BABEȘ-BOLYAI UNIVERSITY OF CLUJ-NAPOCA
FACULTY OF PHYSICAL EDUCATION AND SPORTS
DOCTORAL SCHOOL OF PHYSICAL EDUCATION AND SPORTS

Online platforms – assistance in the practice of tennis by people with a sedentary workplace environment

PhD THESIS SUMMARY

PhD supervisor:
PROF. UNIV. DR. HANȚIU IACOB

PhD student:
ȘERBAN RADU-TIBERIU

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List of published works

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THE CONTENT OF THE THESIS

Keywords: leisure exercise, tennis, online platform, employees with sedentary jobs

The synthesis of the main ideas

Information from the literature on fitness, leisure exercise and modern pedagogical means has led us to wonder how specialists in the field of physical education and sports can effectively use leisure exercise programs supported by a web platform in order to improve physical fitness and the tennis technique.

Knowing the beneficial effects of physical activity and the advancement of information technology, we considered it useful to create a web platform to host educational documents (schedule, feedback sections, results, audio files and video tutorials) in support of leisure time tennis lessons for people with sedentary jobs.

This research is an applied one, in which, starting from the specialized literature, we looked for a more productive method for the implementation of leisure physical activity programs, using some modern pedagogical applications offered by current web technology, assuming that they will improve the results of subjects who have access to them.

In this way we wanted to increase the degree of knowledge of this subdomain located in the area of tangency between the field of physical education and sports and information technology. We started by creating a picture of the level of physical activity among IT employees. We continued with the involvement of some subjects in the physical activity programs consisting of field tennis lessons. The evolution of the results obtained between the initial and final tests, as well as the feedback received from the participants, were encouraging and allowed us to conclude that this intersection of the fields of physical education and sports, information technology and pedagogy can be beneficial and is likely a necessity in the context of the current direction of development of society and technology, as well as in exceptional situations where remote work is required.

The paper was structured in three parts:

- Part I - Reflecting the research topic in the literature;
- Part II - Pilot study
- Part III - Own research

The following is a summary of the main parts of the doctoral thesis.

PART I – REFLECTION OF THE RESEARCH TOPIC IN THE SPECIALIZED LITERATURE

In this part of the paper, reference was made to the perspective of specialists on physical fitness, physical activity and inactivity, as well as on the content and benefits of playing tennis. Attention was also paid to the use of Information and Communication Technology (ICT) in leisure activities and to examples of the incorporation of ICT in physical activities, presenting both the importance of electronic connections and the challenges in technology-assisted teaching.

If in the past physical education had a military character and was aimed at training the soldiers of armies, cohorts and legions, today, physical education is more peaceful and contributes to the physical, mental and social well-being of its practitioners, increasing the quality of life of the human population.

As the human society evolved, physical education has changed in many ways. Occupations of hunters, gatherers and farmers, once with a majority share in the "labour market", have been replaced in the ranking by sedentary jobs that take place from the office, often in front of a computer screen or behind a mobile phone.

Sedentary behaviour is defined as those “activities without or with low energy consumption undertaken from a sitting or lying position during the day (not during sleep)” (Network SBR, 2012).

According to the Council of Europe (1995), it has been found that although physical demands on the workplace are declining, if there is no physical activity in leisure time that increases the level of fitness, people's work capacity decreases to a critical level. Functional capacities at a sufficiently high level not only maintain the capacity to engage in leisure activities, but also become fundamental for maintaining functional independence and social integrity. Good physical fitness is thus an indispensable component of the general well-being of the middle-aged population and the elderly population.

In the United States, research estimates conclude that adults behave sedentarily between 7.2 and 9.5 hours a day and the number of hours increases with age (Matthews, Chen, Freedson, Buchowski, & Beech, 2008).

In France, La Direction de l'Animation de la Recherche, des Études et des Statistiques (DARES) shows that the percentage of employees working more than 20 hours a week in front of a screen increased from 11.9% in 1994 to 22.6% in 2010, with a sharp increase in the case of

managers, from 18.3% to 46.1% (Arnaudo, et al., 2012). For these reasons, researchers recommend the implementation of physical activity programs for employees.

According to Ng & Popkin (2012), sedentary activities - work and leisure - have increased a lot lately, from 26 to 38 hours per week between 1965 and 2009 in the United States and from 30 to 42 hours between 1960 and 2005 in the UK, with alarming prospects for 2030.

Nowadays, jobs with sedentary activities are considered to be a possible health risk factor. According to studies conducted by Wen & Wh (2012), of the 36 million deaths related to noncommunicable diseases recorded annually worldwide, 5.3 million deaths have causes related to physical inactivity.

Along with physical inactivity, excess body weight appears, considered by some researchers as "an epidemic with major health repercussions, which comes with high costs related to treatment" (Sarmiento Quintero, Ariza, & Barboza García, 2016). Because obesity has become so harmful and expensive, an entire industry of diets and physical activity programs has been created (Obert, Pearlman, Obert, & Chapin, 2017).

Although the mechanisms by which physical inactivity increases the risk of cardiovascular disease (CVD) is not fully understood, it is shown that both aerobic and endurance training improve the lipid profile (Gullu et al., 2013), body composition (Atashak, Piraeus, Azarbayejani, Stannard, & Mosalman Haghigi, 2011), blood pressure (Murphy, Neville, Murtagh, & Holder, 2007) and reduce other risk factors for cardiovascular disease.

At the other end of the spectrum are the positive effects of exercising. Health benefits of leisure-time physical activity include reduced mortality in general (Kelly, Kahlmeier, & Gotschi, 2014), mortality and cardiovascular disease (Wilmot, Edwardson, & Achana, 2012), and mortality from colon cancer (Je, Jeon, Giovannucci, & Meyerhardt, 2013) and by breast cancer (Fong, Ho, & Hui, 2012), lower back pain (Steffens, Maher, & S, 2016) or depressive symptoms (Catalan-Matamoros, Gomez-Conesa, Stubbs, & Vancampfort, 2016). Also, practicing physical activities in free time is one of the key elements of active and healthy aging (Hupin, Roche, & Gremeaux, 2015).

Nowadays we are witnessing the presence in everyday life of an avalanche of online applications, the increase of communication speed and a change in the way people choose to get informed. Online platforms and web applications offer the possibility to streamline activities in many, if not all areas, and reduce costs related to their organization.

According to the specialized site Source Reader, the benefits of using such means include the fact that web applications can run simultaneously on several platforms or devices, compatible with each other. At the same time, modern technologies allow them not to be installed on the

hard drive, thus eliminating space limits. In addition, they reduce costs for stakeholders (platform owner and end-users), lower support requirements and system requirements. In this context, online applications and platforms are also present in individual well-being. In recent years, there has been an evolution of technologies and, at the same time, an evolution of their users.

Muntaner Mas et al., (2019) believe that we are witnessing the beginning of a new era of technology in health and sports. They believe that web applications created to assess cardio-respiratory fitness have great potential for development, noting that many of the available applications are not valid or reliable, suggesting that most are of low to moderate quality.

In this context, we started our research from the idea that the use of amateur tennis programs, supported by a web platform with pedagogical resources, can have greater beneficial effects on body composition, physical fitness indices and on the technique of game than in the absence of this learning ecology.

Barron (2004) defined the ecology of learning as: "the set of contexts found in physical or virtual spaces that provide learning opportunities. Each context is composed of a unique configuration of activities, material resources, relationships and interactions involved. If we consider this definition, we can see that modern technologies facilitate participatory relationships, access to information and even the common construction of learning.

Koehler and Mishra (2008) build on Shulman's (1987) idea that teachers should be able to apply their content knowledge in a pedagogical way that is adaptable to students' characteristics and educational context.

The means of information and communication technology (ICT) are today widely applied in areas such as health and physical education. They are often used to manage and monitor the implementation of movement programs in the field of leisure activities or even for the training of top athletes.

In the science of sport and physical education these modern means are used in diagnosis, improving the performance of the musculoskeletal system and in physical activity programs that aim to improve general health, while having an important role in the process of learning, strengthening and improving motor skills.

They have become indispensable for modern sport, being used in the teaching process of a sport or in working with high-level professionals. In addition, in the process of including new technologies, it is important to educate all participants involved in this process, so that they can use modern technologies independently.

The literature suggests that effective technological integration with a specific subject requires teachers to apply their knowledge of curricular content, general pedagogy and technologies. This approach, known as "Technological, Pedagogical and Content Knowledge (TPACK)" (Koehler & Mishra 2008), is based on Shulman's (1987) idea that teachers should be able to apply their content knowledge in a pedagogical, adaptable to the characteristics of the children and the educational context (for example, the gym). Therefore, the relationship between technological knowledge and pedagogical forms of content knowledge is the basis of technological pedagogical content knowledge (TPACK):

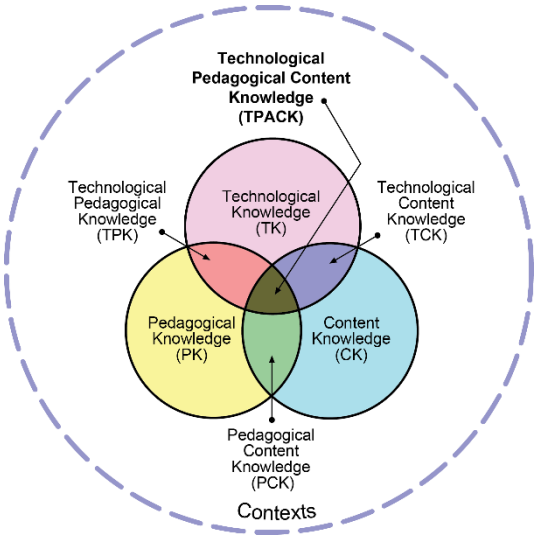

Figure 2 - Graphic representation of the Technological, Pedagogical and Content Knowledge (TPACK) model. Retrieved and translated from TPACK.ORG, author M. Koehler, 2011, http://www.tpack.org/. Reprinted with permission of the author, © 2012 by tpack.org"

Monguillot, González, & Guitert (2015) state that when ICT tools are used correctly, they become a powerful tool for promoting a healthy lifestyle. Moreover, the implementation of ICT tools in leisure tennis training has proven to be useful, helping to achieve better results. The implementation method can be further improved, possibly by developing applications for portable devices that use operating systems such as Android or iOS. It is also possible that such interventions will be beneficial on the motivational side, a variable that can be measured in future research.

However, we believe that technological equipment and tools, even the most advanced ones, should not replace the teacher or the sports coach, as they should be seen as tools that improve the teaching process.

PART II – PILOT STUDY

Chapter 4. Tennis as a recreational activity: organization and effects in adults with a sedentary job

4.1. Introduction

This pilot study was the first step in our research on the effects of physical activity programs on physical fitness and on the technique of performing technical procedures. The target population consisted of people with sedentary jobs in Cluj-Napoca. Taken as a whole, our activity involved the selection of subjects, their involvement in the physical activity program or in the control group and their evaluation before and after the intervention.

Over the years, several test batteries have been developed to assess fitness. The first to create tests applied to large populations were the North Americans, in the middle of the twentieth century, followed by Europeans who developed the Eurofit test battery in the 1970s. Since then, many other means of assessing physical fitness have appeared in the third millennium, Eurofit became the most widely used test battery in Europe (Jurimae & Volbekiene, 1998).

Details regarding the organization of the study are presented below.

4.2. Purpose and objectives

The purpose of the research was to verify the work protocol, the intervention program and the measuring instruments used to evaluate the effects of a leisure physical activity program, based on the organized practice of field tennis, on physical fitness.

The following objectives have been set for this pilot study:

- checking the selection procedure of the subjects and the communication with them;
- elaboration and verification of training programs in field tennis, targeting employees from Cluj-Napoca with sedentary jobs;
- evaluation of the influence of participation in this program on morphological and physical indices;
- evaluation of the working protocol;

4.3. Assumption

The assumption of this study was that following the participation of subjects with sedentary activity at work, in a tennis practice program, the subjects' physical fitness indices are improved.

4.4. Materials and methods

Subjects

Subjects (N = 24) were selected divided into the control group (N = 4) and the experiment group (N = 20), depending on the desire of the subjects.

To communicate effectively with the subjects, a section dedicated to our project was created on a website of the students' association of the Faculty of Physical Education and Sports from Babeș-Bolyai University (http://miscareasportiva.ro - ITennis menu).

Methods

The following research methods were used to conduct this pilot study:

- Method of studying the literature;
- Survey method, by applying 3 online questionnaires;
- Observation method;
- Measurement method;
- Practice method;
- Statistical method for the analysis of the collected data: SPSS v.20, Shapiro-Wilk test, non-parametric tests for independent samples (U Mann-Whitney) and for paired samples (Wilcoxon);

Organizing and conducting the pilot study

A synthesys of the stages of the pilot study is found in Table 2:

Table 1 – Stages of activities in the pilot study

Activity	1.II - 8.III 2016	28.III - 14.IV 2016	12 - 19.IV 2016	25.IV - 1.V 2016	2.V – 12.VI 2016	13-17.VI 2016	20-24.VI 2016	25-30.VI.2016
Discussions with company representatives								
I1 questionnaire application								
Availability questionnaire application (I2)								
Initial mesaurements								
Intervention								
Friendly tournament								
Final measurements and data processing								
Feedback to company representatives								

4.5. Results

The first part of this subchapter presents the results of the responses to the initial questionnaires.

The I1 questionnaire had a number of 55 respondents, of which 26 men and 29 women, all being employed in sedentary jobs (IT companies) in Cluj-Napoca, Romania.

The average age of the respondents was 28.85 years (Men = 29.69 years, Women = 28.1).

Regarding the daily physical activity, the analysis of the participants' answers shows that men exercise on average in 2.58 days a week, and women on average in 2.72 days a week (the answers were given on a scale from 1 to 8, where 1 meant that he did not practice planned physical exercises on any day of the week and 8 meant that he practiced planned physical exercises daily).

In the item *on a scale from 1 to 10 self-assess your level of play*, the subjects said that their level of play in field tennis is low (Figure 30), resulting in the average knowledge of the game being 2.14.

The means were then compared using the Mann-Whitney U test to track the statistical significance of the difference between the subjects in the experimental group and those in the control group. We can observe that there is statistical significance between averages in the case of the "Sit and reach" test (p = 0.02) and in the dynamometry of the palm flexors (p = 0.01). In the case of the averages of the other variables there is no statistical significance.

Table 2 - Comparison of averages of independent samples after intervention (N=24)

Test	U	Z	p	r
Sit-and-reach test (cm)	10	-2,33	0.02	-0,48
Single leg balance test (rep)	30.5	-0.85	0.40	-0,17
Plate-tapping test (sec)	18	-1.7	0.09	-0,35
Vertical jump (cm)	25.5	-1.13	0.26	-0,23
Dinamometry (kgs)	8.5	-2.44	0.01	-0,50
VO_2max (ml/kg/min)	8	-0.73	0.46	-0,15

Statistical analysis of the results of the Eurofit adult test battery samples also shows that in the case of the experimental group, significant differences can be observed between the two measurements in the sit and reach test (p = 0.001), single leg balance test (p = 0.04), in the plate-tapping test (p = 0.001) and in the dynamometry of the palm flexors (0.003).

Table 3 – Comparison of average sample pairs in research groups (N=24)

	EG (N=20)			CG (N=4)		
Test	Z	p	r	Z	p	r
Sit-and-reach test(cm)	-3.56	0.001	-0,58	-1.63	0.10	-0,56
Single leg balance test (rep)	-2.05	0.04	<0,001	0	1.00	-0,32
Plate-tapping test (sec)	-3.77	0.001	-0,65	-1,83	0.07	-0,60
Vertical jump (cm)	-1,31	0.19	-0,38	-1,06	0.28	-0,21
Dinamometry (kgs)	-2,95	0.003	-0,57	-1,6	0.11	-0,47
VO_2max (ml/kg/min)	-0.78	0.43	-0,47	-1,34	0.18	-0,12

In the case of the control group, no statistically significant differences were identified.

From the descriptive analysis it is observed that the fitness indices improved in the case of the experimental group in the case of tests such as vertical jump (M = 1.85 cm), Body Mass

Index (0.06 kg / m2), waist-hip ratio (0.07), sit and reach (4.25 cm), single leg balance (0.6 reps), plate-tapping (1.37 sec) or palm flexor dynamometry (7.97 kg).

At the same time, in the control group the progress was lower: sit and reach (0.625 cm), plate-tapping (0.46 sec) or non-existent as in the case of the single-leg-balance test. Regressions were also noted in tests such as vertical jump (-1 cm), Body Mass Index (-0.15 kg / m2), waist-to-hip ratio (-0.012) and palm flexor dynamometry (-4.17 kg).

It was also noted that the subjects in both groups had an increase in the estimate of the percentage of fat tissue and that both groups registered an increase in the Eurofit Fitness Index and VO_2max.

Table 4 - Mean and standard deviations of the measurements in the pilot study (N=24)

Test	E.G. (N=20)		C.G. (N=4)	
	Initial testing M (SD)	Final testing M (SD)	Initial testing M (SD)	Final testing M (SD)
Sit-and-reach test(cm)	4,68 (8.28)	8.93 (8.59)	-3.38 (6.42)	-2.75 (6.7)
Single leg balance test (rep)	1.8 (1.4)	1.2 (0.52)	2 (1.41)	2 (1.41)
Plate-tapping test (sec)	12.65 (1.48)	11.27 (1.24)	12.84 (1.27)	12.38 (1.19)
Vertical jump (cm)	44.2 (7.45)	46.05 (7.37)	40.5 (8.35)	39.5 (9.26)
Dinamometry (kgs)	46.27 (20.92)	54.25 (22.53)	55.25 (25.94)	51.08 (25.87)
Body mass index	22.79 (3.61)	22.73 (3.60)	21.42 (1.47)	21.57 (1.44)
Body fat estimate	15.95 (5.39)	18.4 (6.07)	13.5 (4.04)	16.25 (4.65)
Waist-to-hip ratio	0.78 (0.09)	0.78 (0.1)	0.83 (0.11)	0.84 (0.11)
Eurofit Fitness Index	75.31 (21.42)	78.62 (13.55)	79.77 (26.39)	89.93 (27.3)
VO_2max	40.53 (11.78)	41.26 (8.58)	43.55 (15.78)	47.02 (17.54)

4.6. Discussions

An article published by Lang et al. (2017) lists best practices for implementing employee-oriented programs in the workplace. It can be seen that there are similarities between the methodology of our study and the recommendations of the authors mentioned above.

Therefore, Lang et al. (2017), following the analysis of some representative studies that included well-designed workplace health programs, concluded that the following aspects are to be considered when organizing such activities:

- to start with a "buy-in", i.e. to obtain the guarantee of the development of the activity by the company's management (leadership, support and involvement being crucial for the beginning and development of the program);

- validate the values promoted by the program and highlight the purpose and objectives of the program;

- to think carefully about the working methodology, as the programs carried out on the existing good practices have a higher chance of success;

- to fully involve the management of the company, going beyond the involvement of senior management, and aiming at activating secondary management.

The percentage of subjects involved in research out of the total number of volunteers (24 out of 55, i.e. 43.63%) is similar to other similar programs, such as Work @ Health (21 out of 41, i.e. 51.21%), carried out by CDC (Centre for Disease Control) and described by Lang et al. (2017).

Regarding the way of recruiting subjects, the medium we have chosen is in line with some trends encountered in recent research.

Greiner (2015) presents an evolution of the recruitment procedures of the subjects used in recent years. He says that before the spread of the Internet and web applications for database management, a wide range of procedures were used to recruit research participants. These include teams of research assistants who came into direct contact with each candidate and distributed hundreds of registration documents.

Since the widespread implementation of the technology, e-mails and other digital means such as Google questionnaires have become the main way to distribute recruitment documents in research, simplifying and reducing the costs of the recruitment process. The way the subjects enrolled in our study is in line with this digitalization trend.

The test-retest reliability of the Eurofit battery was studied by Tsigilis, Douda, & Tokmakidis (2002) on a total of 98 students in Greece. In the above-mentioned study, all Eurofit tests on motor performance and anthropometric measurements were obtained twice a week between the two measurements. The Intraclass correlation coefficient indicated satisfactory coefficients of over 0.70 in most tests. The only exception was the plate touch test, which gave a low value (0.57). These findings indicated that the Eurofit test battery provided reliable data for students.

As expected, regular physical activity improves fitness indices, but apparently the quantity, quality and type of movement involved influence indices. Studies (Erikoglu, Guzel, Pense, & Erikoglu Orer, 2015), which use the Eurofit test battery to measure physical fitness, showed statistically significant differences between active football players and sedentary counterparts in the one-legged state test, throwing the ball medications, 20m shuttle running and VO2max values ($p < .05$), although no significant differences were found in the sit and touch test, vertical jump, 30-second abdominals and plate-touch test . In our study the results are in the same pattern of progress for the subjects in the experimental group and stagnation for those in the control group.

In the case of those variables where no progress was made in the case of the experimental group, an explanation could be the short duration of the intervention. Also, the small number of subjects can influence the statistical analysis of the results.

4.7. Conclusions

At the end of the study we found the fulfilment of some objectives and we formulated useful conclusions for future studies:

- the training program in tennis, targeting employees with sedentary jobs in Cluj-Napoca (employees in the IT field) was carried out according to the proposed methodology, a number of 55 people coming into contact with us with the intention to participate in the intervention;
- participation in this program influenced the physical fitness of the subjects, even if the intervention lasted only six weeks.
- the training means and research methods were accessible to the subjects and thus we had the premises to improve the working protocol that was used in our subsequent studies.

One limitation is the short duration of the deployment and the small number of subjects, but the objectives of this preliminary study for the verification of the research tools and method were achieved.

For eliminating the difficulties, we encountered, in the following studies we will apply some changes:

- a longer intervention, with more subjects involved;
- learning more tennis strokes;
- adding more means of developing the physical fitness;
- preventing the interruption of training due to weather conditions by taking our future lessons on tennis courts covered with a presostatic acclimatized balloon;

Also, for easing the fitness evaluation we will replace the 2km walking test with the 20m shuttle run test, because the second has the advantage of being independent from bad weather conditions, by being applied indoors.

At the end of the intervention, both the participants and the representatives of the collaborating companies showed interest in participating in future programs.

PART III – RESEARCH REGARDING THE USE OF ONLINE PLATFORMS IN THE PRACTICE OF RECREATIONAL TENNIS BY SEDENTARY-WORKERS

Background

The conclusions of the pilot study confirmed that a leisure physical activity program, through tennis, is feasible and would benefit from support from both the management of partner companies and their employees who could participate in future studies.

In the third part of the paper were presented their own research on the effect of playing tennis by people with a sedentary job. These studies aimed at the effect of subjects' participation in physical activity programs on physical fitness and play techniques.

The first study refers to the effect of tennis on fitness, being the more evolved version of the pilot study. In carrying out this research, the lessons learned from the preliminary study were considered, among others.

We mention that in the second and third study the physical activity program benefited from the support of a web platform used in the case of one of the experimental groups. We have thus integrated means of information and communication technology in the instructive-educational process, for recording, managing and visualizing the results of the subjects as well as for facilitating the organization and communication with all subjects. It was tried, therefore, that through this virtual environment we can provide additional theoretical and motivational support to the subjects from the experimental groups during our intervention.

While in the second study the goals and objectives refer to physical fitness (relative aerobic power and strength of the palmar flexors), in the case of the third study they are oriented towards the playing technique in tennis. Thus, the results obtained regarding the elements of physical fitness are presented in chapter VI and the results recorded regarding the playing technique in chapter VII.

Chapter 5. Study I – Tennis as recreational physical activity in sedentary adults: the effect on physical fitness

5.1. Introduction

Leisure sedentary behaviour is very present in middle-aged adults and several studies have indicated that sedentary lifestyle during this period is associated with a high risk of mortality due to CVD (Warren et al., 2010). In this context, we want to see what effect a program of physical activity of free time has, consisting in the practice of tennis, on the body mass index, the estimation of adipose tissue and the ratio between waist and hips. This is interesting to see how a mixed physiological effort (aerobic, sprinkled with moments of anaerobic effort) influences the indices of the measurements listed above.

5.2. Purpose and objectives

The aim of the research was to analyse the effect of a leisure physical activity program based on the organized practice of field tennis on physical fitness in subjects who perform sedentary work.

The objectives of this research were:

- the elaboration of the intervention program;
- the motor and anthropometric evaluation of the selected subjects, before and after the application of the intervention program;
- the statistical analysis of the data recorded at these evaluations.

5.3. Assumptions

The first assumption of this research is that following the participation of some subjects with sedentary activity at work, in a tennis practice program, the physical fitness indices of the subjects are improved. The second assumption is that between the anthropometric measurements and the Eurofit tests there is a relation.

5.4. Materials and methods

The research was performed on a sample of 43 volunteer subjects who had a sedentary activity at work (they worked in Cluj-Napoca in the IT field). Participants were divided into two groups - 27 subjects (12 women and 15 men) in the experiment group (GE) and 16 subjects (5 women and 11 men) in the control group (GC). All participants were informed about the content and purpose of the research and gave their written consent to participate before the study began.

Methods

The following research methods were used to conduct this study:

- Method of studying the literature;

- Survey method;
- Observation method;
- Measurement method;
- Practice method;
- Statistical method for the analysis of collected data: SPSS v.20, Shapiro-Wilk test, parametric and non-parametric tests for independent samples (T-test and U M-W) and for paired samples (T-test and Wilcoxon) and the analysis of the Pearson and Spearman correlation coefficients.

Organizing and conducting the study

A summary of the stages of this research is presented in the diagram below:

Table 5 - Stages of activities in Study I

Activity	20-30.VI 2016	13-20.X 2016	21-31.X 2016	31.X - 13XI. 2016	2.XI.2016 –5.IV 2017	15.III – 5. IV 2017	5-12. IV.2017
Discussions with company representatives							
I1 questionnaire application							
Availability questionnaire application (I2)							
Initial mesaurements							
Intervention							
Final measurements							
Feedback to company representatives							

The study took place between November 1, 2016 - April 5, 2017, during which the subjects from the experiment group participated in a recreational tennis practice program containing field tennis lessons lasting 90 minutes, twice a week.

The development of the intervention program in which the subjects from the experimental group participated was based on the training lessons described in the annexes.

During all this time, the subjects in the control group continued their daily activities without participating in an organized way in new activities involving physical exercises.

During the 22 weeks of intervention, 19 lesson plans were used. In the first 16 weeks, one lesson plan per week was used, and in the last 6 weeks, one lesson plan applied for two weeks. Tennis lessons are described in Annex 15.

The research began with the initial assessment of the subjects' physical fitness by applying tests contained in the Eurofit Adult Test Battery (Council of Europe, 1995) according to the

protocol described in the pilot project with the difference that for the calculation of relative VO_2max we replaced the 2km walking test with the 20m shuttle run test.

Data from the measurements provided by the Eurofit Adult test battery were statistically processed using SPSS statistical analysis software, version 20. Initially, the Shapiro-Wilk test was used to verify normality of distribution and descriptive analysis (mean and standard deviation), followed by comparison of means using parametric (T-test) or nonparametric (Wilcoxon and U Mann-Whitney) tests, depending on the data distribution.

5.5. Results

Answers to questionnaires

Study participants (N = 43) were adults aged 23 to 38 years (28.95 ± 4.31). Of these, 60.46% were male (N = 26) and 39.54% female (N = 17), all being employed in IT companies.

According to the answers to the initial questionnaires, the following could be found:

- the vast majority (77.8%) of the subjects involved in Study I practiced the planned physical exercises;
- for those who planned exercise, the amount of activity ranged from 1-2 hours per week to over 4 hours and it was found that most respondents met the WHO recommendations regarding the amount of exercise performed;
- 87.5% of the respondents carried out physical activities in at least 4 months of the year, while 47.5% carried out organized physical activities for at least 9 months of the year;
- about a quarter (25.9%) of the subjects had not practiced field tennis at all, the vast majority (63%) considered themselves initiated in field tennis, while only 11.1% considered themselves advanced players. No player has evaluated himself as a former performance player.
- only 2 subjects (3.8%) specifically wanted to be part of the control group, while the vast majority (92.3%) wanted to be part of the experimental group. Another 2 subjects (3.8%) agreed to participate in either group;
- the locations preferred by the subjects for the intervention were Dr. Iuliu Hațieganu Sports Park (45%) and Winners Tennis Club (42.5%);
- the afternoons of the first 4 days of the week (Monday-Thursday) were preferred by most subjects, with a lower availability for the weekend and the mornings of the working week.

Their distribution in the experiment group and the control group was made according to the participants' choice.

The research started with the initial measurements, followed by the application of the proposed intervention program for 4.5 months. At the end of this period, the final measurements were performed under conditions identical to those from the initial test.

Motor test results

The results recorded in the motor tests highlighted the presence of statistically significant changes in the physical fitness indices of the subjects in the experimental group: balance ($p = 0.01$), plate-tapping test ($p < 0.001$), vertical jump ($p = 0.05$), palm flexor dynamometry ($p < 0.001$), bent-arm-hang test ($p = 0.01$), 20m shuttle-run test ($p < 0.001$), aerobic endurance ($p < 0.001$), body-fat estimation ($p < 0.001$) and body fat index ($p = 0.001$).

At the end of the intervention, using the Mann-Whitney U test, the statistical significance of the differences between the means of the measured variables in the subjects from the experimental and control group was verified. It was observed that after the intervention there is statistical significance between averages in the case of hand flexor strength ($p = 0.04$), bent arm hang test ($p = 0.04$), shuttle run test ($p = 0.003$) and VO2max ($p = 0.002$), body fat estimate ($p < 0.001$), waist-to-hip ratio ($p = 0.05$) and body adiposity index ($p = 0.004$).

Between the anthropometric measurements and the results of the motor evaluation, positive, average correlations were found between the height and the strength of the palmar flexors.

Small positive correlations were found between: weight and waist-to-hip ratio, weight and strength of the palmar flexors, height and waist-to-hip ratio, height and vertical-jump.

Average negative correlations were recorded between: body fat index and the 20m shuttle run test, body fat estimate and upper limb speed, body adiposity index and upper limb speed, body fat estimate and palmar flexor strength, body fat estimate and the 20m shuttle run test and between the body fat estimate and the relative aerobic power.

Small negative correlations were found between: weight and balance, body fat index and relative aerobic strength, body adiposity index and balance, body mass index and balance, body fat estimate and vertical jump, body fat estimate and upper limb strength.

5.6. Discussions

The general findings of similar research indicate that those who choose to play tennis as a recreational activity have benefits for both their physical fitness and health. These are lower percentages of body fat, more favourable lipid profiles and improved aerobic capacity, which have helped reduce the overall risk for cardiovascular morbidity (Pluim, Bonita, Marks, Miller, Miley, 2007). Also, the same authors note the results of numerous studies that have identified

better bone health not only in the case of tennis players who participate in tennis throughout life, but also in those who started tennis in adulthood.

In the literature there is a paradigm that associates excessive sedentary behaviour with higher levels of excess body weight and obesity in adults. Other researchers (Biddle et al., 2017) suggest a more cautious conclusion. They consider that a large part of the evidence is not such as to support such an association, and studies that have found significant associations have mainly indicated small effect sizes. There is some evidence of higher obesity and increased BMI in adulthood caused by sedentary behaviour in childhood and adolescence and emerging evidence for an association between the frequency of sedentary time interruption and decreased BMI. In addition, the use of motor vehicles and the risk of excess body weight and obesity show positive relationships. However, the causality between sedentary behaviour and obesity in adults cannot be fully demonstrated.

A relatively recent study (van Gemert et al., 2015) shows that physical activity programs or nutrition plans applied to overweight or obese women, bring positive changes to some biomarkers of breast cancer risk, body weight and health self-perceived. From a total of 243 eligible subjects, through a random distribution, a group was created for which a nutrition plan was drawn up (N = 97), a group for which a physical activity program was organized (N = 98) and a control group (N = 48). Both interventions aimed at a weight loss of 5-6 kg. Health-related quality of life was measured at the beginning of the intervention and after 16 weeks using the SF-36 questionnaire. From the data analysis of 214 subjects, weight loss was 4.9 kg (6.1%) diet and 5.5 kg (6.9%) through physical activity. Questionnaire scores increased significantly in the "health change" area by 8.8 points through diet and 20.5 points through exercise, compared to the control group. The direct comparison of diet with exercise showed a statistically significant improvement through exercise. Although there were improvements for both experimental groups and in other areas covered by the questionnaire, they were not statistically significant compared to the control group or compared to the experimental groups. The authors also conclude that an improvement, even a modest one, leads to a positive change in self-perceived health status.

Improvements in body composition were also obtained in a study that included a concurrent exercise program (a combination of aerobic and endurance training). The authors of this research (Atashak, Stannard, & Azizbeigi, 2016) state that there are changes in body composition in both men and women shown by research involving strength training (Atashak, Piraeus, Azarbayejani, Stannard, & Mosalman Haghigi, 2011) or resistance (McTiernan et al., 2007).

In this context, it is interesting to analyse the effects of tennis specific training (mixed effort, aerobic-anaerobic) on body mass index, body fat estimation, waist-hip ratio and body adiposity index.

The study also highlighted that the effect of a recreational tennis program also depends on the duration of the program and the duration of a training session. Comparing the results recorded in this research with those of a previous research (Șerban & Baciu, 2017), we find that the effect of the intervention program extends to several evaluated variables. We mention that in the present study the research methodology has undergone several changes. These consisted of the following: for the calculation of VO_2max, the 2km walking test was replaced with the 20m distance running test, the intervention period was extended from 6 weeks to 4.5 months, the duration of the training lesson it was 90 minutes instead of 60, other elements and technical procedures were involved. This comparison was therefore made to exemplify the usefulness of the proposals made at the end of the pilot study.

5.7. Conclusions

The hypothesis that following the participation of some subjects with sedentary activity at work in a field tennis practice program, the physical fitness indices and the body composition indices are improved is confirmed. However, the end of the study finds that differences between the averages of the variables measured in the two research groups are not significant for flexibility, balance, coordination and vertical jump.

Between the anthropometric measurements and the results of the motor evaluation, statistically significant correlations were found, before and after the intervention, the most important being the following:

- a moderate positive linear relationship between weight and waist-to-hip ratio;
- a moderate positive linear relationship between height and strength of the palmar flexors;
- a moderate positive linear relationship between body adiposity index and the plate tapping test;
- a moderate negative linear relationship between the body adiposity index and the 20m shuttle run test;
- a moderate negative linear relationship between body adiposity index and relative aerobic power;
- a moderate positive linear relationship between the body fat estimate and the plate tapping test;

- a moderate negative linear relationship between the body fat estimate and the bent arm hang test;
- a moderate negative linear relationship between the body fat estimate and the 20m shuttle run test;
- a moderate negative linear relationship between the body fat estimate and the relative aerobic power.

In carrying out this study some difficulties were encountered: the number of participants was reduced due to the peculiarities of training in tennis - for a good density of the activity a coach can manage at the same time a maximum of 6 players on a court; the relatively late hours at which the intervention took place, the employees having to start the trainings after the work schedule and finish them sooner, in order to be able to rest for the next day; the costs are not negligible, but if such programs are supported by both employers and employees, they should not be a major difficulty.

Summarizing the above, we can conclude that such programs are useful and should be implemented in as many companies and units in the business environment, and the study of new methods of implementation and conduct of such interventions is necessary.

Chapter 6. Study II - Using an online platform to study the effects of recreational tennis on the relative aerobic power and strength of the palm flexors

6.1. Introduction

According to the literature, even moderate-intensity physical activity has a protective effect on health, confirming that exercise and an active lifestyle are decisive factors for successful aging Chodzko-Zajko et al. (2009). Research on this topic has led to the creation of recommendations, guidelines, protocols, policies and networks implemented for the well-being of people of all ages.

Information and communication technology (ICT) are also present in individual well-being. In recent years, there has been an evolution of developed technologies and, at the same time, an evolution of their users.

In the context of movement and sports science, the use of technology has changed and decisively enriched the teaching-learning processes, methods, assessment tools and archiving of data on the activities and physical performance of participants, while requiring the updating of specialists in our field. their skills and their continuous training.

The use of tools and applications in physical education, as well as on the Internet, can implement a dual perspective for students and teachers: promoting conscious physical activity, favouring an extension of the educational effects of intervention in physical activities and sports even after periods of activity in gyms (self-assessment of performance, levels of physical activity and related behaviours) but also increasing the quality of the educational process and communication between practitioners / athletes and specialists.

Also, through various ICT means, it is possible to promote the highlighting of successful participants in each task, thus strengthening the student's behaviour (Eberline & Richards, 2013).

Barron (2004) defined a learning ecology as: "the set of contexts found in physical or virtual spaces that provide learning opportunities. Each context is composed of a unique configuration of activities, material resources, relationships and interactions which they involve ". If we take this definition, we can see that ICT facilitates participatory relationships, access to information and even the common construction of learning.

Koehler and Mishra (2008) build on Shulman's (1987) idea that teachers should be able to apply their content knowledge in a pedagogical way that is adaptable to children's characteristics and educational context. Therefore, the relationship between technological knowledge and pedagogical forms of content knowledge are the basis of technological pedagogical content knowledge.

6.2. Purpose and objectives

The aim of the research was to analyse the impact that the use of a web platform has on the relative aerobic power and the hand flexors strength of its users, following its use to support a program of free physical activity based on the organized practice of tennis.

The objectives of this research were:

- the integration of means of information and communication technology in a web platform (text documents, graphic documents, numeric data, audio and video content) for recording, managing and viewing the results of the subjects;
- providing technical and theoretical support through this virtual environment to the subjects from the experimental groups;
- evaluating the aerobic power and strength of the palmar flexors, of the subjects before and after the application of the intervention program;
- the statistical analysis of the data recorded at these evaluations.

6.3. Assumptions

Our research starts from the assumption that the use of an online platform to support the instructional-educational process in a leisure tennis practice program has beneficial effects on participants' progress in terms of maximum aerobic power and strength of the palm flexors.

6.4. Materials and methods

Subjects

The research was conducted on a sample of 47 subjects working in Cluj-Napoca in the field of IT, divided into three groups: two experimental ($N_1 = 16$; $N_2 = 15$) and one control ($N = 16$).

The sampling was non-random, and from the category of non-probabilistic sampling the criterion of convenience and evaluation were used. Participants were informed of the content and purpose of the research and gave their written consent to participate before the study began.

To collect information related to the availability of employees to participate in the study, a digital form (Google Form) was disseminated on the internal communication channels of the companies where the subjects came from. The form contained questions for those wishing to participate in this project. Those subjects who showed interest, agreed to participate in measurements and training were selected. They agreed to use the results of the research, guaranteeing anonymity.

Methods

The following research methods were used to conduct this study:

- Method of studying the literature;

- Observation method;
- Measurement method;
- Practice method;
- Statistical method for analysis of collected data: SPSS v.20, Shapiro-Wilk test, parametric and non-parametric tests for independent samples (T-test, U Mann-Whitney, Kruskal-Wallis) and for paired samples (T-test , Wilcoxon and ANOVA);

Organizing and conducting the study

The study took place between April 1 and September 23, 2018, and the actual intervention between May 7 and September 16, 2018. The following figure shows the structure of the research and the description of the use of the online platform.

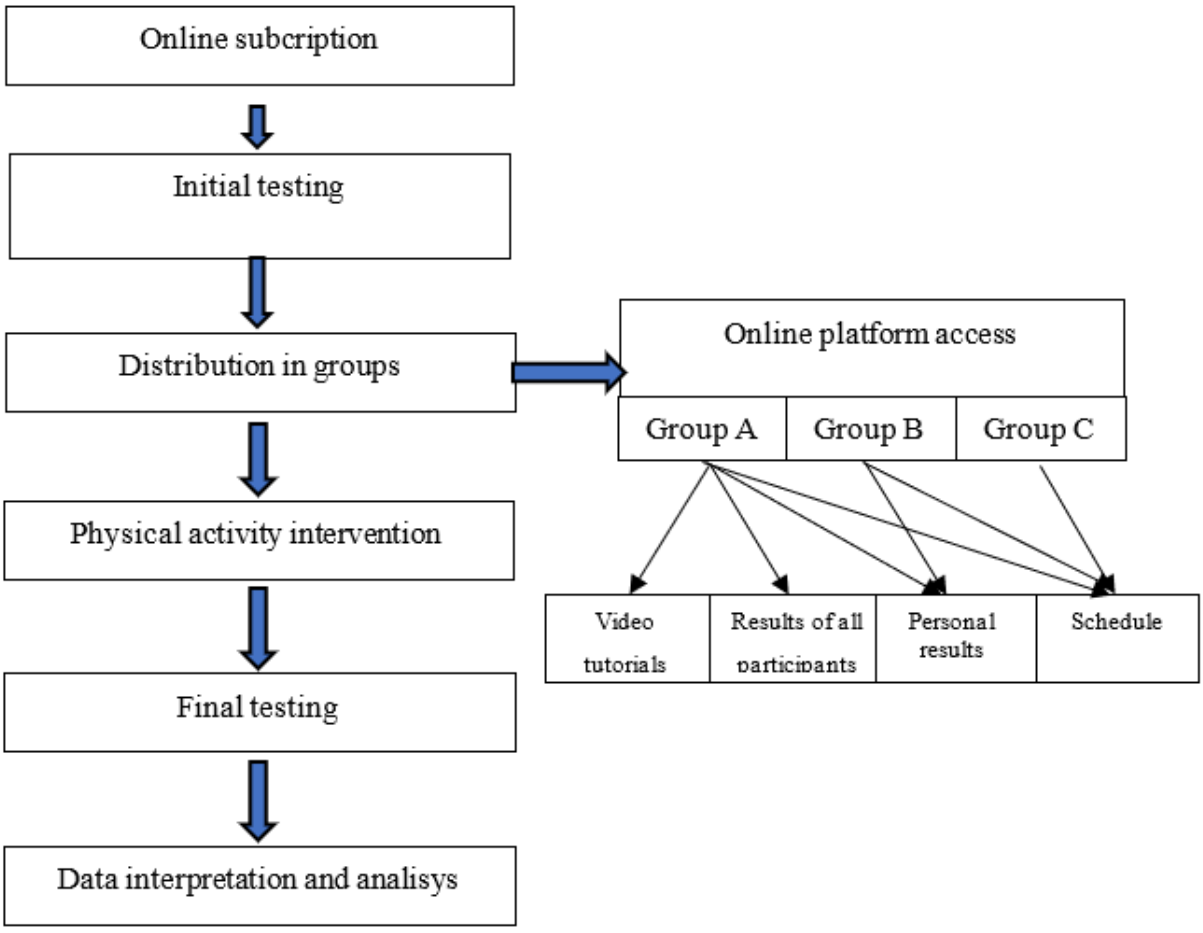

Figure 1. Research structure and use of the online platform

A temporal summary of the activities can be found in Table 18.

Table 6 - The stages of the activities in Study II

Activity	01-12.IV 2018	12.IV-15.V 2018	07-21.V 2018	21.V – 02.IX 2018	03-16 IX 2018	16-23.IX 2108
Discussions with company representatives						
I1 questionnaire application						
Initial mesaurements						
Intervention						
Final measurements						
Feedback to company representatives						

During the study, the subjects from the experiment groups participated in a recreational tennis practice program containing field tennis lessons lasting 90 minutes, twice a week, also having access to the Mov3App platform which offered the possibility to communicate at distance between the coach and the participants, helped to record and view information about the evolution of the players, as well as a suite of videos for educational purposes.

In support of the subjects from the experimental groups were made recordings, editing and video editing whose result was uploaded on the online platform in the form of videos that present information and teachings considered useful as a means to achieve the goals and objectives of the training plan. Thus, the participants with access to the platform were able to watch instructions related to aspects such as: basic tennis shots, tennis racket components, preparation for lateral shots (forehands and backhands), racket grips, points development, fundamental position of waiting for the ball, footwork, balance, movement on the field or efficiency factors when hitting the ball.

6.5. Results

The subjects were 47 (32 men and 15 women) adults working in Cluj-Napoca in the field of IT, divided into three groups: two experimental ($N_1 = 16$; $N_2 = 15$) and one control ($N = 16$) homogeneous in terms of the parameters initially measured.

Considering the data distribution and the significance of the difference between the initial media was analysed using the ANOVA test. The results are shown in Table 23.

Table 7 - Comparison of averages for dependent variables before the intervention program (N = 47)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	η^2
20m shuttle run test	Between Groups	1.07	2	0.53	0.17	0.84	0.008
	Within Groups	135.84	44	3.08			
	Total	136.91	46				
VO_2max	Between Groups	14.73	2	7.36	0.21	0.81	0.009
	Within Groups	1546.57	44	35.14			
	Total	1561.30	46				
Palm flexors dynamometry	Between Groups	7.38	2	3.69	0.02	0.97	<0.001
	Within Groups	7585.17	44	172.39			
	Total	7592.55	46				

According to Table 23, it was found that in general the effect of the intervention was not significant for any of the dependent variables: 20m shuttle-run test ($F_{2.44} = 0.17$, $p = 0.84$, $\eta^2 = 0.008$), relative aerobic power ($F_{2.44} = 0.21$, $p = 0.81$, $\eta^2 = 0.009$) and the force of the palm flexors ($F_{2.44} = 0.021$, $p = 0.97$, $\eta^2 = <0.001$).

The significance of the difference between the final averages was analysed using the nonparametric Kruskal Wallis Test. The results are presented in table 24:

Table 8 - Comparison of averages of independent samples after intervention (N = 47)

Variable	Post-test			
	χ^2	df	Sig.	η^2
20m shuttle run test	0.28	2	0.86	0.006
VO_2max	0.27	2	0.87	0.006
Palm flexors dynamometry	0.14	2	0.92	0.003

*Kruskal Wallis test

The Kruskal-Wallis test found that in the three conditions of the level of implementation of the physical activity program the scores do not differ significantly for the 20m shuttle run test ($\chi^2 = 0.28$, df = 2, p bidirectional = 0.86), relative aerobic power ($\chi^2 = 0.27$, df = 2, p bidirectional = 0.87) or for the force of the palmar flexors ($\chi^2 = 0.14$, df = 2, p bidirectional = 0.92).

6.6. Discussions

In the literature there are other studies tangent to this topic. For example, Wijsman et al. (2013) assessed whether a web-based intervention can increase physical activity and improve health in inactive adults. The study that proposed a commercially available web-based physical activity program showed that 42% of those involved reached the expected level of daily physical activity showing the high potential of web-based interventions to improve health.

Van Het Reve, Silveira, Daniel, Casati and De Bruin (2014), compare home training programs on their effect on gait quality and physical performance. In the comparative study between tablet and brochure interventions, it was found that the groups that used tablets had

significant improvements in gait, while there was no significant change in the group that used brochures, concluding that a workout of strength and balance implemented using tablets allows adult monitoring and assistance.

Hong et al. (2014) present iCanFit, a web application dedicated to promoting physical activity in the elderly. The application focuses on the functions that motivate seniors to practice regularly, by setting goals, monitoring activities and providing feedback on activities, progress and achievements.

Other analyses (Ciccarelli, Borgnoni, & Capelli, 2016) have highlighted how national and local authorities are involved in developing programs to promote healthy and active aging using technological devices. The study conducted in this analysis analysed 26 case studies of some cities but did not detect programs and initiatives specifically designed to support physical activity and active aging using ICT.

Initiatives and programs implemented by municipalities consist of interventions, which aim primarily at sustainable urban mobility and the reduction of CO2 emissions.

6.7. Conclusions

The hypothesis according to which the use of an online platform to support the instructive-educational process in a leisure tennis practice program offers additional benefits on the aerobic power and strength of the palm flexors is refuted, as at the end of the intervention there are no differences with statistical significance between the three research groups.

However, at the end of the study, statistically significant favourable changes were found in aerobic power in subjects in experimental group A and in palm flexor strength in subjects in experimental groups A and B.

During this time the subjects in the control group, although they progressed, the differences in the averages of their scores did not have statistical significance.

In conclusion, the implementation of ICT in leisure tennis training is useful, helping to achieve better results, but the implementation method can be further improved by developing applications for portable devices that use operating systems such as Android or iOS.

Chapter 7. Study III - Learning the technique of the game of tennis using an online platform in support of a recreational physical activity program

7.1. Introduction

The means of information and communication technology (ICT) are today increasingly applied in areas such as health and physical education. They are often used to manage and monitor the implementation of movement programs in the field of leisure activities or even for the training of top athletes.

In our field, these modern means are used in diagnostics, improving the performance of the musculoskeletal system and in physical activity programs aimed at improving general health, while having an important role in the process of learning, strengthening and improving motor skills. .

They have become indispensable for modern sport, being used in the teaching process of a sport or in working with high-level professionals. In addition, in the process of including new technologies, it is important to educate all participants involved in the process so that they can use these technologies independently.

In addition to the inclusion of new technologies, a mandatory part of its application is to ensure a certain level of education and expertise of the professionals who use it.

However, modern technology is not and will not soon be able to completely replace specialists in the field of physical education and sports, it is very suitable to provide assistance in many segments of the instructional-educational process, both for teachers and athletes. .

The ideal combination of specialized knowledge and modern technology ensures the subject in question (the athlete) total confidence that he is treated in a defined and ideal manner individually.

7.2. Purpose and objectives

In conducting the research, the aim was to analyse the impact that a web platform has on its users concerning the learning of tennis technique, the correctness and precision of the basic tennis strokes.

The objectives of this research were:

- the integration of information and communication technology in a web platform (text documents, graphic documents, numeric data, audio and video content) for recording, managing and viewing the results of the subjects;
- providing technical and theoretical support through this virtual environment;

- evaluating the game technique (basic technical elements) of the subjects before and after the application of the intervention program;
- the statistical analysis of the data recorded in these evaluations.

7.3. Assumptions

The first assumption of this research was that supporting a free physical activity program based on organized tennis practice through a web platform has positive effects in terms of learning the game technique and the efficiency of tennis strokes. The second assumption is that between the relative aerobic power and hang flexors strength (determined in the study II) and the parameters of stroke efficiency analysed in this study there is a relation.

7.4. Materials and methods

Subjects

The study was conducted on a sample of 47 subjects working in Cluj-Napoca at jobs with sedentary activity, divided into three groups: two experimental (N_1 = 16; N_2 = 15) and one control (N = 16).

The sampling was non-random, non-probabilistic and using the convenience and evaluation criteria. Participants were informed of the content and purpose of the research and gave their written consent to participate before the study began.

To gather information related to the availability of employees to participate in the study, a form was disseminated for those wishing to participate, on the internal communication channels of the companies where the subjects came from. Those subjects who showed interest, agreed to participate in measurements and training were selected. They agreed to use the results of the research, guaranteeing anonymity.

Methods

The following research methods were used to conduct this study:

- Method of studying the literature;
- Observation method;
- Measurement method;
- Practice method;
- Video recording method;
- Statistical method for the analysis of collected data: SPSS v.20, Shapiro-Wilk test, parametric and non-parametric tests for independent samples (T-test, U MW,

Kruskal-Wallis) and for paired samples (T-test, Wilcoxon and ANOVA) and the analysis of the Pearson and Spearman correlation coefficients.

Organizing and conducting the study

The period was May 7, 2018 - September 16, 2018, during which the subjects from the experimental groups participated in a recreational tennis practice program containing field tennis lessons lasting 90 minutes, twice a week. , also having access to the web platform, Mov3App, which is detailed in study II. At the same time, the subjects from the control group also participated in the leisure tennis program, but without access to the web resource.

The research began with the initial assessment of the level of playing technique in field tennis using a series of own tests that aimed at the efficiency (direction, length and accuracy) of tennis blows in isolated conditions on the spot and away.

Table 9 - Structure of the tests applied in Study III

The evaluated dimension	The evaluated components	Test
Tennis technique	Basic shots efficiency	Static and dynamic forehand Static and dynamic backhand Alternative static and dynamic forehands and backhands Serves

To assess the ability of the subjects to control the direction and length of the basic tennis strokes (forehand, backhand and service), the following tests were performed:

- evaluation of the static forehand;
- evaluation of the dynamic forehand;
- evaluation of the static backhand;
- evaluation of the dynamic backhand;
- evaluation of alternative (successive) static forehands and backhands;
- evaluation of alternative (successive) dynamic forehands and backhands;
- service evaluation.

For each shot evaluated, players had 20 attempts, and for each ball that landed in the target area, one point was awarded. At the end, a total score was calculated, which represented the sum of the scores from the 7 tests.

In order to assess the accuracy of the side kicks, the balls had to be sent by the subjects to the target area (a circle with a radius of 2.5 m) which was placed in the center of the "forbidden zone" (the space between the service line and the bottom line).

The tests were carried out with 3 or more subjects present, so that they have time to rest between tests, but also to help the smooth running of the tests, by collecting the hit balls.

In the weeks following the initial assessment, subjects participated in the intervention program. At the end of the tennis exercise period, the final testing of the subjects was performed, using the same tests.

Data from the measurements were statistically processed using SPSS statistical analysis software, version 20. In the first phase, the Shapiro-Wilk test was used to verify the normality of the distribution and descriptive analysis (mean and standard deviation), followed by comparison of means using parametric (ANOVA, paired samples T-test, independent samples T-test) and nonparametric tests (Wilcoxon, Kruskal-Wallis and U Mann-Whitney).

7.5. Results

The subjects were 47 (32 men and 15 women) adults working in Cluj-Napoca in the field of IT, divided into three groups: two experimental ($N_1 = 16$; $N_2 = 15$) and one control (N = 16) homogeneous in terms of the parameters initially measured, as can be seen in Table 28 and 29. During the intervention one of the subjects in the experimental group withdrew due to an injury in his spare time and his results were not taken in calculation.

Considering the data distribution, the significance of the difference between the initial averages was analysed using the ANOVA test for the variables with normal distribution, respectively the Kruskal-Wallis test for those that did not have normal distribution.

Table 10 - Comparison of averages to dependent variables before the intervention program (N = 47)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Total technical score	Between Groups	1.50	2	0.75	0.004	0.99	<0.001
	Within Groups	7547.30	44	171.53			
	Total	7548.80	46				
Static forehands and backhands	Between Groups	0.09	2	0.04	0.01	0.99	<0.001
	Within Groups	212.83	44	4.83			
	Total	212.93	46				
Dynamic forehands and backhands	Between Groups	0.12	2	0.06	0.012	0.98	<0.001
	Within Groups	238.68	44	5.42			
	Total	238.80	46				
Serves	Between Groups	0.50	2	0.25	0.017	0.98	<0.001
	Within Groups	634.73	44	14.42			
	Total	635.23	46				

According to Table 28, it was found that in general the difference in averages before the intervention was not significant for any of the dependent variables: total technical score ($F_{2,44} = 0.004$, $p = 0.99$, $\eta^2 = <0.001$), static forehands and backhands ($F_{2,44} = 0.01$, $p = 0.99$, $\eta^2 = <0.001$), dynamic forehands and backhands ($F_{2,44} = 0.012$, $p = 0.98$, $\eta^2 = <0.001$) and the serves ($F_{2,44} = 0.017$, $p = 0.98$, $\eta^2 = <0.001$).

Table 11 - Significance of the difference between the initial averages (N = 47)

Test	χ^2	Df	Sig.	E^2_R
Static forehand	0.103	2	0.950	0
Dynamic forehand	0.012	2	0.994	0
Static backhand	0.002	2	0.999	0
Dynamic backhand	0.085	2	0.958	0

* Kruskal-Wallis Test

According to Table 29, it was found that there were no statistically significant differences between the means of the three groups before the intervention in any of the variables: static forehand ($\chi2 = 0.103$, df = 2, bidirectional p = 0.95), dynamic forehand ($\chi2 = 0.012$, df = 2, bidirectional p = 0.99), static backhand ($\chi2 = 0.002$, df = 2, bidirectional p = 0.99) and dynamic backhand ($\chi2 = 0.085$, df = 2, bidirectional p = 0.958).

Next, the significance of the difference between the final means was analysed using the ANOVA test for the variables with normal distribution, respectively the Kruskal-Wallis test for those that did not have normal distribution.

Table 12 - Comparison of means to dependent variables by intervention program (N = 47)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.	η^2
Total technical score	Between Groups	2329.63	2	1164.81	6.92	0.002	0.23
	Within Groups	7401.53	44	168.21			
	Total	9731.16	46				
Static forehand	Between Groups	138.40	2	69.20	4.96	0.01	0.18
	Within Groups	613.03	44	13.93			
	Total	751.43	46				
Dynamic forehand	Between Groups	57.99	2	28.99	4.72	0.01	0.17
	Within Groups	269.83	44	6.13			
	Total	327.83	46				
Static backhand	Between Groups	42.62	2	21.31	3.73	0.03	0.14
	Within Groups	251.12	44	5.70			
	Total	293.74	46				
Static forehands and backhands	Between Groups	38.94	2	19.47	2.63	0.08	0.10
	Within Groups	324.97	44	7.38			
	Total	363.91	46				
Dynamic forehands and backhands	Between Groups	6.45	2	3.22	.59	0.55	0.02
	Within Groups	237.37	44	5.39			
	Total	243.83	46				
Serves	Between Groups	60.38	2	30.19	3.31	0.04	0.13
	Within Groups	400.42	44	9.10			
	Total	460.80	46				

The data in Table 30 show that in general the difference in averages at the end of the intervention was significant for the dependent variables: total technical score ($F_{2,44} = 6.92$, p = 0.002, $\eta^2 = 0.23$), static forehand ($F_{2,44} = 4.92$, p = 0.01, $\eta^2 = 0.18$), dynamic forehand ($F_{2,44} = 4.72$, p = 0.01, $\eta^2 = 0.17$), static backhand ($F_{2,44} = 3.73$, p = 0.03, $\eta^2 = 0.14$) and serves ($F_{2,44} = 3.31$, p = 0.04, $\eta^2 = 013$).

Table 13 - Significance of the difference between the final averages (N = 47)

Test	χ^2	Df	Sig.	E^2_R
Dynamic backhand	9.15	2	**0.01**	0.20

* Test Kruskal-Wallis

According to Table 31, it was found that there is a statistically significant difference between the averages of the three groups after the intervention in the case of the dynamic backhand (χ^2 = 9.15, df = 2, bidirectional p = 0.01).

Next, the significance of the difference between the initial and final averages was analysed using the parametric T-test for paired samples, in the case of variables with a normal distribution, and for variables that do not have a normal distribution, the Wilcoxon nonparametric test. The comparative analysis of the significance of the differences for paired samples is presented in Table 32.

Table 14 - Comparison of the averages of the paired samples in the research groups (N = 47)

Test	EGA (N=16)			EGB (N=15)			GC (N=16)		
	z/t	Sig.	D/r***	z/t	Sig.	D/r***	z/t	Sig.	D/r***
Total technical score	-15.4	<0.001*	-1.66	-6.79	<0.001*	-0.74	-7.52	<0.001*	-0.55
Static forehand	-3.25	0.001**	-0.57	-3.78	0.002*	-0.55	-1.52	0.15*	-0.16
Dynamic forehand	-5.4	<0.001*	-1.24	-2.70	0.017*	-0.33	-1.64	0.10**	-0.29
Static backhand	-3.19	0.001**	-0.56	-2.93	0.011*	-0.61	-4.75	<0.001*	-0.74
Dynamic backhand	-5.99	<0.001*	-1.56	-3.78	0.002*	-0.79	-2.82	0.005**	-0.5
Static forehands&backhands	-4.31	0.001*	-1.00	-3.85	0.002*	-0.89	-1.46	0.16*	-0.22
Dynamic forehands&backhands	-3.01	0.009*	-0.63	-2.73	0.016*	-0.46	-3.87	0.002*	-0.47
Serves	-3.21	0.006*	-1.10	-2.63	0.020*	-0.41	-2.25	0.04*	-0.43

* Paired samples T-test
** Wilcoxon Test
*** Cohen's D/ r – size effect depending on the data distribution

According to Table 32, in the case of EGA and EGB significant differences can be observed between the two measurements in the case of all variables.

Regarding the control group, there are significant differences between the averages of the initial and final measurements in the case of the total technical score (t = -7.521. Df = 15, p <0.001), of the static backhand (t = -4.753, df = 15, p <0.001), of the dynamic backhand (Z = -2.82, p = 0.005), of the dynamic forehands and backhands (t = -3.873, df = 15, p = 0.002) as well as in the case of the serves (t = -2.253, df = 15, p = 0.04). In the case of the static forehand, dynamic forehand and static alternative forehands and backhands, no statistically significant differences were recorded.

Table 15 - Comparison of averages of independent samples after intervention (N = 47)

Test	G.E.A. - G.C N_1=16, N_2=16			G.E.B. - G.C. N_1=15, $N_2$16			G.E.A. -G.E.B. N_1=16, N_2=15		
	U	Sig.	r	U	Sig.	r	U	Sig.	r
Total technical score	43.00	<0.001	-0.57	98.50	0.39	-0.15	63.50	0.03	-0.40
Static forehand	60.50	0.01	-0.45	94.00	0.30	-0.19	76.00	0.08	-0.31
Dynamic forehand	56.50	0.01	-0.48	110.50	0.70	-0.07	65.50	0.03	-0.39
Static backhand	79.50	0.07	-0.33	115.00	0.84	-0.04	69.00	0.04	-0.37
Dynamic backhand	50.50	<0.001	-0.52	95.00	0.32	-0.18	71.50	0.05	-0.35
Static forehands&backhands	73.50	0.04	-0.37	79.00	0.10	-0.30	110.50	0.70	-0.07
Dynamic forehands&backhands	104.00	0.36	-0.16	117.50	0.92	-0.02	98.50	0.39	-0.15
Serves	65.50	0.02	-0.42	108.00	0.63	-0.09	75.50	0.08	-0.32

* U MannWhitney Test

From those presented in Table 33, we can see that after the intervention, when we compare the averages of experimental group A with those of the control group there is statistical significance between averages in the case of the total technical score (p <0.001), of the static forehand (p = 0.01), to the dynamic forehand (p = 0.01), of the dynamic backhand (p <0.001), of the static alternative forehands and backhands (p = 0.04) and of the serves. (p = 0.02).

The means of experimental group B are not significantly different from the control group.

Between the averages of experimental group A and experimental group B there are differences with statistical significance for the variables: total technical score (p = 0.03), dynamic forehand (p = 0.03), static backhand (p = 0.04) and dynamic backhand (p = 0.05).

Correlations

Next, the power and direction of the relationship between the total technical score, the relative aerobic power and the strength of the palmar flexors were analysed by calculating the Pearson and Spearman correlation coefficients both before and after the intervention.

Table 16 - Correlation between technique, aerobic power and hand flexor strength before intervention (N = 47)

		Technical Score		VO_2max		Palm flexors dynamometry	
		rho	r	Rho	r	rho	r
Technical score	rho/r	1.00	1.00	0.34	0.36	0.56	0.54
	p			0.02	0.01	<0.001	<0.001
VO_2max	rho/r	0.34	0.36	1.00	1.00	0.48	0.48
	p	0.02	0.01			<0.001	<0.001
Palm flexors dynamometry	rho/r	0.56	0.54	0.48	0.48	1.00	1.00
	p	<0.001	<0.001	<0.001	<0.001		

Following the statistical analysis, before the intervention, the following positive correlations were observed, statistically significant:

- between the score obtained in the technical tests and the relative aerobic power (rho = 0.34, df = 47, p = 0.02); those with the highest level of technical tests also had the best aerobic endurance;

- between the score obtained in the technical tests and the strength of the palm flexors (rho = 0.56, df = 47, p <0.001); those with the highest level in the technical tests also had the best results in the dynamometry of the palm flexors;

- between the relative aerobic power and the dynamometry of the palm flexors (rho = 0.48, df = 47, p <0.001); those with the highest level of aerobic power have the greatest results in the dynamometry of the palm flexors.

Table 17 - Correlation between technique, aerobic power and hand flexor strength after intervention (N = 47)

		Technical Score		VO_2max		Palm flexors dynamometry	
		rho	r	rho	r	rho	r
Technical score	rho/r	1.00	1.00	0.35	0.37	0.48	0.50
	p			0.02	0.01	<0.001	<0.001
VO2max	rho/r	0.35	0.37	1.00	1.00	0.42	0.45
	p	0.02	0.01			<0.001	<0.001
Palm flexors dynamometry	rho/r	0.48	0.50	0.42	0.45	1.00	1.00
	p	<0.001	<0.001	<0.001	<0.001		

Following the statistical analysis, after the intervention, the following positive correlations were observed, statistically significant:

- between the score obtained in the technical tests and the relative aerobic power (rho = 0.35, df = 47, p = 0.02); those with the highest level of technical tests also had the best aerobic endurance;

- between the score obtained in the technical tests and the force of the palm flexors (rho = 0.48, df = 47, p <0.001); those with the highest level in the technical tests also had the best results in the dynamometry of the palm flexors;

- between the relative aerobic power and the dynamometry of the palm flexors (rho = 0.42, df = 47, p <0.001); those with the highest level of aerobic power have the greatest results in the dynamometry of the palm flexors.

The scatter plots in the figure below suggest a small positive linear relationship between the technical score and the dynamometry of the palmar flexors, before ($R^2 = 0.288$) and after the intervention ($R^2 = 0.253$):

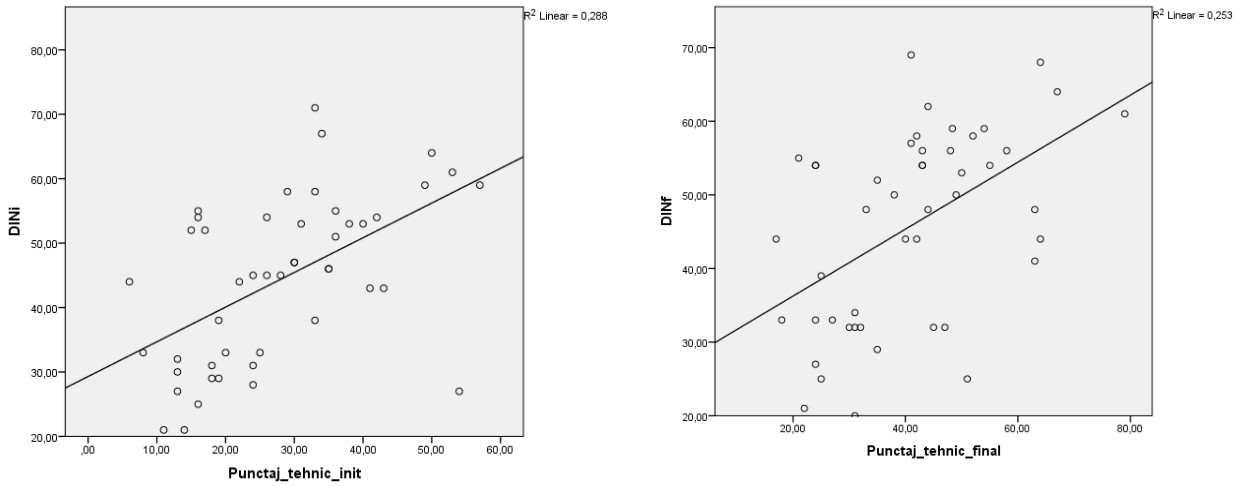

Figure 2 - Dispersion diagrams illustrating the relationship between technique and the strength of the palm flexors before and after the intervention

The scatter plots in the figure below suggest a small positive linear relationship between relative aerobic power and palm flexor dynamometry, before ($R^2 = 0.236$) and after intervention ($R^2 = 0.203$):

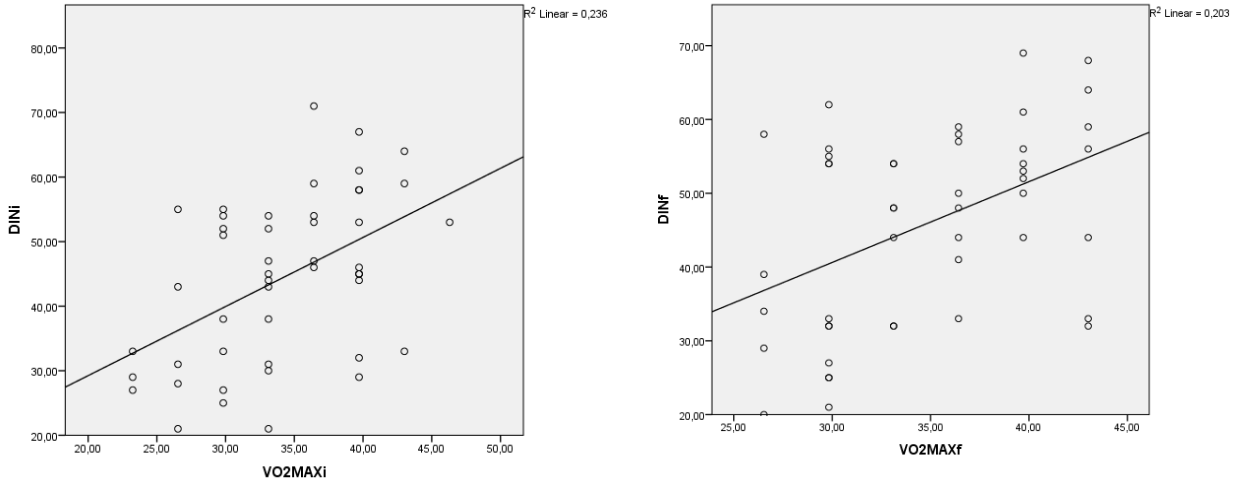

Figure 3 - Dispersion diagrams illustrating the relationship between aerobic power and palm flexor strength before and after intervention

7.6. Discussions

In the literature, the topic of information and communication technologies and "gamification" in teaching is current so there are more and more studies focused on the effects of these new concepts on the motivation and progress of some indicators of fitness.

After reading, we can see a number of common variables specific to interventions through physical education supported by technology, which can be a theoretical basis for the development of this field: awareness (activities, progress, own limits), persuasion (accessibility, fun, interaction, behaviour), motivation (motivational messages, comparison, competition, cooperation), social connection (creating a community, interaction), self-monitoring, positive reinforcement (reward strategies) and goal setting (encouraging behaviour change).

For example, the study of Silveira, van Het Reve, Daniel, Casati, & De Bruin (2013) involved 13 people who, for two weeks, followed the training plan proposed by an application. The results showed that without application, participants did not feel motivated to exercise; while with the support of the application they felt more motivated.

Rosen (2011) warns us that children born in the first decade of this millennium are known as the "iGeneration". This category of people has access to forms of technology unknown two decades ago. The implications of these rapid changes through access to technology among children and young people should be highlighted in all areas of learning (Chin & Edginton, 2014).

A study by Dillon (2008) showed the effects of subsequent feedback on children's learning performance in the ability to throw and catch a ball through cognitive learning. Those children who received video feedback in addition to the verbal one presented higher score than those who received only verbal instructions from the teacher.

While research on the integration of technology into physical education is still evolving, the literature suggests that the inclusion of technology may have a positive influence on both teachers and students (Hew & Brush, 2007; Gibbone, Rukavina, & Silverman, 2010). New technologies (i.e. software applications, mobile applications, wireless connectivity, etc.) have substantially improved the possibilities of personalized learning in the educational environment, including physical education (MacArthur, 2009).

The FIT curriculum was implemented in a large-scale study that observed student activity levels and attitudes, with a sample of 211 high school students in 12 grades in 2006 in the Northeastern U.S. Analysis of the data in this study suggests an effect short-term motivational use of accelerometers, as the level of physical activity increased immediately after participants had access to the measuring instruments.

7.7. Conclusions

The hypothesis that the use of an online platform to support the instructive-educational process in a tennis program has beneficial effects on the playing technique, as at the end of the study there were statistically significant differences between the 3 research groups, in the case of the total technical score, of the static forehand, of the dynamic forehand, of the static backhand, of the dynamic backhand and the score on the serve.

Moreover, statistical tests comparing the averages of the paired samples indicate statistically significant changes for all dependent variables in both experiment groups. We mention that significant differences were also found in the case of the control group in terms of total technical score, static backhand, dynamic backhand, dynamic forehands and backhands as well as in the case of serves.

Comparing the averages of the independent samples at the end of the intervention, between the experimental group A and the control group, statistically significant differences were found in the case of the evolution of 6 of the 8 registered variables. Between experimental group A and experimental group B, statistically significant differences were found in the case of the evolution of 4 of the 8 registered variables. No significant differences were identified between experimental group B and control group.

The following statistically significant positive correlations were observed:

- between the score obtained in the technical tests and the strength of the palm flexors;
- between the score obtained in the technical tests and the aerobic power;
- between the relative aerobic power and the dynamometry of the palm flexors.

Given the above we can conclude that subjects' access to ICT tools in leisure tennis training is useful, helping to achieve better results, even though technology is often accused of increasing the prevalence of sedentary lifestyle.

However, equipment and technological tools, even the most advanced ones, should not replace the teacher or the sports coach, as they should be seen as tools that improve the teaching process.

Chapter 8. General conclusions and proposals

8.1. General conclusions of the research

Following the implementation of our intervention programs, the conclusions presented below were reached.

Tennis training programs targeting employees with sedentary jobs in Cluj-Napoca (IT employees) were conducted according to the proposed methodologies and participation in these programs influenced the physical fitness of the subjects as well as the level of tennis playing technique;

Following the pilot study, it was found that the intervention based on the organized practice of tennis produces improvements with statistical significance. At the end of the tennis practice program, the comparison of the averages of the independent samples showed that there is statistical significance between the averages in the case of the "sit and touch" test ($p = 0.02$) and in the dynamometer of the palm flexors ($p = 0.01$).

Furthermore, the analysis of the results recorded in study number I highlighted the presence of statistically significant changes in physical fitness indices in the subjects of the experimental group: balance ($p = 0.01$), plate tapping test ($p < 0.001$), vertical jump ($p = 0.05$), palmar flexor strength ($p < 0.001$), bent arm hang test ($p = 0.01$), 20m shuttle running test ($p < 0.001$), aerobic endurance ($p < 0.001$), body fat estimate ($p < 0.001$) and body adiposity index ($p = 0.001$).

Moreover, at the end of the study, the results show that between the means of the subjects in the experimental group and those in the control group there are differences of statistical significance in the case of the strength of the palmar flexors ($p = 0.04$), the bent arm hang test ($p = 0.04$), 20m shuttle running ($p = 0.003$), VO2max ($p = 0.002$), body fat estimate ($p < 0.001$), waist-to-hip ratio ($p = 0.05$) and body adiposity index ($p = 0.004$).

Thus, the hypothesis that following the participation of some subjects with sedentary activity at work in a tennis practice program, the physical fitness indices and the body composition indices are improved was confirmed. However, at the end of the study it is found that differences between the averages of the variables measured in the two research groups are not significant for flexibility, balance, coordination and relaxation.

The results of study I also show that between anthropometric measurements and the results of motor assessment there are statistically significant correlations, before and after the intervention, the most important being the following:

- a moderate positive linear relationship between weight and waist-to-hip ratio;

- a moderate positive linear relationship between height and strength of the palmar flexors;

- a moderate positive linear relationship between body adiposity index and plate tapping test;

- a moderate negative linear relationship between the body adiposity index and the 20m shuttle run test;

- a moderate negative linear relationship between body adiposity index and relative aerobic power;

- a moderate positive linear relationship between the body fat estimate and the plate tapping test;

- a moderate negative linear relationship between the body fat estimate and the bent arm hang test;

- a moderate negative linear relationship between the body fat estimate and the 20m shuttle run test;

- a moderate negative linear relationship between the body fat estimate and the relative aerobic power.

In the case of study II, the hypothesis according to which the use of an online platform to support the instructive-educational process in a leisure tennis program offers additional benefits on aerobic power and palm flexor strength was refuted, as at the end of the intervention there are no significant differences between the three research groups.

However, at the end of study II, statistically significant changes in aerobic power were found in the subjects in experimental group A and in the strength of the palmar flexors in the subjects in experimental groups A and B.

Study III studied the influence of using an online platform to support the instructive-educational process in a tennis practice program on the game technique. At the end of this study, statistically significant differences were found between the 3 research groups in the case of the total technical score, the static forehand, the dynamic forehand, the static backhand, the dynamic backhand and the service score.

Moreover, statistical tests comparing the averages of the paired samples indicate statistically significant changes for all dependent variables in both experiment groups. We mention that significant differences were also found in the case of the control group in terms of the total technical score, the static backhand, the dynamic backhand, the alternative dynamic forehands and backhands as well as in the case of services.

Comparing the averages of the independent samples at the end of the intervention, between the experimental group A and the control group were found statistically significant differences in

the case of the evolution of the variables: total technical score ($p < 0.001$), static forehand ($p = 0.01$), dynamic forehand ($p = 0.01$), dynamic backhand ($p < 0.001$), static alternative forehands and backhands ($p = 0.04$) and services ($p = 0.02$).

Between experimental group A and experimental group B, statistically significant differences were found in the case of the evolution of 4 of the 8 registered variables, as follows: total technical score ($p = 0.03$), static forehand ($p = 0.03$), static backhand ($p = 0.04$) and dynamic backhand ($p = 0.05$).

No significant differences were identified between experimental group B and control group.

Statistically significant correlations were found between anthropometric measurements and the results of technical tests, before and after the intervention, as follows:

- a small positive linear relationship between the technical score and the dynamometry of the palmar flexors.

- a small positive linear relationship between the relative aerobic power and the dynamometry of the palmar flexors.

Even though technology is often accused of increasing the prevalence of sedentary lifestyles, the use of an online platform in support of exercise programs has produced statistically significant changes between the environments of web-assisted and non-tennis-assisted tennis players therefore, with regard to the shuttle running test and the tests for evaluating the playing technique

However, technological equipment and tools, even the most advanced ones, should not replace the teacher or the sports coach, as they should be seen as tools that improve the teaching process.

8.2. Limits of the study

In carrying out this study, some difficulties were encountered:

- the number of participants was limited by the peculiarities of the training in tennis - for a good density of activity a coach can manage at the same time a maximum of 6 players on a field;
- all participants were employed in the field of Technology and Communications Industry, so the sociological particularities of these individuals could influence the possibility of generalizing research results to the entire population with sedentary jobs;

- the subjects participated voluntarily in the research, and this method of selection can attract more those who are already passionate about physical exercise or those who due to problems caused by sedentary lifestyle feel more motivated to start lifestyle changes;
- the results of the research may have been influenced by the absenteeism of some of the subjects, caused by the need for them to participate in delegations abroad, injuries or illnesses. In the case of these subjects, the compensation was made by performing additional training;
- the relatively late hours at which the intervention took place, the employees having to start training after work and finish them sooner, to be able to rest for the next day;
- costs are not negligible, but if such programs are supported by both employers and employees, they should not be a major difficulty.
- in the case of outdoor interventions, the weather conditions have sometimes influenced the smooth running of tennis lessons;
- although correlations have been observed between some of the dependent variables, the causality between them remains to be investigated.

8.3. Proposals

- we believe that where this is not already the case, companies need to monitor and participate in encouraging the growth of employees' physical fitness as this could affect their health and productivity. In this sense, funding can be provided for the participation of employees in physical exercise in their free time, they can arrange places for physical exercise at the headquarters of companies, they can hire specialists in the field of physical education and physical therapy to stimulate physical activity behaviours in company;

- the evolution of technology and the exchange of generations in the field of work require the study of new methods of implementation and development of such interventions that must be adapted to the psychological peculiarities of Generations Y (Millennials) and Generation Z.

- our method of intervention could possibly be improved by developing applications for portable devices that use operating systems such as Android or iOS that use gamification and graphical attractiveness to stimulate the involvement of participants;

- our interventions have produced positive results and it is possible that our method of intervention will be beneficial on the cognitive-motor and motivational sides, therefore, in future research these variables and their influence must be measured.

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