 nm, so they are not grouped within the nanofillers.[14]

The extension of osteogenesis is the use of the bone tissue surrounding the tooth as a point of structural and functional anchorage with the neck of the implant to be used, the topographic and chemical structure of the implant is modified, increasing the levels of osseointegration; the main form is ionic modification, lithography, anodization, radiofrequency plasma, used to modify the nanosurface of the implant, taking the tubes, nodules and fusion points.[15] The chemical practice consists in the biofunctionalization of the implant at the surface level, it is the blocking of specific biomolecules for the osteogenesis of the implant, for this purpose proteins, calcium phosphate, peptides and bone are used[13].

Since the main objective of dentistry is to prevent a disease before reaching the treatment, product of the biofilm, including caries, endodontic and periodontal diseases. Therefore, non odontology offers a variety of new therapies for the treatment or prevention of dental diseases, mainly caries and periodontal diseases.[13]

The objective of this research is to determine the level of knowledge of students of the Dentistry course at the Universidad Regional Autónoma de los Andes Santo Domingo, focused on the main technological developments of nanoscience.

METHODS

An observational, descriptive, cross-sectional, descriptive study was carried out at the Universidad Regional Autónoma de Los Andes, Santo Domingo, Ecuador, during the year 2022.

The universe consisted of 160 students enrolled in the dental career, for the selection of the sample; the non-probabilistic (intentional) sampling technique was applied with 57 students selected from the four semesters belonging to the career.

Selection criteria: students over 16 years of age, who are studying dentistry, whose participation in the study was voluntary, and who are studying at UNIANDES Santo Domingo; all the estimated participants were instructed about the intentions and scope of the research.

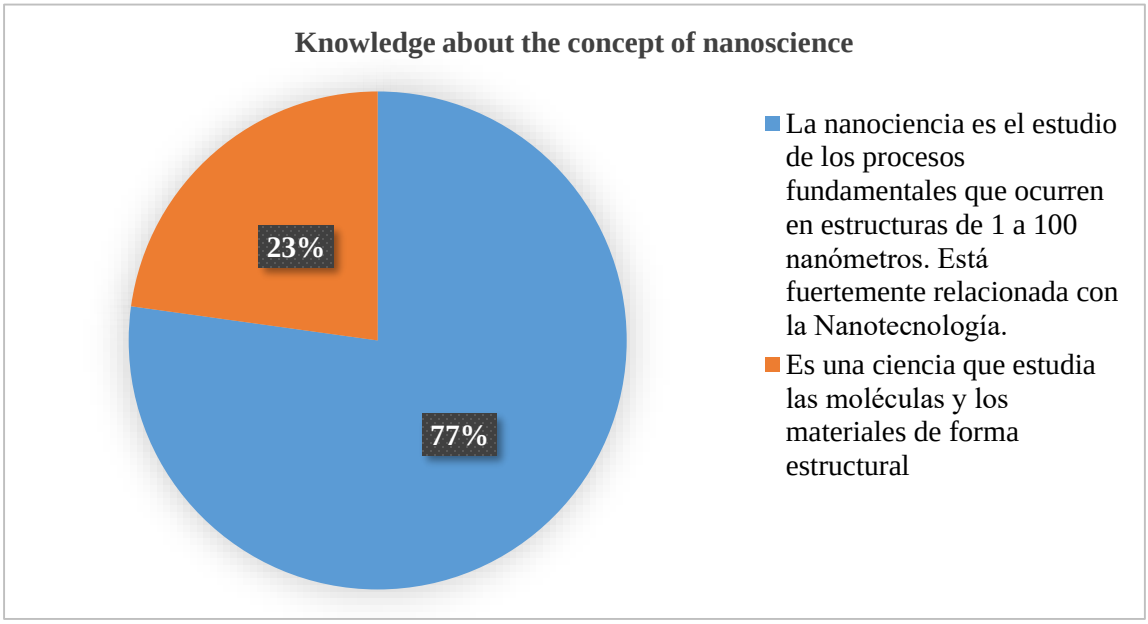
For the collection of data, a survey was applied to the participants to evaluate their level of knowledge regarding nanotechnology. With the results obtained, a database was created in Microsoft Excel, which was later analyzed in SPSS version 23, from which the results were obtained.

The confidentiality of patient data was maintained and the bioethical principles of autonomy, justice, beneficence and nonmaleficence were respected. The study was conducted in accordance with the norms of the Declaration of Helsinki and with the approval of the institution's Ethics Committee.

RESULTS

Once the collection of information about the levels of knowledge of the dental students of "UNIANDES Santo Domingo" was completed, it was found that the average age of the study sample is 20 years; however, most of the study group is in the range of 19 to 21 years of age with 33 students for 58%.

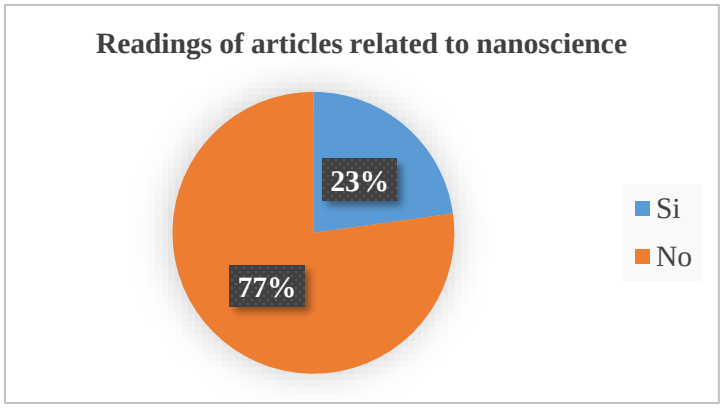
According to the information collected 77 % of the students demonstrate a knowledge or idea of the basic concept of nanoscience as shown in Graph 1, while 23 % have no idea of it.



Graph 1: Distribution of students according to their level of knowledge of the concept of nanoscience

Source: survey

With regard to reading and information on the subject, there is a notable lack of knowledge, since 77% of the study sample shows that they have not read an article related to nanoscience (see Graph 2).

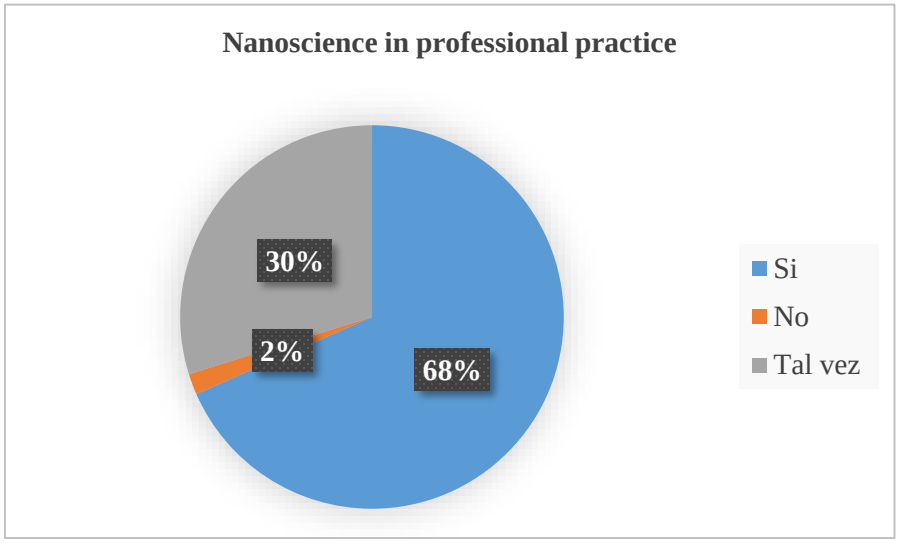


Graph 2: Distribution of students according to reading of articles related to nanoscience.

Source: survey

Regarding the question of whether this new science should be taken into account in professional practice, the sample showed that 68% of the sample affirmed that they

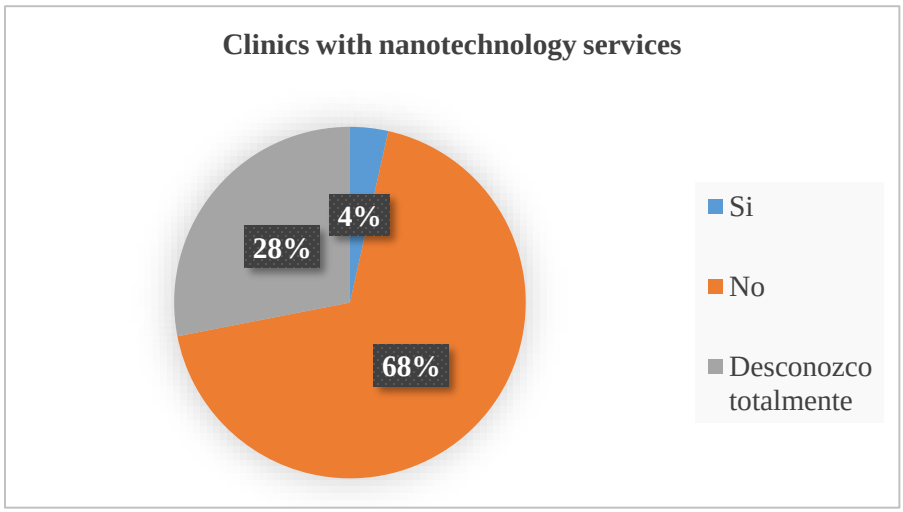
would use this technology in their professional practice, while 30% of the students were uncertain about it (see Graph 3).



Graph 3: Distribution of students according to the use of nanoscience in professional practice.

Source: survey

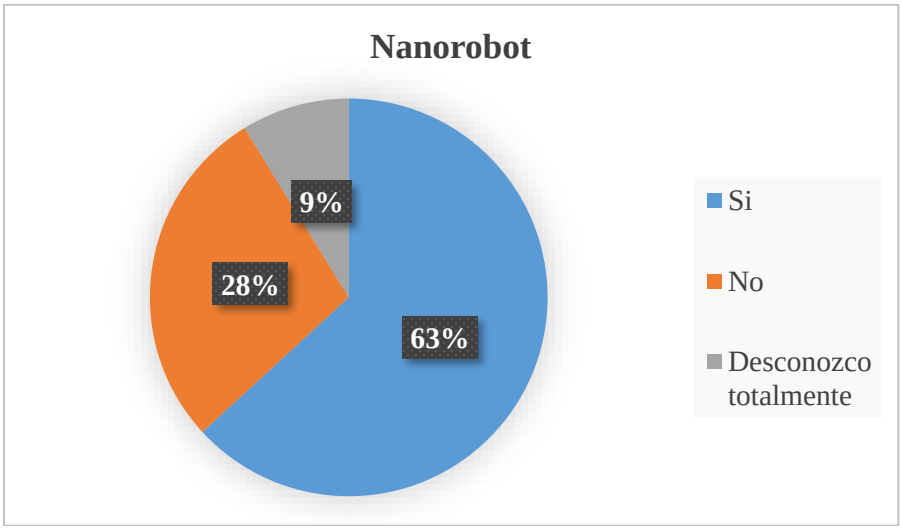
In the question corresponding to the attendance to a dental clinic with nanotechnology services, 68 % of the sample indicated that they had not been to a clinic with these services, 28 % of the sample did not know about the service (see Graph 4).



Graph 4: Distribution of students according to their level of knowledge about the application of nanoscience in dental clinics in Ecuador

Source: survey

Focusing on the nanotechnologies of practical use in dentistry and taking them into account, we have the following results: with regard to nanorobots, 63% say that they know about them; however, 28% of them do not know about them and 9% do not know about them at all, as shown in Graph 5.



Graph 5: Distribution of students according to their level of knowledge about the application of the nanobot in clinical dental practice

Source: survey

In addition, 65% of the sample indicated that they had no knowledge of the subject, while if we take into account toothpastes containing nanotechnology, 81% of the sample indicated that they had no knowledge of the topic.

In the educational sphere, the following data can be seen: 61 % of those surveyed indicate that they did not receive information on the subject in their dental studies, while 33 % admit that they did hear about the subject in a dental course, and 5 % are totally unaware of the subject.

DISCUSSION

The focus of nanotechnology is to improve living conditions both personally and in terms of health, which is why day by day nanotechnology so to speak is gaining momentum because as we saw in the study techniques are being developed as:

Introduction of drugs to the body through this method which will avoid the toxicity of the same throughout the body and will attack directly to the area that needs it.

As well as in other areas such as implantology, restoration, orthodontics, among others that will improve the conditions of the procedures.

In the data evaluation stage of this study, it was determined that most of the sample population has no knowledge about nanoscience as such but at the same time there is a lack of interest in the educational part about it. Although it is the future of medicine and dentistry, it does not have the proper value in the educational field.

CONCLUSIONS

Within the study it was determined that the lack of interest on the part of the students added to the lack of information on the new technologies in the educational field are the main problems within the study that determine that the practice of nanotechnology in dentistry is at theoretical levels.

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