THE POOR IMAGE OF THE X-RAY TECHNICIAN PROFESSION AND HOW IT AFFECTS SUPPLY

Sarit H. Malul MARKOVICH
Alexandru Ioan Cuza University of Iasi
Blvd. Carol I, nr. 22, 700505, Iasi, Romania
saritm4@gmail.com

Andreia Gabriela ANDREI
Alexandru Ioan Cuza University of Iasi
Blvd. Carol I, nr. 22, 700505, Iasi, Romania
andrei.andreia@gmail.com

Abstract.
X-Rays technicians are the link chain between medical knowledge and the inner world of the human body. These operate as any physician's vision tool for investigating the human body in diagnosing illnesses. Due to global technological advancement, diagnostic investigations have developed tremendously in the last 15 years. Today, there are several complex diagnostic tests and procedures, such as computerized tomography (CT), magnetic resonance imaging (MRI), mammography, ultrasound, heart catheterization, blood vessels catheterization etc. All these changes have created a high demand for qualified hi-tech healthcare workers, the X-Rays technicians being the third largest group among healthcare professions. Still, the general public is less familiar with or unaware of the profession, its work areas, and the options it could provide. Except for a few countries, the supply of X-Rays technicians to the labor market is quite low. This study investigates the relationship between the professional image and the low supply of X-Rays technicians. It also explores the perceptions of research participants regarding X-Rays technician profession. The study uses a qualitative research methodology by applying semi-structured interviews in which ten participants – people interested in pursuing academic studies - discussed potential career paths and future professional subjects. Specifically, the interviewees revealed two main issues: lack of knowledge of the X-Rays technician profession and misconception about a profession that deals with ionizing radiation. The interview findings indicate a poor image of X-Rays technician profession. Study indicates that professional image is poor due to misconception regarding the profession and of a profession conducted in an ionizing radiation work environment. Moreover, it shows that professional image is essential in people's decision not to choose or learn about this profession, compromising the supply of professionals in the field.

Introduction

Supply is a term in economics that defines a relationship between the product's price and quantity. It illustrates an inaccurate estimate of the number of products and services produced and offered for sale on the market (Arrow, 1974; Ministry of Education, 2020). According to The International Committee for Medical Imaging, there is a lack of imaging equipment and X-Rays technicians in countries with low-to-medium income (Frija et al., 2021).

McNulti (Rouger, 2018), president of the European Federation of Radiographer Societies, states that 50% of European countries produce too many X-Rays technicians, and the other 50% experience lack of workers in this profession. In the United States, Radiology departments reported an 8.5% understaffing of X-Rays technicians (American Society of Radiologic Technologists, 2019). In Israel, there is no updated database with the number of X-Rays technicians (State Comptroller, 2015),
As a result of the technological progress in medical imaging systems, the increased use of imaging equipment due to the higher frequency of chronic diseases, and the rise in the population's age, advanced imaging technologies are required for driving the market growth in innovation and the demand for more professionals (Report Linker, 2022).

The low supply of X-Rays technicians on the market entails severe problems in the economy's way of conduct. For example, the Israeli Ministry of Health authorized five imaging machines to diagnose diseases and tumors in hospitals. However, in practice, there is a severe lack of X-Rays technicians to operate the machine and radiologists to analyze the tests. One has to wait a long time for scheduled appointments, and the diagnosis of the patient's tumors is delayed (Blumenfeld, 2018).

Given the severe data about the low supply of X-Rays technicians, it is imperative to conduct a study to identify the components that affect the supply. Hence, this study investigates the reasons for the low supply, based on the assumption that the X-Rays technician profession has image problems that compromise the supply.

Literature review

Choice of a profession

Choosing a profession is, in fact, a process of making a difficult decision, and it involves an element of uncertainty. People who have to decide which profession to choose must deliberate between various options and compare the various professions. The choice involves information collection and processing, together with a whole set of considerations.
In Israel, there is a unique feature for choosing a profession, namely military service, that discontinues the sequence between high school and academic studies. People start their studies later, and the choice is perceived as more meaningful (Gati, 2016). One factor that affects the choice of profession is the availability of information sources. Receiving counseling, orientation, and intervention program already at high school can assist individuals in their choice of profession.

X-Rays technicians – Worldwide training pathway and regulation

The term X-Rays technician encompasses X-Rays imaging, MRI, CT, nuclear medicine, and ultrasound. Hospital departments that perform these procedures are called imaging institutes or radiology departments. The imaging system might considerably differ, and not all imaging machines use ionizing radiation (U.S. News & World Report, 2021). Several training pathways in Israel award a B.A. or B.Sc. degrees, and the studies last 3-3.5 years (Ministry of Health, 2021). Moreover, this profession is not regulated by law (State Comptroller, 2015).
European countries have no regulation of the X-Rays technician profession, and various national rules exist. As a result, the degrees change, and some countries have more than one degree for various specializations. Most European institutions grant a B.A. with

various specializations, and the duration of the programs ranges between 3 to 5 years (Couto et al., 2017).
In the United States, there is an educational program on X-Rays technology. Those who wish to be qualified as registered technologists, should complete an X-Rays technician training in a program accredited by the Joint Review Committee on Education in Radiologic Technology. The X-Rays Certification Programs are available for a certificate, associate technician, and graduate studies. In most American states, the programs last between 1-4 years. According to the American Society of Radiologic Technologists, 11 states have no laws regarding X-Rays technicians' license (Best Colleges Organization, 2021). The legal regulation of the X-Rays technician profession in the various training pathways, might result in numerous and different perceptions of this profession among the global public and, thus, undermine its professional image.

The professional image of X-Rays technicians
X-Rays technicians are perceived as workers who just "press the button". They do not enjoy the occupational prestige of other healthcare professionals. A study conducted by a group of physical therapists and occupational therapists showed that the physical therapists had classified the X-Rays technicians in the last place. In contrast, occupational therapists classified them in the 12th place among healthcare professionals (Collins & Nolen, 2002). In 2021, X-Rays technicians were ranked 71 out of the 100 best positions around the globe (U.S. News & World Report, 2021).

Misconceptions of the X-Rays technician profession
Mankind is continuously exposed to natural radiation, referred to as background radiation. In most areas, natural radioactivity is slightly different, and the annual average is mSv2.4. This radiation in Israel and Romania is within the range of the annual average. However, in certain places around the world, there are high deviations from the normal levels, and they are known as areas with high background radiation, up to 100 times higher than the annual average, such as Ramsar, a city in northern Iran with an mSv 260 (Silveiraa et al., 2012). Cytogenetic studies and epidemiological monitoring of this issue do not show meaningful differences between people living in areas with high background radiation compared to those living in areas with average background radiation (Israel Atomic Energy Commission, 2011; Jolyon, 2009; Krishnan, 1990).
X-Rays technicians operate radiation-emitting equipment and, during their work, are at risk of exposure to ionizing radiation at different levels. (Romano, 2012). The annual average exposure of workers in an ionizing radiation environment is less than one millisievert. (Haruz-Waschitz, 2004).

Table 1. Risks of working in a work environment with ionizing radiation (Author's Own Source)

	From the 1940s to 2010	From 2010 to the present
Studies of work environment with ionizing radiation and cancer	There is a relation between work in an ionizing radiation environment and an increased risk of various types of cancer (Steven, 2006; Shinji, 2004; Wakeford, 2009).	It cannot be proven that the low radiation to which X-Rays technicians are exposed during their work constitutes a considerable risk factor and increases the risk of cancer (Kitahara, 2018; Preston, 2016; Terrence, 2015).
The reasons for the change in the findings.	Higher exposure and being unaware of protection against radiation (Shinji, 2004).	Technological development of equipment that reduced exposure to radiation, and deeper epidemiological understanding of the way studies are conducted. (Waldermar, 2012).

Table 1 illustrates the differences in studies that have examined the relation between X-Rays technicians' exposure to radiation during their work and a higher risk of getting sick with various cancer types between the early years (1940-2010) and later years from 2010 until these present days.

The public's level of knowledge about ionizing radiation

Studies conducted among the wide population, exploring its knowledge and perception of ionizing radiation and its risks, found that a large part of the public does not have the necessary knowledge about this topic. A study conducted in Jeddah (Nasr et al., 2019) indicated that only 3% out of 244 research participants had knowledge about ionizing radiation, and they had misconceptions of the actual risks of exposure to it. In another study conducted in Vermont, the participants with a higher education level than the average were asked about the real risks of radiation exposure. The results showed that they had many misconceptions of the actual risks of ionizing radiation, particularly when imaging tests were performed (Evans et al., 2015).

A study conducted by Sesen and Ince (2010) hypothesized that there was erroneous information about radiation and radioactivity on the Internet and that erroneous information led to misconceptions. The research findings illustrated that the search engine preferred by students was Google, offering quite a high number of websites with wrong and insufficient information about radiation and radioactivity.

Hence, this study is important, since it aims to find solutions for improving the supply of X-Rays technicians, by exploring the perceptions about this profession and the factors involved in the formation of misconceptions about the X-Rays technician profession.

Methodology

Research method and research population

This study was conducted according to qualitative research paradigm. The participants were individuals who were interested in academic studies and did not know which profession to choose. The interviewees were chosen according to the "snowball" method. That is, moving from one interview to another by contacting friends who had children over the age of 18 who did not know what to study and which profession for life to choose. All the interviewees signed an informed consent form, demonstrating their agreement to participate in this study. They were guaranteed that their anonymity and confidentiality of their details would be maintained.

Research instruments

At the beginning of the interviews, the participants received an explanation regarding the research aim: "To examine the factors involved in the image of the X-Rays technicians". The interviews were conducted face-to-face, they lasted 20-30 minutes, and were recorded (after receiving the approval of all the participants). The interviews were conducted in three stages.

The first stage comprised general questions about the following topics: acquaintance with the X-Rays technician profession; knowledge of ionizing radiation; considerations for choosing a profession.

At the second stage, the same ten interviewees received true and relevant information about the X-Rays technician profession: pertinent information about ionizing radiation and risks thereof. The information was taken from the empirical literature on this field.

In the third stage, after receiving and complementing the lacking knowledge, those ten interviewees were asked general questions related to their level of interest in the profession; level of apprehension from working with ionizing radiation; perceptions of the profession; and so on.

For due diligence purposes, it should be indicated that the researcher herself is an X-Rays technician who manages the imaging setup of Assuta Medical Centers in Israel. She has previous acquaintance with some of the interviewees but is not familiar with others. This attests to involvement and the ability to understand the interviewees' experience deeply. Patton cited in (Shkedi, 2003) argues that to understand the investigated topic, one should be part of it and remain distinct from it. Consequently, researchers should be aware of their positions. This study's researcher invested efforts to remain loyal to the interviewees' words.

Data analysis method

After every interview, the recorded interview was transcribed, and its content was analyzed. The transcribed material was read, and initial ideas for categories were marked next to the transcription. Then, the text units were divided into categories and consolidating and arranging the themes began. A citation was inserted in each theme, clearly manifesting the interviewee's position. This stage helped the researcher note and analyze the results that constituted part of the data analysis. When writing the results, the findings were described in relation to the chosen themes (Shkedi, 2003).

Results

First theme: Misconceptions of a profession that involves ionizing radiation, before and after information delivery.
Category 1: Lack of knowledge about ionizing radiation.
The content analysis showed that most interviewees did not know ionizing radiation. This was attested by the interviewees' words when they answered questions related to ionizing radiation. Before delivering the information, eight out of ten interviewees knew nothing about ionizing radiation and, some of them, gave wrong answers. Two interviewees had just a little knowledge. For example: "I do not know exactly what ionizing radiation is"; "ionizing radiation that is above ultraviolet wavelength, how many wavelengths that means, I cannot say".
Evidence of little knowledge about ionizing radiation: "I don't know how the sensor absorbs the radiation back… what you see on the final picture"; "radiation emitted naturally from planet earth has a scale… this is about 2".
After receiving the information, the interviewees were surprised to find out and learn new information about radiation, a topic about which they knew nothing before. For example: "I received new information also about background radiation that varies in different countries"; "I am constantly exposed to radiation, around the globe, and in Brazil, it's much higher".
To sum up, delivering information about radiation can change the misconceptions of the imaging profession and favorably affect its choice as a career. Eight of the ten interviewees pointed out they had misconceptions about radiation before receiving the information, while two stated no such misconceptions.

Category 2: Apprehension of ionizing radiation.
The content analysis illustrated that people had very little information about ionizing radiation, and part was wrong. Hence, they were apprehensive of and concerned about radiation. Before receiving the information, the interviewees mentioned that they thought that people working in an ionizing radiation environment had higher chances of becoming sick with cancer. Nine out of the ten interviewees responded that radiation workers were more likely to get cancer, compared to those who were not radiation workers. For example: "I know that people can at least protect themselves"; "Yes, radiation can cause damage"; "Of course, it is risky".
Individuals who had to choose a profession, obtained knowledge from personal experiences that left an impression about radiation. For example: "In the past, I underwent an imaging procedure near some machine. They placed me in a really big machine, but I do not remember it precisely because I was very young and they argued whether this involved radiation or whether to have radiography".
After delivery of the information, the interviewees were asked about their apprehension of radiation. They stated that they were apprehensive, but their apprehension level was decreased. Eight out of the ten interviewees indicated that their apprehension was reduced, while two said they had no apprehension even before the delivery of the information. The interviewee's answers evidenced this: "Immediately after hearing about the radiation, which is cancerous, this is frightening and discouraging. Now, after the explanation, I am much less apprehensive"; "This renewed many things for me and reduced many apprehensions regarding the radiation environment".
To sum up, apprehension of radiation can lead people to avoid choosing this profession.

Category 3: Apprehension of working with ionizing radiation.
Before delivering the information, the interviewees were asked whether they would consider working in a profession that involved an ionizing radiation environment. Those unfamiliar with the working environment, the way X-Rays technicians protected themselves, and the machines they operated would not have chosen to work in this environment. Six out of ten interviewees said they would not, and four said they were not apprehensive since they had little knowledge about the working environment. One interviewee was willing to work in an ionizing radiation environment because he thought the wages were higher. For example: "Sometimes, there are leaks, and this is not under control"; "This is only because of the radiation… it damages the body when people work daily in such an environment. I would not choose this kind of work".
Following the delivery of information, the interviewees understood that radiation workers were usually not exposed to radiation, that their annual exposure was low, and that everyone around the world was living with background radiation daily. This information considerably reduced the apprehension of working in an ionizing radiation environment. Nine out of ten interviewees stated they would work in an ionizing radiation environment. Six of them had changed their mind. For example: "they are in a protected place"; "I have just realized there is no radiation in MRI"; "It surprised me to know that there is not as much radiation as I have thought".
To sum up, the interviewees received information about radiation levels and ways of protection. Moreover, they learned that X-Rays technicians were hardly exposed to ionizing radiation and that some machines that they operated did not emit ionizing radiation, such as ultrasound (sound waves) and MRI (magnetic resonance). This greatly reduced the apprehension of working in an ionizing radiation environment. Lack of knowledge and apprehension of working in an ionizing radiation environment result in misconceptions that affect the professional image of this profession and, thus, people will not consider learning it.

Second theme: Lack of knowledge about X-Rays technician profession.
Category 1: Level of knowledge about the profession.
The decision about studies and profession for life is highly important and one should collect as much information as possible in order to make the right decision. Analysis of the content related to knowledge about X-Rays technician profession showed that the level of knowledge was low and most interviewees were not familiar with the essence of this profession, the training pathways, the machines operated by the X-Rays technicians, the advantages and disadvantages of the profession, and so on. This was due to the fact that they have never heard about the profession, nor have they inquired about it.
Prior to the delivery of information, eight out of ten interviewees knew nothing at all about the profession and two of them had low-level and insufficient knowledge. The data collected from the interviews showed that the knowledge about the profession came mainly from personal acquaintance, while the interviewees themselves experienced the imaging procedure, or from someone close to them who was familiar with the profession. For example: "I have heard about this profession in general, but I have never known what it does"; "I don't really know what X-Rays technicians do. My mother, who has an X-Rays technician at work, told me many stories about the work"; "My mother talked to me about this X-Rays technician profession".
After the delivery of information, the interviewees' knowledge was improved, and they realized it could interest them and match their expectations. Some of them even changed their mind after being exposed to the information that was new to them: "I found out

that it was diversified"; "I understood what X-Rays meant and how it was done"; "There are various directions of development and it seems interesting… I can diagnose and that is something I was unaware of and it sounds fascinating".
Analysis of the content related to misconception of this profession indicated that eight out of ten interviewees attested that they had a misconception of the profession, while two of them said they did not have such a misconception. A misconception can undermine the professional image of this profession and it might harm the supply.
To sum up, misconceptions about the X-Rays technician profession stem from lack of knowledge that causes individuals to avoid choosing this profession as a career for life.

Category 2: Knowledge about the profession increases the interest in it.
The content analysis gave rise to this category as associated with the theme 'misconceptions of the X-Rays technician profession'.
Before delivery of the information, nine out of ten interviewees attested that they had no wish nor interest to study the X-Rays technician profession, while only one interviewee, who works in a hospital, stated that he considered this profession as an option of studies. For example: "I know nothing about it and I have never shown any interest in it"; "I am not connected and don't like it. This is not the field in which I see myself in future".
Following the delivery of information, some of the interviewees started accumulating knowledge about the profession with which they were not familiar at all. They showed interest in it and some of them even said they would consider studying it. Several misconceptions were manifested due to lack of information in this field. Moreover, the data illustrated that the information they received, helped the interviewees in changing their mind as to the choice of X-Rays technician profession as a career for life. Once they realized that they were interested in the field of medicine, and that this profession has also a component of initial diagnosis of the findings, it increased their inner wish and the chances of choosing this profession. "I might have engaged in it as this profession is also part of medicine, diagnoses…"; You opened to me a whole new world now, and I will consider learning this profession".
To sum up, information regarding the X-Rays technician profession can change the misconceptions of this field, resulting in a chance of choosing to study this profession as a career for life.

Category 3: Lack in knowledge.
In order to identify the lacking knowledge necessary for deciding whether to learn this profession, the interviewees were asked what additional information they needed for making this decision. The findings showed that an explanation campaign about the profession was very important, i.e., someone who would inform and explain more about the profession itself. Moreover, practical experience in the field, inquiry, and learning are the factors that individuals lack in order to decide whether to learn this profession. For example: "I would be pleased to come and see in practice how they work, what they do, there is nothing like seeing it with your own eyes".
To sum up, complementing the lacking knowledge about the X-Rays technician profession, practical experience in the field to see what these technicians actually do, can help in choosing the field of imaging as a career for life.

Discussion and conclusions

Choosing a profession is a process of decision-making that is being consolidated by data collection (Gati, 2016). X-Rays technicians work in an ionizing radiation environment, but their exposure to annual average radiation is low (Haruz-Waschitz, 2004). Hence, they have no risk of getting cancer because of their work in this environment (Kitahara, 2018; Preston, 2016; Terrence, 2015). Nevertheless, studies (Nasr et al., 2019) show that most of the public does not have the necessary knowledge about ionizing radiation and the risks thereof. Consequently, the public has misconceptions of these issues.
The X-Rays technician profession has a low professional image (Collins & Nolen, 2002). Furthermore, many countries around the globe experience lack of X-Rays technicians on the labor market (The International Committee for Medical, 2021). The findings obtained from the content analysis are in line with the empirical literature on this issue (Keynan, 1996). They illustrate that the low professional image stems from misconceptions of ionizing radiation and lack of knowledge about the profession, affecting the supply of technicians. Figure 1 presents the relation between the components that affect the low professional image and, thus, undermines the supply.

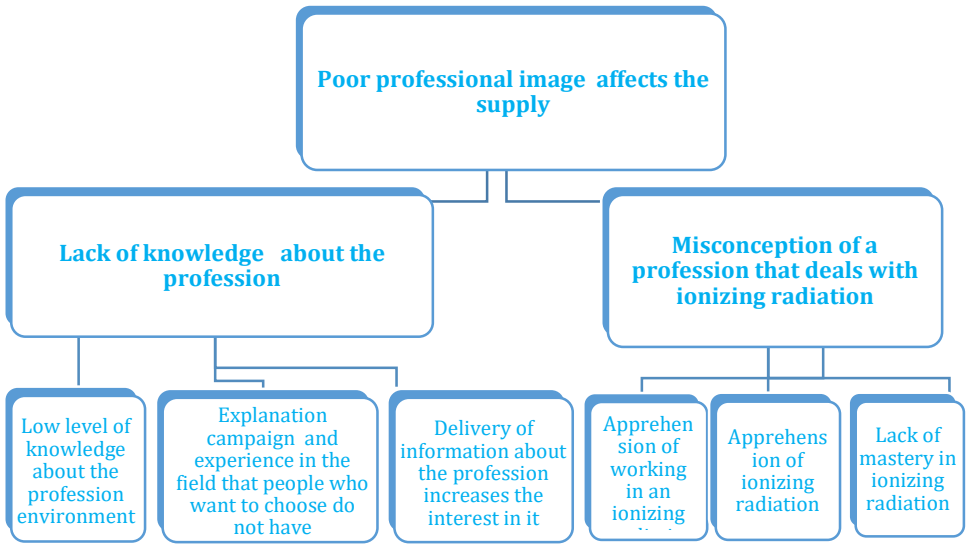

Figure 1. The relation between the components affecting the poor professional image that undermines the supply (Author's Own Source)

Figure 1 indicates misconceptions of the profession, resulting from a considerable lack of knowledge about the essence of the profession and the optional variations it enables, study pathways, promotion pathways, and workplaces. The lack of these elements directly impacts the professional image that the choosing individuals have of the profession. Moreover, the lack of knowledge leads to a negative professional image that affects the supply. Providing knowledge about the profession increased the individuals'

interest of choosing it as a profession for life. An explanation campaign about the profession, as well as an option of practical experience in this field, would have considerable improved the public's lacking information about the profession.
There are components that inhibit the choice of this profession. They are associated with a misconception of a profession that is conducted in an ionizing radiation environment. This misconception stems from the public's lack of knowledge regarding the professional nature of the profession's working environment, apprehension of radiation in general and working in an ionizing radiation environment in particular. Reducing the apprehension by learning about ionizing radiation, its risks, ways of protection against it, which machines do not emit ionizing radiation at all, and so on, will mitigate the existing apprehension and will offer a real opportunity for learning and engaging in this interesting profession as a career for life.
To sum up, the content analysis of the interviews showed that the poor professional image of X-ray technicians made this profession unattractive and reduced the supply of human resources in the field. It can be inferred that a balance between the demand and supply of human resources in the X-Rays field of activity can only be achieved if the professional image of X-Rays technicians is restored. The results of this study indicated the increased need to find solutions for improving the image of the X-Rays technician profession. The research suggested that misconceptions and the poor image of this profession should be addressed to bridge the gap between the low supply and high demand of staff in the X-Rays field.

Research limitations

The data obtained in this study are drawn from interview-based research conducted with ten Israeli interviewees who do not necessarily reflect the attitudes of the worldwide population. Moreover, the interviewees in this study are Israeli participants with limited knowledge about the X-Rays technician profession and ionizing radiation, ~~or~~ people who have not made an extensive inquiry of this field. Consequently, we caution about this research limitation.
In spite of these limitations, this small-scale research can transmit an important message to the Israeli Ministry of Health, the Israeli population, and the world at large. This message highlights the imperative need for dispelling misconceptions and cultivating the professional image of X-Rays technicians. The joint efforts of researchers, professionals in the field, educators, and regulatory bodies are needed for improving the image and, thus, the attractiveness of the X-Rays technician profession. As this study has shown, only an improved image of the profession will allow the necessary growth of human capital in this extremely important field, whose service supply is vital for the entire population.

References

American Society of Radiologic Technologists (2019). *Radiologic Technologist Staffing and Workplace Survey*. https://www.asrt.org/main/news-publications/research/staffing-surveys

Arrow, K. J. (1974). General Economic Equilibrium: Purpose, Analytic Techniques, Collective Choice. *The American Economic Review Journal, 64*(3), 253-272. http://www.jstor.org/stable/1808881

Best Colleges Organization (2021). *How to become an X-Ray technician: Training and Certification Requirements*. Best Accredited Colleges. https://bestaccreditedcolleges.org/articles/how-to-become-a-certified-x-ray-technician.html

Blumenfeld, R. (2018). *An Absurd Situation in the Ministry of Health: Imaging Machines Have Been Authorized but There Is No One to Operate Them.* https://news.walla.co.il/item/3175979

Changying, W. (2007). Analysis of Teacher Attrition. *Chinese Education and Society, 40*(5), 6-10. Doi: https://doi.org/10.2753/CED1061-1932400501

Collins, K. S., & Nolen, K. (2002). Enhancing your professional image (My Perspective). *Radiologic Technology,* 7*3*(3). https://www.thefreelibrary.com/Enhancing+your+professional+image.+(My+Perspective).-a082738417.

Couto, J. G., Mcfadden, S. I., Bezzina, P., McClure, P., & Hughes, C. (2017). An Evaluation of the Educational Requirements to Practice Radiography in the European Union. *Education of Radiographers in the European Union Project.* https://www.researchgate.net/publication/318925950_An_evaluation_of_the_educational_ requirements_to_practise_radiography_in_the_European_Union

Evans, K. M., Bodmer, J., Edwards, B., Levins, J., O'Meara, A., Ruhotina, M., Smith, R., Delaney, T., Hoffman-Contois, R., Boccuzzo, L., Hales, H., & Carney, K. K. (2015). *An Exploratory Analysis of Public Awareness and Perception of Ionizing Radiation and Guide to Public Health Practice in Vermont.* https://doi.org/10.1155/2015/476495

Ewing, R. A., & Smith, D. L. (2003). Retaining quality beginning teachers in the profession. *English Teaching: Practice and Critique, 2*(1), 15-32. http://education.waikato.ac.nz/research/files/etpc/2003v2n1art2.pdf

Frija, G., Blažić, I., Frush, D.P., Hierath, M., Kawooya, M., Donoso-Bach, L., & Brklijačić, B. (2021). How to Improve Access to Medical Imaging in Low- and Middle-Income Countries? . *eClinicalMedicine, 38*, 101034. https://doi.org/10.1016/j.eclinm.2021.101034

Gati, I. (2016). *Ways of assisting in making career decisions.* Hebrew University.

Haruz-Shitz, S. (2004). *A Survey of the Risk of Employees' Exposure to Ionizing Radiation in Industrial Plants that Process Phosphates and Coal Ash*. Ben-Gurion University of the Negev, Faculty of Engineering Sciences, Department of Bio-Medical engineering.

Israel Atomic Energy Commission (n.d.). Radiation Safety Zone. *Sorek: Nuclear Research Center.* https://nrcn.gov.il/ NuclearSafety/ Pages/ NORM.aspx

Jolyon, H. (2009). Human Exposure to High Natural Background Radiation: What Can It Teach Us about Radiation Risks? *Journal of Radiological Protection*, *29*(2), 29-42. Doi: 10.1088/0952-4746/29/2A/S03

Keynan, O. (1996). *Teachers' Lounge – Teachers' Professional Culture*. Ben-Gurion University of the Negev.

Kitahara, C. M. (2018). Occupational Radiation Exposure and Thyroid Cancer Incidence in a Cohort of U.S. Radiologic Technologists, 1983–2013. *International Journal of Cancer*, *143*(9), 2145-2149. Doi: 10.1002/ijc.31270

Krishnan, M. N. (1999). Population Study in the High Natural Background Radiation Area in Kerala, India. *Radiat Res*, *152*(6), 145-148. https://doi.org/10.2307/3580134

Ministry of Education (2020). *Introduction to Economics – Chapter 6.* Ministry of Education, Administration of IT and Information Systems. https://meyda.education.gov.il/files/MadaTech/NihulTaasiaYazamut/nihulesky/heshbonaut/2020/perek6mavolkalkala.pdf

Ministry of Health (2015). *Guidelines for Requesting a License for a Medical Radiation Machine / Special Medical Machine*. Ministry of Health. https://www.health.gov.il/hozer/RD_25082015.pdf

Ministry of Health (2021). *Managing Director Circular – Certified X-Rays and Medical Imaging Technician.* https://www.gov.il/BlobFolder/policy/mk05-2021/he/files_circulars_mk_mk05_2021.pdf

Nasr, R. Y., Barnawi, R. A., Radi, O. N., Wazzan. M., Batawil. N., Khashoggi, K., Hagi, S., & Khafaji, M. (2019). Analysis of Public Perception about Ionizing Radiation, *Radioprotection, 54*(4). 289–293. https://doi.org/10.1051 /radiopro/2019035

Preston, D. L. (2016). Breast Cancer Risk and Protracted Low-to-Moderate Dose Occupational Radiation Exposure in the US Radiologic Technologists Cohort, 1983–2008. *British Journal of Cancer, 115*, 1105-1112. Doi: 10.1038/bjc.2016.292

Report Linker (2022). *Medical Imaging Analysis Software Market – Growth Trends, COVID 19 Impact, and Forecasts (2022 – 2027)*. https://www.reportlinker.com/p06249241/Medical-Imaging-Analysis-Software-Market-Growth-Trends-COVID-19-Impact-and-Forecasts.html?utm_source=GNW

Romano, J. M. (2012). Stress Management for the Radiologic Technologist. *RadTech, 84*(1), 55-71. https://pubmed.ncbi.nlm.nih.gov/22988262/
Rouger, M. (2018). *Levelling EU Qualifications for Radiographers.* https://healthcare-in-europe.com/en/news/levelling-eu-qualifications-for-radiographers.html

Sesen, B. I., & Ince, E. (2010). Internet as a Source of Misconception: Radiation and Radioactivity. *Turkish Online Journal of Educational Technology, 9*(4), 94-100. https://www.academia.edu/en/820099/Acar_Sesen_B_%C4%B0nce_E_2010_Internet_as_a_source_of_misconception_Radiation_and_radioactivity_The_Turkish_Online_Journal_of_Educational_Technology_9_4_94_100.

Shinji, Y. (2004). Cancer Risks Among Radiologists and Radiologic Technologists: Review of Epidemiologic Studies. *Radiology, 233*(2), 313-21. Doi: 10.1148/radiol.2332031119

Shkedi, A. (2003). *The Meaning beyond Words: Methodologies in Qualitative Research-Theories & In Practice*. Ramot Publications.

Silveiraa, M. A. G., Medinab, N. H., Pereiraa, B. R., & Aguiarb, V. A. P. (2012). *High Natural Radiation in Brazilian Sands*. https://journals.lww.com/health-physics/Abstract/2002/01000/VERY_HIGH_BACKGROUND_ RADIATION_ AREAS_OF_RAMSAR,.11.aspx

State Comptroller (2015). *Ministry of Health Advanced Imaging Tests – Annual Report 65C.* Ministry of Health.

Steven, L S. (2006). Estimating Historical Radiation dDoses to a Cohort of U.S. Radiologic Technologists. *Radiat Res, 166*(1), 174-92. Doi: 10.1667/RR3433.1

Terrence, L. (2015). Occupational Ionizing Radiation and Rsk of Basal Cell Carcinoma in US Radiologic Technologists (1983–2005). *BJM*, *72*(12), 861-9. Doi: 10.1136/oemed-2015-102880

U.S. News & World Report (2021). *Radiologic Technologists in High Demand*. Advent Health University. https://www.ahu.edu/blog/news/radiologic-technologists-high-demand

Wakeford, R. (2009). Radiation in the Workplace-A Review of Studies of the Risks of Occupational Exposure to Ionizing Radiation. *Journal of Radiological Protection, 29*(2A), 61-79. Doi: 10.1088/0952-4746/29/2A/S05

Waldemar, H. (2012). Reduction of Radiation Exposure and Improvement of Image Quality with BMI-Adapted Prospective Cardiac Computed Tomography and Iterative Reconstruction. *European Journal of Radiology, 81(11), 3568-3576.* Doi: 10.1016/j.ejrad.2011.06.055