

Original Article

Biotechnology, Health, Nursing and Future: Views of Society in Turkey**Gonul Bodur, BSN, PhD**

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Correspondence: Gonul Bodur, Nursing Education Department Istanbul University Florence Nightingale Nursing Faculty, Istanbul, Turkey E-mail: gonul.bistanbul@gmail.com**Abstract****Background:** Increased developments in technologies show that rapid transformations will affect health care in the future.**Aim:** This research was conducted to determine views on the future of biotechnology in society.**Methodology:** A descriptive research design was used. The universe of the research consisted of people living in Marmara, and the participants were ones who met designated research criteria. The sample group was determined using simple random sampling. The inclusion criteria were: no disorders that prevent cognitive, affective and verbal communication, age between 18 and 65 and voluntary participation. Data were collected using an information form and Visual Analogue Scale (VAS). The researchers contacted a total of 1017 people. SPSS 16.0 was used to analyze the data.**Results and Conclusions:** The mean age of the participants was 28.49 ± 4.32 , 68.6% were female. Of them, 32.1% had graduated from a university. Of the participants, 52.8% stated that they had knowledge about biotechnology, and 15.8% stated that they were keeping track of information about biotechnology. The participants were asked in which areas biotechnology can be used most, 66.8%, 54%, 51.7%, 35.7%, 32.9% and 27.5% said gene studies, health informatics applications, artificial organ studies, nanotechnology, robotic applications and wearable technology, respectively. Of the participants, 55.8% stated that biotechnology would affect medical practices, and 42% said that biotechnology would affect nursing practices. The results showed that the item, "Genetically modified organisms will increase in the future," had the highest mean score (7.60 ± 2.97), which was followed by the items: "Stem cell and genetic studies will increase in the future" (7.32 ± 2.98), "Diseases such as cancer and AIDS can be treated thanks to biotechnology" (6.44 ± 3.21), "With biotechnology, individual-specific drugs can be used in the future" (6.21 ± 3.06), "In the future, biotechnology will affect health and nursing." (6.07 ± 3.17). The results showed that biotechnology is not known well enough.**Keywords:** biotechnology, technology, health informatics, society**Introduction**

Increased global welfare, developments in information and communication technologies, rapid changes in science, technology and genetics show that rapid transformations will take place in the twenty-first century. They will directly affect health care services. It is predicted that developments in biotechnology, nanotechnology, genetics and health informatics will be the determining dynamics of health care systems (Saritas & Smith 2011; Gore 2013; Leyshon et al, 2014; TUSİAD, 2016).

The use of biotechnological developments in human life has a long history, which is as old as the history of humanity. The developments in molecular biology and molecular genetics that took place in 1950s began to affect biotechnology in 1970s. Thus, modern biotechnology, which is a field with increasing efficiency and productivity, new outputs can be produced thanks to genetic processes conducted at the molecular level, has developed. In general terms, biotechnology includes all of the technologies used to develop plants, animals and microorganisms with DNA technology and to

obtain substances that do not exist in nature or only exist in adequate amounts (Surmeli and Sahin 2009; Ernst&Young, 2014; UNESCO, 2017). The rapid advancements in molecular biology, genomics and cell biology in the last twenty years have contributed to the development of biotechnology, and the effects of this development have affected industry, agriculture, environment, food and particularly, health.

Biotechnological health research includes gene therapy, recombinant vaccines, biopharmaceuticals and the development of artificial organs and tissues for replacement or repair (PSFK, 2014; European Commission, 2015; OECD, 2016). Thanks to biotechnological practices and international projects, rapid changes in molecular biology and gene technology became very popular topics starting in the 1990s. The Human Genome Project's search for information about human genetic structure attracted attention globally, and gene technology began to affect every aspect of life. Along with information technology, modern biotechnology is one of the technologies expected to make the most significant contributions to future human welfare.

An examination of literature shows that according to futurists, biotechnological practices will come to the forefront in the field of health. The development of codes (artificial intelligence) which has started today and will increase in the near future with the help of computer technologies to create new artificial organisms and the fact that processors operating with brain and nervous systems will develop artificial organs are included among the changes emphasized in the *Human 2030 Report of the Turkish Futurists Association*. In addition, enabling many diseases to be treated, developing devices which enable the parameters related to common chronic diseases to be measured at home, making the home care practices common by means of easy-to-use special computers, smart and wearable biosensors that speak the same language, and of other technologies, developing the systems which are used to monitor and intervene in the functions of the heart and lungs remotely and simultaneously in the near future are the goals of gene therapy, which is defined as mapping individuals' genes, determining the

genes that cause disease and replacing missing genes (Saritas and Smith 2011; National Intelligence Council 2012; Leyshon et al, 2014; Turkish Futurists Association 2015; Bodur and Kaya, 2015; TUSIAD, 2016; OECD, 2016; World Economic Forum, 2016). Studies have predicted that, thanks to the development of robotic technology, new treatment opportunities for paralytic patients will develop and the production of artificial organs will become possible and common by means of 3-D printers. According to the *Vision 2023 Report* by TUBITAK, it is predicted that new molecules can be developed using DNA technology, degenerative diseases can be treated with cell and gene treatments, mind-controlled artificial organs and joints, which can learn and adjust themselves, and biocompatible artificial sensory organs can be developed in the near future.

In this context, the fact that biotechnology will directly lead health care systems in the future is an undeniable truth according to the reports of futurists and the changing world. However, studies on the effects of futuristic technologies in the field of health are new and not widespread in Turkey. No sociological studies have been done in Turkey to reveal the views of Turkish society about futuristic technologies and their effects, whereas innovative studies on biotechnology are being conducted for health practices. It is very important for the society receiving health care services to be aware about the effects of biotechnology in the future and to benefit from these changes in positive ways. Given this information, the aim of this research was to determine the views of Turkish society about the future of biotechnology. A descriptive research design was used. In accordance with this purpose, answers were sought for the following questions:

- What is the knowledge level of Turkish society related to the future of biotechnology?
- What is the knowledge level of Turkish society related to the areas of use of biotechnology?
- What are the views of Turkish society about the effects of biotechnology in the future?

This research aimed to determine the knowledge level and views of Turkish society related to the future of biotechnology using a descriptive research design.

Methodology

The universe of the research consisted of residents of the Marmara Region, which is one of the most densely populated regions in Turkey. Its participants were individuals who met the designated research criteria. The sample group was determined using simple random sampling, which is an improbable sampling method. The inclusion criteria were: no disorders that prevent cognitive, affective and verbal communication, being at the age between 18 and 65 and voluntary participation. The Marmara Region is a large mixed-population region including people from all strata who have different views. The researchers reached a total of 1017 individuals.

The data were collected using an information form and the Visual Analogue Scale (VAS), which were developed by the researchers in accordance with the literature and consisted of 24 questions in total, to determine the identifying characteristics of the participants and their views about the future of biotechnology. The information form, which consisted of questions to determine the participants' gender, marital status and educational levels, was developed by the researchers in accordance with the literature. The Visual Analogue Scale (VAS) contains items related to the future of biotechnology, which were prepared by the researchers in accordance with the literature. The participants were asked to rate each item on a 10-point scale ranging from 0 (disagree) to 10 (strongly agree). The data were collected from the participants between December 2015 and February 2016 while respecting the willingness and voluntariness principles, and their informed consents were received. Prior to data collection, the participants were informed briefly about the research, and their verbal consent was obtained.

The data were analyzed with SPSS software using frequencies, percentages and arithmetic means.

Results

The mean age of the participants was found to be 28.49 ± 4.32 . Of the participants, 68.6% were female, and 31.4% were male. Of them, 32.1% were university graduates, 44.1% were high school graduates, and 8.9% had a master's degree. Finally, 34.5% were married.

The Knowledge Level of Society Related to Biotechnology (N: 1017)

Of the participants, 52.8% stated that they had knowledge about biotechnology, and 15.8% stated that they keep track of information about biotechnology. The participants were asked which area is most affected by biotechnology, and of them, 76.1%, 64%, 48.6%, 43%, 40% gave the answers, health, genetics, nutrition, environment and agriculture, respectively. When participants were asked in which areas biotechnology can be mostly used, 66.8%, 54%, 51.7%, 35.7%, 32.9% and 27.5% said gene studies, health informatics applications, artificial organ studies, nanotechnology, robotic applications and wearable technology, respectively.

Of the participants, 55.8% stated that biotechnology will affect medical practices, and 42% declared that biotechnology will affect nursing practices (Table 1). Some participants said that about medical and nursing practices:

"...Producing artificial organ, gene studies and the production of new medicines and vaccine will be applied by biotechnology in the future."

"...Robotic implementations will increase."

"...Biotechnology can make medical implementations easier and help treatment and diagnosis in the future."

"...There will be also new improvement on medical treatments."

"...Nurses will also apply this new improvement about biotechnology on their jobs."

"...There is no need for nurses because biorobots will replace humans in the future."

"...Biotechnology will bring innovation to care and treatment thus nurses must have knowledge."

"...Advanced technology will be used on health care and contribute to health researches."

"...Lots of things which already exist on nursing implementations (vital signs etc.) will be much easier thanks to technological tool in the future."

"...As a result of emerging new technologies such as robot-nurses, the workload of nurses can be reduced."

Table 1 The Knowledge Level of Society Related to Biotechnology (N: 1017)

The Knowledge Level of Society Related to Biotechnology		n	%
Knowledge about biotechnology	I know.	537	52,8
	I don't know.	480	47,2
Following up the publications about biotechnology	Follow	161	15,8
	Not follow	856	84,2
Area is most affected by biotechnology*	Health	774	76,1
	Genetic	651	64,0
	Nutrition	494	48,6
	Enviromental	438	43,0
	Agriculture	407	40,0
	Industry	277	27,2
	Have no idea	176	17,3
Areas biotechnology can be mostly used *	Gene Studies	679	66,8
	Health Informatics Applications	549	54,0
	Artificial Organ Studies	526	51,7
	Nanotechnology	363	35,7
	Robotic Applications	335	32,9
	WearableTechnology	280	27,5
	Other	193	19,0
The state that biotechnology will affect medical practices.	It will affect	566	55,8
	It won't affect	7	9,7
	Have no idea	444	34,5
The state that biotechnology will affect nursing practices.	It will affect	427	42,0
	It won't affect	29	2,8
	Have no idea	561	55,2

*More than one option were marked.

Table 2. Views of society about the future of biotechnology (N: 1017)

Factors	X±SD
1.Genetically modified organisms will increase in thefuture.	7,60±2,97
2.Stem cell and genetic studies will increase in thefuture.	7,32±2,98
3.Diseases such as cancer and AIDS can be treated thanks to biotechnology.	6,44±3,21
4.With biotechnology, individual-specific drugs can be used in future	6,21±3,06
5.In future, biotechnology will affect health and nursing.	6,07±3,17
6.Health tracking will be carried out by wearable technology in future.	6,04±3,13
7.Biological warfare will commence cause of the biotechnology in thefuture.	5,71±3,33
8.Genetic structure of human population will change in thefuture	5,70±3,17
9.Thought-controlled artificial organs can be used in the future	5,59±3,24
10.Patient monitoring will be much easier with biosensors in thefuture.	5,58±3,23
11.Creating organs can be possible with 3D printers in thefuture	5,56±3,26
12. Enviromental pollution will be prevented by using biotechnological methods	5,38±2,97
13. Biosensors will be used in healthcare in thefuture.	5,32±3,24
14. Biorobots will replace humans in future.	5,04±3,21

The View of Society about the Future of Biotechnology (N: 1017)

The results showed that the item, "Genetically modified organisms will increase in the future," had the highest mean score (7.60 ± 2.97), and was followed by the items: "Stem cell and genetic studies will increase in the future" (7.32 ± 2.98), "Diseases such as cancer and AIDS can be treated thanks to biotechnology" (6.44 ± 3.21), "With biotechnology, individual-specific drugs can be used in the future" (6.21 ± 3.06), "In the future, biotechnology will affect health and nursing" (6.07 ± 3.17), and, "Health tracking will be carried out by wearable technology in the future" (6.04 ± 3.13). The item, "Biorobots will replace humans in the future," had the lowest mean score (5.04 ± 3.21) (Table 2).

Discussion

Most of the participants in the research group were in the young age group and were female, married, high school and university graduates. Of the participants, 52.8% stated that they had knowledge about the biotechnology, and 15.8% stated that they keep track of information about biotechnology. The participants were asked which area is the most affected by biotechnology, and of them, 76.1%, 64%, 48.6%, 43%, 40% gave the answers, health, genetics, nutrition, environment and agriculture, respectively. In a study conducted by Surmeli and Sahin (2009) with university students in different departments in Turkey, the participants expressed their views that the biotechnology would be used in the areas of medicine, genetics, agriculture and food. Moreover, the 2030 OECD report on the future (2011) emphasized that the use of biotechnology takes place near the top of future scenarios in the field of health. Technological innovations are expected to most affect health and genetics-related areas, and this is regarded as a finding that gives rise to thought that the society is ready for these changes.

When the participants were asked in which areas biotechnology can be mostly used, 66.8%, 54%, 51.7%, 35.7%, 32.9% and 27.5% said gene studies, health informatics applications, artificial organ studies, nanotechnology, robotic applications and wearable technology, respectively. Informatics applications, the Internet of Things, biotechnology and genomics, robotic applications and 3D printers were included as expected future changes in the report published by OECD in 2016 and the *Future of*

Jobs (2016) report by the World Economic Forum. Furthermore, *The Human 2030 Report of the Turkish Futurists Association* (2015) predicted that the use of easy-to-use special computers and wearable biosensors that speak the same language, of remote-controlled nanorobots that operate intravenously, of the robots which help elderly or disabled individuals live independently and of the easy-to-use and portable medical devices will increase. Studies in the literature emphasize that individuals in Turkey and all around the world will be part of cyber-physical systems that collect data continuously from many different sources (medical devices, local or remote control systems, sensors and smart objects, etc.) and will use these systems more actively in the near future. The fact that this study's participants also expressed this view indicates that society is ready to use these innovations (PSFK, 2014; Future of Health Report, 2016; OECD, 2016).

The views of individuals related to the future of biotechnology such as the increase in genetically modified foods and in the number of stem cell and gene studies came to the forefront in this research. A study conducted by the Australian Government in 2010 to determine the community attitudes towards biotechnology found stem cell and gene studies included in the health practices of biotechnology, as the areas which were most commonly adopted and found least risky by the community. Today, diseases such as Mediterranean anemia, leukemia and lymphoma are treated successfully with the transplantation of cells obtained from bone marrow. Moreover, studies are being conducted for the treatment of many diseases such as Parkinson's disease, Alzheimer's disease, multiple sclerosis, heart muscle defects, some neurological disorders, immune system diseases, cartilage and bone tissue losses for various reasons with embryonic stem cells (Tuncgenc, 2014). According to the *Vision 2023* report published by TUBITAK in 2004, it is expected that individual-specific cellular and genetic treatments will be possible, the structures of genes will be determined as a factor of disease, and each individual will be able to obtain the mapping of their own genes thanks to the development of stem cell studies. The *Future of Health* report, published in Cambridge in 2016, included health-related forecasts that new chemotherapeutic agents will develop, the treatment of allergic diseases will be possible, new vaccines and artificial organs can be created,

the number of fields such as tissue engineering, biomedical and material engineering and gene engineering will increase, gene treatment will be used often for diseases such as cancer, and individuals will be able to obtain the mapping of their own genes. The 2020 Technology Forecast Program in England forecasts stem cell research, the determination of tissue engineering technologies, genetic profiling and DNA analysis, genetically modified organisms, computer simulations and drug development technologies, robotic applications, biomedical engineering and artificial tissue studies (Leyshon et al, 2014; Technology and Innovation Futures, 2017). There are several forecasts that thanks to gene technology, many diseases such as cancer, Alzheimer's disease and Parkinson's disease, which threaten community health in the world, will be diagnosed early at the level of genes, and many diseases will also be eradicated by means of gene treatment and studies (Leyshon et al, 2014; PSFK, 2014; OECD, 2016; Future Health Report, 2016). According to the *Human 2030 Report of the Turkish Futurists Association* (2015), the development of codes that will create new artificial organisms seems possible with the help of computer technologies. It is forecasted that processors that will operate with the brain and the nervous system will be used to enable the visually impaired to see again and for artificial intelligence. According to the assessment of these studies, the awareness of society about genetic studies and practices was at high levels.

The views of individuals about the effects of biotechnology on health were examined in this study, and the participants were found to have the views that the treatment of diseases such as cancer and AIDS would be possible with biotechnology, that individual-specific drugs could be used thanks to biotechnology, that biotechnology would affect health and nursing, and that health monitoring would be carried out by wearable technology in the future. Scientific and technological developments in Turkey and in the world and the decrease in the death rate thanks to the early diagnosis and treatment of diseases have caused lifetimes to extend, and the population aged 65 and older to increase within the total population. These developments require changes in providing health care and different practices. *The Human 2030 Report of the Turkish Futurists Association* (2015) emphasized forecasts that with the elderly population, which will increase in the 2030s, diseases such as heart

diseases, cancer, depression and obesity will also increase, and that medical practices with the purpose of disease treatment will be replaced with individual-centered protective medical practices (TUSIAD, 2016; PSFK, 2016). Moreover, the *European Health* report by the World Health Organization (2015) also emphasized that the number of comparative genome studies, the fields of stem cell and tissue engineering and artificial organ and intelligence studies will increase. According to the report published by Future Health Index in 2016, the fact that a large part of the world population has technological devices will further increase the importance of health informatics practices in patient care. Keeping the records of patients digitally and the transfer of health data to electronic media will enable the flow of information between patients and health professionals to be reliable and sound. Moreover, studies in the literature emphasize that many innovations thanks to smart and wearable sensors developed within the context of health informatics practices, clothes that can measure the vital signs, blood sugar implants, biosensors that stick to the skin of individuals and measure their vital signs, easy-to-use and portable medical devices and biotechnology will directly affect the future of health and nursing (European Commission, 2009; Gerard et al, 2014; Deloitte & Touche Company, 2015; Hooper et al, 2015; Schartinger et al, 2015; Turkish Futurists Association, 2015; TUSIAD, 2016). The examination of the trends of Turkish Academic of Sciences (TUBA) related to the year 2030 and the more distant future (2004) forecasts diagnosing diseases and providing treatments with holographic patient monitoring and 3D images on virtual platforms, remote-controlled nanorobots that will operate intravenously, smart medication administration and an increase in neurological studies. These results suggest that the society, which also constituted the research group, predicted the health-related changes in the future, and in accordance with these predictions, they had the potential to use these changes positively.

This study found that the item with which the participants agreed least was, "Biorobots will replace humans in the future." *Futurescan 2016-2021: Healthcare Trends and Implications*, published by the American College of Healthcare Executives in 2016, reports that robotic practices will increase in health care in the future. Futurists

emphasize that innovative opportunities that will affect the future of health include robotic practices, robot doctors and nurses, digital hospitals and telemedicine practices (Institute of Medicine 2010, Saritas and Smith, 2011; Valiga, 2012; Grossmann and Valiga, 2013, Gerard et al, 2014, Turkish Futurists Association, 2015; Technology and Innovation Futures, 2017). In a qualitative study by Bodur and Kaya (2017), which included the predictions of nurses and nurse educators about 2050, the statements of participants about the fact that robots will become common in health care system in the future came to the forefront. In addition to this finding, a study conducted to determine the perceptions of nurses about the 2050s who were working at well-established research and training hospitals in Istanbul found they regarded robotic practices as a threat to their own profession and the health system (Bodur and Kaya, 2017). Today, robotic studies are increasing rapidly in the world, and it is expected that they will become common. Studies of robotic practices are new in Turkey, and the number of social studies about this topic is limited. Although innovative technologies in the field of health informatics have been developed in Turkey, robotic practices have not become popular yet. This suggests that society approaches robotic developments more cautiously. In this study, 55.8% of the participants stated that biotechnology would affect medical studies, and 42% said that biotechnology would affect nursing practices (Table 1). In a report published by the Institute of Medicine (IOM) in 2010, practices about health informatics, technological applications and practices for the development of health care technologies were prominently featured as competencies that doctors and nurses will need to have in the future. Futurists forecast that doctors and nurses will have new roles in the fields such as mobile applications, web-based care and training practices, health informatics, telemedicine practices, simulation, social network practices in health, reflecting changes in technology and in the world in their professional practices (Hain, 2012; Valiga, 2012; Doyle et al, 2013; Shellenbarger and Robb, 2015). Nurses are the key members of health care teams, who use changing technology in practices such as monitoring vital signs (blood sugar implants, biosensors inserted in the body) and planning the interventions by means of electronic record systems, as well as mobile technology. Therefore, it is certain that there will be many changes in the

roles and practices of doctors and nurses (Valiga, 2012; Grossman and Valiga, 2013; Gerard et al, 2014). The fact that the views of the participants were found to comply with the literature and the forecasts of futurists can be interpreted to indicate high levels of awareness about new trends that will affect the world and the future of health care systems and about the fact that technology will affect health in the future.

Conclusion

This study found that society members were aware of the dynamics that will affect the world, health and biotechnology in the future, but their knowledge of these practices was not adequate. Its results suggest that:

- Research and social studies should be conducted to increase the knowledge of individuals and health professionals in terms of biotechnology practices and their effects on the future.
- Training programs should be planned to increase people's knowledge about futuristic technologies such as biotechnology, genetics and robotics.
- Online information sources and virtual learning environments such as e-portals, internet, videos and virtual learning should be made common in society so that people can follow current developments in biotechnology.

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