Attitude towards Telemedicine among various health students in Wrocław

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Abstract

Aim: This study aimed to explore the utilisation, experiences, and perceptions of telemedicine among health students, particularly in the wake of the COVID-19 pandemic, which significantly accelerated the adoption of remote healthcare services.

Methods: An online survey was filled by 51 (+53) students to indicate current feelings towards telemedicine and the inclination towards its future application. The survey explored the frequency of telemedicine use, types of services accessed, the effectiveness and reliability of telemedicine consultations, and the specific technologies employed.

Results: More than half of the respondents rated their telemedicine experiences positively, though opinions on its reliability were mixed. The most common applications of telemedicine were found in psychology (i.e. chatbots). Interestingly, a significant portion of students expressed interest in participating in future telemedicine projects, however optimism in applying telemedicine in their careers is lower than 10 years ago. We found that women are significantly more likely to accept and trust telehealth solutions.

Conclusions: The study reveals concerns about the perception of reliability of telemedicine and indicates a need for further education and evidence-based reassurances to foster trust among future healthcare professionals. The notable interest in telemedicine's application of chatbots (as effect of COVID-19 lockdowns and revolution in Large Language Models) and the use of technology like smartwatches for health monitoring suggests areas for further development and integration into healthcare curricula.

Keywords: sensors, wearables, telemedicine, AI-enhanced medicine

Introduction to Telemedicine

The COVID-19 pandemic altered how telemedicine is viewed. Research and observations conducted in this field indicate that telemedicine is notably efficient in diagnosing i.e. upper respiratory tract infections, and telerehabilitation has a positive impact on Long-COVID patients, irrespective of the methodology employed (Goharinejad et al., 2021). Furthermore, the swift advancement of technology in the 21st century is poised to enhance telemedicine's efficacy even further (Romaszko-Wojtowicz et al., 2023). Health workers' attitude is the central element of a successful treatment (Ćwiklicki et al., 2022). Telemedicine is a form of providing medical services and health care that com-

bines elements of telecommunications, IT, and medicine. E- or m-health is an increasingly common method of providing medical services, especially since the outbreak of the COVID-19 pandemic, when patients were kept at home for longer and a solution was needed to enable the treatment and rehabilitation of patients remotely, without exposing them to contact with other people (especially important during a pandemic). With the expansion of the Internet of Things, apps for mobile health management have become more and more popular. In the Technology Acceptance Model (TAM) or the Information Technology Acceptance Model (ITAM), data can be measured and processed mainly by chronic patients (Ćwiklicki et al., 2022).

Healthcare Workers in the E-Health Era

Many telemedicine solutions have become so popular that they are still very widely used (Romaszko-Wojtowicz et al., 2023). Modern telemedicine can be understood as [Fig. 1]:

1. Creation of games (Czekaj & Jarynowski, 2024) for health rehabilitation and physical activity (for example, visualisation in the app, biofeedback).
2. Patient observation records consisting of: i) recordings of biosignals (Rutkowski et al., 2021), such as spirometry, ECG, saturation, respiratory rate, nasal airflow, body movements, and ambient acoustics with cough detection, as well as temperature; ii) clinical history, information about the course of the disease and rehabilitation (Trafalska & Pawlik, 2022), questionnaires (quality of life, socio-demographic, anxiety, (e-)health competence, satisfaction with the use of the tool), etc., collected directly from patients and during teleconsultation.
3. Remote diagnosis, including screening for the most common comorbidities (Czekaj et al., 2020).
4. Chatbots (Algner, et al., 2021) i.e. for Mental Health Support.
5. Mobile apps for multiple medical issues (Dąbek et al., 2022).
6. Adaptation of a system to detect sudden exacerbation of chronic problems based on Artificial Intelligence (AI) methods—including alarm generation and pre-piloting of telemedical support in inpatient/ambulatory rehabilitation settings.

Meanwhile, the standard (Walczak et al., 2022) is:

- Remote consultation: the provision of health services, in which distance is a critical factor, by all health professionals using information and communication technologies to exchange important information for the diagnosis, treatment, and prevention of diseases and injuries,
- Communication: According to the American Telemedicine Association (ATA): "telemedicine is the exchange of medical information between two or more users using electronic communication for the purpose of improving the health of patients" (Klisowska et al., 2019),

- Tool for teaching patients: "education of service providers, all in the interest of promoting the health of individuals and their communities" (WHO, 2016),
- E-prescription (Grabowska et al., 2021), organisers (schedulers or e-registration).

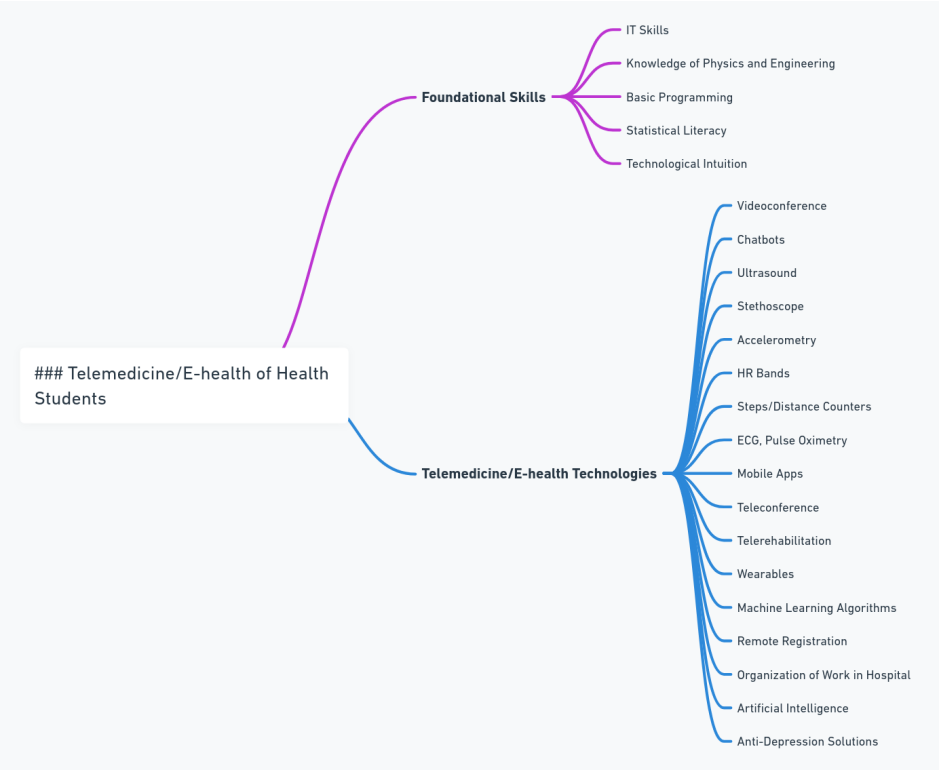

Fig. 1. Concepts of teaching modern telemedical technology to health students developed in a pilot study and from observation in implementation projects (Maksymowicz et al., 2022). Own Research.

From a clinical perspective, telemedicine i.e. VR and telerehabilitation may be cost-effective interventions or diagnostic tools in Poland (Rutkowski et al., 2023).

Patients' perspectives are well described for Poland in areas of e-prescription, Internet Patient Account, teleconsultation, electronic sick leave, and electronic information about treatment dates (Duplaga, 2022; Płaciszewski et al., 2023). However, the perspective of professional staff is much more complicated.

The exploration of attitudes towards telemedicine among healthcare students, particularly in response to the COVID-19 pandemic, is an evolving field with several studies contributing insights into how health students perceive and engage with telemedicine technologies.

State of the Art

The biggest part of scientific interest comprises surveys on knowledge and attitudes among healthcare professionals (Rosiński et al., 2019) focused partially on telemedicine. A study evaluating healthcare professionals in Saudi Arabia found that while attitudes towards telemedicine were generally positive, the majority had limited knowledge of it, suggesting a need for specialised educational programmes for proper implementation and sustained use of telemedicine (Bashir et al., 2023). An assessment in Turkey found telemedicine awareness to be at a moderate level among medical students and physicians, suggesting the benefit of adding telemedicine education to the medical school curriculum (Mutlu et al., 2022). A systematic review emphasised the importance of knowledge, attitudes, and perceptions of telemedicine among medical students for the successful adoption of new technologies, indicating gaps in current education and training (Ghaddaripouri et al., 2023).

Another concept is measuring awareness and skills (Waszkowski et al., 2022) among health professionals and students via observation or exercises. Research in India highlighted that despite limited experience and knowledge in telemedicine technology among health professionals working in teaching hospitals, a fair number exhibited a positive attitude towards it, pointing to the necessity of education and training in telemedicine (Zayapragassarazan & Kumar, 2016). An observation of medical students in the USA indicated a lack of prior exposure to telemedicine but a strong interest in its future utilisation across various specialties, underscoring the importance of integrating telemedicine education into medical curricula (Kong et al., 2020).

Back in 2014 (10 years before our study), most Polish health students did not get even a single mention of telemedicine during the course of their studies (Polski et al., 2015). Students lacked comprehensive training and telemedicine knowledge, revealing that many participants were in favour of increasing telemedicine education to improve healthcare delivery. However, in the meantime, a revolution in the use of technology and AI appeared (Zybertowicz & Piekutowski, 2022).

Aims of the Study

In our study, we wanted to check how often students of medical-related fields use telemedicine, what their experiences and opinions are, and whether they trust this form of providing medical services (Bogacz et al., 2024). The role of medical personnel in promoting telemedicine and pro–e-health attitudes seems to be key to adopting these solutions in practice. The Technical University of Wrocław opened, in the academic year 2023/2024, a small programme for "Cybernetic" Medical Doctors (Jarynowski, 2023). However, the question is how to scale up technical literacy more widely among health students who are still in training, as observations show that postgraduate education is much more difficult (Babenko et al., 2017). We also wanted to check whether people taking part in the survey would declare their willingness to use telemedicine in their future professional work.

It should also be remembered that telemedicine is not a new field that has only appeared in the face of the pandemic. The oldest records of the use of telemedicine date back to the early 20th century (Glinkowski, 2002), when ECG data began to be transmitted over the telephone network. In Poland, initiatives to popularise telemedicine focus mainly on the development and implementation of systems for transmitting ECG signals by telephone (also via mobile phones), on the efficient transmission of X-rays, USG, CT, etc. via the Intranet or the Internet for consultation purposes, as well as on the efficient organisation of databases and the necessary access control systems for these information banks. The target group of respondents were predominantly in their fourth year of unified studies or first year of master's programmes (shortly after intensive practice in a clinic, but before graduating and beginning to work in the field).

Methodology

A computer-assisted web interviewing (CAWI) survey (a self-test) was performed. Two authors have the right to perform psychometric tests according to the Psychological Testing Centre of the Polish Psychological Association. We created a survey including 22 questions related to telemedicine and experiences in it. The study was piloted among 51 health and medicine and additionally 53 paramedic students at Wrocław Medical University, for validating questions and relevance of problems. In the first part, we asked respondents about their age, gender, and studies.

The first section of questions concerned telemedicine itself: how often it was used, where, and what is your opinion about the visit? Whether it is an effective and reliable form of treatment, what elements, according to the respondent, teleconsultation should include, and what technologies were used and what the opinion was regarding their use. The last section of questions concerned the future use of telemedicine in a professional context. The respondents were asked about their willingness to use telemedicine in future work, about what projects they would like to participate in, and what telemedicine technologies they would like to use.

The survey was conducted online, sent via the Facebook platform to the fields of Public Health, Nursing, Emergency Medical Services, and Medicine at Wrocław Medical University. Our target population was advanced students (at least 2 years of study) and early graduates in postgraduate training (such as residency). To simplify, all trainees and university students are called "students." The study was performed within the PulmoRehab project with clearance from the Bioethical Committee at the University School of Physical Education in Wrocław (decision no. 11/2023 from 13.05.2023). For the analytical part, a latent variable (Jarynowski et al., 2019) describing cumulative attitude towards telemedicine (Duplaga, 2024) was constructed. Multivariable generalised linear regression models were developed. T-tests (comparison of means) were used (for an extended sample with a pilot study) to verify whether differences between groups were significant.

Results

51 people responded to the main survey for advanced students, 70.6% of whom were women.

Descriptive Part

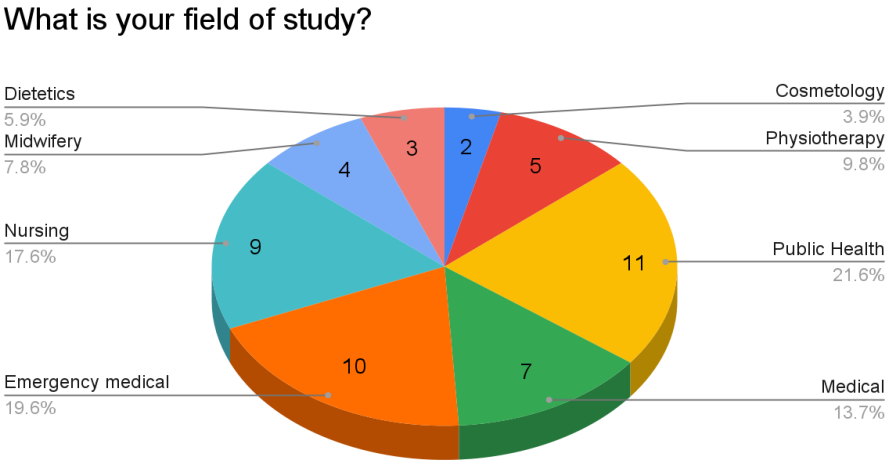

Fig. 2. Pie chart of study subject. Own Research with Google Sheets.

All respondents were students of a medical-related field [Fig. 2]. The majority (25.5%, 13 people) were currently in the fourth year of long-cycle studies or the first year of a master's degree. 10 early graduates of medical-related fields took part in the survey (19.6%).

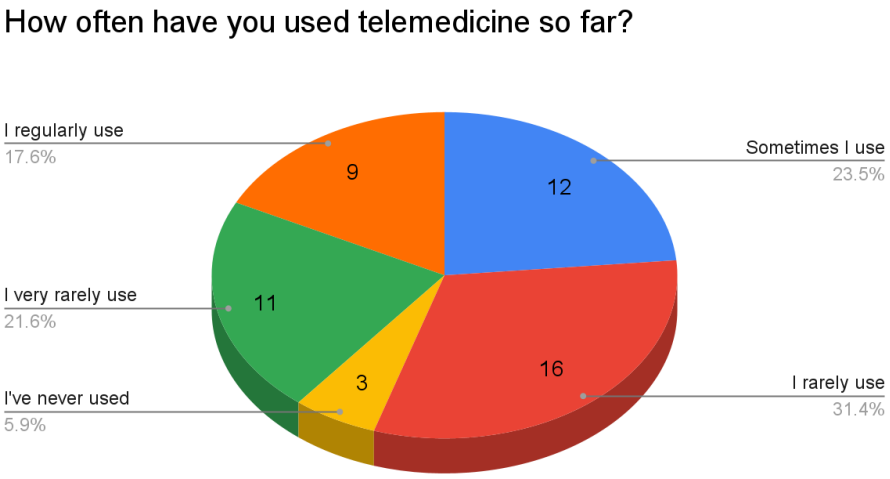

Fig. 3. Pie chart of frequency of telemedicine use. Own Research with Google Sheets.

31.4% (16 people) rarely use telemedicine, while 23.5% (12 people) use it sometimes [Fig. 3]. Most often, the visit took place at a family doctor or primary care physician (48%, 24 people).

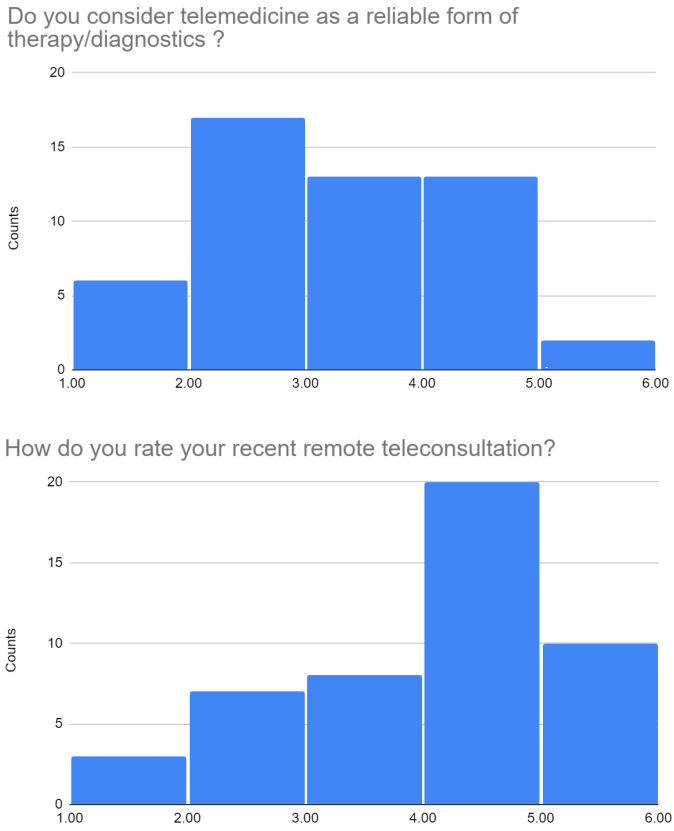

Fig. 4. Histograms of reliability (left) and rating last telemedical use (right). Own Research with Google Sheets.

The majority of respondents rate their last tele-treatment/diagnosis as good or very good [Fig. 4]. Almost half of the respondents (20 people) rated their visit as good, and 10 people as very good. 3 (6.3%) respondents were dissatisfied with the visit and rated it as very bad. However, when it comes to the reliability of treatment via teleconsultation, the results differ slightly [Fig. 4]. The same number of respondents (13 people) have no opinion or assess the reliability of teleconsultations positively, while 17 people believe that it is not a reliable form of diagnosis or treatment.

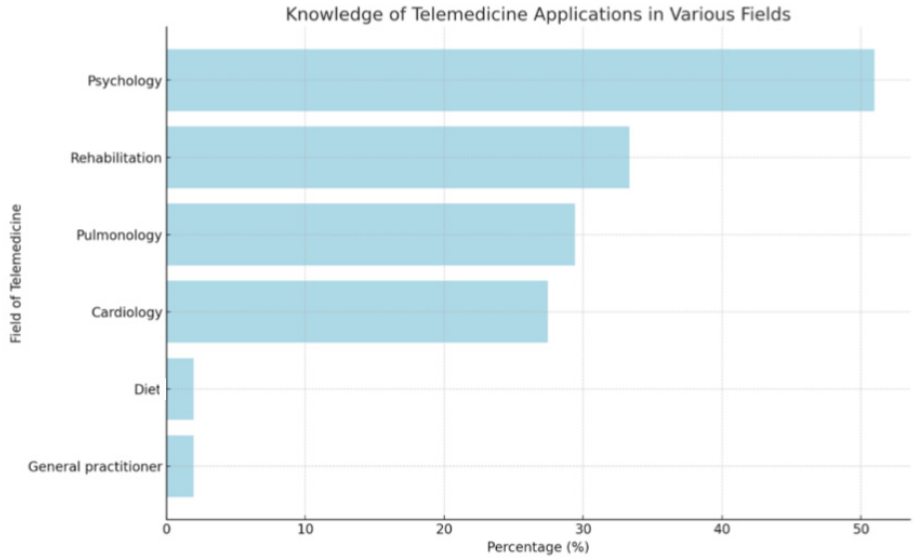

Fig. 5. Histogram field of medicine with application of telemedicine (multiple choice). Own Research with Google Sheets.

Most respondents know about the use of telemedicine in psychology [Fig. 5], and the technology they most often use is a smartwatch with simple functions or an exercise plan in a phone application [Fig. 6].

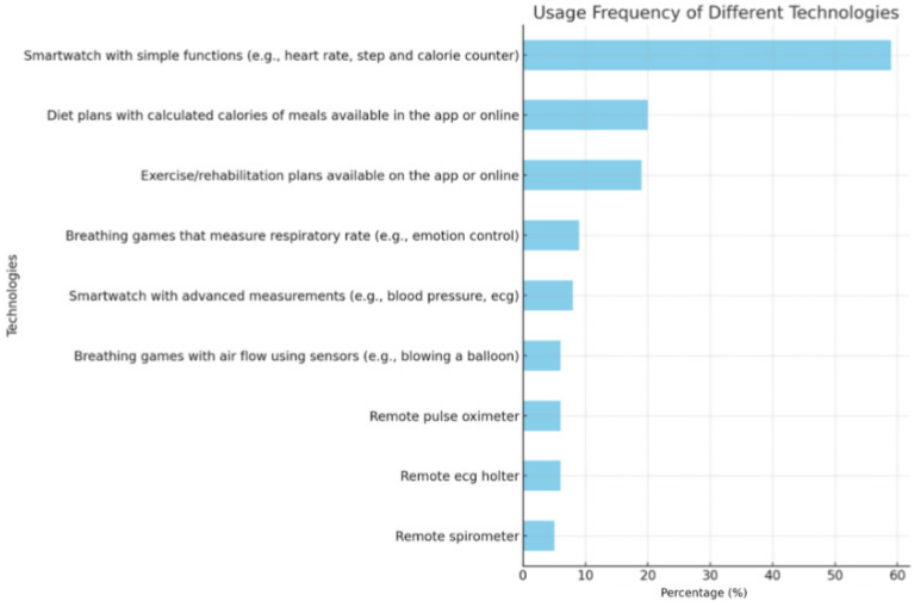

Fig. 6. Histogram of used technologists (multiple choice). Own Research with Google Sheets.

In comparison to people of the same age from the general population [Fig. 6], health students use apps less often, but wearables more often (Płaciszewski et al., 2023). While studying at a "prestigious" Polish medical university, most of the respondents did not have classes with more sophisticated telemedical equipment.

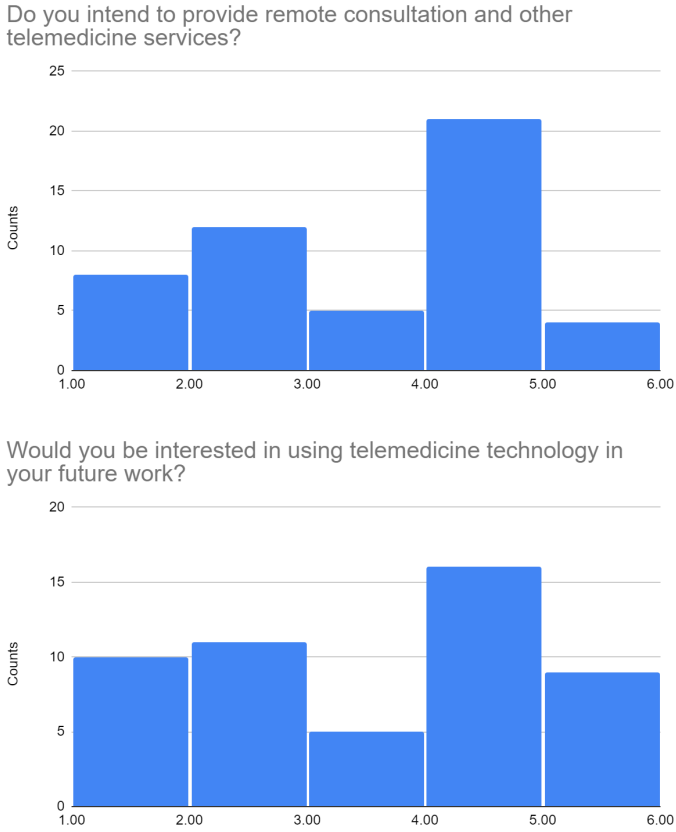

Fig. 7. Histograms of plans for future intention (left) and interest (right). Own Research with Google Sheets.

The Majority (36) of respondents express their willingness to take part in telemedicine projects in the future [Fig. 7]. When it comes to the willingness to use telemedicine technology in future professional work, the results are divided approximately in half.

Analytical Part

Let us create a cumulative index of attitude towards telemedicine: all_tele a sum of:

- „How do you rate your recent remote consultation with a doctor?" (1:5)
- „In your opinion, is telemedicine an effective form of therapy/diagnosis?" (1:5)
- „Do you consider telemedicine as a reliable form of therapy/diagnostics?"
- „Would you be interested in taking part in telemedicine projects?" (1:5)
- „Do you intend to provide remote consultation and other telemedicine services?" (1:5)
- „How do you evaluate the use of telemedicine technology?" (1:5)
- „In your opinion, are telemedicine technologies an effective form of therapy/rehabilitation?" (1:5)
- „Do you consider telemedicine technologies as a reliable form of diagnostics?" (1:5)
- „Would you be interested in using telemedicine technology in your future work?" (1:5).

Missing values were imputed at Random using the mice package in R.

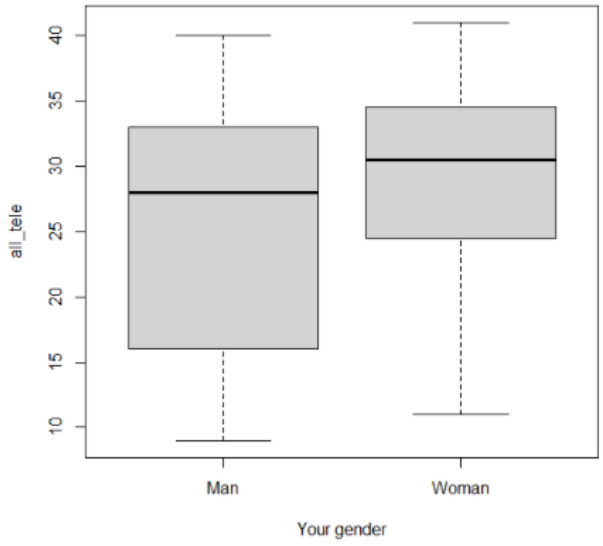

Fig. 8. Construct (all_tele) of all questions about telemedicine in ordered form in boxplot comparing genders. Own Research with R.

Women show a higher value of all_tele on average [Fig. 8]. Young women (who in Poland are the leaders in e-health (Duplaga, 2024; Kwiatkowska et al., 2020; Wójta-Kempa & Wolska-Zogata, 2020)) are more enthusiastic about telemedicine.

Table 1. Attitude towards telemedicine (LINEAR REGRESSION). Own Research with R.

Factor/Predictor AOV for all_tele	Df	Sum Sq	p-value
How often have you used telemedicine so far?	1	1456.1	1.4e−07
Cardiology	1	95	0.1114
What is your field of study?	7	622.1	0.0326
Your gender	1	56.9	0.2148
Residuals	40	1433.1	—

We clearly see that the field of study and previous experience significantly predict the attitude towards telemedicine [Tab. 1].

If we also take the results of the pilot of this study from 53 first-year paramedic students and apply the Welch Two Sample t-test: 104 case (study + pilot) on the question i.e. "How do you evaluate the use of telemedicine technology," then the difference in gender will be significant (p-value = 0.03) with a mean score of 3.5 (women) and 3.0 (men). This means that in the extended group, women were significantly more likely to show a positive attitude towards telemedicine tools, thus confirming the general trend mentioned earlier. This may also indicate that their belief calculations (with the use of the Health Belief Model (Rosenstock, 2000)), which will be described in the discussion, are more favorable for the development of these tools in the future.

Discussion

According to the respondents' answers, telemedicine is an area that many people are willing to use and have positive feelings about. The credibility of telemedicine [Fig. 4] is not rated very well, and one could consider what can be done to make people trust the methods and technology used in telemedicine more.

The technological enthusiasm of young women (higher than men in our sample) is a very good sign in highly feminised health professions. We see substantially higher [Fig. 8] acceptance of technology in women (29.5 in all_tele score) compared to men (25.2). Moreover, it seems that the willingness to use telemedicine [Fig. 7] among current students (59%) is lower than it was a decade ago, when it was 71% (although a different methodology, different construction of the sample (Glinkowski et al., 2013)). Polish health students have been already compared to others and our uniqueness is that no technology anxiety among women was observed, unlike in the Swedish sample (Dallora, et al., 2024). Such a profile may indicate not only greater confidence in using digital tools but also a readiness to adapt to the technological transformation of health care, which positions Polish students as particularly well-prepared for the future challenges of digital medicine.

It is also interesting that the vast majority of respondents were aware of the use of telemedicine in psychology [Fig. 5]. This is probably due to the fact

that we studied young people, aged between 20 and 35 (students or graduates). This age group spends a lot of time on social media such as Facebook, Instagram, TikTok, or Twitter/X, where psychologists' services offered online are very dynamically advertised. Additionally, in Poland and other countries as well, the topic of going to a psychologist is often still a taboo, and a person admitting to attending therapy may be stigmatised. However, it is changing, which requires searching for other explanations. As said before, this research generation, also referred to as „digital natives," is much more open to new technologies (e.g., applications for learning foreign languages). Hence, perhaps, there is greater interest in such methods among younger people, which provide an easier at-home and cheaper form of securing support, offering the sense of anonymity and autonomy.

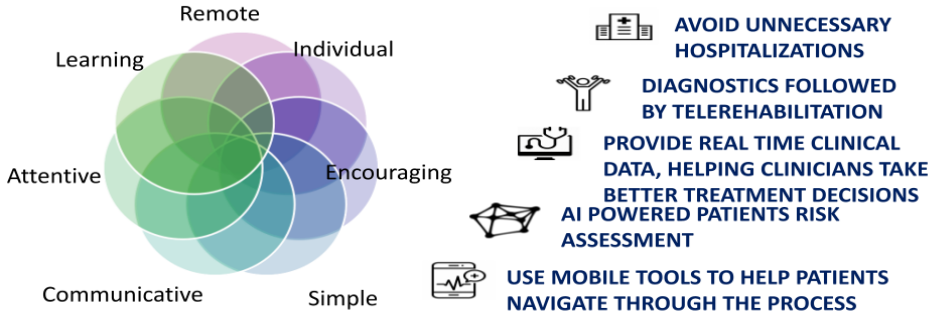

Fig. 9. Adopted RIESCAL model of inclusive telemedicine and telerehabilitation by S. Maksymowicz. Own research.

On the other hand, we see a decrease in the perception of usefulness of telemedicine in the last 10 years in a Likert (1-5) scale from ~4 in 2014 (different medical universities and different study populations (Polski et al., 2015)) to ~3 in our study (one point less). This may suggest that the optimism of the past decade is not shared anymore by new healthcare trainees to such an extent (Doniec et al., 2022). Thus, students need to change their mindsets to be encouraging for future remote work with patients [Fig. 9]. However, this requires a change in the perception of telemedicine. As numerous studies show, one of the barriers to its implementation is beliefs about telemedicine, which treat it as more of a lifestyle tool (e.g., smart watches). Therefore, there is a need for a significant shift in emphasis among young people towards treating telemedicine as a medical technology.

Conclusions

We can observe a decreasing optimism toward technology among health students. As discussed (Zybertowicz & Piekutowski, 2022), despite significant

advances in technology in the last 10 years, current health students are less prone to learn how to implement new technology compared to their counterparts in 2014 (Polski et al., 2015). This is in line with the authors' experience with patients' perception (Bogacz et al., 2024), who do not feel that telemedical solutions are part of "serious medicine," but rather more of a "fun" tool. Thus, a transformation of e-sport/play into serious tele-rehabilitation medicine has to be more clearly explained to students, who may have similar attitudes. In another medical university, there was discovered polarised pattern with ~30% of telemedicine enthusiasts and 15% of enemies (Frankowska, Walkowiak, Walkowiak, 2025). Such a high proportion of "enemies" among future healthcare professionals requires further investigation to understand the roots of resistance and to design effective educational strategies. This polarisation not only highlights the necessity of targeted educational interventions but also signals that without addressing these negative attitudes, telemedicine implementation in Poland may face structural barriers. Emphasising clinical evidence, patient safety, and the professional role of digital medicine in the curriculum could help mitigate resistance and build more balanced perceptions among future practitioners.

There may be several reasons for this situation:

1. Telemedicine tools are often part of an additional package for the patient, to which public entities rarely have access in practice.
2. Many tools of this type are still at the research stage, so access to them is limited by participation in grants.
3. The profitability of the tools is sometimes questioned compared to a face-to-face meeting—thus the valuation of such services is less favorable, limiting staff's time.
4. There is no single platform for their development, and each is provided by a different entity, which sometimes makes integration with hospital systems impossible.
5. There are numerous concerns related to the security of patient data processing in the IT system, which is a big barrier considering Poland's strict regulations.
6. Telemedicine tools, if they are to modify the patient's health, require certification, which is very expensive.
7. In practice, there are still few real possibilities of using these tools due to the lack of central procedures for their acquisition and use—this necessitates the creation of an appropriate team, open to technology, which would be willing to devote time to implementing it.

Of course, there may be more such barriers.

What is particularly interesting is that young women are driving change in telemedicine as they are significantly more enthusiastic about telemedicine. There is currently no gender difference in the current use of IT technology and telemedicine, but the future is in women's hands [Fig. 8]. The data we obtained also confirms analyses from other countries. For example, in one report (South-

wick, 2022) in „Chief Healthcare Executive," data was published indicating that „female doctors, and female patients, are more likely to use telehealth." The key in this dimension is that female physicians tend to spend more time with patients. But as a result, "while female physicians may be doing more to meet their patients' needs, they can end up earning less if they see fewer patients." Another study from the New England Journal of Medicine shows that women primary care physicians spend, on average, an additional 2.4 minutes with their patients, and they generated 11% less in annual revenue (Ganguli et al., 2020). Therefore, one explanation for women's greater openness to telemedicine tools may be the willingness to use additional tools to communicate with their patients. This, in turn, would allow them to devote more attention to them, which could be perceived as an important benefit. An alternative interpretation is that promoting STEM in the education of women in Poland (Sikora & Pokropek, 2012) is driving change; however, unfortunately, it is not entirely the case in the opinion of the authors.

Psychological chatbots [Fig. 5] are the most popular medical AI/distance solutions among health students, which may be a consequence of distance learning during the pandemic. Some sectors [Tab. 1] are more enthusiastic (paramedics), some less (beauty sector). However, it seems that these differences are difficult to explain by different approaches to using these tools at work. It even seems that they would be more useful in cosmetology than in emergency medical services. The observed differences should be explained by personal perception of the benefits: the work of a paramedic is very mentally demanding, so they actively seek psychological help, and in time-sensitive work, a chatbot may be one of the solutions, which affects their answers. Cosmetology, on the other hand, is not particularly strenuous, so the use of psychological chatbots by cosmetologists would probably be perceived as less important.

That may explain the huge interest in psychological chatbots [Fig. 5]. And it may be also a result of remote teaching during the pandemic: on one hand, health students are aware of some solutions on the market (Algner, et al., 2021); on the other hand, the most sociable time of their life was curtailed by lockdown due to COVID-19. Thus, young or future healthcare workers are digital nomads, and some of them could have fewer social skills, which is very dangerous for caring professions (such as physiotherapy or nursing).

For students pursuing careers in healthcare, understanding the latest technologies is not just advantageous; it's essential. Real-time signal broadcasting of surgical procedures from the operating theatre has been recognised as one of the key improvements of telemedicine in medical education at another Polish medical university (Borejsza-Wysocki, et al., 2024). Students especially appreciated the possibility of following live operations while receiving direct explanations from the surgical team, which helped them better understand each stage of the procedure. Such an approach not only made the learning process more engaging but also bridged the gap between theoretical knowledge and practical clinical experience, making telemedicine a valuable complement to traditional surgical training. By coupling wearable systems with Artificial

Intelligence frameworks, future healthcare workers (if they understand the sense of e-health and telemedicine) may have a much better picture of their patients. Industry 4.0, characterised by advancements such as cyber-physical systems, the Internet of Things (IoT), cloud computing, and Big Data analytics, offers transformative benefits to healthcare. These innovations extend well beyond simply enhancing service delivery (Zybertowicz & Piekutowski, 2022). They pave the way for a future where healthcare is smart, ubiquitous, and supportive, providing both patients and the general public with intelligent tools. These tools empower healthcare professionals and patients alike to make informed decisions, heralding a new era of healthcare that is both adaptive and insightful.

Thus, well-prepared students can implement telemedicine solutions for patients to improve access to specialised medical care. The study depicts future caregivers, who (through training and telemedicine) will be better able to provide care services with the ability to reconcile them with their own work (Tański et al., 2023). Moreover, students are exposed to modern technology (mainly AI-driven chatbots and mobile apps), and their knowledge of telemedicine is higher than that of current professionals (Walczak et al., 2022). However, students in our study seem to underestimate the usefulness of telemedicine.

Meanwhile, since in the future these health students will play a crucial role in providing modern solutions and the promotion of telemedicine, their possible technological hesitancy may affect their ability to mitigate professional concerns regarding AI (for instance, about privacy (WHO, 2024)) and help in more personalised treatment and prevention. Encouraging the adoption of telemedicine in future professional practice requires addressing technological and ethical competencies, ensuring the upcoming generation of healthcare providers is well-equipped to leverage telemedicine effectively. Thus, the question still remains: What can be done to ensure that young people (future medical professionals) use telemedicine and understand AI more often?

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