



Artificial Intelligence in Healthcare The perspectives of Medical Students and Health Professionals

João Pedro Alves de Bessa

Dissertação para obtenção do Grau de Mestre em
Medicina
(mestrado integrado)

Orientador: Prof. Doutor Henrique Manuel Gil Martins

maio de 2021

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Dedication

To my parents, for building the path that allows me to walk forward.

To my sister, for the constantly shared laughs.

To João and Beatriz, for selflessly supporting me through hard times.

To the city of Covilhã, for helping me feel at home.

Acknowledgments

I express my deepest gratitude to Professor Henrique Martins for his guidance and persistent support. For pushing me to aim higher and keeping me motivated, thank you.

Thank you to everyone that found the time to participate in this investigation and to the institutions that helped me share it, especially Ordem dos Enfermeiros through the kind Patrícia Guerreiro. Your collaboration made my work possible.

Finally, thank you to Tiago for helping me with the statistical analysis.

Resumo alargado

Introdução: Numa fase em que os sistemas de saúde enfrentam uma enorme pressão, o uso crescente de tecnologias e, particularmente, de ferramentas baseadas em Inteligência Artificial (IA), promete otimizar a prestação de cuidados.

Servindo-se da sua capacidade de aprendizagem, adaptação e manipulação de dados os sistemas de IA são capazes de mimetizar o raciocínio humano e auxiliar na execução de variadíssimas tarefas, desde cirurgias robóticas à definição de um plano de cuidados individualizado.

Contudo, apesar dos sucessos registados e da aparente receptividade por parte da população, os profissionais de saúde parecem estar algo reticentes quanto à adoção de tecnologias de IA, o que naturalmente coloca em risco o sucesso da sua implementação uma vez que eles desempenham um papel central nesta transição digital.

Sendo eles os principais utilizadores destas ferramentas, o seu conhecimento, atitude e confiança tornam-se fatores-chave para o sucesso na implementação e adoção de sistemas baseados em IA. Como tal, as suas opiniões e sugestões devem ser consideradas ao longo dos processos de idealização e conceção tecnológica.

Assim, poder-se-á conceber um ambiente pautado pela segurança e informação sustentada, em que os profissionais se sentem mais confiantes na utilização de ferramentas que reconhecem ser úteis, com conseqüente repercussão numa adoção mais positiva e consciente.

Objetivos: Este trabalho de investigação tem como objetivo explorar as perspetivas e expectativas de profissionais de saúde e estudantes de medicina relativamente à adoção de IA na saúde, tentando compreender a sua visão no que diz respeito aos principais desafios, preocupações e oportunidades que acompanham este processo.

Desta forma, será possível compreender que passos devem ser tomados pela indústria no sentido de desenvolver ferramentas que vão ao encontro das suas necessidades reais e que, portanto, serão mais facilmente aceites e utilizadas com efeito.

Materiais e métodos: Com base em modelos de aceitação de tecnologia e revisão da variada literatura disponível, construímos e aplicámos um questionário online. Este era composto por oito questões de escolha múltipla e sete questões assentes em escalas de

Likert de sete pontos, explorando interesse, conhecimento e opiniões em torno da aplicação de IA.

Recorrendo às *mailing lists* de associações de estudantes das várias escolas médicas nacionais e de ordens profissionais da área da saúde, o questionário online foi disseminado no sentido de recolher o maior número possível de repostas. Posteriormente, os dados obtidos foram organizados e analisados através do IBM SPSS (versão 25).

Resultados: Os resultados exploram a análise descritiva baseada em respostas de 119 profissionais de saúde e 154 estudantes de medicina matriculados em “anos clínicos”. Os participantes tinham mais frequentemente menos de 25 anos e eram maioritariamente do sexo feminino. Os estudantes de medicina estavam mais frequentemente matriculados no sexto ano do mestrado integrado, enquanto os profissionais de saúde eram principalmente médicos e enfermeiros.

A quantificação do interesse em tecnologia mostrou-se equilibrada no que diz respeito às respostas positivas e negativas, apesar de cerca de 50% dos participantes reconhecer como limitado o seu conhecimento acerca das aplicações da IA na saúde.

Apesar de a vasta maioria dos participantes considerar que a integração de IA na saúde é positiva, apenas um terço sente que a sua instituição está preparada para adotar mais tecnologias desta natureza. Menos de 15% está satisfeito com as ferramentas de IA existentes no local de trabalho e apenas cerca de 10% se sente apoiado para as utilizar.

O custo das tecnologias (75%), a burocracia associada aos cuidados de saúde (70%) e a falta de formação (60%) foram identificados como os principais desafios à implementação de IA. Por outro lado, as preocupações em torno desta temática dizem principalmente respeito a problemas de responsabilização (66%), iniquidade (54%) e receio de ser influenciado a tomar decisões erradas (51%).

A formação dos profissionais (85%) e a articulação com outros atores (62%) foram identificados como aspetos essenciais no sentido de acelerar o desenvolvimento de soluções adequadas, sendo que estas devem ter como principal foco a eficiência e só posteriormente a melhoria das habilidades clínicas dos trabalhadores.

Conclusões: A utilização de IA na saúde encontra-se ainda numa fase inicial. Apesar de mostrarem interesse na sua integração, os profissionais reconhecem que o apoio e as soluções existentes no local de trabalho estão ainda longe do ideal. Na verdade, parece não existir ainda uma “cultura digital” vincada nas suas instituições de saúde.

A complexidade deste tema está espelhada nos diversos desafios e múltiplas preocupações ainda sem resposta clara, como aspetos de responsabilização, segurança e financiamento, que demonstram que, pelo menos no caso português, parece não existir ainda um caminho exato a seguir.

Por outro lado, fica claro que as ferramentas de IA desenvolvidas devem priorizar a eficiência global.

Ao mesmo tempo, parece lógico começar por automatizar tarefas simples e repetitivas, como é o caso das excessivas atividades administrativas que consomem uma porção considerável do tempo dos profissionais, impedindo-os de se focar em tarefas mais relevantes e na exploração de novas tecnologias.

Para além de otimizar o funcionamento laboral, esta automatização fomentaria sentimentos de confiança e utilidade, com repercussão positiva nas atitudes e adoção subsequente de ferramentas de IA mais complexas.

Finalmente, a educação e empenho de todos os atores nesta transição digital, particularmente de estudantes de medicina enquanto futuros prestadores de cuidados, parecem ser fundamentais para uma adoção consciente de IA no sentido de maximizar as suas capacidades.

Palavras-chave

Inteligência Artificial;Transição digital;Saúde digital;eSkills;Profissionais de saúde

Abstract

Background: When healthcare systems worldwide face unprecedented pressure the growth of information technology use and in particular artificial intelligence (AI) embedded tools promise to improve health and care.

However, health professionals remain quite reticent about adopting AI technologies. Such attitude bears the potential to damper its successful implementation since they play a central role in this digital transition.

Aims: This investigation aims to explore the perspectives and expectations of health professionals and medical students on the adoption of AI in healthcare while understanding their vision on the main challenges, concerns and opportunities that accompany this process.

Materials and methods: Base on technology acceptance models and literature review an online survey was designed and applied. It was composed of eight multiple choice questions and seven questions using a seven-point Likert scale, evaluating interest, knowledge, satisfaction and opinions on AI's application.

A link to the online survey was sent via email to health professionals and medical students through mailing lists of medical faculties and health associations, intending to collect as many answers as possible. Data was analyzed using IBM SPSS (version 25).

Results: The results provide descriptive analysis covering answers from 119 health professionals and 154 medical students undergoing clinical rotations.

Even though the vast majority of respondents agrees it makes sense to integrate AI in health, only one third of them feels their institution is prepared to adopt more AI-based technologies. Less than 15% are satisfied with the current AI applications in the workplace and only about 10% feel supported to use them.

The top challenges to AI implementation were considered to be technology costs (75%), healthcare-associated bureaucracy (70%) and lack of training (60%). The main concerns associated with liability issues (66%), increased healthcare inequity (54%) and fear of making bad decisions following AI-based recommendations (51%).

The main focus of AI-based tools should aim at making processes more efficient (90%), with staff training (85%) and articulation with other stakeholders (62%) being identified as key aspects to faster developing adequate solutions.

Conclusions: AI use in healthcare is still in its begging, with respondents recognizing lack of support and alternatives despite showing interest. There are important challenges that need to be addressed and concerns that need clarification, mirroring the complexity of this matter. Nonetheless, it seems clear that future AI technologies should prioritize overall efficiency thereby tackling health systems' increasing demand.

It seems a wise adoption of AI depends on right attitude and education of all stakeholders, particularly medical students as future care providers, in order to leverage its capabilities.

Keywords

Artificial Intelligence; Digital transition; Digital health; eSkills; Healthcare professionals

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List of Acronyms

| | |
|-------|--|
| AI | Artificial Intelligence |
| IA | Inteligência Artificial |
| CPME | Comité Permanent des Médecins Européens (Standing Committee of European Doctors) |
| EC | European Commission |
| TAM | Technology Acceptance Model |
| UTAUT | Unified Theory of Acceptance and Use of Technology |

Chapter 1

Introduction

AI is “transforming our world, our society and our industry” (1). The overwhelming growth of digital technologies has granted new and faster ways to perform a multitude of tasks (2).

That has been notably true in health, where the increased demand for better and more cost-efficient care has paved way for the development of a variety of AI-based tools, with several different purposes, that have confirmed their anticipated potential to improve outcomes (3). It has become clear that AI can effectively help face many of those difficulties (4).

Nevertheless, its successful implementation depends in great part on health professionals’ knowledge and attitude towards AI, being that they will be daily users of these tools. Their conscious involvement is paramount (5).

Plus, many health professionals may not yet be knowledgeable enough or have the intended positive attitudes towards these technological tools. In that sense, their views on this subject should also be taken into consideration.

Creating a well-informed and trustworthy environment where they feel AI-tools are useful and safe will determine crucial aspects for a positive deployment, such as “ease of implementation”, “acceptance” and “intention to use” (6)(7).

1. Background

1.1. Historical development of new tools

The essence of the human species has been tailored by the discovery of new realities and the development of innovative tools since the beginning of its existence, allowing a constant adaptation through the development of new skills.

Throughout the centuries, this commitment resulted on countless breakthroughs and in time technology and, particularly, the digital universe, became the epicenter of contemporary advances (8).

With that, the growing interest and gradual understanding of the possibilities and areas of investment around this theme, in a time when access to information and knowledge is at your fingertips, have made digital technologies gain unprecedented attention and develop at an absolutely breathtaking pace (9)(10).

Efforts in this direction have reached such magnitude in our lives that many believe we are on the verge of a “Fourth Industrial Revolution” (11).

1.2. The rise of Artificial Intelligence

Over the last few decades, one of the central points of this digital (r)evolution has been AI, commonly considered “one of the most strategic technologies of the 21st century” (1).

Noting remarkable progress in the various industries, it has affirmed in several ways as one of the symbols of the most complex, capable, and diversified alternatives that technological growth has provided us, registering multiple reports of success despite its youth.

Although a consensual definition does not yet prevail, the European Commission clarifies AI “*refers to systems that display intelligent behavior by analyzing their environment and taking actions – with some degree of autonomy – to achieve specific goals*”. And adds that “*AI-based systems can be purely software-based, acting in the virtual world (e.g. voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g. advanced robots, autonomous cars, drones or Internet of Things applications)*” (1)(12).

Having come a long way since Allan Turing first introduced us to the Turing test, AI disseminated profusely (13)(6). Making use of a broad range of digital technologies from Machine Learning and its branches to Natural Language Processing, AI is able to store information, learn from it, and adapt to the changing environment in which it operates in order to make suggestions and accurate predictions (12), aiming - from a generalist and unfairly reducing view - the optimization of problem solving and overall improvement of outcomes (14).

1.3. (Opportunities for) AI in healthcare

With its rapid development, AI acquired natural relevance in healthcare, seeking to tackle growing challenges in this sector that’s been registering increased expenditure and intensification of professionals’ workload and burnout levels, given the amplified complexity of patients, who live longer and frequently present with multiple chronic

comorbidities (15)(4).

This adds to excessively bureaucratized tasks and constant demand for elevating standards of care that also contribute to the increasing pressure healthcare systems are feeling (16).

Indeed, AI's potential was promptly identified as a versatile tool for delivering better, faster and more cost-efficient care while improving patient access and experience (17), with a wide range of strategies being outlined in order to leverage its capabilities in a way that is safe and well structured (18)(1).

In fact, the application of AI in health has grown exponentially with innovative applications all across the board, ranging from scientific research, monitoring of chronic pathologies such as diabetes, assistance in clinical decision making regarding diagnosis, prognosis and treatment, to rehabilitation, surgery and care delivery through its association with robotics (4)(19).

Plus, AI's applications concerning bureaucratic overload also start to play an important part in reforming healthcare systems (3).

These reflect some of the benefits that are expected to be brought by AI on a bigger scale with regard to analyzing health trends in populations, planning personalized treatments, improving patient experience, increasing productivity, and providing equitable and cost-effective care (2).

AI has therefore been one of the flags of "Digital Health", defined by the World Health Organization as one of the priorities in health, capable of augmenting human tasks, skills and responsibilities (18).

However, as we record these successful progresses, we must also be aware of the new obstacles and challenges that arise and may threaten a smooth and safe digital transition (20).

In fact, the relationship between the opportunities and risks is often quite difficult to balance - and the challenge increases as more tasks start to rely on AI - and even if over the past few years several European Commission policies and regulations have been developed to support the digitalization of healthcare systems, there are still many doubts around aspects such as liability, regulation of use, safety of users and their personal data and the capacity and willingness of health professionals and users to deal with this type of technology, which must be analyzed and tackled in order to ensure a necessary environment of trust and strength (17)(21)(22).

1.4. The central role of health professionals

Furthermore, the balance between possibilities and threats must not be superficial and cannot make us forget that this digital transformation is not simply about technological achievements. It is about reshaping healthcare systems so that by adopting AI we can empower health professionals, patients, and the whole healthcare community (14).

Moreover, it is crucial to understand that the use of AI in health will be accompanied by a remodeling of the way we provide care, leading to fundamental changes in how professionals work and act and, ultimately, creation of new roles than combine medical capabilities and data-science expertise (3).

That means that the perception that this gradual burst of AI may give rise to virtually unlimited health applications cannot wipe out the fact that the workforce has a fundamental role in the success of its implementation.

Having said that, reports on this matter reveal that despite the successes that have accompanied the evolution of AI technologies in health (3) and population's positive feedback - translating some of their confidence (24) - health professionals, who even recognize AI as being advantageous, have shown some reluctance and unease in its application (25)(26).

This turns out to be vital for the integration of AI in healthcare and may be one of the reasons why the health sector is trailing other industries in adopting AI-based technologies (26).

Actually, we may be approaching a point where, having certified that AI can successfully improve care delivery at various levels, the main obstacle to its application becomes the receptiveness, confidence and adaptability of healthcare professionals, administrations and the general population towards technology (23).

This becomes one of the key questions around AI because, although a joint effort is needed for health to accompany other industries in this automation, health professionals play a leading role in this transformation (5), as users and perhaps main beneficiaries of the capabilities provided by AI. In addition to making use of its information for their daily practice, the workforce will also be responsible for the diffusion of knowledge and education of the population and peers throughout the transition process (3)(4).

1.5. Making their voice heard

Considering thus health professionals as essential actors in the establishment of AI in

health, their opinion, point of view, experience and fears, must be actively and permanently considered by decision makers not only in the process of technology development, but also while defining global strategies and concrete measures that help implementation in a quick but appropriate way (5)(22). That's something that has been lacking throughout.

Only then will we be able to envision a well-structured technological transition, guided by a common effort to improve health and care, amplify the potential of AI and harness the best of what it has to offer through synchronized networking and harmony between all stakeholders in analyzing opportunities, identify gaps and create a global environment of trust. This, so that AI is integrated firmly, but almost invisibly in a perfect symbiosis between humans and technology.

1.6. Technology Acceptance

The arrival of new technologies was accompanied by the development of technology acceptance models that look to assess their influence and helpfulness. That way we are able to understand if a given technological instrument adequately fits users' needs and expectations in order to actually be adopted (6).

In this regard, two of the most prominent technology acceptance models are TAM and UTAUT.

TAM focuses on “perceived ease of use” and “perceived usefulness” - influenced by a subjective norm - to analyze attitude and ultimately behavioral intention in adopting a technological tool (Figure 1).

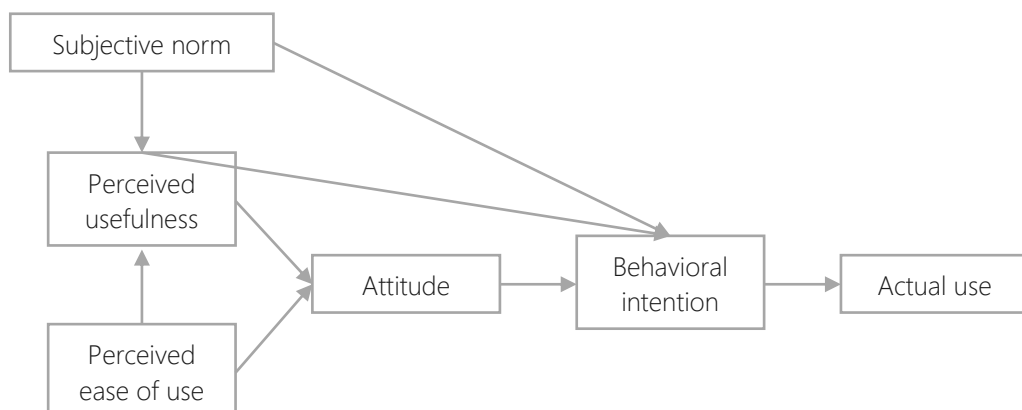


Figure 1 - Technology Acceptance Model scheme (adapted from: Schepers J, Wetzels M. 2007¹)

¹ Schepers, J, Wetzels, M. A meta-analysis of the technology acceptance model: Investigating subjective norm and moderation effects. *Information and Management*. 2007;44(1),90–103. doi: 10.1016/j.im.2006.10.007

The UTAUT model originated from the compilation of the best features of eight different technology acceptance models, including TAM, and can be divided into four different categories impacting technology use:

1. Performance expectancy, “the degree to which an individual believes that using the system will help him or her to attain gains in job performance”²;
2. Effort expectancy, “the degree of ease associated with the use of the system”²;
3. Social influence, “the degree to which an individual perceives that important others believe he or she should use the new system”²;
4. Facilitating conditions, “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system”².

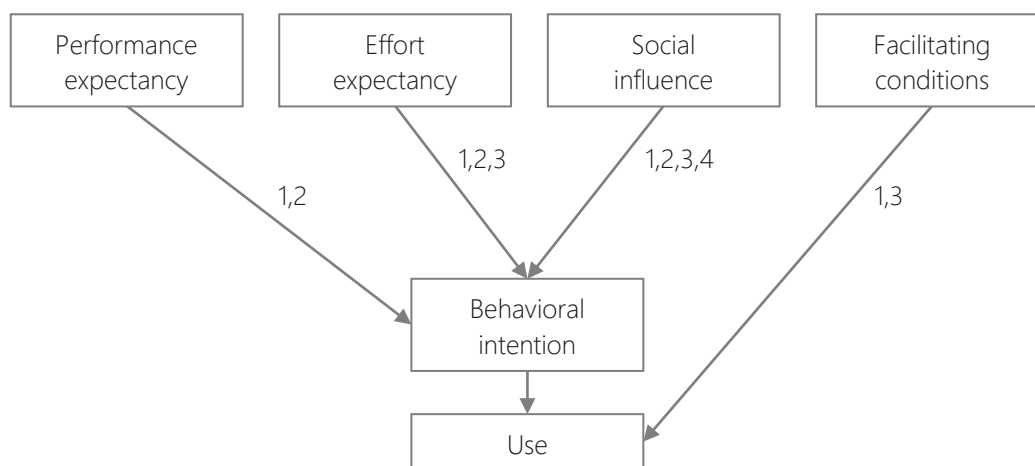


Figure 2 - UTAUT scheme (adapted from: Venkatesh V, Morris MG, Davis GB, Davis FD. 2003²)

Label: 1 – age; 2 – gender; 3- experience; 4 – voluntariness

This model was later reviewed, adding “hedonic motivation”, “price value” and “experience and habit” as important predictors of technology usage (5).

Proving their validity, these technology acceptance models have become essential for companies and other decision makers to explore what can be done to guarantee a smooth and confident digital transition.

² Venkatesh V, Morris MG, Davis GB, Davis FD. User Acceptance of Information Technology: Toward a Unified View. *Inorganic Chemistry Communications*. 2003;27(3),425–478. doi: 10.1016/j.inoche.2016.03.015

2. Objectives

This dissertation aims to explore the perspectives and expectations of portuguese health professionals and medical students, as future providers of care, regarding the use of AI in health.

With that, we expect to understand, among other things, if they consider their institutions are prepared for this transition, what kind of tasks they would like to see automated and what are the main challenges (internal and external) to the use of AI.

We intend to go beyond the simple assessment of AI acceptance, already documented in several scientific studies, and try to clarify what steps need to be taken in order to meet the real needs of the main users of this technology and achieve a more effective adoption. With this, AI developers may be able to grasp what AI-based products should be conceived so that its adoption is maximized.

In addition, we are looking to identify proposals and scenarios for the use of AI in health, as well as explore the relationship between perspectives and expectations regarding this emerging technology and the awareness of professionals and users.

Chapter 2

Materials and methods

1.1. Survey design

An online survey (Appendix 3) was developed and applied using the Google Forms platform after reviewing literature on the adoption and implementation of AI and exploring technology acceptance models such as TAM and UTAUT.

1.2. Survey structure

The survey was composed of an initial sociodemographic section, which made up the only difference between surveys addressed to health professionals and medical students, followed by seven seven-point Likert-scale-based questions and eight multiple-choice questions. The number of answers allowed in each multiple-choice question varied depending on the number of answer options.

1.3. Analyzed aspects

Four blocks can be considered in the survey, each looking to assess different aspects: (1) sociodemographic parameters, involving age group, sex, profession/faculty clinical year and workplace; (2) interest and knowledge around AI; (3) satisfaction, support and readiness regarding AI use in the workplace; (4) perceived challenges, benefits, concerns and priorities concerning its deployment.

We also asked physicians to indicate their medical specialty and requested medical students to consider their “workplace” as the health institution where they usually undergo their clinical rotations.

1.4. Survey distribution

The target populations for this study were active licensed health professionals (namely: nurses, pharmacists, physical therapists, physicians, dentists, nutritionists, psychologists and hospital administrators) and medical students undergoing clinical rotations – which in Portugal occurs during the fourth, fifth and sixth years.

We contacted the corresponding national representative associations of each group, via e-mail, describing the investigation, its goals and asking them to share a link to the online survey through their mailing lists. We obtained positive feedback in the majority of the cases.

Considering the nature of the study and health system overload due to the COVID-19 pandemic, it was expected the survey had a limited reach. So, we defined a minimum answer goal of 150 medical students and 100 health professionals. Nonetheless, all collected answers were taken into account on the final results.

1.5. Survey approval

The proposed investigation - including the online survey - was approved by the Ethics Committee of the University of Beira Interior beforehand. Before confirming their consent to participate in the study, information was provided to the respondents on its scientific purposes and associated ethical constraints.

To assure an easier and better understanding of its introduction and all subsequent questions, the survey was translated to portuguese prior to approval.

1.6. Statistical analysis

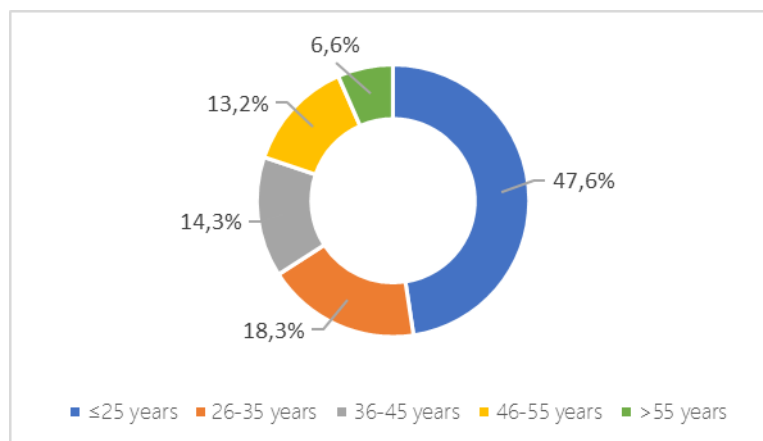
The online survey was opened for answering for roughly 10 weeks. Next, the collected data was downloaded and transposed to the Statistical Package for the Social Sciences (SPSS), version 25, for statistical analysis. Descriptive statistic was used, which included relative (%) and absolute (n) frequency for categorical variables.

Chapter 3

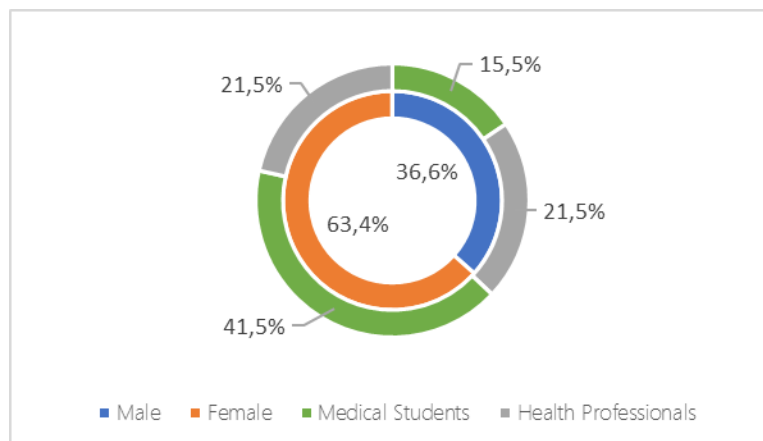
Results

1.1. Demographic characterization of the sample

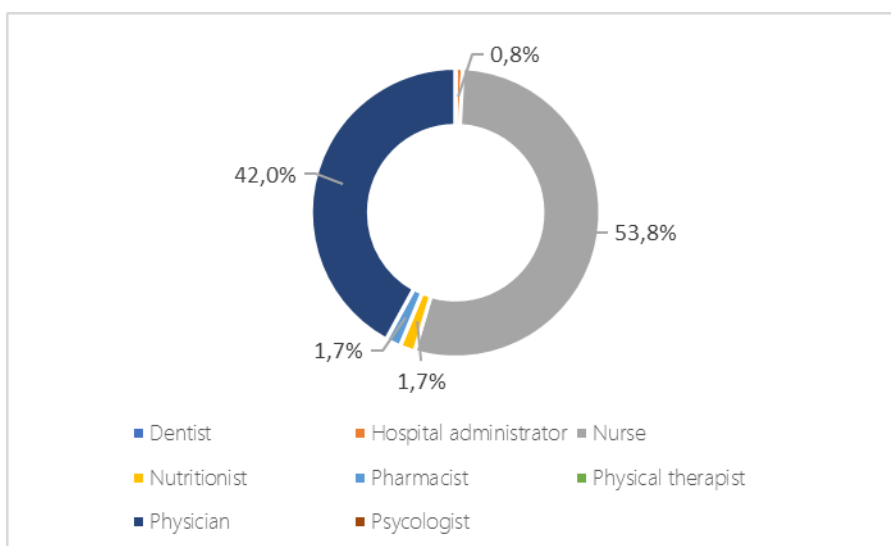
Our sample included a total of 273 participants, 154 (56.4%) medical students and 119 (43.6%) healthcare professionals. Medical students were mainly younger than 25 years old (83.8%), while healthcare professionals were more frequently 46 to 55 years old (30.3%). 173 (63,4%) participants were female and 100 (36,6%) were male. Both groups had a female gender predominance. Students underwent the fourth (22.7%), fifth (32.5%) or sixth (44.8%) year of the medical course. Nurses (53,8%) and physicians (42,0%) dominated the responses on the healthcare professionals' side. More detailed demographic characteristics of the sample are shown in Graphs 1, 2 and 3.



Graph 1 - Age distribution of the sample



Graph 2 - Gender distribution of each group

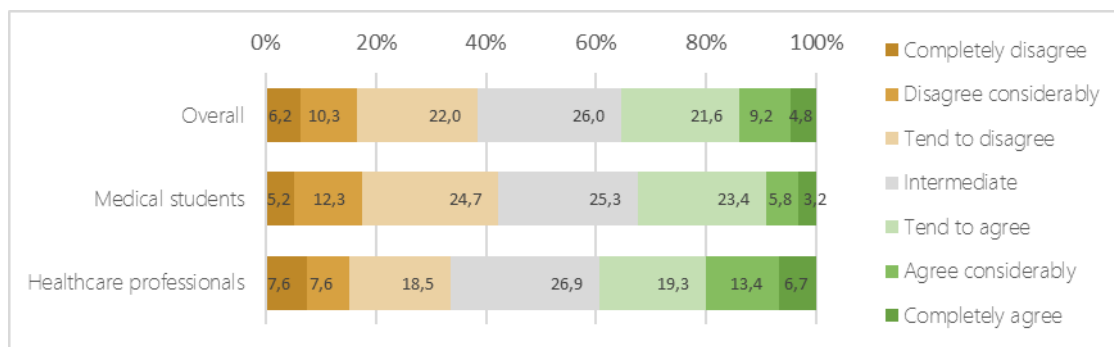


Graph 3 – Health professionals' career distribution

1.2. Interest and knowledge around AI

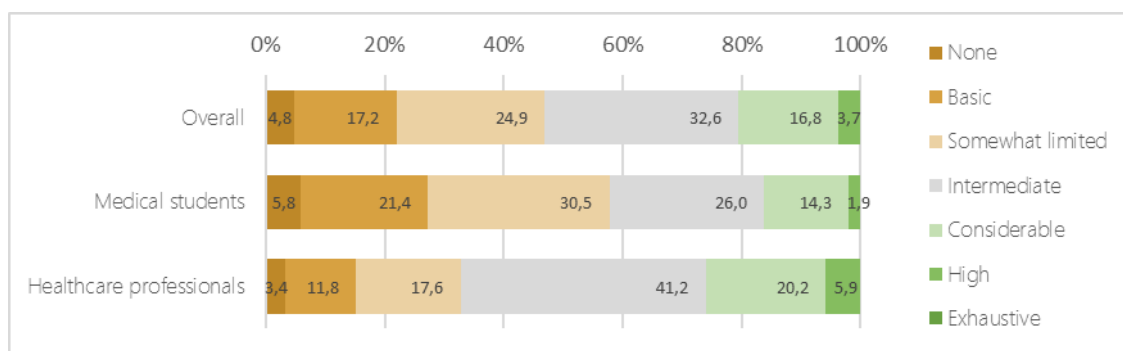
To evaluate the level of interest and knowledge revolving AI, the respondents were asked to rate their level of agreement with three questions using a 7-point Likert scale.

High and very high interest in AI was found in 42.0% and 33.6%, respectively, of healthcare professionals, opposing to 29.2% and 18.2% of medical students. Medical students admitted having considerable interest in AI in 35.7% of the cases, in contrast to 15.1% of the healthcare professionals (Graph 4).



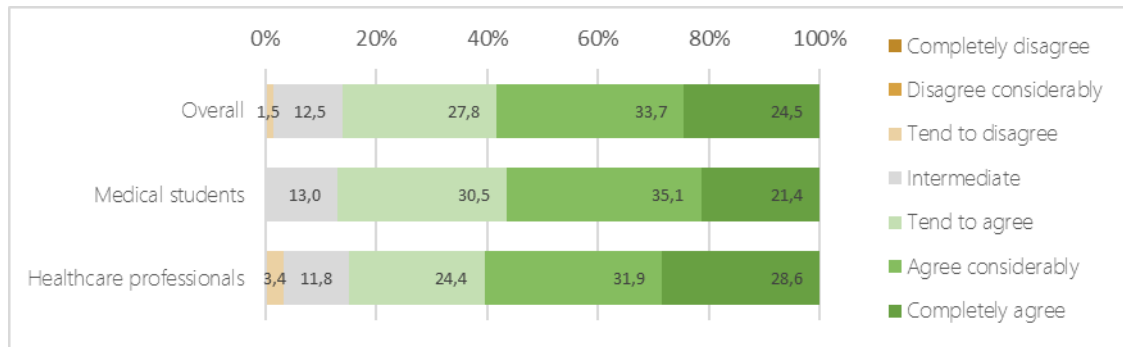
Graph 4 - Answer distribution to Q1: Do you see yourself as a digital driven person?

The degree of perceived knowledge concerning AI was also superior in healthcare professionals, as more than half of the latter considered they had an intermediate or higher level of knowledge on AI. 30.5% of students reported limited knowledge on AI (Graph 5).



Graph 5 - Answer distribution to Q3: How do you classify your knowledge about AI?

The view concerning the integration of AI in healthcare was overwhelmingly positive and similar in both groups, with 21.4% of students and 28.6% of workers showing a complete agreement (Graph 6).

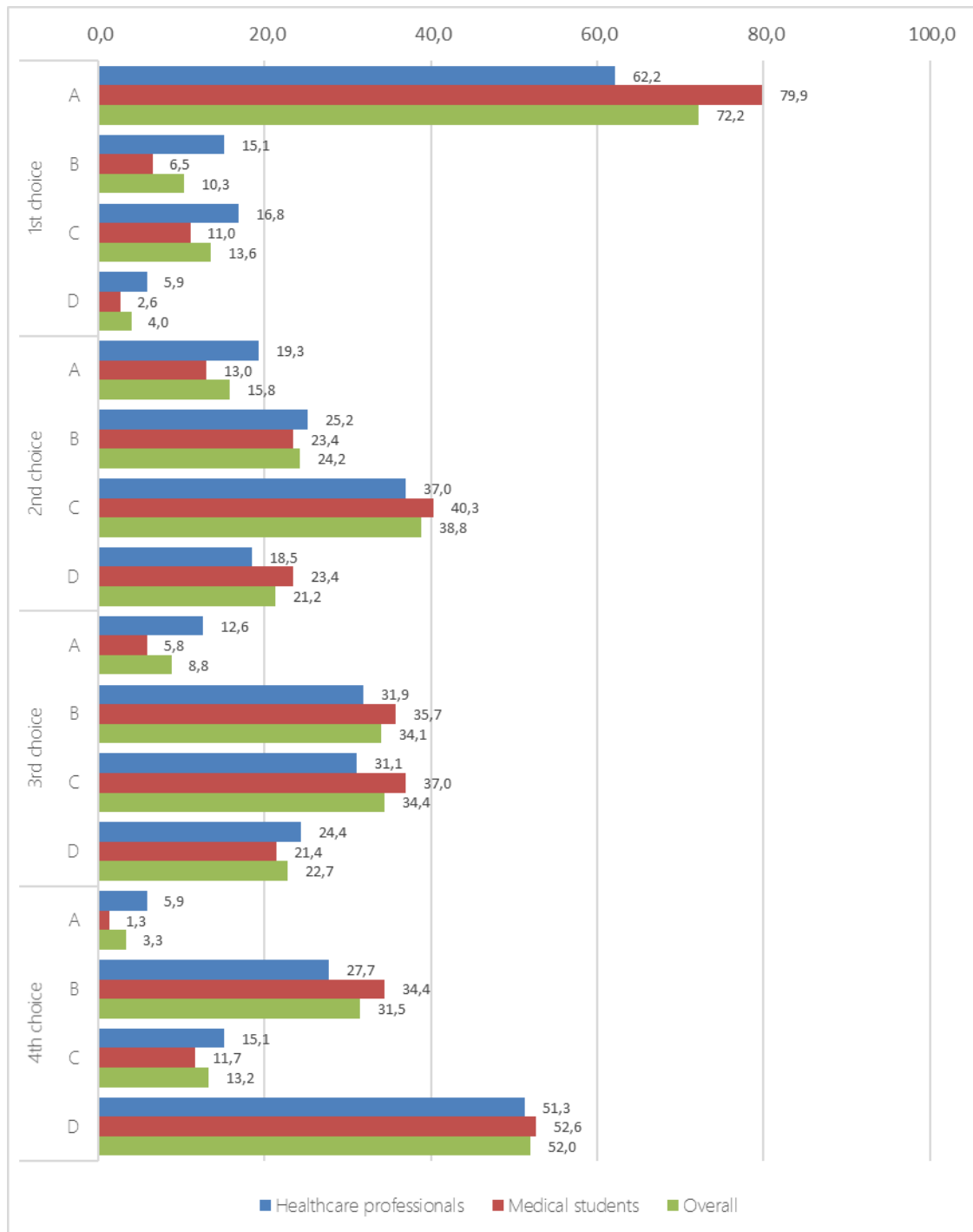


Graph 6 - Answer distribution to Q4: Do you believe it makes natural sense for AI to be integrated in healthcare?

To assess the participant’s basic understanding of AI technology, they were asked to arrange provided statements that best fitted their definition of AI (Graph 7). The first and most common choice between healthcare students (79.9%) and professionals (62.2%) was option A (“A multitude of technologies that extend human capabilities by interpreting, comprehending, judging and learning, aiding users carry demanding tasks.”).

Option C (“The ability of systems and machines to exhibit human-like intelligence and use it to replicate human behavior to a limited extent.”) was also consistently chosen as the second-best definition of AI.

The last choice also exhibited some level of agreement between groups, as “Machines with embedded information on how to conduct a specific task, having limited capability to adapt and learn.” was considered to be the worst fit into the definition of AI for both medical students (52.6%) and healthcare professionals (51.3%).

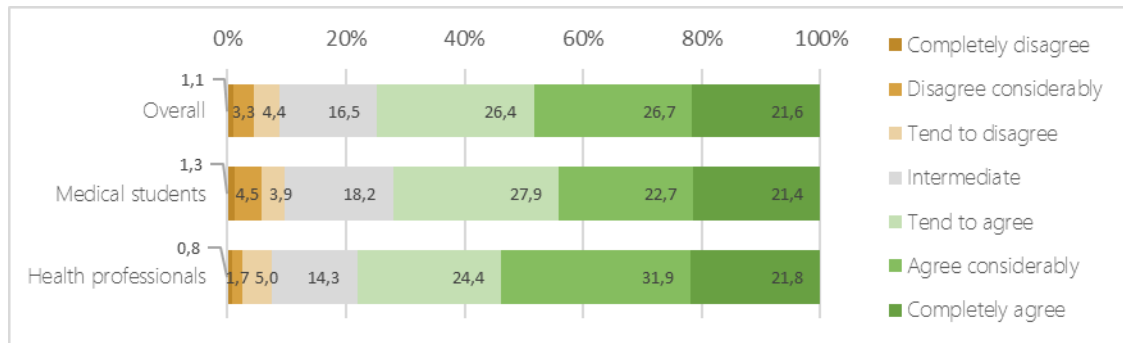


Graph 7 - Answer distribution to Q2: Rank the following definitions according to how you think they best fit the definition of AI.

Label: A: A multitude of technologies that extend human capabilities by interpreting, comprehending, judging and learning, aiding users carry demanding tasks. B: A diverse collection of systems that display intelligent behavior and aim to substitute users by doing things freely and autonomously. C: The ability of systems and machines to exhibit human-like intelligence and use it to replicate human behavior to a limited extent. D: Machines with embedded information on how to conduct a specific task, having limited capability to adapt and learn.

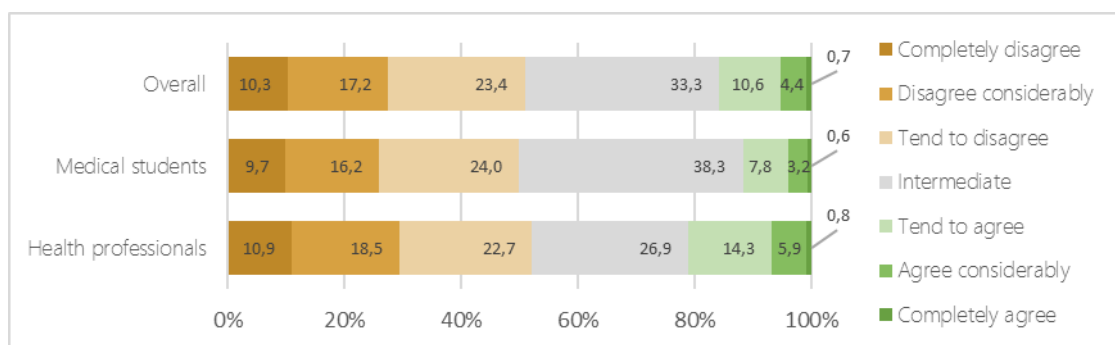
1.3. AI in the workplace: satisfaction, support and readiness

The impact of the COVID-19 pandemic on the view over AI was more noticeable in the healthcare professionals' group, as 31.9% considerably agreed that the current situation displays a unique opportunity for the implementation of AI, comparing to only 22.7% of the medical students (Graph 8).

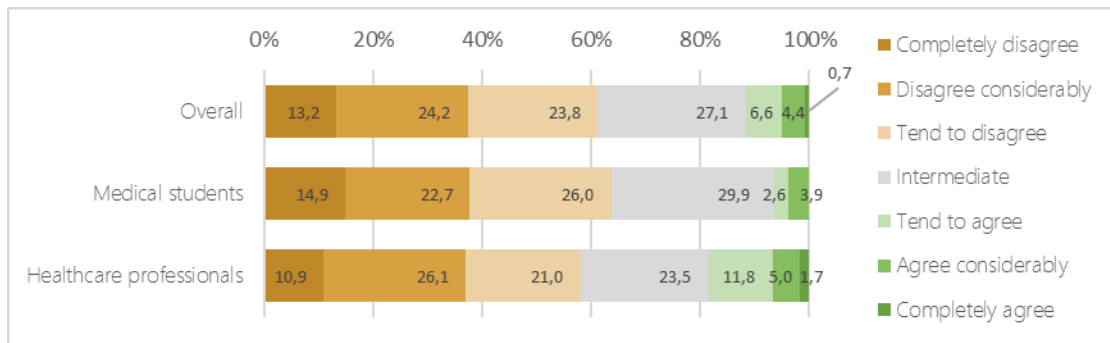


Graph 8 - Answer distribution to Q5: Does the COVID-19 pandemic present as a unique opportunity for us to leverage AI-based technologies?

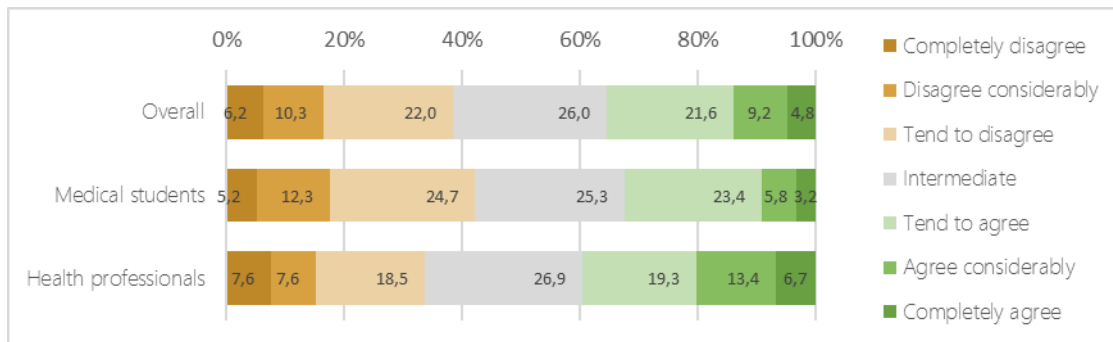
The satisfaction with the implementation of AI in health-related workplaces (Graph 9) and the support provided by institutions (Graph 10) was found to be comparable between groups, although healthcare workers believed organizations were ready to adopt AI technologies more often than medical students did (Graph 11). 42.2% of medical students felt negatively about their workplaces' readiness in adopting AI-based technologies, while only 33.7% of the healthcare professionals had the same opinion.



Graph 9 - Answer distribution to Q6: Are you satisfied with the current applications of AI in your health institution?



Graph 10 - Answer distribution to Q7: Do you feel supported by your institution to use AI in your daily practice?

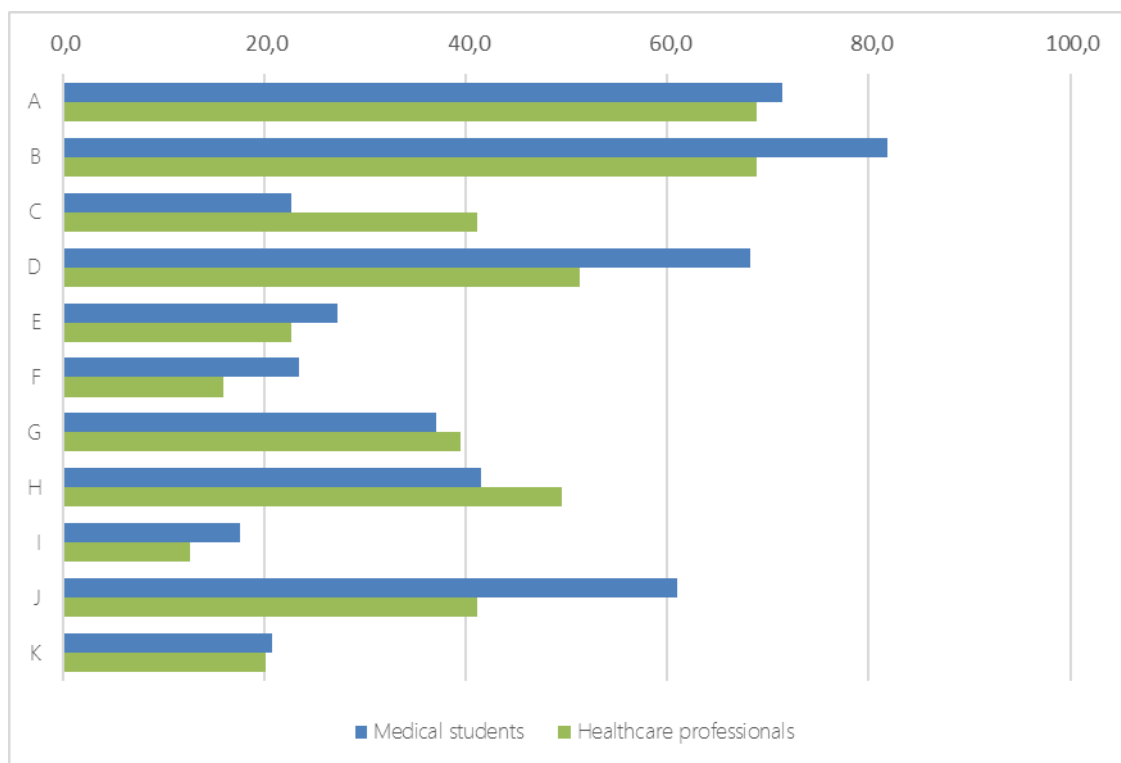


Graph 11 - Answer distribution to Q8: Do you feel your institution is prepared to start adopting more AI-based technologies?

1.4. Perceived challenges and barriers

The cost of technology, bureaucracy in healthcare and the lack of staff training to adequately use technology were the main 3 challenges pointed out by both medical students and healthcare professionals behind the implementation of AI (Graph 12). Healthcare workers felt that the difficulty in finding the right technologies (41.2%) was more often an obstacle than students (22.7%), while understanding of the medicolegal, regulatory and licensing aspects of AI was more important for students (61.0%) and not as imperative for workers (41.2%).

Convincing the population of the benefits of technologies and an adequate professional compensation for using them were considered to be the least valuable of the listed potential barriers.

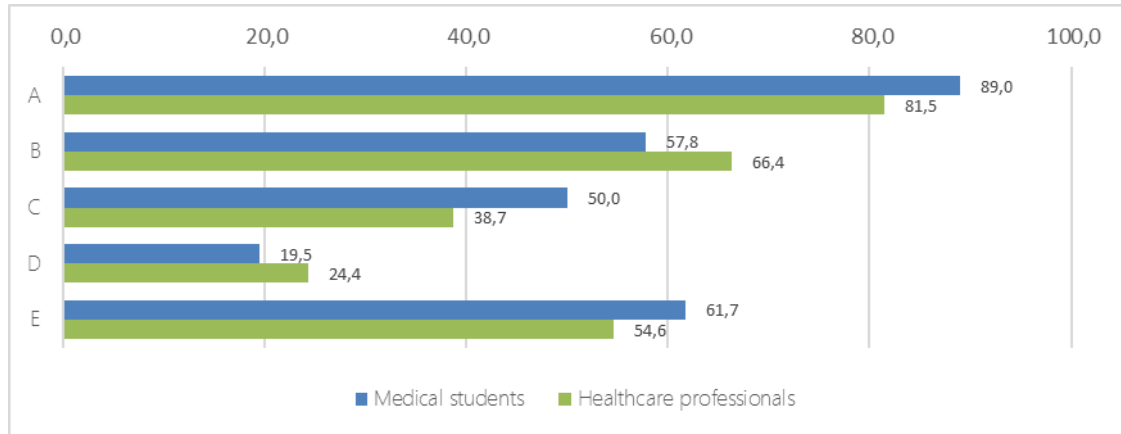


Graph 12 – Answer distribution to Q9: What do you feel are the top challenges your institution in facing to implement AI-based technologies?

Label: A: Bureaucracy in healthcare (that delays staff from focusing on AI alternatives). B: Cost of technology. C: Finding the right technologies. D: Lack of staff training to adequately use technology. E: Complexity of technology. F: Lack of demand from the patients/general population. G: Convincing staff of the benefits of technologies/Staff motivation and willingness. H: Staff motivation and willingness. I: Convincing the population of the benefits of technologies. J: Understanding medicolegal, regulatory and licensing aspects of AI. K: Adequate reimbursement or compensation for using the technologies.

1.5. Perceived facilitating conditions

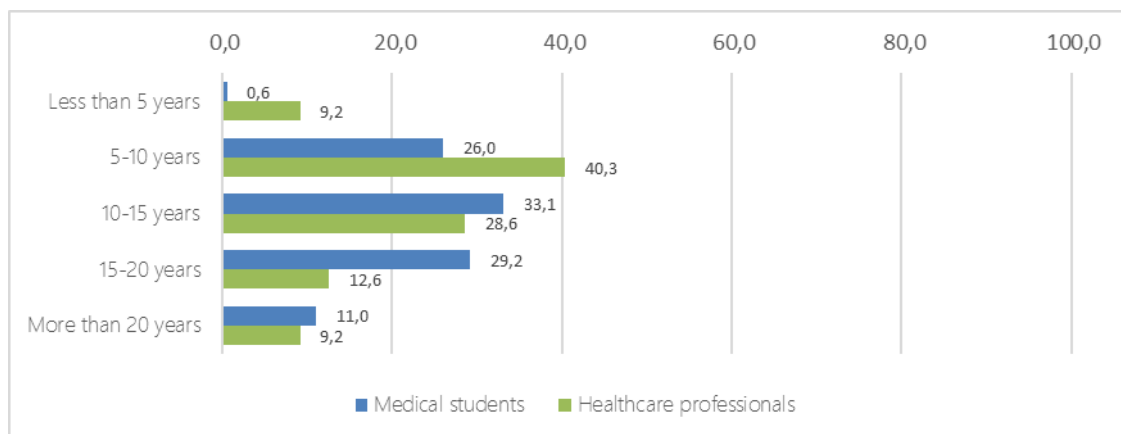
Staff training was perceived as the most crucial aspect to boost AI deployment by both groups, while the collaboration between the population and industry stakeholders was regarded as the least important (Graph 13).



Graph 13 – Answer distribution to Q15: Of the following aspects, which do you think will be crucial to accelerate the deployment of AI technologies?

Label: A: Staff training on AI technologies. B: Staff working with other industry stakeholders on developing the most adequate AI technologies. C: Raising population awareness and knowledge revolving AI technologies. D: Population working with other industry stakeholders on developing the most adequate AI technologies. E: Reforming healthcare financing.

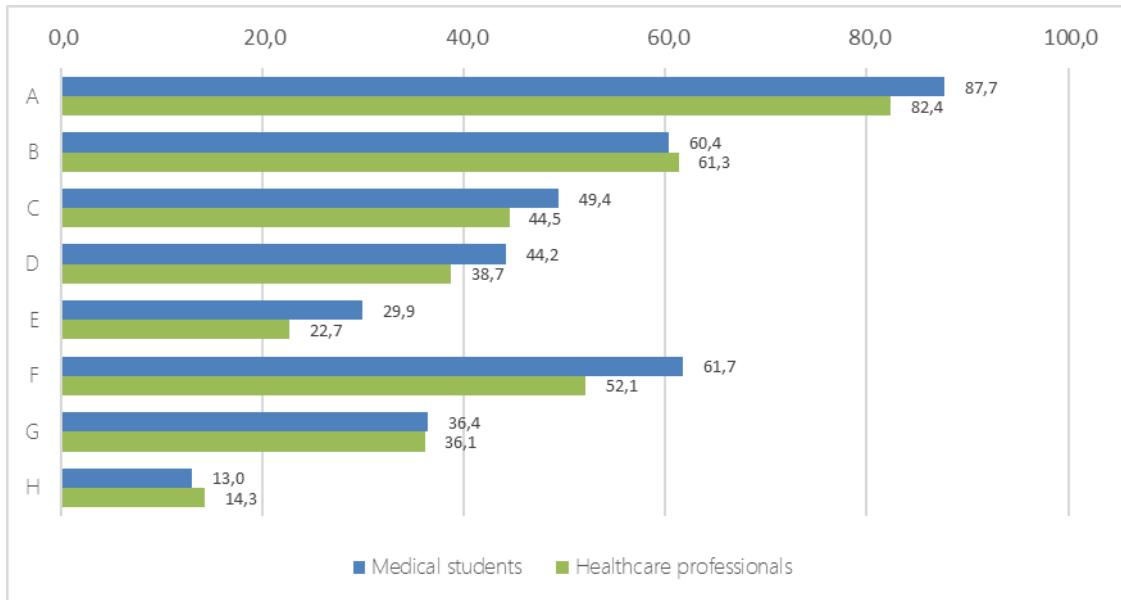
Medical students believed that the implementation of AI technologies in their workplace will occur later than healthcare professionals did (Graph 14). 26.0% of students thought that this transition will occur in the next 5 to 10 years, while almost double (40.3%) of the workers believed it will take the same time. Only 0.6% of students said the integration would be complete within the next 5 years, whereas for workers this percentage was notably higher (9.2%). Nevertheless, the vast majority of respondents expected it will take less than 15 years for their institutions to fully integrate AI.



Graph 14 – Answer distribution to Q14: How long do you think it will take for your organization to fully integrate AI technologies?

1.6. Perceived priorities

The gain in efficiency was seen as the top priority for both students (87.7%) and health professionals (82.4%) when considering the adoption of AI (Graph 15). Improving clinical ability and enhancing interoperability came second and third overall, respectively.

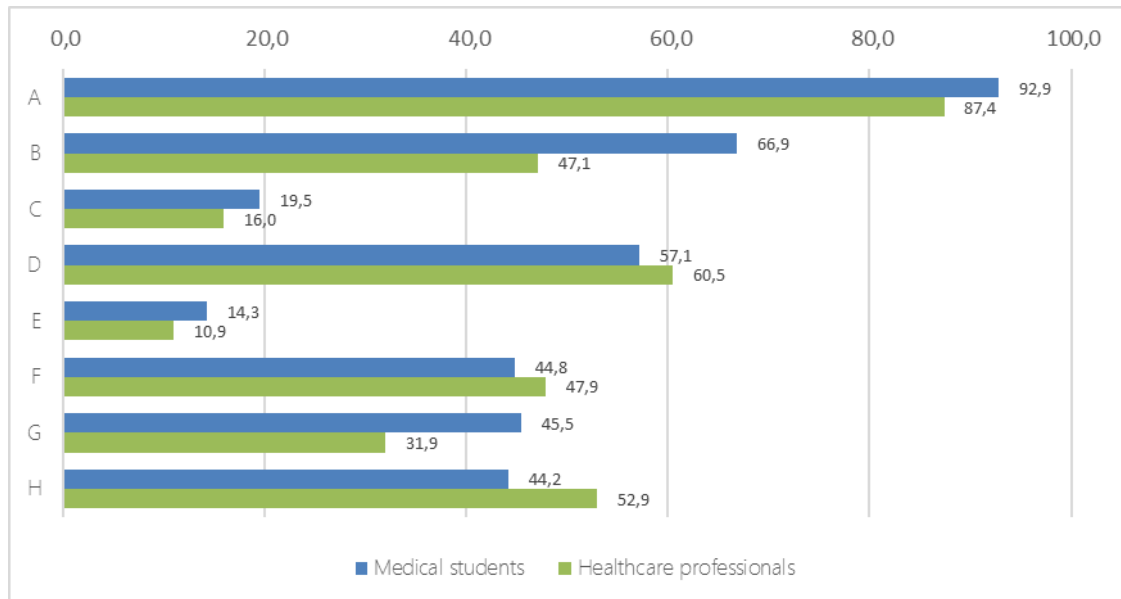


Graph 15 – Answer distribution to Q11: Which of the following aspects should your institution prioritize when acquiring AI-based tools?

Label: A: Making the processes more efficient. B: Improving decision making (clinical ability). C: Making employees more productive. D: Lowering costs. E: Enhancing relationships with patients. F: Enhancing interoperability. G: Discovering new insights through research and data mining. H: Enabling new services and business models.

1.7. Perceived usefulness

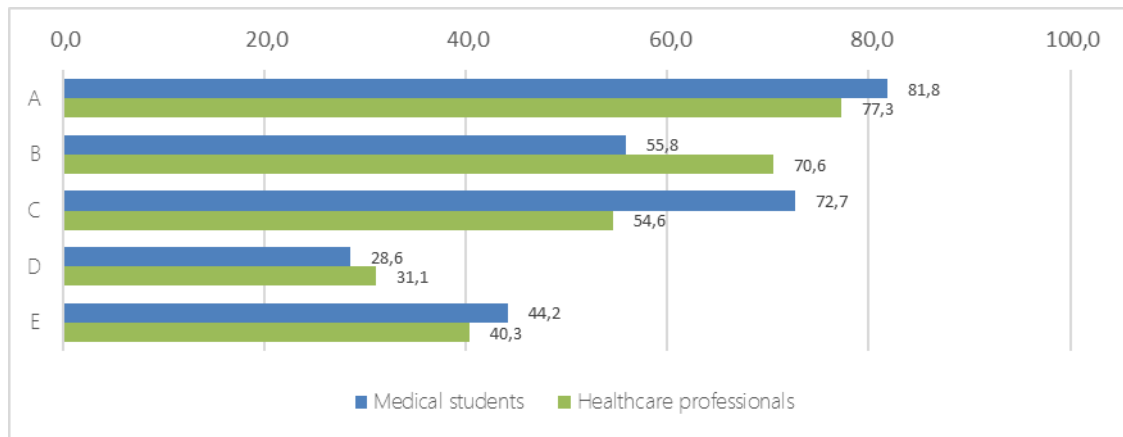
The ability to save time and resources was identified by both groups as the main benefit of AI automation, accounting for 92.9% of students and 87.4% of workers’ choices (Graph 16). Moreover, 66.9% of medical students felt that the workload reduction was the second most important benefit, while 60.5% of the workers valued the clinical accuracy in prediction, diagnosis and treatment plans. Patient experience and engagement was consistently considered the least important benefit deriving from AI automation.



Graph 16 – Answer distribution to Q10: Which aspects could benefit most from AI automation?

Label: A: Saving time and resources (efficiency), which includes administrative work. B: Workload reduction. C: Staff and physician job satisfaction. D: Clinical accuracy in prediction, diagnosis and treatment plans. E: Patient experience and engagement. F: Prevention, including health coaching for patients and risk stratification. G: Driving research. H: Healthcare cost reduction.

While both students (81.8%) and workers (77.3%) agreed that care delivery was the area that could benefit most from AI-based technologies, medical students showed to value more the triage and diagnosis abilities (72.7%) and workers the clinical decision support (70.6%) as the second greater impact areas that could improve by the use of AI (Graph 17).

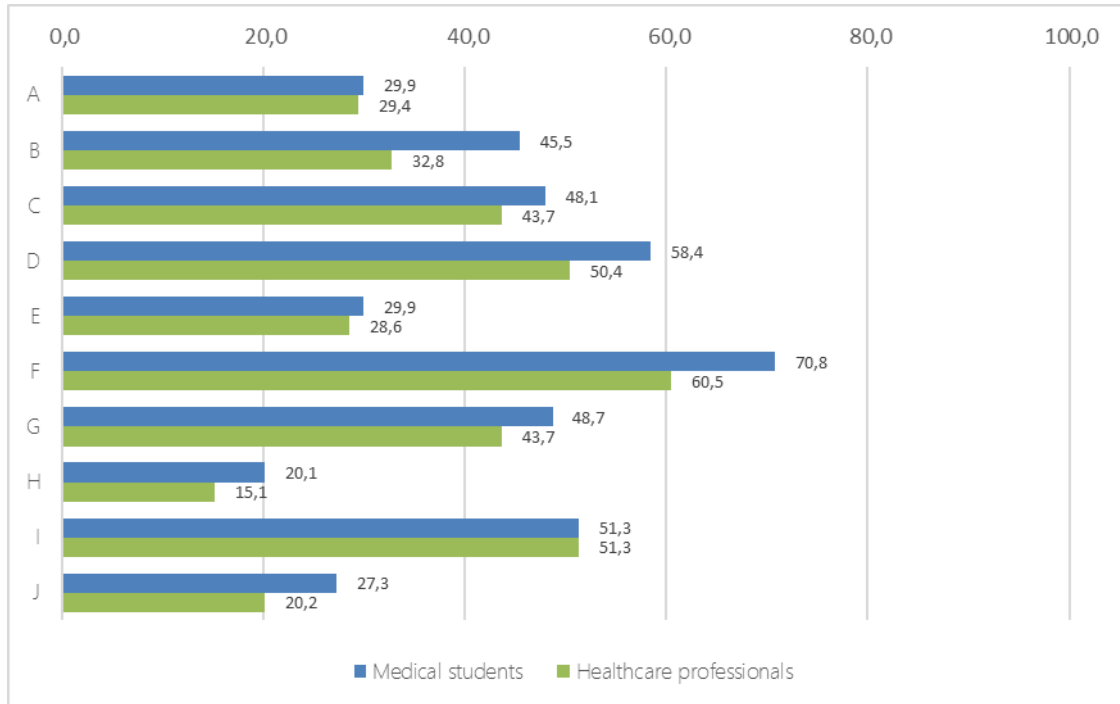


Graph 17 – Answer distribution to Q12: In what areas of healthcare will AI have a greater impact?

Label: A: Care delivery (like refilling stock, retrieve required information from medical records and reporting exams) B: Clinical decision support C: Triage and diagnosis D: Self-care/prevention/wellness E: Chronic care management

1.8. Concerns and perceived risks

Liability issues were pointed out by 70.8% of medical students and 60.5% of healthcare professionals as the major concern surrounding AI's performance (Graph 18). Inequity and fear of making bad decisions based on AI's recommendations were also interpreted as other major risks deriving from AI implementation.



Graph 18 - Answer distribution to Q13: What are your major concerns surrounding AI's performance?

Label: A: Staff will be in a more passive position for making decisions. B: Potential job losses from AI automation. C: Privacy of patients' health information. D: Inequitable/Unfair for certain groups (like people with poor access to healthcare and people with poor digital skills). E: Transparency of policies, protocols and guidelines. F: Liability issues (not clear who is responsible when errors occur from using AI). G: Jeopardy of physician-patient/customer relationship. H: Clinical underperformance (not living up to expected). I: Making bad decisions based on AI's recommendations. J: Backlash from costumers.

Chapter 4

1. Discussion

1.1. Interest and knowledge around AI

There is a generalized interest in digital tools, reflecting the growing influence they have been having in our society and especially in healthcare. In fact, this digital and technological literacy will prove to be an important skill when working in an environment reshaped by AI. In line with previous research studies, greater interest and knowledge on technology associates with an easier adoption (6).

At the same time, it becomes evident that this technological transition is being very well received and respondents are clearly eager to integrate AI in their practice, reflecting its vastly anticipated potential.

Albeit understanding the concept of AI, responses to Q3 may reflect that notions around it may still be quite abstract and remote. As said, this lack of knowledge can actually be one of the obstacles to the use of AI, especially if it translates into a lack of confidence when time comes to use it. Trustworthiness will be a major ingredient for success, according to the EC, also being a measured aspect in several technology adoption models (7)(28).

As such, we should bet on increasing literacy on AI - as it becomes clear as we go along the survey answers - so that by better understanding the entire framework professionals feel more confident throughout the whole transition process, from solution-proposing to decision making.

Interestingly, medical students considered their knowledge of AI to be lower than that of professionals, showing that from their perspective, this technology is still rather vague. This may explain why they were more conservative regarding its rapid integration in health systems as well as more conscious about lack of training. As future professionals, avid users and educators themselves, these results are somewhat disappointing and show that their education in particular should be encouraged perhaps by including this theme of digital technologies in health in the curricula of medical schools (29)(30).

Still, as we will see, the main challenges towards implementing AI-based technologies related more to technical and logistical aspects than to lack of evidence and belief in its

abilities. It looks clear that were beyond accepting that AI allows for care optimization, as reflected in questions related to perceived usefulness.

1.2. AI in the workplace: satisfaction, support and readiness

As many of us could recognize, the COVID-19 pandemic has exposed many of health services' weaknesses and struggles (31) that led health professionals to identify redundant tasks and find space for automation that would significantly ease workload and burden. In fact, it seems this pandemic presents as a unique opportunity to reorganize, reform and provide professionals with tools that allow them to make better, faster decisions.

The truth is this period of healthcare stress has already led to the implementation of AI-based solutions with satisfactory results that lay the foundation for future changes (32). Thus, there may be no better time to (carefully) act.

However, it seems that portuguese health institutions don't yet have a strong digital culture. This explains the generalized dissatisfaction with regard to the (in)existing solutions and lack of support, which ultimately contribute to the feeling of unreadiness for employing AI technologies. As a matter of fact, according to a Deloitte report, Portugal tends to lag other European countries in using digital technologies (33).

As we will continue to explore, it is necessary to improve education and training in order to promote a conscious digital culture so that professionals can naturally begin to feel more comfortable and capable of making this digital transition.

1.3. Perceived challenges and barriers

Indeed, topics regarding knowledge and general understanding of AI in healthcare were consistently considered important barriers to the use of AI, confirming that tackling these aspects is key to a successful shift.

At the same time, excessively bureaucratized health systems are blocking staff from exploring digital alternatives (16), becoming in themselves an obstacle towards approaching other difficulties - such as understanding legal aspects and benefits.

So, as it's been recommended by several authors, we should start by automating routine, repetitive and administrative tasks that soak up a significant amount of professionals' time. That way we start by automating simpler tasks, easier to assimilate, enabling familiarization and trust that will later allow us to take bigger strides (3)(4).

These appear to be initial steps to an AI-led transition respondents believe will be complete in less than 15 years, maybe alongside health financing reforms being that the cost of AI tools was considered the greatest hurdle to its deployment.

On the other hand, apparently patients and the general population won't pose a significant barrier to the use of AI, since their use of digital technologies for health purposes has been increasing (24). Regardless, their education on AI technologies must not be overlooked, given that they will make use of these tools in many ways.

1.4. Perceived facilitating conditions

Indeed, this point was recurrently neglected by respondents, which can turn out to be a fatal error, seeing that patients play an active role in eHealth as direct users and beneficiaries of AI-based technologies (3) – especially considering the massive burden of chronic non-communicable diseases, that could potentially be monitored at home through AI's capabilities, and other areas that greatly depend on their inputs (15)(34).

Apart from leading to the empowerment of patients and general population and naturally contribute to a clinical workload reduction, their involvement would help understand what kind of tools should be developed.

Hence, as we've hinted, the essence is that encouraging education and training around AI of all actors will be vital to a quicker and more mindful digital transition, granted that new skills and expertise will be required as innovation unfolds.

On top of all that, it seems the acquisition of the best suitable technologies depends substantially on the ability of health professionals to come together in cooperating with other industry stakeholders, such as company boards and policy makers. This will conduct a joint effort across different fields to stimulate progress (14).

1.5. Perceived priorities

Furthermore, it becomes clear it is expected AI's main focus be on making processes more efficient, relegating it's role on improving clinical abilities to second place. Actually, this makes total sense if we remember the increased health sector workload and pressure explored in the introductory section.

In turn, this gain in efficiency can have a positive impact on interoperability, productivity and cost reduction, aspects also considered fundamental to be provided by AI-based

technologies. Therefore, it is a feature health institutions should look for if they wish to succeed.

The enrichment of the health professional-patient relationship ended up not being considered that significant, maybe because it shouldn't depend on whether AI is involved or not. Notwithstanding, by making processes more efficient this bond will probably benefit, allowing in one hand for a more attentive direct contact, if needed, and on the other for a permanent virtual connection.

1.6. Perceived usefulness

Having said that, it shouldn't surprise us that professionals appear to be looking for AI-based technologies that improve health systems' efficiency with subsequent workload relief. It successfully mirrors the previewed hope for AI in this regard and the room for automation.

This will concede more time to devote to more demanding tasks, research work, studying and even personal activities.

As said, only afterwards do they worry about boosting clinical accuracy, which may be surprising to some, since we tend to hear of AI technologies that focus primarily on enhancing human capabilities.

Nonetheless, respondents revealed more concern towards increasing clinical accuracy than reducing health care costs, maybe indicating that they don't forget the essence of their profession – to care.

Actually, the answer dispersion in Q12 shows that once they trust AI, the respondents will rely on it to augment their clinical abilities at many levels with emphasis on hospital skills and tasks - in opposition to “at-home care”, such as chronic monitoring and prevention. This connects to the more passive role they consider patients and the general population will have.

AI's expected impact on care delivery - through refilling stock, gathering and organizing medical information, reporting exams and many other things – once again delves into how AI can relief workers' burden with applications not directly related with clinical skills, touching on its fundamentals of replacement of non-clinical skills and enhancement of clinical aspects.

1.7. Concerns and perceived risks

The youth of AI in health and lack of knowledge around it, in association with the current diminished experience dealing with these technologies gives space for several concerns that mainly have to do with liability issues, albeit respondents not really being concerned with the transparency of existing policies and guidelines, translating the good efforts being made by European policy makers in assuring a careful and well-structured transition. Evidently, a secure environment is needed in order to guarantee protection and stability that fuel trust and propel further investments (17).

Truth be told, these ethical aspects inherent to health care may be one of the reasons why the deployment of AI becomes such a sensitive and complex matter - not only depending on purely technical and scientific issues – and may partly explain why the health sector is lagging other industries.

Regardless, workers don't really seem worried about losing their job or status, showing that we've overcome the initial concern that AI could come as nothing more than a human replacement. Rather, it is understood that it presents as a breath of fresh air that intends to serve as an aiding tool (35).

Meanwhile, that doesn't oppose the fact that health professionals will have to adapt and develop new capabilities to "help them navigate this digital world" (3).

Plus, concerns regarding sporadic AI-induced errors still naturally exist, taking into account that it is a novelty, even though respondents aren't worried that it might underperform. This is explained by Bertalan Meskó through a brilliant analogy linking the dawn of AI and the acceptance of the stethoscope by the medical community (35).

Moreover, there is still some logical concern that engagement with patients may be jeopardized and that private health-related information may be exposed. These issues are expected to pose a lesser issue as AI's framework becomes more robust but still need to be addressed.

Lastly, despite not really prioritizing the population's involvement in decision making - as we have explored - health professionals still don't forget that inequity is one of the top factors that we have to consider when deciding what AI-based technologies to choose. They believe that if we take the right steps, the population should see this transition with good eyes, considering this (r)evolution will favor them. Yet, we must make sure that we do it in an inclusive way, bearing in mind that not all people stand on an equal footing. Very much on the contrary.

2. Limitations and future work

This investigation covered answers from 273 participants, a scarce number considering there are about 3000 portuguese medical students undergoing clinical rotations and more than 100.000 health professionals actively working. As such, the collected opinions may not translate the national reality. More extensive work should be performed.

Unfortunately, given the nature and authorship of the study it was expected it would have a limited reach. Despite having contacted all portuguese medical schools and several certified portuguese health professionals' associations, not all of them replied, including the more substantial ones.

On top of that, the online survey was released in a moment when the portuguese health system was facing tremendous pressure due to the COVID-19 pandemic. That was perhaps the main obstacle in collecting more responses.

Plus, it is important to note that the lack of knowledge on digital technologies and AI, that we know is a complex subject, may have been a limitation to some of the participants while trying to connect answer options to real-world applications. This may have led to them not feeling too confident and certain that the answers given actually reflected their view.

3. Implications and recommendations

The future of healthcare directly relates to investing in AI. Digital technologies should start to be a more frequent subject in all healthcare institutions as to build a culture that allows for action and engagement.

In this fashion, regularly held meetings could bring together stakeholders from different communities, such as engineers, nurses and politicians, in order to actively work towards a well-structured digital transition.

Training, education and discussion sessions for health professionals should be introduced, providing better understanding of how digital technologies are impacting the health industry and ultimately increase acceptance, trust and commitment. Later on, additional studies on how this influences AI adoption could be conducted.

Further down the road, dedicated centers for AI solutions would be able to experiment with the most promising tools and serve as pilot tests to real-world scenarios.

Likewise, medical schools should consider updating their curricula so that students acknowledge the changing landscape in healthcare and develop important skills to thrive in a technology-powered workplace. Dedicated courses, AI-labs and other hands-on activities would hopefully lead to better attitudes and awareness. With that, medical students would certainly be better prepared to integrate digital healthcare systems.

4. Conclusions

The conclusions that can be summarized from this work are:

- The use of AI in health may still be in its begging but it has already become clear it can help tackle many of healthcare difficulties, confirming its anticipated potential
- Health professionals and medical students, as future care providers, are vital to the success of this digital transition that, among other things, will require them to adapt to new roles. Indeed, they are on board with it but a robust framework and supportive workplace environment must be created so as to boost readiness, confidence and trust
- Even though AI's expected benefits outweigh inherent risks, there are still several challenges that need to be addressed and important concerns that need clarification to guarantee a smooth deployment of AI tools. Nonetheless, it is reassuring that health professionals and medical students seem to be on the same page in this regard
- Technology developers and health institutions, respectively, should focus on creating and acquiring tools that primarily focus on overall efficiency of health systems thereby tackling the increasing demand for constantly improving standards of care
- A wise adoption of AI must rely on appropriate education, training and permanent communication between all stakeholders in leveraging its capabilities

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Appendix 1

Research approval by the Ethics Committee



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Parecer relativo ao processo n.º CE-UBI-Pj-2020-097:ID469

Na sua reunião de 15 de dezembro de 2020 a Comissão de Ética apreciou a documentação científica submetida referente ao pedido de parecer do projeto “**Artificial Intelligence in Healthcare: The perspectives of Medical Students and Healthcare Professionals**”, do proponente **João Pedro Alves de Bessa**, a que atribuiu o código n.º CE-UBI-Pj-2020-097.

Na sua análise não identificou matéria que ofenda os princípios éticos e morais, sendo de parecer que o estudo em causa pode ser aprovado.

Covilhã e UBI

A Presidente da Comissão de Ética

Assinado por: **ANA LEONOR SERRA MORAIS DOS SANTOS**
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(Professora Doutora Ana Leonor Serra Morais dos Santos)
(Professora Auxiliar)

Appendix 2

Online survey: Preliminary English version

Demographic aspects

1. Occupation

1.1. Health professional

- 1.1.1. Nurse
- 1.1.2. Pharmacist
- 1.1.3. Physiotherapist
- 1.1.4. Physician
 - 1.1.4.1. Medical specialty
- 1.1.5. Dentist
- 1.1.6. Nutritionist
- 1.1.7. Psychologist
- 1.1.8. Medical imaging technologist
- 1.1.9. Hospital administrator

1.2. Medical student

- 1.2.1. Fourth year
- 1.2.2. Fifth year
- 1.2.3. Sixth year

2. Age

- 2.1. ≤25 years old
- 2.2. 26-35 years old
- 2.3. 36-45 years old
- 2.4. 46-55 years old
- 2.5. >55 years old

3. Gender

- 3.1. Male
- 3.2. Female
- 3.3. Other

4. Health institution

Scientific aspects

Q1: Do you see yourself as a digital driven person?

Likert scale 1-7

Q2: Rank the following definitions according to how you think they best fit the definition of AI.

- a. A multitude of technologies that extend human capabilities by interpreting, comprehending, judging and learning, aiding users carry demanding tasks.
- b. A diverse collection of systems that display intelligent behavior and aim to substitute users by doing things freely and autonomously.
- c. The ability of systems and machines to exhibit human-like intelligence and use it to replicate human behavior to a limited extent.
- d. Machines with embedded information on how to conduct a specific task, having limited capability to adapt and learn.

Q3: How do you classify your knowledge about AI?

Likert scale 1-7

Q4: Do you believe it makes natural sense for AI to be integrated in healthcare?

Likert scale 1-7

Q5: Does the COVID-19 pandemic present as a unique opportunity for us to leverage AI-based technologies?

Likert scale 1-7

Q6: Are you satisfied with the current applications of AI in your health institution?

Likert scale 1-7

Q7: Do you feel supported by your institution to use AI in your daily practice?

Likert scale 1-7

Q8: Do you feel your institution is prepared to start adopting more AI-based technologies?

Likert scale 1-7

Q9: What do you feel are the top challenges your institution in facing to implement AI-based technologies?

- a. Bureaucracy in healthcare (that delays staff from focusing on AI alternatives)
- b. Cost of technology
- c. Finding the right technologies
- d. Lack of staff training to adequately use technology
- e. Complexity of technology
- f. Lack of demand from patients/general population
- g. Convincing staff of the benefits of technologies
- h. Convincing the population of the benefits of technologies
- i. Understanding medicolegal, regulatory and licensing aspects of AI
- j. Adequate compensation for using the technologies

Q10: Which aspects could benefit most from AI automation?

- a. Saving time and resources (efficiency), which includes administrative work
- b. Workload reduction
- c. Staff and physician job satisfaction
- d. Clinical accuracy in prediction, diagnosis and treatment plans
- e. Patient experience and engagement
- f. Prevention, including health coaching for patients and risk stratification
- g. Driving research
- h. Healthcare cost reduction

Q11: Which of the following aspects should your institution prioritize when acquiring AI-based tools?

- a. Making the processes more efficient
- b. Improving decision making (clinical ability)
- c. Making employees more productive
- d. Lowering costs
- e. Enhancing relationships with patients/customers
- f. Enhancing interoperability
- g. Discovering new insights through research and data mining
- h. Enabling new services and business models

Q12: In what areas of healthcare will AI have a greater impact?

- a. Care delivery (like refilling stock, retrieve required information from medical records and reporting exams)
- b. Clinical decision support

- c. Triage and diagnosis
- d. Self-care/prevention/wellness
- e. Chronic care management

Q13: What are your major concerns surrounding AI's performance?

- a. Staff will be in a more passive position for making decisions
- b. Potential job losses from AI automation
- c. Privacy of patients' health information
- d. Inequitable/Unfair for certain groups (like people with poor access to healthcare and people with poor digital skills)
- e. Transparency of policies, protocols and guidelines
- f. Liability issues (not clear who is responsible when errors occur from using AI)
- g. Jeopardy of physician-patient/customer relationship
- h. Clinical underperformance (not living up to expected)
- i. Making bad decisions based on AI's recommendations
- j. Backlash from costumers

Q14: How long do you think it will take for your organization to fully integrate AI technologies?

- a. Less than 5 years
- b. 5-10 years
- c. 10-15 years
- d. 15-20 years
- e. More than 20 years

Q15: Of the following aspects, which do you think will be crucial to accelerate the deployment of AI technologies?

- a. Staff training on AI technologies
- b. Staff working with other industry stakeholders on developing the most adequate AI technologies
- c. Raising population awareness and knowledge revolving AI technologies
- d. Population working with other industry stakeholders on developing the most adequate AI technologies
- e. Reforming healthcare financing

Appendix 3

Online survey: Applied Portuguese version

Caro(a) participante,

Antes de decidir se vai colaborar nesta investigação importa clarificar o seu propósito, o intuito da sua participação e de que forma serão tratados os dados obtidos.

O meu nome é João Pedro Alves de Bessa, aluno do sexto ano do Mestrado Integrado em Medicina na Faculdade de Ciências da Saúde da Universidade da Beira Interior e venho solicitar a sua participação na dissertação de Mestrado que estou a desenvolver, com base num trabalho de investigação, em volta do tema: “Artificial Intelligence in Healthcare: The perspectives of Medical Students and Health Professionals” sob orientação do Professor Doutor Henrique Martins, Professor Auxiliar Convidado da Faculdade de Ciências da Saúde.

As tecnologias e o universo digital têm-se desenvolvido a um ritmo arrebatador. O conhecimento crescente sobre esta temática tem levado ao aparecimento de alternativas mais complexas, capazes e diversificadas, onde, ao longo das últimas décadas, se tem incluído de forma clara a Inteligência Artificial, registando progressos notáveis nas várias indústrias e adquirindo relevância ao nível dos cuidados de saúde.

A Inteligência Artificial (IA) apresenta-se como um ramo da tecnologia capaz de simular a inteligência humana através do armazenamento de informação e aquisição de conhecimento, com vista a ajudar o utilizador a realizar uma determinada tarefa (ou conjunto de tarefas). Para isso, serve-se normalmente de programas de software envolvendo algoritmos de “*deep learning*” e “*machine learning*”.

Os resultados da adoção e utilização de Inteligência Artificial nos cuidados de saúde têm-se mostrado essencialmente positivos. Contudo, trata-se de um campo com um horizonte ainda vastíssimo de potencialidades, e com uma margem de desenvolvimento considerável.

Os profissionais de saúde, e os estudantes de Medicina, enquanto futuros profissionais, são atores centrais no que diz respeito ao tipo de soluções desenvolvidas e, posteriormente, à sua implementação nos cuidados de saúde e têm, por isso, um papel determinante nesta matéria.

Apenas com a sua satisfação, crença e confiança é que as soluções baseadas na Inteligência Artificial adquiridas pelas instituições de saúde poderão ser efetivamente utilizadas de forma adequada e rentável, com um impacto positivo nos outcomes. Isso explica a necessidade de explorar as suas perspetivas em torno deste assunto.

Assim sendo, esta dissertação tem como objetivo principal analisar as perspetivas e expectativas dos profissionais de saúde e estudantes de medicina no que diz respeito à utilização de Inteligência Artificial na saúde; e como objetivos secundários, identificar propostas e cenários de utilização da Inteligência Artificial na saúde e explorar a relação entre as perspetivas e as expectativas perante uma tecnologia emergente e as necessidades de formação/sensibilização dos profissionais e utentes.

Este estudo mereceu Parecer favorável da Comissão de Ética da Universidade da Beira Interior e a sua participação é opcional, livre e voluntária. Destina-se a profissionais de saúde que estejam no ativo e a estudantes de Medicina matriculados em anos clínicos (nomeadamente, quarto, quinto e sexto anos).

Este projeto não tem qualquer tipo de financiamento, e dele não advém qualquer remuneração ou proveitos, para além dos científicos, para os investigadores.

Não existem quaisquer riscos para os participantes e não se esperam benefícios imediatos, para além do conhecimento e reflexão que deriva da análise própria desta temática.

Os dados fornecidos são inteiramente confidenciais e anónimos, e destinam-se unicamente ao tratamento estatístico, que será efetuado através de uma lente global e nunca de forma individualizada. O seu acesso estará limitado ao investigador principal.

No final do questionário existe a possibilidade de deixar o seu endereço de correio eletrónico, caso tenha interesse em participar numa sessão de debate em grupo, em torno deste tema, com outros colegas.

É essencial que leia atentamente todas as questões e que responda com a máxima sinceridade.

O preenchimento do questionário demora cerca de 8 minutos.

Caso necessite de qualquer esclarecimento pode contactar-me através do e-mail a35513@fcsaude.ubi.pt.

Agradeço, desde já, a sua disponibilidade!

Antes de iniciar, por favor valide as seguintes opções, assinalando que:

- a) Aceita participar no estudo
- b) Permite o armazenamento e tratamento dos dados fornecidos

Parâmetros sociodemográficos

1. Profissão

1.1. Profissional de Saúde

- 1.1.1. Enfermeiro(a)
- 1.1.2. Farmacêutico(a)
- 1.1.3. Fisioterapeuta
- 1.1.4. Médico(a)
 - 1.1.4.1. Especialidade médica
- 1.1.5. Médico(a) Dentista
- 1.1.6. Nutricionista
- 1.1.7. Psicólogo(a)
- 1.1.8. Técnico(a) Superior de Diagnóstico e Terapêutica
- 1.1.9. Técnico(a) Superior de Saúde
- 1.1.10. Administrador(a) Hospitalar

1.2. Estudante de Medicina

- 1.2.1. Quarto ano
- 1.2.2. Quinto ano
- 1.2.3. Sexto ano

2. Idade

- 2.1. ≤25 anos
- 2.2. 26-35 anos
- 2.3. 36-45 anos
- 2.4. 46-55 anos
- 2.5. >55 anos

3. Sexo

- 3.1. Feminino
- 3.2. Masculino
- 3.3. Outro

4. Instituição de Saúde

Parâmetros científicos

Q1: Como quantifica o seu interesse por ferramentas tecnológicas?

Escala de Likert 1-7

Q2: Ordene as seguintes opções começando pela que mais se enquadra na sua visão de Inteligência Artificial (IA).

a. Um conjunto de tecnologias que se serve da sua capacidade de interpretação, compreensão, julgamento e aprendizagem para replicar competências humanas, ajudando os utilizadores a realizar tarefas com diferentes graus de exigência

b. Um conjunto diversificado de ferramentas tecnológicas que apresentam comportamento inteligente e têm como objetivo substituir os utilizadores, realizando tarefas de forma livre e autónoma

c. A capacidade de ferramentas tecnológicas e outras máquinas de exibir inteligência semelhante à inteligência humana e utilizá-la para replicar o comportamento humano até um determinado limite

d. Máquinas com informações embutidas sobre como realizar uma tarefa específica, tendo capacidade limitada de adaptação e aprendizagem

Q3: Como quantifica o seu conhecimento acerca das aplicações da IA na saúde?

Escala de Likert 1-7

Q4: Considera que a integração da IA nos cuidados de saúde é, na sua globalidade, uma ideia positiva?

Escala de Likert 1-7

Q5: Considera que a pandemia da COVID-19 constitui uma boa oportunidade para a disseminação da utilização de tecnologias baseadas em IA na saúde?

Escala de Likert 1-7

Q6: Está satisfeito/a com a utilização atual da IA na sua instituição de trabalho?

Escala de Likert 1-7

Q7: Sente-se apoiado pela instituição de trabalho a utilizar, na sua prática, tecnologias baseadas na IA?

Escala de Likert 1-7

Q8: Considera que a sua instituição de trabalho está preparada para a adoção mais alargada de IA?

Escala de Likert 1-7

Q9: Quais são, na sua opinião, os principais desafios que a sua instituição enfrenta para implementar tecnologias baseadas na IA? (por favor, selecione até 5 opções)

- a. Burocracia associada aos serviços de saúde (que retarda o foco em alternativas inovadoras)
- b. Custo das tecnologias
- c. Encontrar as tecnologias certas
- d. Falta de treino/capacidade técnica dos profissionais para utilizar as tecnologias de forma adequada
- e. Complexidade das tecnologias
- f. Falta de interesse por parte dos utentes/população em geral
- g. Convencer os profissionais dos benefícios das tecnologias
- h. Motivação e disposição dos profissionais
- i. Convencer a população dos benefícios das tecnologias
- j. Compreender os aspetos médico-legais, regulamentares e de licenciamento da IA
- k. Remuneração/compensação adequada dos profissionais pelo uso das tecnologias
- l. Outro (qual?)

Q10: Na sua opinião, que aspetos beneficiariam mais com a automatização por IA? (por favor, selecione até 4 opções)

- a. Economização de tempo e recursos (eficiência)
- b. Redução da carga de trabalho dos profissionais
- c. Satisfação laboral dos profissionais
- d. Precisão clínica a nível preditivo, diagnóstico e de planos de tratamento
- e. Experiência e envolvimento dos utentes
- f. Prevenção, incluindo formação em saúde para utentes e estratificação de risco
- g. Realização de projetos de investigação
- h. Redução dos custos em saúde
- i. Outro (qual?)

Q11: Que aspetos considera que a sua instituição deveria priorizar aquando da adoção de tecnologias baseadas em IA? (por favor, selecione até 4 opções)

- a. Tornar os processos mais eficientes
- b. Melhoria da decisão clínica (habilidade clínica)
- c. Aumento da produtividade dos profissionais
- d. Redução de custos
- e. Melhoria da relação com os utentes
- f. Melhoria do trabalho em rede

- g. Descoberta de novas informações através de investigação e *data mining*
- h. Habilitação de novos serviços e modelos de negócio
- i. Outro (qual?)

Q12: Na sua opinião, em que áreas da saúde será mais significativo o impacto da IA? (por favor, selecione até 3 opções)

- a. Apoio aos cuidados (como reposição de stock, recuperação de informação de registos médicos ou relato de exames laboratoriais e de imagem)
- b. Apoio à decisão clínica
- c. Auxílio à triagem e diagnóstico
- d. *Self-care*/Prevenção/Bem-estar e *wellness*
- e. Gestão de patologias crónicas
- f. Outra (qual?)

Q13: Quais são as suas principais preocupações em torno da utilização de IA na saúde? (por favor, selecione até 5 opções)

- a. Os profissionais estarão numa posição demasiado passiva na tomada de decisões
- b. Potencial perda de empregos devido à automatização de tarefas
- c. Segurança no acesso à informação clínica dos utentes (privacidade)
- d. Iniquidade para com determinados grupos da população (como utentes com difícil acesso aos cuidados de saúde e/ou poucas habilitações digitais)
- e. Transparência das políticas, protocolos de utilização e guidelines
- f. Problemas de responsabilização (não estar claro quem é responsável caso advenham erros da utilização da IA)
- g. Prejuízo da relação utente-profissional de saúde
- h. Desempenho inferior ao expectável
- i. Tomar decisões erradas com base nas recomendações da IA
- j. Apreensão dos utentes
- k. Outra (qual?)

Q14: Na sua opinião, quanto tempo demorará até que a IA esteja completamente integrada nos cuidados de saúde?

- a. Menos de 5 anos
- b. 5-10 anos
- c. 10-15 anos
- d. 15-20 anos
- e. Mais de 20 anos

Q15: Quais dos seguintes aspetos considera fundamentais para acelerar a implementação de tecnologias baseadas em IA? (por favor, seleccione até 3 opções)

- a. Formação dos profissionais de saúde em IA
- b. Articulação dos profissionais de saúde com outros *stakeholders* no desenvolvimento de tecnologias de IA adequadas
- c. Fomentar o conhecimento e consciência da população em torno da IA
- d. Articulação dos utentes/população em geral com outros *stakeholders* no desenvolvimento de tecnologias de IA adequadas
- e. Reforma do financiamento no setor da saúde
- f. Outro (qual?)

Caso esteja interessado/a em participar numa pequena sessão de debate com outros participantes via Zoom, em data a marcar, por favor deixe o seu contacto de correio eletrónico.

Note que ao associar o seu endereço de e-mail, este questionário perderá o seu anonimato. Relembro, contudo, que a confidencialidade dos dados obtidos está garantida e que estes nunca serão alvo de análise individual e/ou que permita identificação. Após a conclusão deste trabalho de investigação, este dado que possa conduzir à identificação dos participantes será destruído.

Muito obrigado pelo tempo despendido na participação neste trabalho de investigação!