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The Effectiveness of Using Computer Integrated Anthropometry and Vertical Jump as Measuring Device

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Abstract This research aimed at determining the effectiveness of the use of computer-integrated anthropometrics and vertical jump as a measuring device. The participants were 42 students aged 18-21 years old. The research design used was counterbalanced-design. The instrument used was the Integrated Anthropometric Test (IAT) to measure body weight (BW), body height (BH), arm span (AS), limb length (LL), and vertical jump (VJ) in one set of device and compared with Standard Anthropometric Test (SAT) consist of anthropometric measurements including BW, BH, AS and LL that follow the standard procedure from the International Standards for Anthropometric Assessment (ISAK) and Sargent Jump test to measure vertical jumps. The results showed that the IAT and SAT measurements had a validity measurement value of BW measurements of 0.994, BH of 0.969, AS of 0.820, LL of 0.745, and VJ of 0.903 with P <0.01, and the total duration of the IAT measurement process was 36 minutes 18 seconds, SAT was 1 hour 7 minutes 27 seconds. It was concluded that the Integrated Anthropometric Test (IAT) had a very high validity value for the BW, BH, AS, and VJ measurements and a high category for LL measurements so that it can be used as an anthropometric and vertical jump measurement device. As IAT had a shorter measurement duration than SAT, it can be said that IAT had a good level of effectiveness.

Keywords Anthropometry, Vertical Jump, Sports Technology

1. Introduction

Program for coaching and developing athletes in the developed countries has achieved their sporting achievements by obtaining adequate support from resources, not only support from the government and society but also the support from the experts through synergizing the scientific approaches [1]. Sophisticated measurements and evaluation devices and the discovery of the right instruments have encouraged us to work effectively in identifying and selecting talented athletes [2]. There are ten elements in identifying physical characteristics in identifying the athlete, namely agility, quickness, strength, power, endurance, coordination, flexibility, speed, vision, and anthropometrics [3,4]. From the tenth elements, two elements are often used in the identification of the initial athlete, namely the power test in the form of a vertical jump and an anthropometric test. Sidik [5] revealed that the dominant measurement was anthropometric measurement that had a more influential factor on the achievement were Body Height (BH), Body Weight (BW), Body Mass Index (BMI), Arm Span (AS), and Limb Length (LL).

Nowadays, anthropometric and vertical jump measuring devices have a variety of shapes and variations in their use. There are manual operating systems and digital operating systems. The previous research [6] revealed the limitations in manual anthropometric measurement, it required exhausting special training or certification and took a long duration in making many direct measurements during the examination. Another researcher [7] added that to have a digital vertical jump measurement device, it requires quite a lot of costs, as an illustration, Jump DF series TKK-5414 production by the Japanese Takei company is valued at IDR 107,000,000 per one unit and the American AMTI-Accu Power Force Plate is valued IDR 635,300,000 per one set.

Technology in the field of sports has been widely used, especially in developed countries as an effort to improve sports performance and achievement. However, it cannot be neglected that Indonesia is still left behind in innovation and technological advancements due to its tendency as a technology consumer country [8,9]. Therefore, a collaboration between stakeholders, scientists, athletes, coaches, and practitioners, as well as academics, is needed to improve and develop sports science and technology to accelerate and optimize sports achievements and the creation of useful sports equipment.

The use of appropriate technology in measurement and training can help to improve the performance of athletes, both amateur and professional athletes [10]. The use of sensors and the right, as well as integrated with a good application program can help measurement activities. Therefore, the application of sports science in sports is a necessity in the development of sports technology to push achievement to a higher level.

Many previous studies have discussed the importance of anthropometric measurements for athletes in various sports fields such as soccer [11,12], volleyball [13], basketball [14], and their comparison to non-athletes [15]. But there is still limited research discussing the validity of anthropometric measurements, especially for sports measurements by utilizing a new technology.

Besides, the use of anthropometric measuring devices in Indonesia is usually carried out in the university admission test with the specifications sports department and also the entrance test of government institutions that require a medical checkup as one of the indicators of employee recruitment. This certainly requires a relatively long time to measure, record, and score the results or values of each of the anthropometric tests. It takes a lot of human resources to carry out the process, moreover, human error can occur due to misrepresentation of results or values. To overcome this, we need a tool that can help us to solve these problems and can be proved with transparent and fast results on one computer screen.

Therefore, researchers assume that it was very necessary to be able to test the validity of measurements and the effectiveness of anthropometric measuring instruments which included measurements of body height, body weight, arm span, limb length, and vertical jump measurements. All of these measurements could be measured through a device that was integrated with a computer and was named as Integrated Anthropometric Test (IAT).

2. Materials and Methods

This research was Quasi-Experimental Design research using the Counterbalanced Design method which was used to homogenize the experimental and control groups. Therefore, in this design, each group was given all treatments but in a different order [16]. This research design is commonly used in testing the validity of measuring instruments that have recently been developed by comparing to the existing measuring instruments [17,18]. In this case, the researcher tested the validity of the instrument that was made, namely the Integrated Anthropometric Test (IAT) compared to the existing standard tools, then the duration of the measurements was compared to see its effectiveness based on the duration needed by the two instruments in carrying out the measurement process.

Participants in this study were 42 students of the Sports Department at the Faculty of Sports and Health Education (FPOK), the Education University of Indonesia consisting of 28 man and 14 women aged 18-21 years (19 ± 0.71) who were in good health, do not experience minor or severe injury and agreed to give consent before participating in this study according to local ethics committee regulations.

The instruments used in this study were the Integrated Anthropometric Test (IAT) as a test instrument and the Standard Anthropometric Test (SAT) as a reference instrument. Integrated Anthropometric Test (IAT) was a tool developed by the researchers to measure height, arm length, limb length using an ultrasonic sensor, body weight measurement using a load cell sensor, and vertical jump measurement using a microcontroller-based infrared sensor in one tool. This IAT measurement was directly integrated with a computer so that the measurement results could be seen directly, and there was a data storage system that provides easiness for the researcher to do further data processing and data analysis. Meanwhile, the Standard Anthropometric Test (SAT) was a standard manual measurement that already exists, including the measurement of height and weight, measured using Seca™, the arm length and limb length using anthropometric tape with an accuracy of 0.1cm which refers to the international measurement standard [19] and the vertical jump was measured by Sargent jump test using a vertical board to determine the height of the jump [20,21].

The data analysis technique used in this research was a quantitative analysis technique to determine the validity of the test instrument using the Pearson product-moment correlation coefficient correlation test by utilizing SPSS 23 application. Furthermore, to determine the level of effectiveness of the tool, the total measurement time of the test instrument and reference instrument was compared.

3. Result

Based on the results of the research that has been done, the results obtained by the measurement of IAT and SAT are presented in table 1.

Table 1. The Result of IAT and SAT Measurement

Type of Measurement	Tester 1 (IAT)	Tester 2 (SAT)
Body Weight Mean ±SD	61.98 ± 7.13	60.88 ± 6.85
Body Height Mean ±SD	168.87 ± 8.16	167.88 ± 7.90
Arm Span Mean ±SD	168.53 ±9.92	168.5 ±8.62
Limb Length Mean ±SD	97.10 ±6.91	97.4±5.50
Vertical Jump Mean ±SD	39 ±8.49	40.31 ±7.75

Table 1 shows the IAT measurement data with the average value of the measurement of body weight, body height, and arm span was higher than the SAT measurement. Meanwhile, the measurement of limb length and vertical jump using the SAT were higher than measurements using IAT.

Table 2. Validity Test Data of IAT and SAT Measurement

No	Variable	Type of Measurement	*Pearson's r*
1	Body Weight	IAT	0.994
		SAT	
2	Body Height	IAT	0.969
		SAT	
3	Arm Span	IAT	0.820
		SAT	
4	Limb Length	IAT	0.745
		SAT	
5	Vertical Jump	IAT	0.903
		SAT	

Table 2 shows the results of the validity test of IAT and SAT measurements showing that the validity values of body weight, body height, arm span, and vertical jump obtained a very high validity category of 0.820 - 0.969, while the measurement of limb length obtained the validity value of the high category.

To determine the effectiveness of the device, a comparison of the duration of the measurement between IAT and SAT is shown in Figure 1. The time duration includes (1) measurements of body weight and body height; (2) measurement of arm span and limb length; (3) measurement of vertical jump; (4) the exact time of measurement; and (5) total measurement time. In Figure 1 it can be seen that the measurement using the IAT required less time than using the SAT except for the measurement of arm span and limb length.

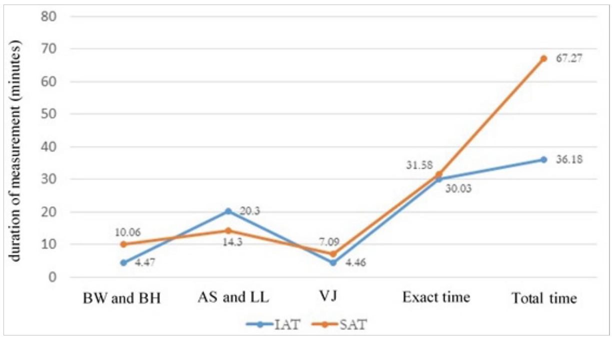

Figure 1. The Duration of IAT and SAT Measurement

Measurement of exact time was started when the test taker stood or got ready in front of the measuring instrument then the tester took the measurement, mentioned the measurement results, and ended when the tester recorded the measurement results. The exact time data for each measurement included (1) body weight and body height; (2) arm span and limb length; (3) vertical jump; then were calculated to be the exact time of measurement. Meanwhile, the total measurement time was the duration of time required by a test taker to perform all series of measurement types including BW, BH, AS, LL, and VJ in one measurement session including the displacement time of each measuring instrument.

4. Discussion

Research about testing the new measurement device, as well as measurement method in sports science, have been developed by some experts to improve performance in sports, such as the research [22] which developed an effective test to identify the talent of female hockey athlete by evaluating the anthropometric, physiological, and skill-related test. Other research was focused on anthropometric measurements, body composition, and strength variables as the prediction of jump results [23]. Besides, research [24] provided references to fitness and body size in basketball players based on the position and the playing characteristics were also carried out. Meanwhile, this research was initial research conducted by combining anthropometric measurements and vertical jumps in one set of measuring devices connected to a computer called the Integrated Anthropometric Test (IAT). The purpose of this study was to test the validity of the measurement device and the effectiveness of the Integrated Anthropometric Test (IAT) measurement device compared to the Standard Anthropometric Test (SAT).

The results of this study showed that all measurement sensors had reached their effectiveness. The ultrasonic sensors had been proved to be effective in measuring body height, arm span, and limb length. The use of this type of sensor is often used for distance measurements in various measurement applications [25,26]. The use of load cell sensors in measuring pressure or weight [27] was applied to measure body weight. An infrared sensor was used to measure the jump time which was applied to measure vertical jump [28,29].

In the vertical jump measurement, the calculation of the jump height was obtained by entering the jump time value into the jump height formula proposed by Bosco, et al., [30]. as follows:

$$\text{jump height (m)} = (g \times t^2)/8$$

$$g = \text{acceleration due to gravity } 9.81 \text{ m/s}^2$$

$$t = \text{jump duration (second)}$$

In summary, the above equation was simplified by Young [25] as follows:

$$\text{Jump height (cm)} = 122.625 \times t^2$$

Bosco et al., [30] and Young [31] revealed that this method was valid to be used under the assumption that the position of the body in making a jump is in the same condition. It means that the test taker jumps and lands in the same place.

The validity test measurement showed the results of correlation measurements in the very high category for body weight (0.994), body height (0.969), arm span (0.820), and vertical jump (0.903), and the high category for measurement of limb length (0.745). This means that the IAT tool had good validity compared to similar measuring devices. Whereas in the effectiveness device test, the duration of the IAT measurement required an exact time of measurement of 30 minutes 3 seconds, and the SAT measurement required an exact time of measurement of 31 minutes 57 seconds with a measurement time difference of 1 minute 54 seconds. The total duration of IAT measurement required a measurement time of 36 minutes 18 seconds and SAT measurement required a measurement time of 1 hour 7 minutes 27 seconds with a measurement time difference of 31 minutes 9 seconds.

In this study, IAT had the effectiveness of measurement results better than the SAT seen from the exact time of measurement and the total time of measurements made. In line with these results, the use of sensors and the right application can make it easier to monitor activities and measurements [32–34].

5. Conclusions

Integrated Anthropometric Test (IAT) can be used to measure anthropometrics and vertical jumps with a very high level of instrument validity for body weight (BW), body height (BH), arm span (AS), vertical jump (VJ), and high category measurements at limb length (LL). Besides, this tool also had a good effectiveness value compared to similar manual measurements seen from a shorter measurement duration. Besides, the superiority of data storage and data processing contained in the measurement application provided easiness for the tester to evaluate the measurement results.

In this study, the measurement of limb length was still in the high validity category. Therefore, for further research, the researchers recommend being able to improve the performance of limb length measuring device so that the device is expected to work more optimally and be able to achieve very high validity so that the accuracy of the device can be improved. Furthermore, the use of the counterbalanced design method was very good to be used in testing the validity of a newly developed device compared to an existing device.

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Human Resource Development through Novice Coach Education and Training in Indonesia

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Abstract Coach is one of the supporting factors in creating outstanding athletes and improving sports achievements in Indonesia. The Ministry of Youth and Sports (Kemenpora) organized a training program that involved 100000 coaches and sport staffs. In this study, researchers focused on discussing what is meant by novice coach training; why novice coach training is absolutely pivotal; and what is the function of novice coach training. This research employed qualitative method. There were 150 participants involved in this study. They were the organizing committee, speakers, sports teachers, club coaches, and sports students. The instruments used in this research were document study, interview, and observation. From this research, it can be illustrated that the training of novice coaches is the flagship program of the Ministry of Youth and Sports which has been carried out as an effort to improve national sports achievements. Training is an activity designed to develop human resources through a series of planned identification, assessment, and learning processes. Novice coach training activities will motivate coaches, always improve their abilities and competencies and can create potential athletes in the future. With the existence of novice coaches training, it helps the local government, especially for KONI (National Sports Committee of Indonesia) in Regency/City level and the governing body of the sports branch for collecting data and mapping coaches. The coaches in this case are those who have not been well recorded.

Keywords Novice Coach, Sport Policy, Sports Achievements

1. Introduction

The national interest in the sports sector for Indonesia in global development is the ability to achieve high achievements in various competitions among participating countries. Sports excellence is a symbol of economic progress, science, technology, and civilization [1,2]. This is because sporting achievements involve the full collaboration of research, science, technology, education, economics, political policy, and social support from society to fight and excel in global competition [3,4]. Sports coaching must involve the aforementioned components which are then managed in a sophisticated, systematic, and modern way. The sophistication of its management is marked by the National Sport Policy and its elaboration into strategic planning with a long-term framework which is a dynamic process for realizing the vision of national sports. Neatly organized managerial and training programs that are full of innovation and applied sports science are demands for continuous improvement [5]. The coaching system must also be able to move the building of sports starting from upstream; starting from school sports, physical education, talent search and confirmation, expanding participation to increase the pool or barn of talented athletes to the development program of potential beginner athletes. The final destination of this effort is the high performance programs which are specifically prepared in order to take elite athletes to the International podium. Factors such as facilities and infrastructure, improvement of the quality of trainers, quality competition, sports science, character excellence and culture of champions, and the values of good sportsmanship must also be the top priority.

Achievements can be achieved if coaching programs have been established since an early age, started from the grass roots. One of the examples is tiered soccer competitions at various age levels, an increasing number of licensed coaches and referees, and also the provision of adequate sports infrastructure throughout Indonesia. The Ministry of Youth and Sports in the era of President Joko Widodo's leadership has started a program to improve sports achievements by referring to the Indonesian Centric concept which reflects the President's Nawacita that mandates Indonesia's development from the periphery through a program called 1 Desa 1 Lapangan/ 1 Village 1 Field [6]. In regard to the program to add licensed coaches and professional referees to be directed by the President, Kemenpora (Ministry of Youth and Sports) has established so through the Training Program for Referee, Coaches and Sports Staff that is currently still running and will be improved from both quality and quantity.

Creating athletes winning international achievements cannot be done instantly and suddenly. Athlete training should be carried out in a sustainable and tiered way through a modern and up-to-date process. High sports achievements cannot be separated from the training that is carried out as early as possible through the search and monitoring of talent, nursery, sports education and training based on the more effective science and technology. Creating good relationships between organizations and sports stakeholders, both at the central and regional levels is also an important factor in the concept of sustainable development. The training program of 100000 novice coaches and other sports personnel is one of the long-term programs to improve national sports achievements by strengthening the National Sports System (SKN). Through the strengthening of the National Sports System supported by sports personnel both in quantity and quality, specifically the development of educational sports and recreational sports becomes the foundation for the birth of national sports achievements [7].

Similar programs have already been implemented in developed countries such as the United States. They have implemented Instructional Coaching as part of the integration and collaboration of coaches and teachers in schools [8]. Instructional coaching is one way to provide support by professional coaches and a teacher whose aim is to improve student literacy skills, thereby increasing teaching and students' [9,10]. Instructional coaching supports and provides initial and ongoing professional development for teachers in each of the main reading components, administration and interpretation of instructional assessments, and differentiated instruction categories [11].

In sports, either coaches or teachers play a major role in providing safety interventions to players, motivate, and educate the application of technology as an effort to facilitate training and learning processes [12,13]. In addition, the coach also determines what specific activities the player must do during training to improve physical abilities, technical skills, and reduce the risk of injury [14]. Therefore, the comprehension of being a coach needs to be one of the special concerns in order to improve sports performance. The training program for 100,000 Indonesian novice coaches and sports instructors is a program designed by the government to increase the quantity and quality of coaches in Indonesia. It is interesting to examine the significance of the activity, the urgency, and the impact. Therefore, this study aimed at examining the three things: first, the definition of novice coaches; second, the importance and urgencies of novice coaches training program; and third, the implementation of the novice coach training program results.

2. Materials and Methods

This research employed qualitative design by exploring documents, phenomenal data and thoughts or opinions that are explored in the form of words, actions, documents, situations and events that can be observed [15]. Based on institutional and operational studies on novice coach training, the researchers determined six research objects, namely 1). Bandung City; 2). Sukabumi City; 3). Purwakarta Regency; 4). Kab, Sumedang; 5. Tasikmalaya City; and 6). Ciamis Regency. The selection of the 6 regions referred to the consideration of the existence of these areas that are located in West Java Province, making it easier for researchers to conduct research regularly in these regions.

The participants in this study were leaders of the stakeholders who have particular criteria. 150 people were involved as the research participants including, the training committee, the training speakers, the dean / the deputy deans 2 of FPOK-UPI, deputy assistant, head of achievement sports division, sports teachers / PJOK, club coaches from various sports such as football, basketball, volleyball, martial arts and so forth representing their respective regions and sports students.

Qualitative research method portrays researchers as the main instrument (human instrument), where researchers conduct their own research into the field to find the data and information needed [16]. Research instruments included 1). Document Review Guidelines; 2) Interview Guidelines; 3) Observation Guidelines; 4) Questionnaires.

The document review guidelines were used to review all documents that were already in the training committee's hands. With the document review guidelines, it means that researchers collect data by recording data that already exists; variables in the form of notes, transcripts, various government policy documents, regulations, minutes of meetings, agendas, and all documents about the development of national sports.

Interview guidelines were a guideline designed and compiled to explore more about unrevealed matters when conducting a document review and observation. Interview guidelines in the form of structured interviews asked questions to participants to explore data in the form of principles, thoughts, ideas, opinions, expectations, plans, or programs of the Ministry of Youth and Sports.

Observation guidelines were used to observe the activities of organizational actors in carrying out their main tasks and functions. Observation guidelines are instruments which are used to collect data about physical phenomena that can be directly observed.

The questionnaires were distributed to 150 respondents. The selection of respondents was based on the reasons that: (a) the respondents have time to answer questions or statements, (b) each respondent faces the same arrangement and method of filling in the questions addressed, (c) the respondents have the freedom to give answers, and (d) can be used to collect data or information from many respondents on a number of questions submitted in the questionnaire.

This study aimed to reveal contextual actions, events, empirical events, or objects in the field. Therefore, the data collected were descriptive and comprehensive. The steps taken in the data processing in this study were:

a). Data categorization and classification is to divide the data needed based on research questions in each area implementing novice coach training.
b). Verification was done by carefully checking the required data obtained through document review guidelines, interview guidelines, observation guidelines, and questionnaires, Whether the data are appropriate and relevant to the research question. If there is the data that has not been obtained or answered, it is recorded and asked back to the respondent in the area where the training was held.
c). Validation was carried out to determine the extent to which the required data reflect the results of accurate data.
d). Data reduction means that unnecessary data must be discarded. In 6 regencies / cities in West Java that were selected as the object of research, a re-check was made on all questions by re-verifying, categorizing and re-checking the completeness. Then, unnecessary data was discarded.
e). Data narrative is that each finding was described in detail and clearly one by one, compiled based on research questions, thereby getting a picture of what was found during the study.
f). Discussions are the part where the findings are interpreted, then given a comment supported by the results of previous research and relevant research results, as well as existing theories and concepts

3. Result

The government's commitment through the Ministry of Youth and Sports to improve the professionalism of sports coaching in Indonesia continues to be done with a variety of schemes. One of which is the novice coach training, which becomes one of the priority activities. Novice coach training activities will motivate coaches to always improve their abilities and competencies in order to create potential athletes. Coaches resulted from the training program can create excellent athletes in the future. The rationale of establishing this program is due to the commitment of the Ministry of Youth and Sports to improve human resources in sports. It is due to the given the number of coaches and sports organizations in the area is still limited.

As a manager and an organizer of sports, The Ministry of Youth and Sports has been working hard to implement programs to improve the quality of national sports. One of them is by continuing to equip knowledge to the coaches, the spearhead of improving athletes’ achievement. Improving sports performance can be supported through various activities, such as training, workshops, seminars, refreshment, and coaching clinics. In order to improve the professionalism of sports management and the capacity of sports organizations, the Ministry of Youth and Sports through the Deputy for Sports Performance Improvement has conducted training activities for 100000 novice-level sports coaches and instructors throughout Indonesia. The training was carried out in almost all cities / regencies in Indonesia. The existence of this program will have a positive impact on the development of sports achievements in Indonesia. It is expected that of 100000 novice coaches, one coach will guide one potential athlete, in accordance with the training motto.

From Figure 1, it can be seen that the distribution of novice coach trainees, amounting to 100,000 trainees, of which 40,000 are responsible for the governing body of the sports branch (IOCO), and 60000 are under the authority of the Dean forum of the Faculties of Sports and Health Education at some University-Based Education (FPOK LPTK). The details of the 100000 novice coach training participants can be seen in table 1.

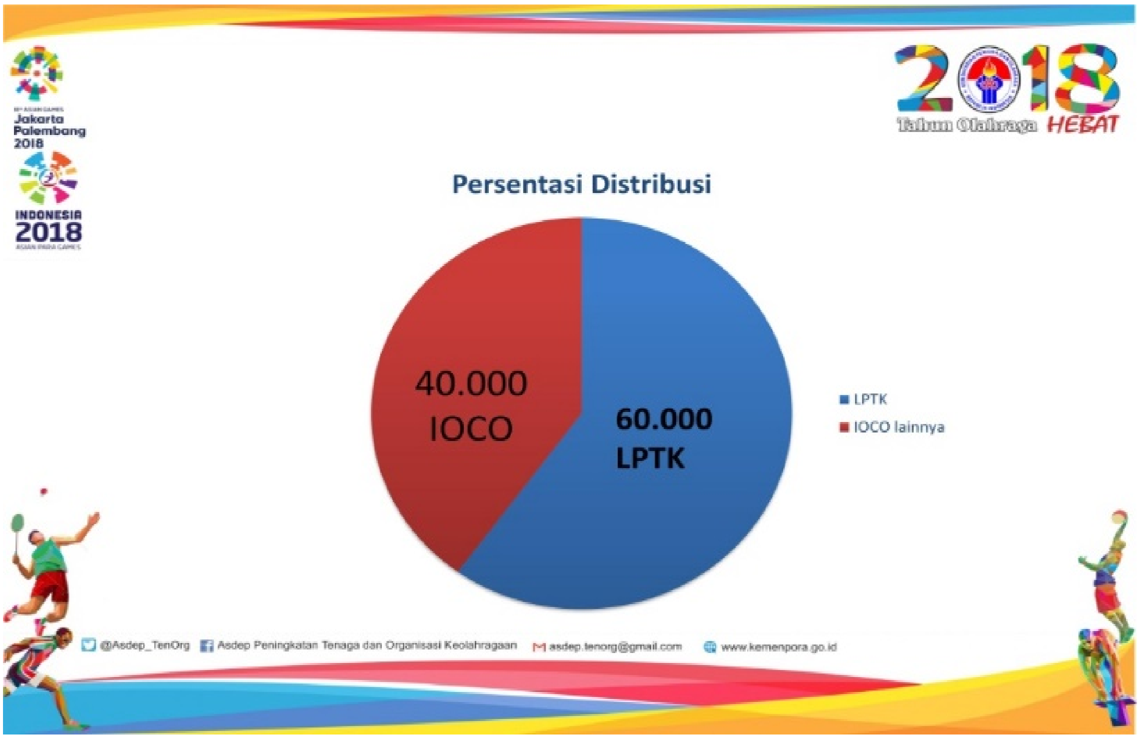

Figure 1. Percentage of Participant Distribution

Table 1. Distribution of Novice Coach Training Participants in Indonesia

No	University	Number of Participant	Note
1	UNIMED	4000	Each region provides 500 participants consisting of: • Coaches • Teachers • University students
2	UNP	4000	
3	UNJ	5000	
5	UNNES	5000	
6	UNESA	5000	
7	UM	4000	
8	UNDISKA	3000	
9	UNIM	4000	
10	UNIMA	3000	
11	UNG	3000	
12	UNY	5000	
13	UNS	4000	
14	UNCEN	3000	
15	UNJA	3000	
16	Governing body of sports branch	40000	
Total		100000	

From the data in table 1, it can be seen that there are 60000 participants who are the authority of the dean's forum. Moreover, it can also be seen the distribution for each University that has the Faculty of Sports, get the number of coach trainees who will take part in the training. While the remaining 40000 participants would be given to the governing body of the sports branch or sports institutions. In addition, these institutions must follow the rules and conditions set by the Ministry of Youth and Sports.

From the participants' perceptions, the novice coach training that they participate in can foster motivation, inspiration, and become a place to share experiences of achieving success in the field of coaching. In addition, there is an understanding of how to initiate behavioral change to master training skills. Tips for success as a coach will also be obtained. Building dreams through change is a conception of novice coaches prepared in the novice coach training program. Based on the conceptions and perceptions of the novice coaches, towards the educational patterns applied to those who are very concerned about the world of coaching, basically training is a process of transfer of knowledge, skills improvement and changes in behavior or attitudes. All of which practiced directly so that it becomes a separate experience for participants of the training. Novice trainees can learn on their own, manage themselves, be creative in order to achieve good results in accordance with the mechanisms achieved in the training.

The importance of the role of coaches, instructors and sports personnel in Indonesia becomes a full concern of the Ministry of Youth and Sports. The presence of novice trainees in the training will spearhead the development of sports achievements in Indonesia. Participants who attend the novice training activities are expected in the future will be able to increase capacity and quality for the achievement of the mission to achieve the highest achievements in Indonesian sports.

Sports professionals have competencies based on their level. For sports coaches, they are expected to be able to improve the quality of management so that in the future they will be able to encourage sports achievements in regional level. The participants who participated in the training activities varied from sports teachers, sports students, and sports coaches. With the existence of novice coaches training, it can also help local governments, especially for KONI (National Sports Committee of Indonesia) in Regency/City level and the governing body of the sports branch for data collection and mapping of coaches who have not been well recorded, aside from the main objectives to be achieved by the Ministry of Youth and Sports of the novice coach training program.

A good training can provide benefits for participants who participate in this case the novice coach training program. The main objective to be achieved from the training is knowledge. Novice coaches who are newly trained are expected to get enough knowledge to be able to do the work that will be given. Skills are related to novice trainers who are newly trained in which they are expected to be able to perform tasks when placed in a predetermined process. Meanwhile, attitude is related to situations after conducting training, which is expected that the new novice coaches can have interest and awareness on how their works to be done. Novice coach training is very popular across ages.

4. Discussion

4.1. The Meaning of Novice Coach Training

The Ministry of Youth and Sports has a superior program based on President Joko Widodo's instructions, a training program of 100000 novice coaches. It is a long-term program to improve national sports achievements by strengthening the National Sports System. Through strengthening the foundation of sports development in the regional level, this program is also supported by sports personnel in terms of quantity and quality. Novice coach training is one of the ways taken by the Ministry of Youth and Sports. Novice coach training program is a brief educational effort to provide insights into beginner-level coaches / instructors carried out in a structured manner. As an applied science, coaching has an artistic and empirical meaning. Artistic meaning explains that in its application, it is necessary to pay attention to the unique and varied characteristics of athletes because a training method applied to different athletes sometimes cannot obtain the same results [17]. While the empirical way means the more a coach applies his knowledge, the more diverse the right method he can choose for his athlete [18]. The most fundamental basis of the training profession is a training philosophy whose function is very important because it is a compass for the coaching process so that the training philosophy enlightens the direction and purpose of training [19].

In this training program, the term novice coach was defined as someone who is in charge of preparing a physical, technical, tactical and mental training program for athletes. In training activities there is a head coach who is responsible for organizing and making all with the help of his assistants. A coach is not only required to have experiences and expertise in playing techniques, but also needs to understand the training program procedures from the beginning until the end. In order to get optimal results, a coach is also required to have fast adaptability in understanding the situations and conditions of the athletes he trains. A coach must learn continuously, understand, develop, and practice his knowledge as a form of self-actualization (experience) so that his competence continues to increase. Thus, through a series of these processes, in addition to obtaining a comprehensive understanding of coaching, coaches will also discover and have the art of training.

A coach is the most essential component for successful sports achievements. This is evidenced by the various awards given to the coaches, both from athletes, managerial teams, and even institutions. There are two types of coaches, namely novice and professional coach. Those types have the same goal of improving the quality of various aspects which will be demonstrated through the competition performance in all sports. The thing that distinguishes the two of them is that the novice coaches are not legally contracted, but they are more defined by their dedication and interest in training the athletes. In contrast, professional coaches are legally contracted and are usually defined by their ability and professionalism. Besides, they belong to recognized and legal institutions. Therefore, their rights and obligations are fulfilled properly, including financial rights. Therefore, coaches must have a wealth of knowledge and experience in order to carry out their duties properly. The coach is a figure who is noticed by various parties, ranging from athletes, management, and the wider community. In addition, in order to have the ability to train the athletes, they also should have a good attitude. Besides, in order to achieve optimal performance, coaches need to continue innovating to adapt to the demands and developments of the sports trends.

4.2. The Reason for the Importance of Beginner Trainer Training

A training is ideally designed to realize the objectives, both the objectives of the organization conducting the training and the objectives of the participants who take part in the training individually. The objectives of the training include: 1) developing expertise, so that work can be completed faster and more effectively; 2) developing knowledge, so that work can be done rationally; 3) developing attitudes, so that the ability to cooperate with fellow employees and leaders can be enhanced [20], [21].

Mesquita, Ribeiro, Santos, & Morgan [22] stated that the purpose of the training is to help trainees to acquire skills, attitudes, and habits of thinking efficiently and effectively. Understanding the training objectives clearly reveals that training must be a means of meeting the needs of trainees to be able to develop skills, knowledge, attitudes, which can be utilized by the trainees in accordance with their competencies. Therefore, novice coach training becomes important in its implementation as a foundation to create great coach candidates and encouraging the quality of national sports. In line with this, a previous research conducted in Brazil on the analysis of the organizational structure of the program offered by the Brazilian Sports Federation concluded that the development of certain competencies related to the context of performance was very important and theoretical tests or seminars aimed at showing the competencies needed at each level of certification can also be done [23]. Furthermore, another research adds that to better assess trainers' experiences in the programs carried out by enriching the quality of activities developed so that the creation of a collaborative learning environment that is supported by real experience will enable coaches to discuss and reflect in order to make them construct their knowledge [24].

4.3. Benefits of Novice Coach Training Results

Novice coach trainees get a change in attitudes, knowledge, and skills gained from the training process. The Ministry of Youth and Sports, especially the Deputy of Sports Achievement, a leading sector in the development of sports achievement, has big responsibilities to improve sports achievements in Indonesia. National sporting achievements have suffered a long drought at various international events. One of the efforts made was by conducting a training program for 100000 novice coaches. With this training approach, it is expected that it can provide broad opportunities for novice coaches to develop their capacity to achieve the title of professional coaches.

In the novice coach training, the activities carried out are not only conveying the materials. However, it can also provide knowledge about the main principles of coaching that can align abilities, related to the growth and development of young athletes. Understanding of the trainer, understanding of the values of athlete development, motivation theory, affective and psychomotor aspects, by providing direct work experience to trainees based on the types of coaches based on their expertise and professional fields by paying attention to the attitudes, skills and results of each training. Empathy is the basis of the coaching spirit. Increased empathy makes services to others increase as well. The higher the attitude of one's service combined with good character; the coaching competence will increase. Novice coach training is an effort to make someone care and useful for others. One's coaching competence is determined by how much empathy or level of concern they have for others.

Other research states that training can be applied as a tool to improve the appearance / ability of individuals or groups in order to improve skills [25]. Certain skills are taught so that the coaches can carry out tasks according to the desired standard. Training can also improve attitudes towards work, towards leaders or towards trained athletes. Besides, other benefits of training are improving service standards [26].

5. Conclusions

Based on the results of this study, it can be concluded that the training of novice coaches, which became the flagship program of the Ministry of Youth and Sports, was carried out as an effort to improve the achievement of national sports. Training is an activity designed to develop human resources through a series of planned identification, assessment and learning processes. Education and training are expected to bring sportsmanship values, work ethic motivation, instill good values, and support excellent programs from the Ministry of Youth and Sports. Changes in mindset, values and paradigms, as well as other theories that are given during the training process take place and are carried out through the process of learning by doing or on job training.

The aim of the mass novice coach training by the Ministry of Youth and Sports is an effort to improve the quality of human resources, especially in sports. The existence of this training can also help local governments, especially for KONI (National Sports Committee of Indonesia) in Regency/City level and the governing body of the sports branch to record and map the trainers who have not been well recorded.

Novice coach training is expected to be a tool for coaches who have an interest and awareness of their work to keep improving their competence. Another benefit that can be gained from the results of the novice coach training is that the coaches of sports at the regional level will no longer have difficulties in finding coaches for coaching programs for their clubs and sports branches. The Central Government and Local Governments have the right to direct, guide, assist and supervise the organization of sports activities in accordance with statutory regulations. The Central Government and Regional Governments are obliged to provide services and facilities as well as guarantee the implementation of sports activities for every citizen without discrimination. The Central Government has the task of establishing and implementing policies and standardization of the sports sector nationally. Meanwhile, the Regional Government has the duty to implement policies and coordinate the development of sports and carry out standardization of the sports sector at the regional level.

5.1. Recommendations

In terms of the importance of developing the competence of novice coaches in Indonesia, the results of this research have not provided adequate information because the trainees did not get an assessment from training speakers and supervisors. For future researchers, it is suggested to carry out more comprehensive and comparative research, for example, training conducted at regional sports branch and national sports branch by involving various policy makers as well as where the training is further extended to regions that have the potential to develop a model training coaching for sports achievements. In addition, it is also necessary to consider the use of motivation levels in sports coaching aspects by taking into account the factors causing weaknesses in the preparation of instruments.

In a training organization, there are several components that are interrelated with one another. The training component is one of the factors that influences the training quality and becomes the main key in compiling a training program that includes all sources and facilities that support training activities in the training. It includes curriculum, training objectives, learning resources, learning facilities, costs needed and training managers. Furthermore, the trainees also have a variety of characteristics such as knowledge, skills and expertise, gender, education, learning needs, socio-cultural background, economic background and study habits.

It is very important for policy makers and stakeholders to develop sports achievements and implement the ten pillars of policy to implement coaching in sports. It needs to be done to build a solid foundation in the systematic development of national sports.

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Effects of Plyometric Training on Speed and Agility among Recreational Football Players

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Abstract Plyometrics are exercises that involved the enhancement of muscle performance. The objective of this study is to evaluate the effects of 6-weeks plyometric training on speed and agility performance among recreational football players. This study was conducted following the pre-post test model of quasi-experimental method. Twenty-two recreational football players were chosen for this study (aged between 19 to 26 years old) and randomly assigned into control (N=11) and intervention group (N=11) for six weeks. Subjects in the control group did not undergo any plyometric training. In contrast, the intervention group performed plyometric training for six weeks. All subjects participated in two tests; 1) Sprint test of 20 m distance for speed performance and; 2) Agility test using Agility T-test for agility performance before (pre) and after (post) training. For the intervention group, significant improvement in the difference of sprint time before and after six weeks of training were discovered (t = 3.76, p = 0.001) when compared to the control group. The agility performance of the intervention group also showed a significant difference when compared to the control group (t = 2.53, p = 0.01). Therefore, this will help players to improve their performance during a football match and prevent injury among recreational football players.

Keywords Plyometric, Recreational Football Players, Speed, Agility

1. Introduction

Football is a game that includes high speed runs at full or sub-normal speeds, high power projections, quick changes in ball direction. Sports coaches often design a training regime for sports coaching and performance research that covers a range of physiological and mechanical requirements. The training regime is, therefore, ready to use by athletes and coaches for their everyday sports activities. Many team sports (such as football, netball, martial arts and baseball) includes intermittent, dynamic and ballistic movement. This requires advanced conditions, along with high aerobic and intermittent sprinting capacity, strong muscles and strength, speed flexibility, speed and adaptability.

Plyometrics are exercises that involve the enhancement of muscle performance [1]. Most of the trainings in sports involve jumping, hopping, and skipping movements [2]. These exercises also facilitate sturdy muscle activities in energetic activities, during which the movement would come with a stretch of the muscle instantly by an explosive modification of the muscle [3].

Most researchers and practitioners share a common view that plyometric training is one of the approaches in every field often used for athletes, notably those with the short-shortening cycle (SSC). These training are designed to improve explosiveness and dynamic efficiency [4]. Previous studies have shown that through plyometric training, jumping and sprinting capabilities and specific trajectory activities could be improved [3]. An effective technique for boosting the running economy, joint stability and the severity of knee injuries was also found [5].

Intensive training with high-intensity interval training components consisting of stamina, strength, aerobic and anaerobic is a need in recreational football games. It can use a multifaceted training style, that simultaneously stimulates multiple fitness areas. As part of this analysis, research studies that can provide evidence-based advice on how to manage the best training environment to maintain maximum intensity and load for different groups of participants are of great interest [6].

Speed is defined as the ability to move or to cover a distance in a short time. In many sports, sprint performance is important. Therefore, the interest of successful athletes in learning basic skills in sprinting was high. In order to develop a successful and efficient sprint training strategies, a lot of training needs to be done, as young athletes need to be exceptionally performing in all of their sport's physical aspects (e.g. strength, stamina and exercise techniques). The test requires a single maximum sprint with a reported time of over 20 metres. There will be a thorough warm-up, including the start of some practice and acceleration [7].

The ability to maintain a stable body position and change the direction quickly without loss of balance, body control or speed is described as agility [8]. Agility components were classified as balance, coordination, strength and speed. It is important for professional, recreational and "tactical" athletes who need the capacity to change sports or operate on all plane quickly. Improved agility benefits include increased body stability during quick motion, increased intramuscular control, and decreased risk of injury or re-injury. The Agility T-Test is an agility test for athletes that involve going forward, sideways and backwards [9].

Training for most sports requires completely different physical attributes to be stressed regularly, in order to maximise sports efficiency during the tournament. Short-run plyometric training, such as two sessions, had changed the stiffness of muscle-tendon each week for five years and has improved the strength, capacity, and SSC function of lower limbs in persons [10]. The output of a short-term experiment following a 6-week training plan could boost players' capacity, which should be of significant concern to coaches, practitioners and scientists. Therefore, this study aims to examine the effects of plyometric training on speed and agility among recreational football players. We hypothesised that plyometric training enhance speed and agility performance among recreational football players.

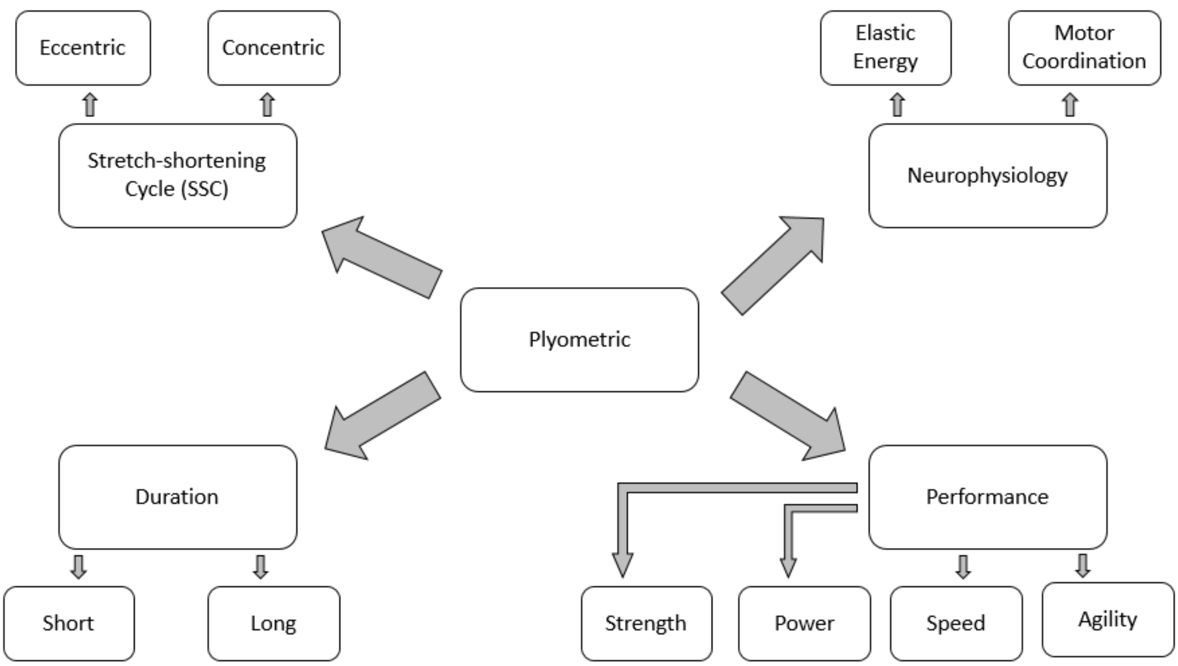

Figure 1. Theoretical Framework of Plyometric Training

2. Methods

2.1. Study Area and Duration

This research was conducted to investigate the effect of 6 weeks plyometric training on speed and agility among recreational football players. This study was conducted following the pre-post test model of quasi-experimental method. This research was conducted for 7 weeks starting from recruitment of the participants.

2.2. Research Design

An experimental randomised pre-test and post-test control group design was used to test the hypothesis in this study. This design was selected because it can compare information on the subject's original condition (pre-test) with the result of post-test after they were given the training. Moreover, this design was chosen as the research was designed to see how the independent variable affects the dependent variable. The use of a control group in this study was allowed post-test result differences to be attributed to the treatment difference and no other variables.

2.3. Participants

The participants that participated in this study consisted of twenty-two recreational football players from Kesukeb FC with age between 19 – 26 years old (age: 21.55 ± 1.57 years). The participants were randomly assigned into two groups; 1) control group (CG) (N=11) and 2) intervention group (IG) (N=11). This study was approved by the research ethics committee, Universiti Teknologi MARA, Shah Alam, Malaysia. The participants selected did not exhibit any presence of lower extremity injuries and did not have any medical condition. Participants were excluded if the history of injury six months ago, reconstructive lower extremity surgery in the last twelve months or musculoskeletal conditions unresolved.

2.4. Instrument

2.4.1. 20-meter Sprint Test

A self-paced 3-minute warm-up run, participants performed two sub-maximum 20-meter (m) sprints from a starting line, followed by three maximum timed sprints on a flat surface football field. A 2-minutes' walk recovery interspersed each sprint. After completion, each participant's time was recorded to the nearest 0.01s with a handheld stopwatch (Casio HS-3V-1R). Altmann and Ringhof [11] found the 20m sprint test to be highly reliable with interclass reliability coefficient of ICCs>0.75.

2.4.2. Agility T-test

Agility t-test area was used with a scale of 10 meters by 10 meters. Participants ran forward or moved when the "go" order as quickly as possible to the central cone. Then, they ran sideway 5 m to the right cone and ran sideway 10 m away to the far-left cone to the left and ran sideway back to the middle on the right cone. The individual either ran or moved backward as soon as possible to reach the finish line. The researcher began the stopwatch (Casio HS-3V-1R) and stopped when the participant crossed the finishing line plane. The time to complete each test is measured in seconds. Pauole and Madole [12] found the Agility t-test to be highly reliable with intraclass reliability was 0.98.

2.5. Procedures

Participants that fulfilled the inclusion criteria for the study were approached by the researcher to participate in this study. The participants attended a series of training sessions for plyometric two times a week for six weeks in the intervention group. The control group were free to do any activity during six weeks' time as the team did not have any training sessions, thus, it can control to minimize the Hawthorne effect among football team players. The pre-test data collected on 2^{nd} weeks after recruitment and post-test data collected after finish plyometric training on the 7^{th} weeks. The plyometric training programme was focused on frequency and volume recommended from [13]. Plyometric training sessions take about 35 minutes and start with regular 10 minutes (min) warm-up, 5 min of a jog, 5 min of stretching, and 20 min of side jumping (SJ), countermovement jump (CMJ) and double-bound leg jumping (DBJ) training and five minutes of cooling down. SJ was an exercise in which subjects had to jump side to side between a cone with feet together while CMJ needed subjects to fully bend their knees with arm swing backwards followed by one jump as high as possible with arm swing forward and upward. DBJ required the subjects to jump forward horizontally twice with both feet close together. Each exercise was performed with ten repetitions for each set. It was decided that every type of jumps were performed for four sets with ten repetitions in each set as shown in Table 1. This was because a similar intensity for six consecutive weeks may cause adaptation of neuromuscular function to the training regime. In addition, it was noted that in both low and moderate training courses a week there was an improvement in 20 m sprint performance, jump contact time and maximum strength compared to high training frequencies [14]. Rest was given 3 minutes between each set and 5 minutes between each exercise. 30 minutes' rest was given between testing and training.

Table 1. Detail Description of 6th Week Plyometric Training

Weeks	Plyometric Exercises	Repetitions and Sets
1st week	Side Jump	10x4
	Countermovement Jump	10x4
	Double Bound Leg Jump	10x4
2nd week	Side Jump	10x4
	Countermovement Jump	10x4
	Double Bound Leg Jump	10x4
3rd week	Side Jump	10x4
	Countermovement Jump	10x4
	Double Bound Leg Jump	10x4
4th week	Side Jump	10x4
	Countermovement Jump	10x4
	Double Bound Leg Jump	10x4
5th week	Side Jump	10x4
	Countermovement Jump	10x4
	Double Bound Leg Jump	10x4
6th week	Side Jump	10x4
	Countermovement Jump	10x4
	Double Bound Leg Jump	10x4

2.6. Statistical Analysis

In the analysis of the study, the statistic program version 25.0 of the Statistical Package for social science (SPSS) was used. To test whether data were normally distributed, a Shapiro-Wilks test was used. Both variables had a *p*-value greater than 0.05, and parametric statistics were therefore used for analysis. For comparison of groups, data was evaluated using an independent T-test. All results were rounded to two decimals. Data with a $p<0.05$ were set to be significant. Therefore, there is a significant difference in speed and agility among recreational football players who performed plyometric training and null hypothesis can be rejected. Participants were measured in kilograms (kg) for weight, and in centimeters (cm) for height. The sprint and agility test results were measured in seconds (s). Mean, and the standard deviation was provided as descriptive results.

3. Results

This research aims to investigate the effects of plyometric training on speed and agility performance among recreationally trained football players. The results of the analysis are arranged according to the following subtopics, descriptive analysis, comparison between control and intervention group, comparison the effect of plyometric training on speed between control and intervention group and comparison the effect of plyometric training on agility between control and intervention group.

Table 2 provides detailed statistics for age, height, weight, body mass indices, pre-test velocity and pre-test strength for the mean and standard deviation for the control and intervention group. The results of the independent t-tests showed that there was no statistical difference in age, height, weight, body mass, pre-test speed and pre-test agility before starting the plyometric training program ($p > 0.05$) between the two groups, control and intervention groups are presented in Table 3.

Table 2. Mean and Standard Deviation of Participant Characteristic, Pre-test Speed and Pre-test Agility for Control and Intervention Group

Category (N = 22)	Control Group (N = 11)	Intervention Group (N = 11)
	M ± *SD*	*M* ± *SD*
Age	21.55 ± 1.57	20.91 ± 1.64
Height	173.8 ± 4.72	169.7 ± 4.94
Weight	70.3 ± 13.94	64.30 ± 9.98
Body Mass Index	23.20 ± 4.07	22.27 ± 2.94
Pre-test Speed	3.99 ± 0.31	3.85 ± 0.09
Pre-test Agility	13.02 ± 0.35	12.74 ± 0.44

Table 3. Pre-test Speed and Pre-test Agility Data for Control and Intervention Groups

	t	df	p
Pre-test Speed	1.41	20.0	0.17
Pre-test Agility	1.66	20.0	0.11

The results analyzed by Paired T-test on effect of plyometric training on speed performance show an overall significant decrease ($p<.001$) of 6.12% after plyometric training. Table 4 shows that the comparison was statistically significant decrease in speed performance time from pre-test (*M* = 3.92, *SD* = 0.24) to post-test (*M* = 3.68, *SD* = 0.86). The mean decrease in speed performance time was 0.24 with 95% interval ranging from 0.107 to 0.374. There is a significant difference in the effect of plyometric training on speed between control and intervention group as the value for this comparison was found to be smaller than the significant level (p = 0.001 < 0 .05) as shown in Table 5. Result showed that the intervention group had faster time during the 20m sprint test after plyometric training compared to the control group. Therefore, there is a significant difference in speed among recreational football players who performed plyometric training.

The results analyzed by Paired T-test on effect of plyometric training on agility performance show an overall significant decrease ($p<.01$) of 2.32% after plyometric training. Table 4 shows the paired t-test shows that the comparison was statistically significant decrease in agility performance time from pre-test (*M* = 12.88, *SD* = 0.08) to post-test (*M* = 12.58, *SD* = 0.12). The mean decrease in agility performance time was 0.30 with 95% interval ranging from 0.054 to 0.551. There is a significant difference in the effect of plyometric training on agility between the control and intervention group as the value for this comparison was found to be smaller than the significant level (p = 0.01 < 0 .05) as shown in Table 5. Result showed that the intervention group had faster time during the agility t-test after plyometric training compared to the control group. Therefore, there is a significant difference in agility among recreational football players who performed plyometric training.

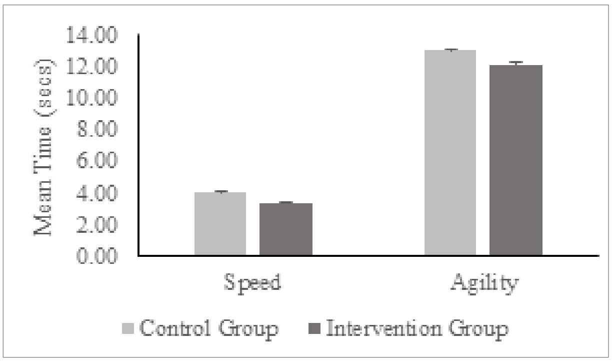

Figure 2. Post-test Mean and Standard Deviation of Speed and Agility Performance between Control and Intervention Groups

Table 4. Effect of Plyometric Training on Speed and Agility of Recreational Football Players

		Mean	Std. Deviation
Speed	Pre-test	3.92	0.24
	Post-test	3.68	0.86
Agility	Pre-test	12.88	0.08
	Post-test	12.58	0.12

Table 5. Paired T-test for Speed and Agility Score in Pre and Post Training

				95% Confidence Interval	
	Mean	*t*	*p*	Lower	Upper
Speed	0.24	3.76	0.001	0.107	0.378
Agility	0.30	2.53	0.01	0.054	0.551

4. Discussion

One of the aims of this research was to determine whether or not the plyometric training will improve speed performance. The findings show that the sprint performance of the intervention group has substantially increased after six weeks of plyometric training (p = 0.001, p < 0.05). Similar results were found in previous work carried out by [15] to determine the effect of a sprint-specific plyometric intervention system on sprint-training intervention. The plyometric group showed substantial decreases in time over the sprint results at a distance of 10-m and 40-m (p = 0.001).

Other studies have also shown that plyometric training with a distance of 30 m and 40 m respectively, as reported in [16] and [17], influenced the sprinting abilities. During the plyometric training, the stretch-shortening cycles are related to the improvement of the sprint results. This study's results illustrate the importance of achieving high strength rates to boost sprint efficiency in recreational football players, with intervention group players showing the highest sprint efficiency and control group players showing the lowest sprint performance. Importantly, plyometric training has also been shown to reduce the frequency of football players' injuries.

The current research has also consistently demonstrated that a variant plyometric frequency training (420 DJs, 840 DJs and 1680 DJs) could substantially reduce the sprinting output over time, as noted in a meta-analysed by [18]. The combination of these factors would lead to higher gains relative to the effects of each exercise alone. Furthermore, a combination of plyometric exercises (i.e., SJ + DBJ, DBJ + CMJ) led to better training outcomes compared to the use of one form of exercise. Further gains in sprint performance can be caused by training consistency. Sprint times can be increased by exercising with more horizontal acceleration (e.g., bounding and running).

The ability to perform full running on short distances is considered an important part of running during football matches. Leading to better neuromuscular changes (e.g. intra and inter muscular coordination), and quick movement (based on a short stretch cycle) increases their speed of sprinting

The increase in sprint time among recreational footballers after six weeks of plyometric training is most likely due to improvement of the drive control and stretch-shortening capacity or musculoskeletal rigidity because of improved leg explosive strength [19]. Plyometric training improves the performance of the sprint, especially from 10 m to 40 m [20]. It can also refer to sprint performances, which explain the differences. As a result, plyometric training has significantly improved the performance of football players in the current study.

The results of this research showed that six weeks of plyometric training would improve the agility of recreational football players. Results of the analysis showed that plyometric training substantially increased agility and did not alter the agility of the control group substantially. The findings of this study have also substantially increased the resilience of the intervention group (p<0.05).

The present research has shown that plyometric preparation affects T-test agility and reduces time. Fewer research has investigated the effect of plyometric exercise on individual endurance, but the results are more robust than those from sprint tests. Thomas, French [21] found that while the sprint remained unchanged, the agility of the semi-professional adolescent footballers significantly improved for six weeks of plyometric training (9 percent). Miller, Herniman [22] showed an improvement by 5 per cent and 3 percent after six weeks of plyometric training, T-agility and Illinois agility test respectively. Such results are higher than those observed in other studies. However, comparisons are difficult to be made because [22] do not address the training status of the participants. Upon plyometric preparation, neural adaptation tends to be the beneficial effects of agility, primarily to enhance inter muscle coordination.

In a previous study by [2] on the efficacy of plyometric exercises for speed, jumping and agility in players, agility on both the right and left sides improved substantially after training relative to pre-training. The findings of this analysis are consistent with previous work that records similar agility improvements. In football, simple movement patterns require high agility.

After six weeks of high-intensity plyometric training (4-meter by 9-meter shuttle sprint, t-test, and agility review Illinois), study by [23] showed a major increase in the agility of young men's basketball players. A plyometric Agility T-test by [22] was used to assess agility when vertical, lateral, and horizontal plyometric jumps were used by [22] and improve agility was suggested. Miller, Herniman [22] also found that the agility of an athlete could also be improved by six weeks of plyometric training (T-test and Illinois strength test). In the same test but different study, [25] demonstrated the advantages of a short-term plyometric agility training program for young basketball players (T-testing and Illinois agility testing), demonstrating the need for plyometric training to enhance efficiency in activities requiring acceleration, decelerations and a change of course. It is also well known that agility requires generating muscle factors (such as strength and power) to increase the speed of directive change and agility seems to have a connection between energy and power [26]. Improved power output can be one of the key variables to increased agility. Therefore, in football players, both plyometric training programs can be used as an important form of preparation to preserve or enhance strength during the season.

5. Conclusions

All exercises and methods of outcomes used in this study had been adapted from the previous study and had been proved of its reliability and validity for research purposed. Plyometric training was carried out at the same time for every week for the subjects as the subjects were homogenous in terms of the academic schedule. Thus, removing bias through training time or regimes.

The implication to the practical practices, plyometric training method must be appropriately incorporated into an intensive training program that enhances the essential technical skills that are necessary for achieving adequate speed and agility performance among players in recreational football to develop training adaptations. The finding of this study shows an improvement of 6.12% for speed performance and 2.32% for agility performance after 6 weeks of plyometric training on recreational football player. Coaches and physical trainers can plan 6 weeks with twice a week training session as in this study protocol. These results will benefit coaches and physical trainers in the search to refine regular training routines and develop players' speed and agility performance before any game or football game.

A generalisation of recreational football players should be made to improve the accuracy of the recreational football players' representation. Thus, include more volunteers who may result in a better sample and possibly a significant difference in speed and agility between the intervention group and the control group. Different sports code such as hockey, rugby, basketball etc. recommended for future study because different sports have different type sport specific drills and different physical demands in each sport. In future study, it is recommended to use timing gate because of the accuracy of start and stop of timing. Timing gate also can be set at 10m mark, and 20m mark to investigate the acceleration and deceleration phase during 20m sprint test. Other components such as flexibility and explosiveness also can be investigated in future research. Flexibility and explosiveness are also important components in sports movements to enhance players performance. Furthermore, observations are also needed with differing intensities and volumes of plyometric training to determine their optimum dosage for this form of preparation.

This research indicates that plyometric training is an essential component of the recreationally trained football players' training program based on results that support the theoretical principles for using these forms of training to increase speed and agility performance. Therefore, this will help players to improve their performance during a football match and prevent injury among recreational football players.

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Ethical Approval

The study was approved and conducted by following the ICH Good Clinical Practice Guidelines, Malaysia Good Clinical Practice Guidelines and the Declaration of Helsinki set by the board of ethics committee Universiti Teknologi MARA.

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Quickly Understanding on Progressive Muscle Relaxation with Video-based Learning in Secondary School Students

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Abstract Progressive muscle relaxation can improve students' learning performance in the classroom because it provides a good focus during classroom learning sessions in developing technical communication for educational institutions. This study aims to determine the effectiveness of video-based learning on the understanding of secondary school students related to Progressive Muscle Relaxation. The research was a quantitative descriptive method. Based on research that has been done, researchers found differences in students' understanding between before and after watching videos related to progressive muscle relaxation. In this study, respondents need to answer questions raised by researchers before viewing the video and after watching the video. The respondents in this study were only six students. The percentage of respondents who answered the question correctly after seeing the video provided by the researcher rose quite significantly. Respondents are interested in the video provided, and respondents can understand the video content they want to convey. The use of video in teaching and learning is beneficial for students to increase their interest and demand Progressive Muscle Relaxation knowledge. Video-based learning can be implemented in teaching and learning in various fields of education. Visual lessons are more quickly remembered and understood by students. Learning to use videos can increase student's interest in learning new things.

Keywords Understanding, Progressive Muscle Relaxation, Video-based Learning, Secondary School Students

1. Introduction

Stress is a person who experiences physical or mental instability related to daily life. Stress also includes anxiety, fatigue, and depression due to a problem that cannot be overcome. Stress and anxiety often occur in a person, including the students. During the learning session, students need to complete various tasks given by the teacher. Teachers provide much work to students because they want to make sure their students understand the learning content delivered in class. Therefore, students can suffer from stress because many tasks must be completed. One positive way to deal with stress is with specialist therapy in psychiatric nursing through Progressive Muscle Relaxation (PMR), which is part of relaxation therapy (Dolbier & Rush, 2012). Progressive muscle relaxation is a non-pharmacological therapy (Ekarini et al., 2019). Progressive muscle relaxation is a stress management technique that is widely used (Chellew et al., 2015). A continuous muscle relaxation technique is a technique that is done by stretching the muscles and then doing muscle relaxation. Some of the benefits of this technique include reducing muscle tension, anxiety, neck and back pain, building positive emotions from negative emotions. The indications for progressive muscle relaxation techniques are those with insomnia, frequent stress, anxiety, and depression.

Progressive muscle relaxation, as an additional method, can reduce anxiety and improve sleep quality (Liu et al., 2020). Progressive muscle relaxation is also very effective in reducing feelings of stress and acute anxiety (Vancampfort et al., 2011). With continuous muscle relaxation therapy, students can reduce the presence of muscle tension after doing many activities at school. Students will feel pain in their muscles after a day at school with a variety of activities and the number of assignments given. Therefore, students need to do progressive muscle relaxation to reduce pressure on their muscles. Muscles that experience fatigue or pain will make students unable to focus in class for learning sessions. Relaxation can adjust the hypothalamus reaction with the parasympathetic nerve. These conditions allow the body to reduce heart rate, blood pressure, metabolism, and respiratory rate and lower oxygen use and muscle tension (Feldman et al., 2010). Student learning performance deteriorates and will result in students trapped in high-stress situations.

Students can avoid the occurrence of high blood pressure and other diseases with PMR. This condition causes the activities carried out to reduce the pulse and give rest to the body. Students need to take good care of their health so that they do not suffer from dangerous diseases that can affect their lives. Energy-efficient use is manifested as lower VO2, lower heart rate, and more moderate physical consumption seen in response to intense exercise accessible to physical strategies such as spiky or with psychological approaches such as progressive muscle relaxation (Maimunah & Hashim, 2016). Students must practice this progressive muscle relaxation to reduce the risk of hypertension and other dangerous diseases. This continuous muscle relaxation activity also increases circulation throughout the body and increases the body's resistance to viruses and bacteria that enter the institution. Progressive muscle relaxation can reduce anxiety and can increase endurance. Progressive muscle relaxation is beneficial to give rise to calm, comfortable, and relaxed responses (Sulidah et al., 2016).

Progressive muscle relaxation (PMR) is a systematic technique for achieving a level or state of total relaxation in the muscles. This activity involves the use of the whole body to reduce heart rate and relax muscles. A technique used to teach patients to relax muscles through a two-step process. At PMR, the patient first makes movements so that the muscles contract and hold tension. Second, they release all tension and focus on the sensation of relaxation (Lauche et al., 2013). Therefore, students need to do progressive muscle relaxation activities. Progressive muscle relaxation can give students many benefits and overcome problems that occur in students. Besides, students who practice this activity can also improve their learning performance in the classroom because they will provide good focus during the learning sessions in class. In addition, developing technical communication is very important for educational institutions (Jamaludin et al., 2019).

2. Methodology

The research method used in this study was a quantitative descriptive method in which researchers look for differences between before and after viewing videos related to progressive muscle relaxation. Quantitative methods are a way of approach to quantitative data involving numerical measurements (Mustafa et al., 2020). Descriptive statistics refer to the collection, submission, description, analysis, and interpretation of data collection (Franzese & Iuliano, 2018). Respondents were physical education students at the Abu Bakar Temerloh Vocational School to respond to the questions given. The number of respondents selected was only six students. This study uses SPSS 23 to analyze the data obtained.

The research instrument is a series of questions that researchers have given to respondents. There are five questions related to progressive muscle relaxation (PMR) given to six students, namely about how well-positioned to do progressive muscle relaxation and which parts of the body need to be done progressive muscle relaxation. A series of questions is given to students via Google forms. A set of questions is given to students before they can see the video provided by the researcher. Students must answer the questions posed without seeing the video. They will then see videos related to progressive muscle relaxation supplied by researchers. After that, students answer back all questions given by researchers after watching the video.

3. Results and Discussion

In this section, researchers will tell the results of the survey conducted to respondents. The results of this study will illustrate the answers of respondents before and after seeing the video.

Table 1. Respondent Survey Results

No.	Question	Answer Choice	Pre-Test		Post-Test	
			Frequency	Percentage	Frequency	Percentage
1	Questions 1. What is Progressive Muscle Relaxation (PMR)?	Yes	0	0	19	83.3
		No.	26	100.0	7	16.7
		Total	**26**	**100.0**	**26**	**100.0**
2	Questions 2. What is the function of using progressive muscle relaxation?	Yes	21	66.7	26	100.0
		No	5	33.3	0	0
		Total	**26**	**100.0**	**26**	**100.0**
3	Questions 3. When is the best time to do progressive muscle relaxation?	Yes	22	66.7	26	100.0
		No	4	33.3	0	0
		Total	**26**	**100.0**	**26**	**100.0**
4	Questions 4. What is an excellent position to do progressive muscle relaxation	Yes	3	16.7	24	83.3
		No	23	83.3	2	16.7
		Total	**26**	**100.0**	**26**	**100.0**
5	Questions 5. Which part needs to be started to perform progressive muscle relaxation?	Yes	13	50	26	100
		No	13	50	0	16.7
		Total	**26**	**100**	**26**	**100**

Based on table 1, the first question above, the students do not get the right answer before watching the video provided by researchers. Therefore, the table can show six learning frequencies equal to 100%. Respondents did not know about progressive muscle relaxation and were not exposed to progressive muscle relaxation. After the respondent sees the video given by the researcher about progressive muscle relaxation, the respondent can answer the question correctly. Thus, the percentage of students who answered the questions precisely increased, a table showing five respondents able to answer correctly 83.3%. Researchers have stated the video determines muscle relaxation. While one respondent mistakenly answered 16.6%. This student is because respondents did not focus on the video. After all, the definition of muscle relaxation was mentioned at the beginning of the video.

Based on table 1,in the second question, the chart shows the results showing four respondents who answered correctly together with 66.7% without seeing the video. The answer given in the subject is as much as the word itself. Meanwhile, two respondents failed to answer correctly at 33.3%. These respondents are less involved in co-curricular activities. After responding to the video provided, the percentage of respondents who responded successfully increased to six respondents with 100% success. This question is easy to understand and closely related to the fact that the item was written.

Based on table 1, the third question shows the results of two respondents who managed to answer correctly 33.3% without seeing the video. This is because respondents are given choices to answer questions. Therefore, the respondent guessed the answer correctly. Meanwhile, four respondents failed to answer correctly, which is equivalent to 66.7% because they did not know the progress of muscle relaxation. After responding to the video provided, the percentage of respondents who responded correctly increased to five respondents, with 83.3%. In the video provided, it is mentioned that the right time for progressive muscle relaxation. Meanwhile, one respondent failed to answer correctly, with 16.7%. Respondents are confused by the choice of answers, which is almost exactly the original answer.

Based on table 1. the fourth question shows the results of only one respondent who answered correctly, equivalent to 16.7% without seeing the video. These respondents can guess the answer correctly without knowing about progressive muscle relaxation. Meanwhile, five respondents failed to answer correctly, equivalent to 83.3% because they had not seen the video provided by the researcher. After responding to the video provided, the percentage of respondents who responded correctly increased to five respondents, with 83.3%. This condition is because, in the video provided, we have shown how to do progressive muscle relaxation correctly. Meanwhile, one respondent failed to answer correctly with 16%. The respondents do not understand the movements made in the video.

Based on table 1, the fifth question shows the results of five questions three respondents who answered correctly, and three respondents failed to answer correctly at 50.0% without seeing the video. Respondents understood a little about progressive muscle relaxation through the questions asked. After responding to the video provided, the percentage of respondents who responded correctly increased to 6 respondents with 100.0% success. In the video provided, researchers have shown how to do progressive muscle relaxation correctly.

Progressive muscle relaxation significantly benefits humanity. Progressive Muscle Relaxation (PMR) is a systematic technique that can be used to achieve deep relaxation conditions and has been shown to increase anxiety, depression, and various medical and psychiatric illnesses (Zhao et al., 2012). Therefore, this activity is highly recommended to be carried out by all levels of society to ensure that the community can live healthy and safe. There is evidence of the use of progressive muscle relaxation for the general population as an effective treatment for sleep problems. However, little evidence exists to support the use of PMR for players (McCloughan et al., 2016). This activity for progressive muscle relaxation is also natural to do and is easy to formulate beforehand because it does not require expensive equipment. All interventions were carried out in a private space with sufficient light and warmth to make patients feel relaxed during the study to conduct PMR exercises (Dikmen & Terzioglu, 2019).

This research also found that learning through technology was very useful for students. There was an increase in all questions answered after respondents saw the video provided to answer questions raised by researchers. Learning to use this video can attract students' interest in learning something new. Results (Mendoza et al., 2015), revealed that learning to use video is very useful in increasing students' effectiveness. At present, the use of technological tools is very useful in communicating information because, through this advanced technology tool, information can be transmitted quickly and easily. Digital cameras and mobile cameras have become popular in our daily lives (Duan et al., 2012). The use of video as a type of computer-oriented communication can be easily accessed through the internet network. The internet is a global computer network that facilitates and accelerates access to the distribution of information and knowledge (learning materials) so that the content in the teaching and learning process can always be updated (Muhson, 2010).

Although the presence of technology does not guarantee equality and accessibility in learning, it can increase students' knowledge in various fields. Forms of development and changes in information technology can change the habits of community activities, no exception in the world of education (Divayana et al., 2016). With the development of the internet, and the availability of video capture devices such as digital cameras, cellphones with cameras, digital video collection sizes are fast on the internet (Li et al., 2009). Based on research conducted by (Richard et al., 2018), it is known that video learning has experienced an increase in interest over the past few years. All students have access to resources, information, and things they want to know regardless of their geographical location. This access will make it easier for students to learn and gain various knowledge. Interactive video technology has become an essential component in the teaching and learning process, in part because of developments in theoretical learning, such as teaching and learning (Kumar, 2010). The role of technology also enables better communication, sharing of resources, and better practices to improve knowledge for students. This opportunity is an excellent time and progress for the use of technology to support learning.

4. Conclusions

Video-based learning can be implemented in teaching and learning in various fields of education, including teaching PMR techniques. The results of this study indicate that video teaching is beneficial for students. There was an increase in all questions answered after the respondent saw the video provided. The visual lesson will be more quickly remembered and understood by students. Besides, learning to use video can encourage students' interest to learn new things.

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Effects of Progressive Increased Intensity of PNF Stretching on Hamstring Force and Flexibility

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Abstract In most previous studies of PNF stretching performed at different intensities, the subjects were provided with the intensities in a randomized order. In addition, subjects were aided in maintaining a steady level of contraction force using a dynamometer as visual feedback. However, such a procedure differs from the procedure used in actual clinical settings. This study aimed to examine the effect of the applied order of three different intensities of PNF stretching on the ability to regulate the contraction force and increase muscle flexibility. During the 1st period, three different stretching intensities were applied in the order of 25%, 50%, and 75% of MVC in the group A and in the order of 75%, 50%, and 25% of MVC in the group B. This order was reversed during the 2nd period. The contraction force was measured using the strain gauge and hamstring flexibility was measured using active knee extension. There was no significant difference between target and contraction intensity at three target intensities in both groups. Additionally, contraction forces between different intensities clearly were distinguished by subjects in both groups. In Group A, increase in flexibility was significantly higher in the 1st period than in the 2nd period. Healthy adults could clearly differentiate and regulate contraction intensity when the intensities were differentially applied at 25% intervals. The higher target intensity compliance and increase in flexibility may be anticipated when progressively increase intensity was applied, compared to the same factors in reverse order.

Keywords Hamstring Muscles, Isometric Contraction, Proprioceptive Neuromuscular Facilitation Stretching, Range of Motion

1. Introduction

The mechanism behind the effects of proprioceptive neuromuscular facilitation (PNF) stretching on muscle flexibility still remains partly unclear; however, an increase in flexibility has been clearly verified [1]. During stretching, numerous factors may influence the quantitative increase in flexibility; among them, the intensity, in particular, is considered a key factor [2]. Previous studies examining the effects of the different intensities of stretching on flexibility confirmed that moderate-intensity or above stretching leads to a significant increase in flexibility; moreover, low-intensity stretching also sometimes leads to an increase in flexibility [3–5]. Nevertheless, previous studies conducted in laboratory conditions have several limitations when it comes to the clinical application of their findings.

First, the order of different intensities poses a limitation. In previous studies where more than two different intensities were used, the method of applying the intensity could be categorized into two types: the stretching may be performed in a randomized order for all intensities within a defined subject [4,6–8] or with only one intensity randomly assigned to each subject [3,5,9]. The former method applies randomized order such that the order of different intensities on flexibility cannot be analyzed. In the latter method, the stretching is performed at a single intensity so that the characteristics of individual subjects may easily influence the results and, as in the former method, the effects of the order of different intensities on flexibility cannot be determined. In the preliminary study, when PNF stretching at various intensities was provided with either a progressive increase or decrease in intensity, the perceived exertion was found to vary. Unlike in the research setting, in clinical settings progressively increasing intensity is applied rather than a randomized order of intensity. In addition, even for resistance exercises that use isometric contraction as in the case of PNF stretching, progressively increasing intensity is widely used [10,11].

Second, visual feedback is different in clinical settings. In most previous studies, the contraction force being measured in the experiment was provided to the subjects in real time to aid them in self-regulation of the muscle contraction according to the target intensity [3,5,9,12]. The subjects in such cases were able to monitor the contraction force as a numerical value so that it is possible to perform a muscle contraction of the desired level based on a clear differentiation between two or more intensities assigned for the experiment. However, in clinical or sports settings, to measure the muscle force and provide data to the subjects in real time is difficult. For the measurement of muscular strength, an isokinetic dynamometer (e.g., Biodex, Cybex) is the gold standard, but the device is too large for clinical application and its skilled use demands considerable training, limiting its application [13]. In practice, the intensity is generally adjusted based on both the subjective experience of the physical therapist or trainer and the pain response of the subjects as observed during PNF stretching. In other words, without visual feedback from the device specialized for measurement, it may be challenging for subjects to clearly differentiate between the intensities suggested by the practitioner during performance.

The purpose of this study was to examine 1) whether the subjects could clearly differentiate between three intensities when performing muscle contraction; 2) how close the contraction intensity is to the target intensity; and 3) whether there is a difference in the increase in muscle flexibility upon varying the order of intensity, when the subjects were provided with three different intensities in two orders. In contrast to previous studies, visual feedback was not presented to allow subjects to perform PNF stretching in an environment similar to the clinical setting.

2. Materials and Methods

2.1. Subjects

A total of 28 subjects (age 22.1±1.6 years, height 165.6±8.3 cm, weight of 62.2±12.0 kg) participated in the study and were randomly divided into two groups (Figure 1). The participants in this study had hamstring tightness (defined as active knee extension test >20°). Individuals who had undergone surgery to the hip, knee, or ankle joint within the past 6 months, or active pain were excluded. The study was approved by the institutional review board. Informed consent was obtained from each participant.

2.2. Procedures

Each subject was instructed to lie on the treatment table in the supine position. The hamstring flexibility in the randomly selected lower extremity was measured using the active knee extension (AKE) test. The subject was instructed to perform 90° flexion of the hip and knee joint for the AKE test. While the subject slowly performed knee extension, the examiner recorded the knee extension angle upon maximal knee extension. The Pre-AKE was calculated as 180-knee extension angle. After measuring the Pre-AKE, PNF stretching was performed. First, the subject performed the straight leg raise, while the leg was slowly and passively lifted by the examiner using a sling system to the point right before discomfort or pain. The ankle joint of the subject was immobilized using the strap connected to one side of the sling wire, while the other side of the sling wire was fixed to the ceiling. Here, the position of the sling system was adjusted such that the angle between the ceiling and leg was 90°. The contraction forces were measured by a strain gauge (Re-live Inc., Kimhae, Korea). At maximal hip extension, three trials of maximal voluntary contraction (MVC) were carried out; during the MVC, the examiner used verbal encouragement to help the subject achieve the maximal force. Once the muscle had contracted, it was maintained for 5 seconds per trial. There were 10-second rest periods between trials. During isometric contraction, the examiner controlled the horizontal movement of the subject's leg on both sides of the ankle joint to prevent the leg from swinging sideways. After three MVC trials, an additional set of three different submaximal contractions was performed after 3 min rest. For Group A, the target intensity was defined in the order of 25%, 50%, and 75% of MVC during the 1st period. For Group B, the target intensity was defined in the order of 75%, 50%, and 25% of MVC during the 1st period. As in the case of MVC, three trials were carried out for each level of submaximal contraction, after which the mean of the three values was used. The contraction force measured at each intensity was divided by the maximal contraction forces measured during MVC, and multiplied by 100 to calculate the contraction intensity (% MVC). After the completion of the 1st period of submaximal contractions at three different intensities, the AKE test was performed, and the measured values were recorded as Post-AKE. The ΔAKE was calculated as Post-AKE - Pre-AKE. After the 1st period, the subject was given 10 min to rest. During the

2nd period, an identical process was followed using the other lower extremity. In the 2nd period, however, the three different intensities were provided in the opposite order to that in the 1st period.

2.3. Data Analysis

Normality of data was assessed using the Shapiro-Wilk test. The one sample Wilcoxon test was used to analyze the difference between target and contraction intensity. The Mann-Whitney U test was used for the analysis of the difference in contraction force between Groups A and B. The Wilcoxon Signed-Rank test was used to evaluate each group between the 1st and 2nd periods. In addition, the Friedman test was used along with Wilcoxon Signed-Rank test post hoc analysis to examine the difference in contraction forces measured at three different target intensities. Spearman Rank Correlation was used for analysis of the relationship between 'target intensity' and 'the difference between target and contraction intensity'. Carryover effect was assessed using the Mann-Whitney U test. IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA) was used for analysis of data and statistical significance was set at $p < 0.05$, except for the data analyzed by the Wilcoxon Signed-Rank test after the Friedman test (set at $p<0.05/6$). The Wilcoxon Signed-Rank test was used to compare increases in flexibility before and after isometric contractions in each group during the 1st and 2nd periods, and to compare the difference between the 1st and 2nd periods in each group. The Mann-Whitney U test was used for the analysis of the difference in hamstring flexibility between group A and B. All values were reported as mean ± standard deviation.

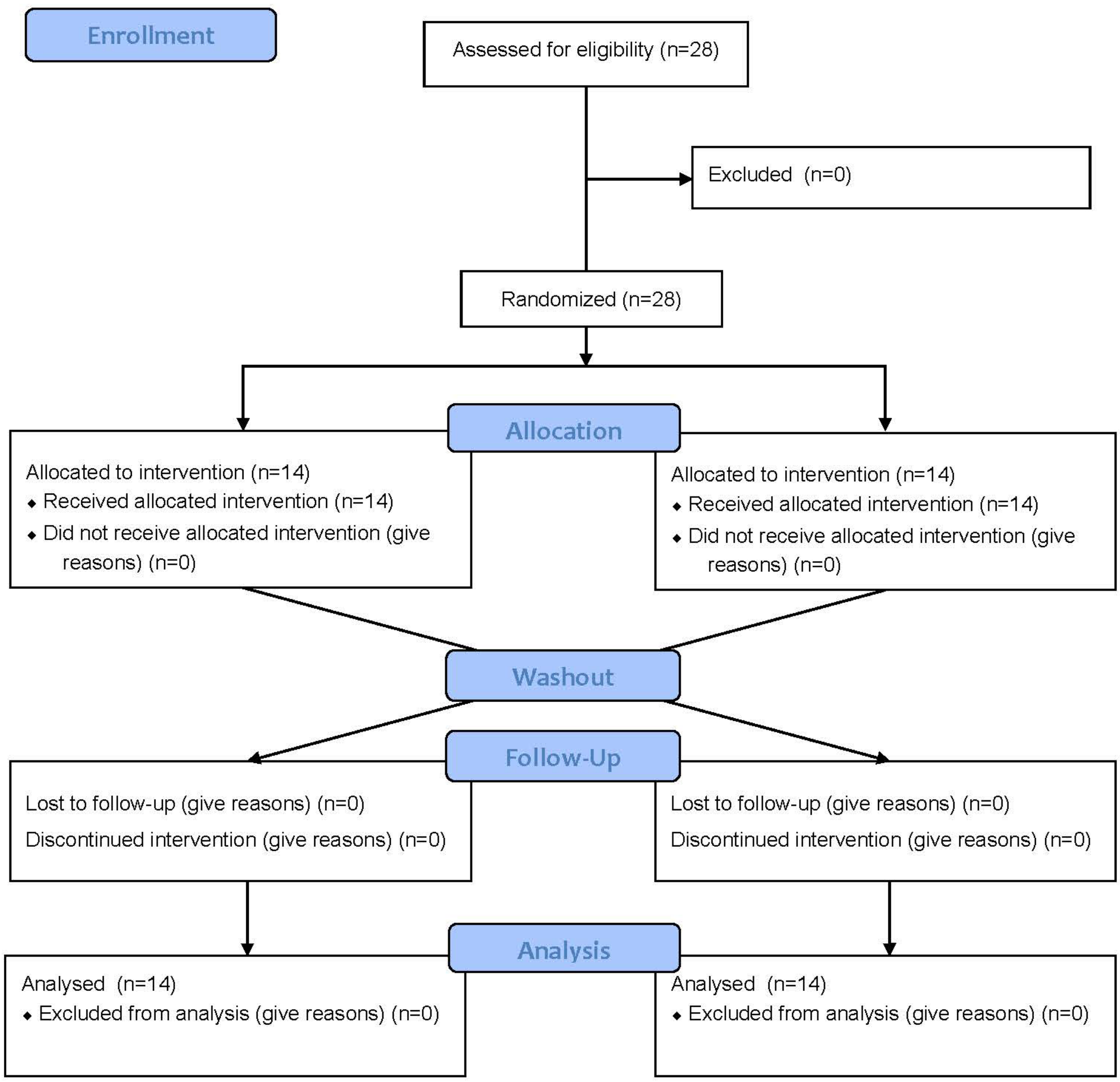

Figure 1. CONSORT flow diagram

3. Results

There was no significant difference between target and contraction intensity at 75% (p=0.650, 0.775), 50% (p=0.691, 0.955), or 25% of MVC (p=0.334, 0.865) in Group A during the 1st period and 2nd period (Figure 2a) and at 75% (p=0.394, 0.078), 50% (p=0.910, 0.910), and 25% of MVC (p=0.532, 0.496) in Group B during the 1st period and 2nd periods (Figure 2b). The mean contraction intensity between Groups A and B at each target intensity was not significantly different. In Group B, a significant relationship (p=0.044) between target intensity and difference between target and contraction intensity was observed during the 1st period (Figure 3).

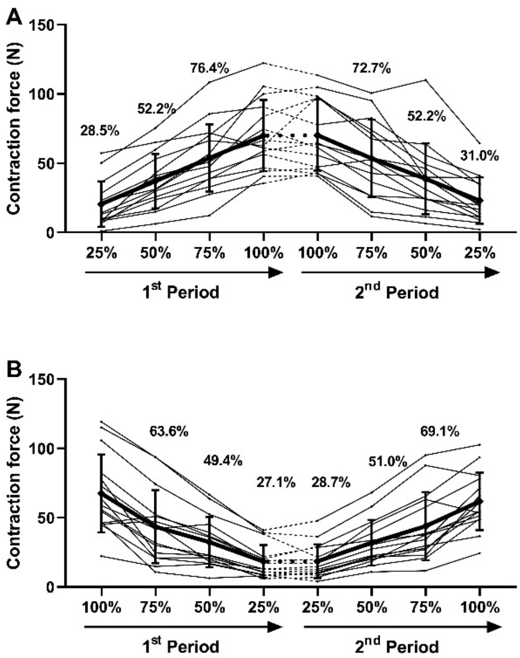

Figure 2. Changes in contraction force during 1st and 2nd period in Group A (A) and Group B (B)

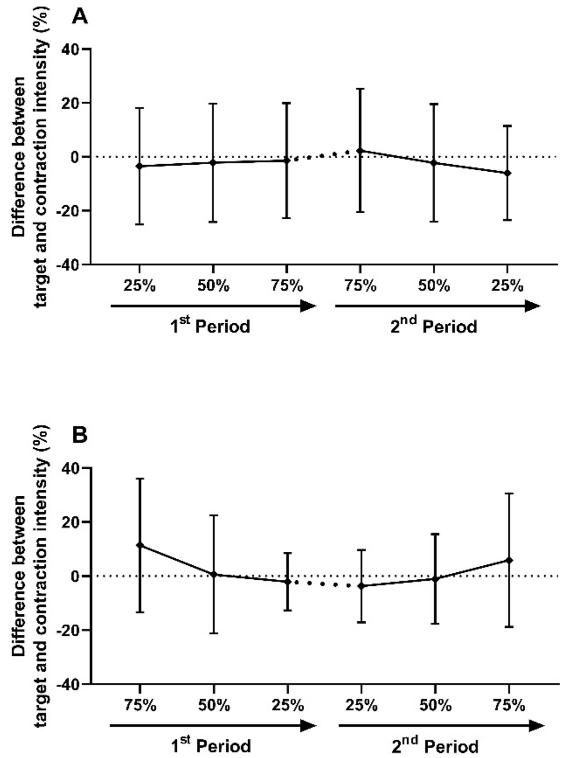

Figure 3. Difference between target and contraction intensity in Group A (A) and Group B (B)

In the within-group comparison for each period, contraction forces between 100% and 75%, 100% and 50%, 100% and 25%, and 75% and 25% of MVC could be distinguished in Group A and Group B. No carryover effect on contraction force was found.

Hamstring flexibility was significantly increased after submaximal isometric contractions during each period in both groups A and B. In Group A, ΔAKE was significantly higher in the 1st period than in the 2nd period (p=0.017); however, there was no difference in the increase in flexibility between the two groups (Figure 4).

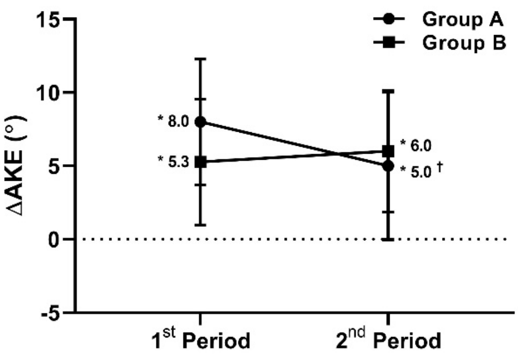

Figure 4. Comparison of increase in hamstring flexibility at 1st period and 2nd period

4. Discussion

In this study, similar to conditions in clinical and field settings, information regarding hip extension force was not provided to subjects during voluntary isometric contraction. Three different target intensities were differentially applied at 25% intervals. The contraction force measured at each target intensity was found to be statistically different from one another. Furthermore, there was no significant difference between contraction intensity (normalized to MVC) and target intensity. This implied that healthy young adults could regulate the level of muscle contraction by clearly differentiating intensities without visual feedback, as well as being able to perform muscle contraction of a desired level based on the intensity imposed by another individual. Much of the information obtained during muscle contraction is sent to the central nervous system in real time through afferent pathways, based on which the human body can perform detailed and accurate movements [14–17]. Such feedback mechanisms are realized through proprioception and may be decreased or increased by an external factor [18–20]. The most well-known proprioceptors in the human body are the muscle spindle and Golgi tendon organ (GTO). The muscle spindle is known to provide information regarding muscle length and velocity. Recently, the changes in muscle length, as well as joint position were reported, to exert an influence [15,21]. The GTO is known to detect changes in muscle force rather than absolute force, as it provides information regarding muscle force [22]. In addition, the afferent input is sent to the CNS by mechanoreceptors in the glabrous skin and chemo-sensitive receptors (type III and IV) found in the muscle tissue [23–25]. The feedback mechanism provides only information obtained during a movement so that it cannot influence the step prior to the movement. For a detailed and accurate movement to be performed, it is sometimes necessary to influence the step prior to the movement. The feedforward system sends an anticipatory input to the sensory area before a movement is generated; consequently, much recent focus has been placed on the feedforward mechanism. The feedforward mechanism incorporates the concept of corollary discharge (an internal copy of the motor signal transmitted from the motor to sensory areas) [26]. This copy of the signal cannot create a movement on its own, but plays a crucial role in determining sensory discrepancy through comparison with reafferent signals coming from the sensory system [22,27,28]. In recent studies, the location where signals arise is not simply restricted to the motor cortex [29]. The integrated information from the feedforward and feedback mechanisms is presumed to assist perceived exertion to approach the actual contraction intensity. Recently, a diversity of factors, including psychological stimuli, in addition to the physical properties described so far, have been shown to exert a complex influence [30].

Although there was no significant difference between the target and actual contraction intensity for all three different intensities, the within-group differences in contraction force between the 1st and 2nd periods revealed a significant trend. To be specific, in Group B, a significant negative correlation (p=0.044) was observed during the 1st period where progressively decreased intensity was applied. On the contrary, during the 2nd period where progressively increased intensity was applied, no significant correlation was found, indicating that the difference between target and contraction intensities in the 2nd period was maintained at a steady level, with no notable change. This was similarly observed in Group A. To put it another way, when progressively decreasing intensity was applied, the difference between target and contraction intensities showed a gradual fall with decreasing intensity, which suggests the possibility of under-production at high-intensity and over-production at low-intensity. According to a previous study examining various intensities, under-production was frequently observed at high-intensity. In a study by Cooper and Jackson (2003), the knee extensor forces were reported to show under-production at 75% of maximal perceived effort [31]. In Pinceviro (2003), likewise, the knee extensor torque showed under-production at high perceived exertion levels [12]. The under-production at high-intensity is sometimes explained as a subconscious response to reduce the risk of injury caused by muscle contraction at excessive high-intensity and energy expenditure [12]. However, this assumption fails to explain the over-production at low-intensity. In Kumar (1994), over-production was observed for the power grip at 20% of MVC [32], while in Sheard (2003), it was observed for the hip flexion at 20% of MVC [7]. The difference between the target intensity and the actual contraction intensity is more likely to be accounted for as a bias arising from each extremity rather than as a protective mechanism. When the assigned target intensity increases or decreases based on 50% of MVC, the actual contraction intensity shows a comparatively smaller margin of increase or decrease, thereby exhibiting a trend in which it is positioned relatively closer to the center, with consequent over-production at low-intensity and under-production at high-intensity. Most previous studies described thus far reported a small difference between target intensity and contraction intensity for moderate-intensity contraction. In this study, the range of contraction intensity at a target of 50% of MVC was 49.4–52.2%. In contrast, the range with a target of 25% of MVC was 27.1–31.0%, higher than the target intensity, while the range with a target of 75% of MVC was 63.6–72.7%, generally lower than the target intensity (except Group A during the 1st period).

For PNF stretching, the maximal and/or submaximal voluntary isometric contraction is repeatedly performed to increase flexibility. The voluntary isometric contraction in this study was identical to the PNF stretching procedure, based on which an increase in hamstring flexibility across the subjects could be predicted. In both groups, the hamstring flexibility showed a significant increase after repeated isometric contractions regardless of the order of intensities. Additionally, in the case of Group A, the progressively increased intensity (the 1st period) led to a more significant increase in flexibility than the progressively decreased intensity (the 2nd period). Group B, likewise, showed a slightly higher increase in flexibility during the 2nd period in which a progressive increase had been applied. During PNF stretching for the improvement of flexibility, the GTO plays an important role with the muscle spindle. The stimulation of the muscle spindle caused by stretching leads to muscle contraction to prevent overstretched muscles, so that the stretching can be inhibited [33,34]. In contrast, the GTO inhibits the contraction of stimulated muscles, thereby assisting in stretching [35,36]. For PNF stretching, the muscle spindle inhibiting the flexibility increase is reduced, whereas the GTO that helps to increase the flexibility is known to be stimulated [6]. Furthermore, the positive effects of neurological properties on flexibility are known to show an extremely sensitive response at low-intensity in comparison to high-intensity stretching [1,14]. In addition, local discomfort may be induced at high-intensity stretching, whereas at moderate-intensity stretching, optimized GTO inhibition may be expected [6]. When high-intensity stretching is applied, the muscle stiffness resists muscle-tendon unit elongation, while the soft tissues exhibit microtears with undesirable pain [37,38]. Although no study has yet examined the flexibility increasing effect based on the order of intensity, as in this study, a previous study reported that low-intensity long-duration stretching may be advantageous in increasing flexibility over high-intensity short-duration stretching [39]. The findings of this study and of previous studies collectively suggest that more effective flexibility increase may be anticipated when a progressive increase in intensity is applied, starting from low-intensity, rather than the reverse order. The subjects are also likely to find this order more comfortable.

For the subjects in this study, muscle contraction could be regulated based on the target intensity, but this may have been possible because of the considerably large differences between consecutive intensities (25%). Thus, further studies should examine the minimum intensity discernable by the human body, by subdividing the intensity interval across various groups. In addition, the subjects in this study were healthy adults, so the findings cannot be generalized to other subject groups.

Regardless of the applied order of intensity, healthy adults could clearly differentiate and regulate contraction intensity when the given target intensities were at least 25% different. They could also perform muscle contraction according to the demanded intensity. For changes in the within-group difference, applying a progressively decreased intensity led to a fall in the difference between the target and actual contraction intensities, whereas the reverse order did not lead to a notable change. In other words, by applying a progressively increasing intensity in clinical settings, far higher target intensity compliance may be anticipated. Additionally, a far higher increase in flexibility may be anticipated in such cases, compared to that when using the reverse order.

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The Validity of Construct Analysis on Assessment Instrument of Basketball Skill for Senior High School in Yogyakarta City

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Abstract This research is quantitative research which aims to know the quality of instrument proved by the validity of construct. The empirical validity of research instrument is tested to senior high school students both public and private school in Special Region of Yogyakarta which hold the basketball competition among senior high school. The result of tested then is analyzed by using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The EFA analysis uses software support of SPSS 23.0 and CFA analysis uses software LISREL 8.8. The result of analysis by EFA shows that the grouping data into two big groups such as skill execution and decision making. The result analysis of EFA also shows that the value of KMO is about $0.747 > 0.50$. The value of Bartlett's test and Chi-square is about 318.020 and the significance is on 0.000, therefore the analysis tested factor can be continued. The result of assessment calculation of basketball skill by using first order CFA shows that the value of p-value=0.16220 (>0.05), RMSEA = 0.042 (>0.08) and chi-square =11.76 > 0.05 which means that the model is appropriate with the data, the analysis of model structural equation, and decision making effect the ability of playing basketball. The amount of contribution of decision making toward the ability of playing basketball is about 26 percent, while the contribution is about 74 percent influenced by another variable.

Keywords Exploratory Factor Analysis, Confirmatory Factor Analysis, Assessment, Basketball

1. Background of Study

According to FIBA in Official Basketball Rules 2012 basketball game defined as follow, basketball game is played by two teams which is each team consists of five players. The aim of this game is by putting the ball into the rival team's basket and trying to prevent the rival team to put the ball into the basket. The game is controlled by referee, desk clerk, and match overseer. The basket attacked is called rival's basket and the basket guarded is called team's basket. The team obtained bigger score is the team winning the game. Basketball game is included in invasion game such as football, handball, and hockey which cooperates among the players in one team to reach the goal of getting the score and preventing the rival team getting the score [1].

The basic skill of basketball player according to Morrow et. al [2] consists of shooting, dribble, passing the ball and jumping. The next progress, proposed by Memmert and Harvey [3], it depends on the game and the category, teachers, coaches or researcher can choose one of or several components of Game Performance Assessment Instrument (GPAI) to evaluate the someone's performance in playing basketball. Two advantages are by using Game Performance Assessment Instrument (GPAI) to evaluate someone's ability in sport, such as (a) Game Performance Assessment Instrument (GPAI) is easily adapted for various kind of sport, physical activity, and (b) GPAI has the ability to measure the skill in processing the ball, but also the skill without mastering the ball (measuring the offensive or defense) [1]. For example, in invasion (including playing basketball), a teacher, coach, or researcher only chooses assessing the component in attacking, skill execution and decision making, or assessing the component in defending, guard or support.

In this research GPAI developed for assessing the ability of the player in playing basketball after doing practice of basketball. More specific for coaching in basketball sport. Game Performance Assessment Instrument (GPAI) is also developed but only taking the component of skill execution and decision making.

Skill execution is player's ability to show the performance which efficient from one skill chosen. In basketball game, there are only three basic skills in playing, such as shooting, passing and dribbling. Appropriate with the definition above, skill execution for on-the-ball in playing basketball is an efficient performance in doing the skill in shooting, passing and dribbling. According to Gutierrez et. al [4] and Memmert and Harvey [3], skill execution got value 1 if it is successful or effective and value 0 if it isn't successful or ineffective.

Decision making is player's ability in making choice of the right skill appropriate with the situation when the player mastering the ball. Assessing the decision making is also done by two ways: decision making which is appropriate or right getting value 1 and decision making which is not appropriate or incorrect getting value 0.

On the principle of assessing by using GPAI is an assessment which is called authentic assessment. Authentic assessment is defined as the assessment of performance based [5]. Authentic assessment has the equivalent of other names such as alternative assessment, performance assessment and direct assessment.

Authentic assessment is direct assessment and using direct size, when doing this assessment, there are many activities which are clearer if they are assessed directly. In this research, the activity of playing basketball needs direct assessment to be able to assess the skill of playing basketball. Authentic assessment is an assessment which asked students to perform the task in real situation by demonstrating the skill applying and meaningful knowledge. The performance needed to be present effectively and creatively. Authentic assessment usually involves a task to be performed and the criteria of assessment or rubric which will be used to assess the performance.

Measuring can be defined as a process collecting information by the rule of giving number or value on the object or certain event by systematic ways. The process of measurement including two things such as determining what will be measured and choosing the instrument to measure what will be measured. The common instrument used by teacher of sport education is various kinds of sport skill test and the test of physical freshness. There are three important elements related with the measuring such as object measured, instrument, unit of measure used by the object which will be measured usually related to the physical condition or someone's phycologist. The instrument used is categorized into two categories such as standard and not standard instrument. Unit of measure of each object is different one to another, though there is a possibility that object measured is the same object, but using different instrument. To measure physical object, the unit of measuring used like the lengthy stated by meter units. For non-physical object such as attitude, perception, motivation and etc., needs the unit of measure made by the researcher that can state quantitative measurement.

In order to make measurement done optimally, it should use the unit of measure which can be able to obtain the accurate information, properly, and relevant. Therefor the instrument used should fulfill the standard instrument required. Related to the statement of Ngatman [6], that the process evaluation in physical education can run well, all the instruments used should have good characteristics. Miller [7] states that a sport skill should fulfill some requirements such as it should be valid, reliable, objective, economist, interesting and proven can be implemented.

Mardapi [8] defines the validity as the size of how careful a test does its measuring function. American Educational Research Association (AERA), American Psychological Association (APA), National Council on Measurement in Education (NCME) define a validity as, how far the prove and the theory supported the specific interpretation from test required by the using proposed. The test validity refers to the level of truth in score test interpretation. This interpretation based on the aims of test using [9]. The validity is how far the accumulation of certain interpretation proof and supported theory from score test by the use and validity refers to the level of truth of score test interpretation on its use.

Saifuddin [10] divides the type of validity from the way of estimation adjusted with the character and function every test to be three categories such as content validity, construct validity, criterion related validity.

Construct validity is a type of validity which shows how far the test revealed a trait or theoretic construct which is measured [11]. According to Mardapi [12] the validity of content is observed from the grid of test such as matrix showing the material test as well the level of thinking involved in doing the test. This validity is analyzed before the test used. Construct validity is obtained from the result of analyzing factor including the number of factors measured of a test. The proof of validity construct is obtained from the result of test using, such as empirical data. The opinion is confirmed by Saifuddin [10], the result of estimation construct is not stated in the form of validity coefficient. Examining the construct validity can also be a technique of statistics analyzing. In its analyzing done by examining the relationship between the items and the factors, so it is called factor analysis. Instrument can be valid if the items are really revealed and applicable as the factor of indicator which can be measured. By contract validity, the researcher sets the construct or concept which will be measured then set the indicators which will be developed next to be items of questions.

Some of studies about the skill in psychomotor assess the technique of playing basketball have been done [13]. Most of them develop the test skill in sport skill test. There is no research yet about skill in playing basketball which assesses about psychomotor skill, affective and cognitive at ones. The test the ability of playing basketball developed in abroad is the test of basketball created by Hopkins, Shicks, & Plack [14]. In Indonesia, there are some studies related to the developing the test of playing basketball skill. The study from Budi Aryanto adaption of skill test of AAHPERD 1984 (1996).

Though there have been studies about skill test of playing basketball for elementary, junior and high school level, but until now days, the data of skill level of playing basketball from each level of school have never been published. Until now, there have been not data of how far the skill level of playing basketball of senior high school students in Indonesia. If there is a study revealed about the skill level, the data taken in this research have purposive character and cannot be generalized. The main key of prestige improvement in the context of basketball coaching is observation of player's skill, and it can be done by doing the match analysis and testing skill. Based on the description delivered, this research focused on the construct validity of assessment instrument of basketball skill. Construct validity is expected to be able to prove the result of measuring obtained through items of test is high correlation with theoretical construct which underlies instrument drafting.

2. Methodology

This research is basically quantitative research which aims to know the quality of instrument proven through the construct validity. Empirical validity of research instrument planned tested to the senior high school students both public and private school in Special Region of Yogyakarta which hold basketball competition among senior high school. The result of tested then is analyzed by using exploratory factor analysis and confirmatory factor analysis. The analysis of EFA uses software supported of SPSS 23.0 and CFA uses software LISREL 8.8.

This tested is done by assessing the ability of the player when they are playing basketball in the competition of DBL 2019 region, Special Region of Yogyakarta. The assessment includes skill execution and decision making. The number of respondents is 250 players. The players playing in personal identity data then during playing they are assessed with two instruments above.

Construct validity gives the proof that the result of measurement is really can be interpreted related to the definition, or the instrument really reveals the skill measured. Instrument validity is based on the empirical data analyzed using confirmatory factor analysis [15]. Construct validity is proven by using loading factor data obtained from CTA. An observation variable is stated to be valid if measuring the variable is latent if the number of factor load is bigger than 0.3. In this research the construct validity is tested by using first order of CFA with software LISREL 8.8 supported.

First order CFA equation can be formed:

$$\chi p = \lambda p \xi + \delta p$$

Where $\chi 1$, $\chi 2$, ... χp is the indicator from common factor. $\lambda 1$, $\lambda 2$ ... λp is loading factor, $\delta 1$, $\delta 2$, ... δp is unique factor for each error equation. The relation between first order CFA and second order CFA, is formed as equation below:

$$\eta = \mathbf{B}\eta + \Gamma\xi + \zeta$$

$$\mathbf{X} = \boldsymbol{\Lambda}\mathbf{x}\eta + \varepsilon$$

Where **B** is coefficient loading, Γ and Λ are loading factors first order and second order, ξ random vector of latent variable, ε is residual (Brown, 2006: 321).

3. Result and Discussion

3.1. Exploratory Factor Analysis (EFA)

Factor analysis is used in this tested of this small-scale use exploratory factor analysis. The principle of exploratory factor analysis is grouping the data based on the intercorrelation among the items. The result obtained from the analysis is statistical analysis which is rotated component matrix. Extraction analysis to explore the number of dimensions is wanted by instrument developed. The table on the rotated component matrix shows that the distribution of the test is on the variable on the number of factors existed. While, the number found in the table is factor loading or the number of intercorrelation among the variable of test with the factor existing.

Based on the result from exploratory factor analysis, it is then interpreted to set whether an item is abort or not. The criteria used are based on the opinion expressed by Safrit and Wood [16], if an item has factor loading under 0.30, so the item is abord. Factor analysis in this research is done by using computer program supporting SPSS 23.0 version.

Assumption underlying whether factor analysis can be used or not is matrix data should have sufficient correlation.

The test of Bartlett of Sphericity is statistical tested to determine the number of correlations among variable which can be tested. Another test instrument used to measure the level of intercorrelation among variable and whether analysis factor can be done or not is Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO MSA).

Table 1. KMO test & Bartlet

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.713
	Approx. Chi-Square	185.677
Bartlett's Test of Sphericity	Df	15
	Sig.	.000

The value of KMO MSA should be bigger than 0.50 to be able to do factor analysis. The result display of output SPSS shows the value of KMO is about 0.713, therefore it can be done factor analysis. The value of Bartlett test with Chi-square is about 185.677 and the significance is 0.000, so it can be concluded that the test of factor analysis can be continued.

Based on the data analyzing done with computer supported from sixth variables analyzed found that the result of computer extraction is divided into two factors based on the value of eigen value >1, factor 1 with the eigen value 3.321, factor 2 with eigen value 1.584. factor 1 is able to explain the variation which is about 55,356 percent. Factor 2 is able to explain the variation which is about 26.393 percent, both of factors are able to explain the variation which about 81.749 percent.

By looking at the component matrix and varimax rotated component matrix, it is clear that grouping in the factor 1 is shooting skill execution, passing skill execution, and dribble skill execution which all the loading factor is about 0.866. while grouping in the factor 2 is shooting decision making, passing decision making and dribble decision making which each loading factor is about 0.831.

Tabel 3. Component Matrix and Rotated Component Matrix EFA

Component Matrix[a]

	Component 1	Component 2
B01	.656	-.588
B02	.716	-.533
B03	.727	-.411
B04	.625	.584
B05	.662	.541
B06	.605	.567

Rotated Component Matrix[a]

	Component 1	Component 2
B01	.881	.005
B02	.888	.087
B03	.815	.184
B04	.070	.852
B05	.127	.846
B06	.066	.827

The tested with big scale skill assessment of playing basketball is done toward the basketball male player of senior high school in Special Region of Yogyakarta. This tested done by assessing the player's skill when they are playing basketball in the competition of DBL 2019 region, Special Region of Yogyakarta. The assessment includes skill execution and decision making. The number of respondents is 250 players. The player playing in personal identity data then during playing, they are assessed with two instruments above.

Analysis in developing the instrument aims to know the validity and reliability of instrument. Data analyzing is to know the construct validity instrument is done by confirmatory factor analysis (CFA) using LISREL 8.8 supported.

Criteria used to set the validity of instrument for CFA tested are by looking at the number of loading factor has by each item of instrument. The number of loading factor can be known when doing CFA. The provision used for validity boundary is 0.3. to know the reliability of instrument, criteria used to set the reliability of instrument is by looking at the number of construct reliability (CR) ≥ 0.7.

Table 2. Eigen Value of EFA

Total Variance Explained

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,321	55,356	55,356	3,321	55,356	55,356	2,501	41,685	41,685
2	1,584	26,393	81,749	1,584	26,393	81,749	2,404	40,064	81,749
3	,418	6,971	88,720						
4	,266	4,431	93,151						
5	,242	4,040	97,191						
6	,169	2,809	100,000						

3.2. Confirmatory Factor Analysis (CFA)

Big scale assessment tested of playing basketball skill is done toward the male player of basketball of senior high school in Special Region of Yogyakarta. This tested done by assessing the ability of the player when they are playing basketball in the competition of DBL 2019 region, Special Region of Yogyakarta. The assessment including skill execution and decision making. The number of respondents is 250 players. The player playing in personal identity data then during playing they are assessed with two instruments above.

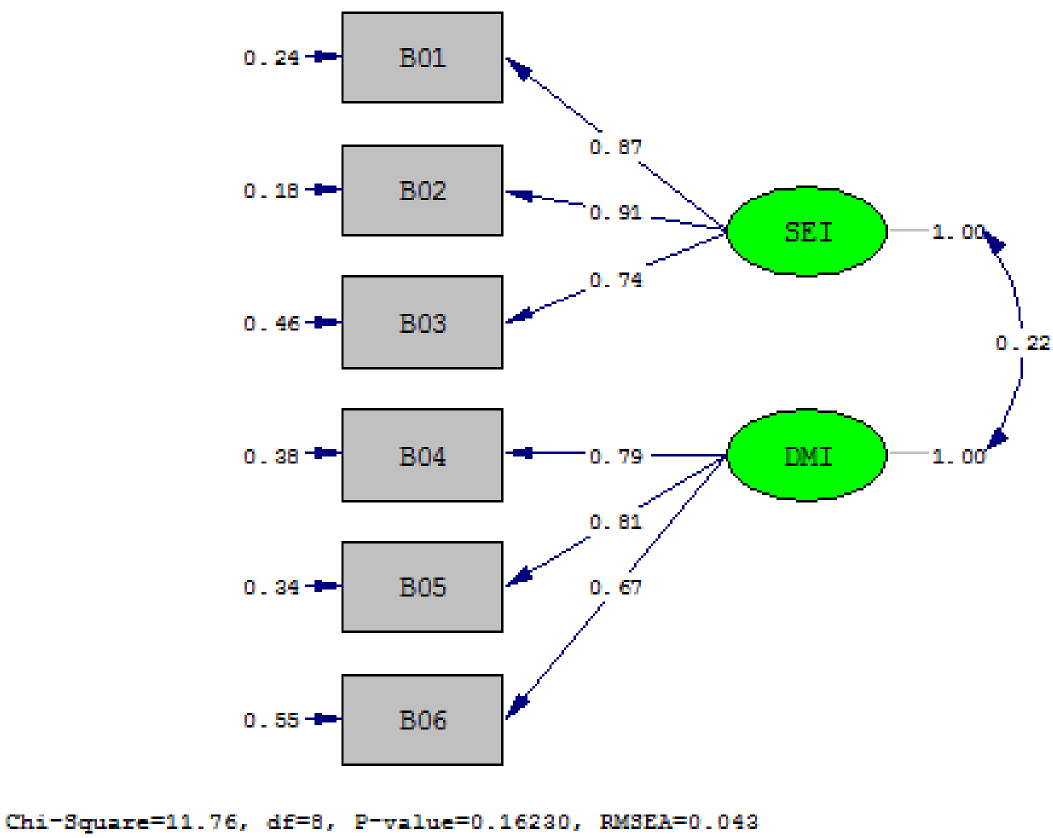
Analysis in developing the instrument aims to know the validity and reliability of instrument. Data analyzing is to know the construct validity instrument done by confirmatory factor analysis (CFA) using LISREL 8.8 supported.

Criteria used to set the validity of instrument for CFA tested are by looking at the number of loading factor has by each item of instrument. The number of loading factor can be known when doing CFA. The provision used for validity boundary is 0.3. to know the reliability of instrument, criteria used to set the reliability of instrument are by looking at the number of construct reliability (CR) ≥ 0.7.

Table 4. Tested Result of Confirmatory Factor Analysis

Factor	Item	*Confirmatory Factor Analysis*		
		LF	t-Val	CR
Skill Execution	SE Shooting	0.87	16,29	0,877
	SE Passing	0.90	17,22	
	SE Dribbling	0.74	12,99	
Decision Making	DM Shooting	0.78	12,90	0,804
	DM Passing	0.81	13.31	
	DM Dribbling	0.69	10,88	

Analysis result of first order CFA on the table 4 above shoe that all of items instrument on the factor of skill execution and decision making have loading factor bigger than 0.30, therefore all of the instrument items are valid. Besides, skill execution and decision-making construct reliability≥ 0.7, therefore it can be stated that the instrument is reliable.



Picture 1. Path Diagram Standard Solution First Order CFA Skill Execution and Decision-Making big scale tested

4. Conclusions

Construct assessment of playing basketball skill consists of assessment toward skill execution and decision making. In skill execution and decision making, there are three basic components of playing basketball assessed such as shooting, passing and dribbling. This case proven by EFA and CFA first order tested. The analysis result with EFA shows that grouping the data into two big groups such as skill execution and decision making. The analysis result with EFA also shows that the value of KMO about 0.747 is bigger than 0.50. the Bartlett's test with Chi-square is about 318.020 and the significance in 0.000. therefore, the test of factor analysis can be continued. The calculation result assessment of the skill playing basketball by using first order CFA shows that the value of p-value=0.16220 (bigger than 0.05), RMSEA= 0.042 (smaller than 0.08) and Chi-square= 11.76 is bigger than 0.05 which means that the model is convenient with the data. The component giving the biggest contribution toward skill execution variable is passing component which is about 91 percent while the component giving the smallest contribution is dribbling component which is about 74 percent. The component giving the biggest contribution to the variable of decision making is passing component which is about 81 percent while the component giving the smallest contribution is dribbling component which is about 67 percent. Based on analysis of structural equation model, skill execution effects the skill of playing basketball. The number contribution of skill execution toward the skill of playing basketball is about 21 percent. While the contribution which is about 79 percent is influenced by another variable.

Based on the analysis of structural equation model, decision making influence the skill of playing basketball. The number of contributions of decision making toward the skill of playing basketball is about 26 percent, while the contribution which is about 74 percent is influenced by another variable.

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Sports Specific Injury Pattern of Sportspersons

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Abstract *Objective:* Previous researches on sports injuries primarily focused on specific games or sports or on specific types of injuries. None of them had tried to explore the injury patterns of games and sports altogether. The current study tried to explore the injury patterns of sportspersons over 16 different types of games and sports. *Materials and methods:* Total of 1008 injury cases (649 male and 369 female, age 21.07±2.78 and 20.81± 3.01 years) between the academic sessions 2008 to 2017 were analysed. Injury data were extracted from the institute injury record book. Apart from age and gender, ' Body site of injury ', ' Types of injury ' and ' Recurring of injury ' were selected as variables for the study. Descriptive statistics, bar and pie diagram were generated using crosstabs function of IBM SPSS. *Results:* An average 101.80±12.59 injury was reported per year. Footballers were found to be the highest injured sportsperson (19.5%). Injury percentage of male players (63.75%) was higher compared to female (36.25%) counterparts. Lower limb area (45.28%) was found to be the highest affected body site of injury followed by upper limb area (29.47%). Acute injury constituted 50.39% of overall injuries. Most injuries were non-recurring in nature (63.65%). Further different combinations of analysis revealed more insight of injury patterns of sportspersons.

Keywords Sports Injury, Types of Injury, Body Site of Injury, Recurring of Injury

1. Introduction

Modern sports have been so popular, organized, and important that, no period of world sports history can be compared with the present status of sports. Rules and regulations are now clear, unified methods are derived for objective comparisons of achievements. Sporting achievements become standards for the assessment of the human potential and at the same time play a role in the further development of landmarks. As sports grew and success became a goal, people began to think about how to enhance their performance. The idea of scientific training for sports came to the human mind in the constant desire to expand the boundaries of human performance. Gradually training becomes organized and systematic to improve the individual's physical, psychological, and intellectual performance capacity but at the same time, the physical and emotional burden on players have been intensified[1]. Higher rate of exposure and innovative training develops better performer but at the same time, it becomes the cause of injury among sportspersons.

Sports injury can be simply defined as the injuries which are associated with exercise and sports activities[2]. Participation in games and sports carries an inherent risk of getting injuries. Even the spectators can be injured in sporting events. Conrad [3] had rightly said:

> " Whether one is a professional athlete or a weekend warrior, almost every participant incurs physical injury at one time or another. "

Along with increasing young participants in competitive sports; rise in the number of sports-related injuries has also been observed [4,5]. Experts have classified injuries based on affected body region [6] and some had classified based on events and associated symptoms [7,8]. A single specific and identifiable event can cause acute traumatic injuries, while subacute and overuse injuries can occur without evidence of a single identifiable event due to repeated micro-trauma [6]. A recurrent injury is the repetition of the same injury[9]. It has been reported that a previous history of injury is a strong risk factor for recurrent injury [7,10].

It has been found that the majority of sports injuries are sport-specific and varied on the level of participation[11]. Researches on sports injuries focus primarily on specific games or sports or specific types of injury. None of them had tried to explore the injury patterns of games and sports altogether. Therefore, in the current study, the researcher intends to explore the injury patterns of sportspersons over different types of games and sports. The results of the study can be considered as adding on with the existing researches in the field of sports injury and will help to identify the injury pattern of sportspersons of different games and sports.

2. Materials and Methods

2.1. Participants

The injury occurrences of the subjects were observed between the academic sessions of 2008 to 2017 of Lakshmibai National Institute of Physical Education (LNIPE), Gwalior, India. Total of 1008 injury cases were recorded during this time period. The record contains 649 male and 369 female injury cases. The mean age of male cases was 21.07±2.78 and mean age of female cases was 20.81± 3.01. Reported injuries at Health and Physiotherapy Centre of the institute are registered in a registry book along with the student's name, age, class of study, sport or game and injury detail. The injury reported students are issued with a health card which also contains all details about his injury. The registry is maintained by the in-charge of the physiotherapy centre. The researcher used this registry and health cards as the source of data for the study. The study was a part of PhD research and it was approved by the research approval committee of the institute. Data were cross verified by the researcher before the implementation of the statistical tests.

2.2. Variables

Age and gender were selected as variable to obtain simple demographic data about the subjects. Year of injury was used as a variable to obtain time-series data of the injuries. Total of sixteen (N=16) games or sports were categorised under the variable games and sports for the analysis purposes. The variable 'Body Site of Injury' was categorised into head & neck, upper limb, trunk and lower limb (Table 1), 'Types of Injury' was categorised into acute, subacute and overuse injury (Table 2). 'Recurring of Injury' was also selected as a variable for the study and it was recorded with the responses yes and no.

Table 1. Injury classification according to body site of injury

Injury Type	Body Region
Head and neck	Head, face, neck and cervical spine
Upper limb	Shoulder, clavicle, upper arm, elbow, forearm, wrist, hand and fingers
Trunk	Sternum, ribs, upper back, abdomen, lower back, pelvis and sacrum
Lower limb	Hip, groin, thigh, knee, lower leg, achilles tendon, ankle, foot and toe

Table 2. Injury classification according to sign and symptoms

Injury Type	Example
Acute	Contusions, sprains tears etc.
Subacute	Jumper's knee, tennis elbow, thrower's shoulder etc.
Overuse	Low back pain, spondylolysis etc.

2.3. Statistical Analysis

Data were analysed using IBM SPSS software (Version 25). Simple descriptive statistics, bar and pie diagrams were used to explain the patterns of injury among sportspersons. Crosstabs function under descriptive statistics in SPSS was used to calculate statistics of different combinations.

3. Results

A total of 1008 injury cases were documented during the academic sessions of 2008 to 2017. Maximum (118) number of injuries were recorded in the year 2016 and minimum (82) was recorded in the year 2009 (Table 4, Figure 1). The average documented injuries were 101.80±12.59 per year (Table 3). Out of 1008 documented injuries, 19.5% injuries occurred to football players, making it the highest among all types of games and sports. This was followed by athletics with 11.3% injuries. The third highest injuries occurred to basketball players with 10.1% of documented injuries. From overall injuries, 8.6% of injuries occurred to cricket players followed by volleyball players (7.6%) and hockey players (6.4%). The handball and kabaddi players were representing 5.9% and 5.7% of overall injuries respectively. The occurrences of injuries to badminton players were 5.3%. The injury percentage of other games and sports was less than five percent of total documented injuries. Among them the table tennis players were having the lowest percentage of documented injuries with only 0.9% of overall cases (Table 4).

Table 3. Descriptive statistics of year-wise documented injury

Minimum	Maximum	Mean	Std. Deviation
82	118	101.80	12.59

Table 4. Distribution of documented injuries by types of games and sports

Games/Sports	Count	%
Football	200	19.65
Volleyball	79	7.76
Handball	59	5.80
Basketball	103	10.12
Cricket	88	8.64
Lawn Tennis	19	1.87
Badminton	55	5.40
Table Tennis	9	0.88
Kabaddi	57	5.60
Judo & Wrestling	38	3.73
Gymnastic	46	4.52
Swimming	30	2.95
Athletics	114	11.20
Yoga	12	1.18
Weightlifting	43	4.22
Hockey	66	6.48
Total	1018	100.00

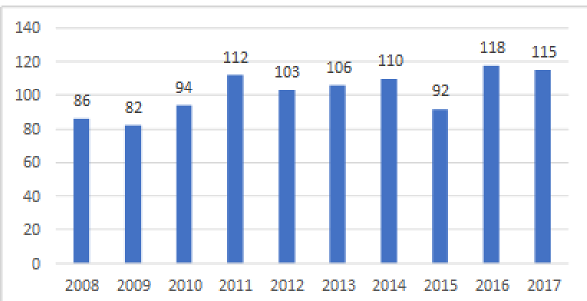

Figure 1. Number of documented injuries by year of injury (2008-2017)

Out of all recorded injury cases, 63.75% of injuries occurred to male players, whereas female accounted for 36.25% of total injuries (Figure 2).

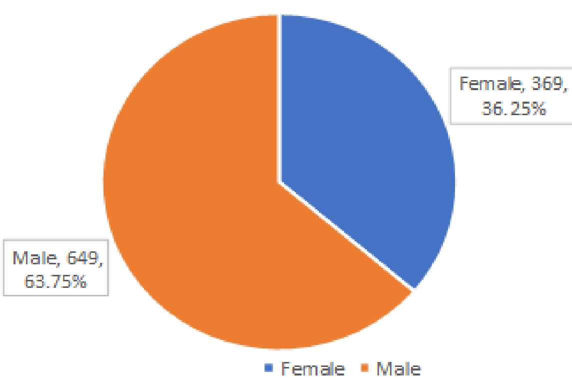

Figure 2. Distribution of documented injuries by gender

Lower limb injuries were reported as the most common injury site among sportspersons with 45.28% reported injuries followed by upper limb (29.47%) and trunk (20.24%). The head and neck region were found to be the least common injury site with only 5.01% of documents injuries (Figure 3).

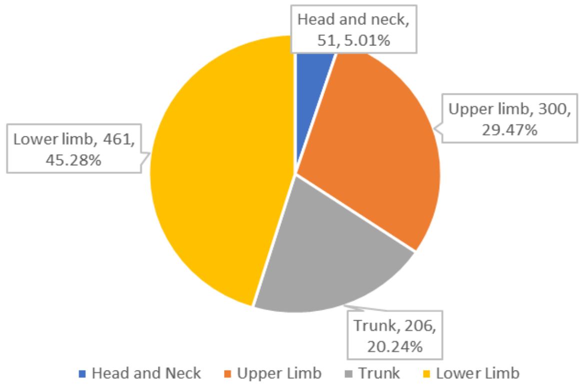

Figure 3. Distribution of documented injuries by the site of injury

Type wise distribution of injuries shows that 50.39% of overall injuries were acute in nature whereas 29.86% were overuse injury. It was also found that 19.74% of overall injuries were subacute injury (Figure 4).

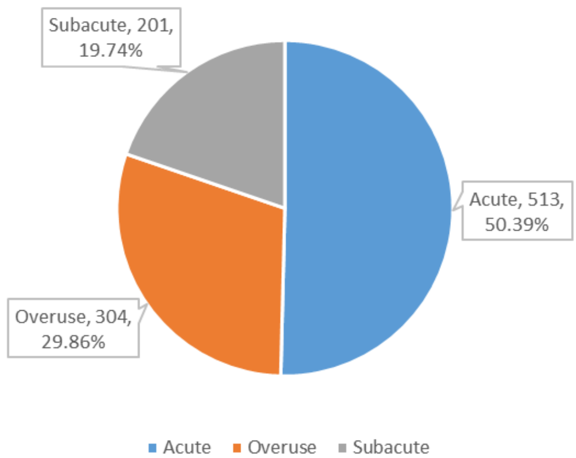

Figure 4. Distribution of documented injuries by types of injury

Analysis of injury recurrence revealed that 36.35% of documented injuries were recurrence of previous injuries whereas 63.65% of injuries were fresh in nature (Figure 5).

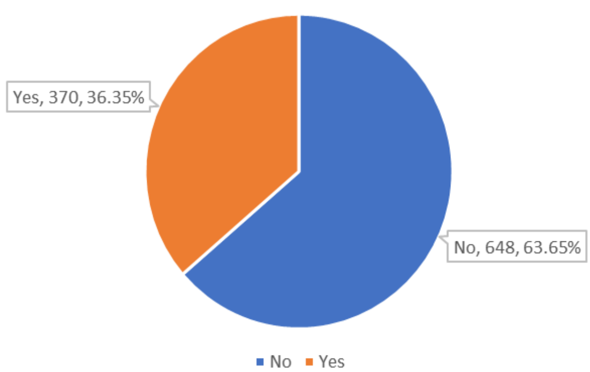

Figure 5. Distribution of documented injuries by recurrence

Descriptive statistics of documented injuries by types of games and sports reveals the average number of injuries of different games and sports per year. The highest counts of average injury were found among the football players (20.00±3.68) followed by athletics (11.40±1.78) and the basketball (10.30±2.21) players. The lowest counts of average injury were found in the table tennis (1.80±0.84) sport followed by lawn tennis (2.11±0.60) and yoga (2.40±1.14). Among other games and sports, average injury counts of cricket players were 8.80±1.81, volleyball players were 7.90±1.66, hockey players were 6.60±1.50, handball players were 5.90±1.45, kabaddi players were 5.70±1.06, badminton players were 5.50±2.17, gymnastic players were 4.60±0.97, weight lifting players were 4.30±0.82, judo and wrestling players were 3.80±1.23 and swimming players were 3.33±1.00 (Table 5).

Table 6 displays the distribution of documented injuries by year and gender. It is revealed, in all the years the maximum percentage of injury occurred to male players. The results of descriptive statistics of the percentage of gender-wise documented injuries per year reveal that throughout the decade the range of percentage of male injury was between 58.70 to 67.86 percentage and the range of percentage of female injury was between 32.14 to 41.30 percentage (Table 6). Further, it was also revealed that average 63.86±3.39% injuries occurred to male players whereas 36.14±3.39% injuries occurred to female players (Table 7).

Table 5. Descriptive statistics of documented injuries by types of games and sports

Games/Sports	N	Minimum	Maximum	Mean	Std. Deviation
Football	10	14	27	20.00	3.68
Volleyball	10	5	11	7.90	1.66
Handball	10	4	8	5.90	1.45
Basketball	10	7	14	10.30	2.21
Cricket	10	6	12	8.80	1.81
Lawn Tennis	9	1	3	2.11	0.60
Table Tennis	5	1	3	1.80	0.84
Badminton	10	2	9	5.50	2.17
Kabaddi	10	4	7	5.70	1.06
Judo and Wrestling	10	2	6	3.80	1.23
Gymnastic	10	4	7	4.60	0.97
Swimming	9	2	5	3.33	1.00
Athletics	10	9	14	11.40	1.78
Yoga	5	1	4	2.40	1.14
Weightlifting	10	3	6	4.30	0.82
Hockey	10	4	9	6.60	1.51

Table 6. Distribution of documented injuries by year and gender

Year	Gender of the subject			
	Female	%	Male	%
2008	28	32.56	58	67.44
2009	29	35.37	53	64.63
2010	31	32.98	63	67.02
2011	36	32.14	76	67.86
2012	34	33.01	69	66.99
2013	39	36.79	67	63.21
2014	44	40.00	66	60.00
2015	38	41.30	54	58.70
2016	46	38.98	72	61.02
2017	44	38.26	71	61.74

Table 7. Descriptive statistics of the percentage of gender-wise documented injuries per year

Gender	Minimum	Maximum	Mean	Std. Deviation
Male	58.70	67.86	63.86	3.39
Female	32.14	41.30	36.14	3.39

Table 8 displays the documented injuries by year and body site of injury. It reveals that in the whole decade, lower limb area suffered from the maximum percentage of injuries followed by upper limb area (except the year 2009). It was also found that the trunk area suffered from third-highest percentage of injuries and the head and neck area was the lowest sufferer of injuries in the whole decade. Further, the descriptive statistics of the percentage of body sites of documented injuries per year reveals that the head and neck area suffered from average 5±1.76% of total injuries per year. The upper limb area suffers from 29.2±3.38% of total injuries per year whereas the trunk area suffers from 20.37±2.41% of total injuries per year. And the lower limb area suffers from 45.43±2.84% of total injuries per year (Table 9).

Distribution of injuries by year and recurring of injury reveals that most of the injuries were non-recurring in nature (Table 10). Further, the descriptive statistics of the percentages of recurring of injury reveals that average 64.07±6.62 percentage of injuries were non-recurring whereas average 35.93±6.62 percentage of injuries were recurring in nature (Table 11).

Table 8. Distribution of documented injuries by year and body site of injury

Year	Body Site of Injury							
	Head and Neck	%	Upper Limb	%	Trunk	%	Lower Limb	%
2008	4	4.65	22	25.58	16	18.60	44	51.16
2009	5	6.10	19	23.17	20	24.39	38	46.34
2010	2	2.13	29	30.85	19	20.21	44	46.81
2011	4	3.57	33	29.46	24	21.43	51	45.54
2012	9	8.74	30	29.13	23	22.33	41	39.81
2013	6	5.66	35	33.02	19	17.92	46	43.40
2014	5	4.55	33	30.00	22	20.00	50	45.45
2015	4	4.35	25	27.17	21	22.83	42	45.65
2016	7	5.93	34	28.81	23	19.49	54	45.76
2017	5	4.35	40	34.78	19	16.52	51	44.35

Table 9. Descriptive statistics of the percentage of body sites of documented injuries per year

Body Site of Injury	Minimum	Maximum	Mean	Std. Deviation
Head and Neck	2.13	8.74	5.00	1.76
Upper Limb	23.17	34.78	29.20	3.38
Trunk	16.52	24.39	20.37	2.41
Lower Limb	39.81	51.16	45.43	2.84

Table 10. Distribution of documented injuries by year and recurring of Injury

year	Recurring of Injury			
	No	%	Yes	%
2008	68	79.07	18	20.93
2009	52	63.41	30	36.59
2010	68	72.34	26	27.66
2011	70	62.50	42	37.50
2012	63	61.17	40	38.83
2013	62	58.49	44	41.51
2014	69	62.73	41	37.27
2015	56	60.87	36	39.13
2016	74	62.71	44	37.29
2017	66	57.39	49	42.61

Table 11. Descriptive statistics of the percentage of recurring of injuries per year

Recurring of Injury	Minimum	Maximum	Mean	Std. Deviation
Yes	57.39	79.07	64.07	6.62
No	20.93	42.61	35.93	6.62

Table 12 displays the documented injuries by year and type of injury. It is seen that in all the years, most of the injury occurrences were acute in nature followed by overuse and subacute recurrent injuries (except the year 2012). Further, the descriptive statistics of the percentage of the type of injury per year displays that the average percentage of occurrence of acute injuries per year was 50.52±3.33, the average percentage of occurrence of overuse injuries per year was 29.90±5.16 whereas the average percentage of occurrence of subacute recurrent injuries per year was 19.57±3.45 (Table 13).

The distribution of documented injuries by type of games and sports and gender of the subjects reveals that, except in gymnastic, swimming and yoga, in most of the other games and sports, the maximum percentage of injuries occurred to male players (Table 14).

Table 12. Distribution of documented injuries by year and type of injury

Year	Type of Injury					
	Acute	%	Overuse	%	Subacute	%
2008	45	52.33	25	29.07	16	18.60
2009	44	53.66	27	32.93	11	13.41
2010	48	51.06	27	28.72	19	20.21
2011	60	53.57	30	26.79	22	19.64
2012	55	53.40	23	22.33	25	24.27
2013	46	43.40	44	41.51	16	15.09
2014	53	48.18	37	33.64	20	18.18
2015	46	50.00	26	28.26	20	21.74
2016	56	47.46	34	28.81	28	23.73
2017	60	52.17	31	26.96	24	20.87

Table 13. Descriptive statistics of the percentage of the type of injury per year

Type of Injury	Minimum	Maximum	Mean	Std. Deviation
Acute	43.40	53.66	50.52	3.33
Overuse	22.33	41.51	29.90	5.16
Subacute recurrent	13.41	24.27	19.57	3.45

Table 14. Distribution of documented injuries by types of games and sports and gender

Games/Sports	Gender			
	Female	%	Male	%
Football	45	22.50	155	77.50
Volleyball	34	43.04	45	56.96
Handball	14	23.73	45	76.27
Basketball	47	45.63	56	54.37
Cricket	14	15.91	74	84.09
Lawn Tennis	5	26.32	14	73.68
Badminton	22	40.00	33	60.00
Table Tennis	3	33.33	6	66.67
Kabaddi	21	36.84	36	63.16
Judo & Wrestling	11	28.95	27	71.05
Gymnastic	32	69.57	14	30.43
Swimming	18	60.00	12	40.00
Athletics	45	39.47	69	60.53
Yoga	10	83.33	2	16.67
Weightlifting	16	37.21	27	62.79
Hockey	32	48.48	34	51.52

The table displaying the distribution of injury occurrences of different games and sports by different body sites of injury reveals that in sports like football, basketball, kabaddi, gymnastic, athletics and weightlifting; the maximum percentage of injuries occurred to lower limb area. On the other hand, in sports like; volleyball, handball, judo and wrestling, cricket, lawn tennis, badminton, table tennis and swimming; the maximum percentage of injuries occurred to the upper limb area. In sports like yoga and hockey maximum percentage of injuries occurred to the trunk area. Except in football and yoga, among all other selected games and sports head and neck area was found to be the least injured area of injury (Table 15).

The table 16 displays games and sports-wise recurring of injury. The results reveal that only in judo & wrestling, badminton and gymnastic; recurrence of injuries was higher than non-recurrence. Further, it is also revealed that in the sport badminton, the highest number of injury recurrences has occurred.

Table 15. Distribution of documented injuries by types of games and sports and body site of injury

Games/Sports	Body Site of Injury			
	Head and Neck	**Upper Limb**	**Trunk**	**Lower Limb**
Football	36 (18%)	7 (3.50%)	23 (11.50%)	134 (67%)
Volleyball	0 (0%)	43 (54.43%)	18 (22.78)	18 (22.78)
Handball	0 (0%)	38 (64.41%)	10 (16.95%)	11 (18.64%)
Basketball	5 (4.85%)	10 (9.71%)	12 (11.65%)	76 (73.79)
Cricket	0 (0%)	52 (59.09%)	18 (20.45%)	18 (20.45%)
Lawn Tennis	0 (0%)	17 (89.47%)	0 (0%)	2 (10.53%)
Badminton	0 (0%)	33 (60%)	10 (18.18%)	12 (21.82%)
Table Tennis	0 (0%)	7 (77.78%)	1 (11.11%)	1 (11.11%)
Kabaddi	1 (1.75%)	6 (10.53%)	2 (3.51%)	48 (84.21%)
Judo & Wrestling	1 (2.63%)	24 (63.16%)	8 (21.05%)	5 (13.16%)
Gymnastic	5 (10.87%)	14 (30.43%)	6 (13.04%)	21 (45.65%)
Swimming	0 (0%)	17 (56.67%)	11 (36.67%)	2 (6.67%)
Athletics	0 (0%)	21 (18.42%)	21 (18.42%)	72 (63.16%)
Yoga	3 (25%)	2 (16.67%	7 (58.33%)	0 (0%)
Weightlifting	0 (0%)	3 (6.98%	19 (44.19%)	21 (48.84%)
Hockey	0 (0%)	6 (9.09%)	40 (60.61%)	20 (30.30%)

Table 16. Distribution of documented injuries by types of games and sports and recurring of injury

Games/Sports	Recurring of Injury			
	No	**%**	**Yes**	**%**
Football	142	71.00	58	29.00
Volleyball	40	50.63	39	49.37
Handball	38	64.41	21	35.59
Basketball	63	61.17	40	38.83
Cricket	52	59.09	36	40.91
Lawn Tennis	14	73.68	5	26.32
Badminton	24	43.64	31	56.36
Table Tennis	9	100.00	0	0.00
Kabaddi	55	96.49	2	3.51
Judo & Wrestling	17	44.74	21	55.26
Gymnastic	23	50.00	23	50.00
Swimming	26	86.67	4	13.33
Athletics	69	60.53	45	39.47
Yoga	11	91.67	1	8.33
Weightlifting	31	72.09	12	27.91
Hockey	34	51.52	32	48.48

Table 17 displays the distribution of injuries by type of games and sports and type of injuries. The results reveal that, in most of the games and sports, the maximum percentage of injuries were acute in nature except in lawn tennis, badminton, table tennis, swimming and hockey in which overuse type of injury percentage was higher.

Table 18 reveals the distribution of documented injures by gender and site of injury. For both male and female maximum percentage of injury occurred to lower limb area of the body (Male: 43.61%, Female: 48.24%) whereas the lowest percentage of injury occurred to the head and neck area (Male: 5.08%, Female: 4.88%). For both the genders, almost 20% of overall injuries occurred to the trunk area (Male: 20.18%, Female: 20.33%). For male 31.12 % injury occurred to the shoulder area and for female, it was 26.56%.

Table 19 displays the documented injuries by gender and recurring of injury. It reveals that for both the genders almost 35% (Male: 36.88%, Female: 35.14%) of total injuries were recurring whereas 65% (Male: 63.12%; Female: 64.86%) of total injuries were not recurring.

Table 20 displays the documented injuries by gender and type of injuries. The result reveals that among all-female injuries 50.14% were acute in nature, 31.71% were overuse and 18.16% were subacute injuries. In male 50.54% of overall injuries were acute, 28.81% were overuse and 20.65% of overall injuries were subacute.

Table 17. Distribution of documented injuries by types of games and sports and types of injury

Games/Sports	Type of Injury					
	Acute	%	Overuse	%	Subacute	%
Football	115	57.50	48	24.00	37	18.50
Volleyball	33	41.77	27	34.18	19	24.05
Handball	24	40.68	21	35.59	14	23.73
Basketball	51	49.51	28	27.18	24	23.30
Cricket	39	44.32	29	32.95	20	22.73
Lawn Tennis	7	36.84	9	47.37	3	15.79
Badminton	16	29.09	21	38.18	18	32.73
Table Tennis	1	11.11	6	66.67	2	22.22
Kabaddi	56	98.25	0	0.00	1	1.75
Judo & Wrestling	17	44.74	10	26.32	11	28.95
Gymnastic	27	58.70	14	30.43	5	10.87
Swimming	9	30.00	14	46.67	7	23.33
Athletics	52	45.61	39	34.21	23	20.18
Yoga	8	66.67	0	0.00	4	33.33
Weightlifting	33	76.74	6	13.95	4	9.30
Hockey	25	37.88	32	48.48	9	13.64

Table 18. Distribution of documented injuries by gender and site of injury

Gender	Site of injury							
	Head and Neck	%	Upper Limb	%	Trunk	%	Lower Limb	%
Female	18	4.88	98	26.56	75	20.33	178	48.24
Male	33	5.08	202	31.12	131	20.18	283	43.61

Table 19. Distribution of documented injuries by gender and recurring of injury

Recurring of Injury	Gender of the subject			
	Female	%	Male	%
No	239	36.88	409	63.12
Yes	130	35.14	240	64.86

Table 20. Distribution of documented injuries by gender and type of injury

Gender	Type of injury					
	Acute	%	Overuse	%	Subacute	%
Female	185	50.14	117	31.71	67	18.16
Male	328	50.54	187	28.81	134	20.65

Table 21. Distribution of documented injuries by the site of injury and recurring of injury

	Recurring of injury			
	No	**%**	**Yes**	**%**
Head and Neck	48	94.12	3	5.88
Upper Limb	181	60.33	119	39.67
Trunk	122	59.22	84	40.78
Lower Limb	297	64.43	164	35.57

Table 22. Distribution of documented injuries by body site of injury and type of injury

	Type of Injury					
	Acute	**%**	**Overuse**	**%**	**Subacute**	**%**
Head and neck	48	94.12	3	5.88	0	0.00
Upper limb	132	44.00	83	27.67	85	28.33
Trunk	82	39.81	87	42.23	37	17.96
Lower Limb	251	54.45	131	28.42	79	17.14

Table 23. Distribution of documented injuries by type of injury and site of injury

	Site of injury							
	Head and Neck	**%**	**Upper Limb**	**%**	**Trunk**	**%**	**Lower Limb**	**%**
Acute	48	9.36	132	25.73	82	15.98	251	48.93
Overuse	3	0.99	83	27.30	87	28.62	131	43.09
Subacute	0	0	85	42.29	37	18.41	79	39.30

Table 24. Distribution of documented injuries by type of injury and recurrence

	Recurrence of injury			
	No	**%**	**Yes**	**%**
Acute	402	78.36	111	21.64
Overuse	140	46.05	164	53.95
Subacute	106	52.74	95	47.26

Table 25. Distribution of documented injuries by recurrence and type of injury

	Type of injury					
	Acute	**%**	**Overuse**	**%**	**Subacute**	**%**
No	402	62.04	140	21.60	106	16.36
Yes	111	30.00	164	44.32	95	25.68

Table 21 displays the distribution of documented injuries by the site of injury and recurring of injury. It is revealed that among all head and neck region injuries, 94.12% were non-recurring in nature whereas only 5.88% were the recurring injuries.

Among all upper limb injuries, 60.33% were non-recurring injuries whereas 39.67% were recurring. In the trunk region, 59.22% injuries were non-recurring whereas 40.78% were the recurring injuries. In the lower limb region, 64.43% injuries were non-recurring whereas 35.57% were recurring in nature.

From table 22 it can be understood that among Head and neck injuries 94.12 % were acute in nature whereas 5.88 % were overuse injuries. Total upper limb injury consisted of 44% acute, 27.67% overuse and 28.33% subacute injuries. On the other hand, 39.81% of trunk injury were acute, 42.23% were overuse and 17.96% were the subacute injuries. In the lower limb region, 54.45% injuries were acute, 28.42% were overuse and 17.14% were the subacute injuries.

Table 23 displays the distribution of injuries by type and site of injury. It can be seen, 9.36% of acute injury occurred to the head and neck region, 25.73% occurred to the upper limb, 15.98% occurred to the trunk and 48.93% occurred to the lower limb region. Among overuse injuries, 0.99% occurred to the head and neck region, 27.30% occurred to the upper limb region, 28.62% occurred to the trunk region and 43.09% occurred to the lower limb region. On the other hand, 42.29% of subacute injury occurred to the upper limb region, 18.41% occurred to the trunk and 39.30% occurred to the lower limb region.

Table 24 shows that 78.36% of the acute injuries were non-recurrent and 21.64% were the recurrent injuries, 46.05% of the overuse injuries were non-recurrent and 53.95% were recurrent and among the subacute injuries 52.74% were non-recurrent and 47.26% were the recurrent injuries. Further, table 24 reveals that 62.04% of non-recurrent injuries were acute, 21.60% were overuse and 16.36% were subacute injuries. Among recurrent injuries, 30% were acute, 44.32% were overuse and 25.68% were subacute injuries.

Most of the non-recurring injuries were acute (62.04%) in nature, followed by the overuse (21.60%) and the subacute (16.36%) injuries. The recurring injuries were mostly overuse injuries (44.32%) followed by the acute (30%) and the subacute (25.68%) injuries (Table 25).

4. Discussion

Injuries increase the health care costs of a young athlete. It also affects the normal life of a sports person. Sometimes it becomes a lifelong physical impairment. Therefore, researchers have been trying to identify the factors and pattern of sports injuries. Most of the time these studies are sports or games oriented and they concentrate primarily on injury pattern of that particular sport or game. In the present study, the researcher intended to understand the injury pattern of sixteen different games and sports. For that purpose, total of 1008 injury cases were analyzed.

As expected, it was revealed that maximum injuries occurred to football players (19.5 %), on the other hand, lowest injury cases were observed to table tennis players. Kerr, et al. [12] also reported footballers were estimated to have highest counts of injuries (22.4%) among all injuries. The same study also revealed that footballer accounted for 36.3% of male injuries [12]. Study conducted by Ristolainen et al.[13] also reported that male players were at increased risk of injury compared to female players. The current study also revealed that male players recorded maximum percentage of injury compared to female players in most of the games and sports. Except in gymnastic, swimming and yoga, in all other games and sports male percentage of injury was higher than female players. Anderson [14] reported that the lower extremity is the most common anatomical area for sports injury. The result of the current study also exhibited a similar result. It exhibits that lower limb area is suffered from maximum percentage of injury (45.43±2.84). Researches conducted by Welton, et al.[15] reported that only 10.5 % of overall injuries were recurrent. Most of the recurrent injuries were subsequent of previous injuries. The current research also displays a similar trend. Most of the injuries were non-recurrent in nature. A single adverse incident causes acute injury whereas the overuse injuries occur over time [7]. Subacute injuries occur when the victim get injured even before recovery from the previous injury. In the current study, most injuries are found to be acute in nature followed by overuse and subacute injuries. Majority of head and neck injury occurs to the sports which involve upper extremity or head action during play [16]. In most cases death during sports is caused by head injury. The sports which demand great biomechanical involvement of shoulder may be prone to upper limb injuries. Sports like tennis, volleyball, handball, or badminton demand great amount of arm movements. These demands mean that players are more prone to arm or upper limb injuries [17]. In the current study it is found that in sports: volleyball, handball, judo and wrestling, cricket, lawn tennis, badminton, table tennis and swimming; maximum percentage of injuries occurred to upper limb area. Rodriguez et al. [18] had mentioned shoulder is the most frequently affected area of amateur badminton players. The same study also mentioned that in lower limb region knee and in upper limb region shoulder area are affected by most injuries [18]. Volleyball players are prone to shoulder injuries because of repeated involvement of overhead motions [19,20]. Myklebust had found, 19% of overall acute injuries and 15% of overall overuse injuries of volleyball players occurred to the upper limb region [21]. Review study conducted by Pococco et al. had reported knee, shoulder and finger areas as the most frequently affected injury region [22]. Most of these injuries were result of throwing mechanism involving primarily shoulder [22]. Investigation on cricket injuries revealed that bowlers account 41.3% of total cricket injuries [23]. Young and Lydecker [24] had suggested not to involve throwing activities during practice for fast recovery from shoulder injuries. Study on epidemiology of tennis injuries revealed the most common overuse tennis injury in shoulder region whereas the lower extremity was found to be more prone to acute injuries [25]. Similar study on epidemiology of swimming had reported 91% exhibition of shoulder injury by young swimmers [26]. Injuries in trunk area indicate the injuries occurred in back, chest and abdomen region. Back injuries generally associated with movement like repeated flexion, extension and rotation [27]. In the current study it is found that in yoga and hockey maximum percentage of injury occurred to trunk area. Lower limb area of human body is the most common injured area in sports [14,28,29]. In the current study also, lower limb is found to be the most affected area by injury. Brant et al. had reported lower extremity sports injuries are highest among football players followed by basketball whereas swimmers suffer from lowest percent of lower extremity injuries[30]. The notable findings of the current study also revealed that among all reported injuries, in badminton the number of injury recurrence was higher compared to other sports. According to Saunders et al. 34% of injured kicking and running sports player may exhibit recurrence of hamstring injury [31]. The results of the current study also reveal that in most of the racket sports injuries were overuse injury. Further it is seen that both genders have a similar pattern of injury occurrence and recurrence over different sites and types of injury. It was found that almost one tenth of the all head and neck injuries were overuse injury and others were acute injury. Among upper limb injuries 44% were acute, 28.33% were subacute and 27.67% were overuse injury. Among trunk injuries subacute injury accounted for almost one fifth of overall injuries, whereas other part was almost equally divided by acute and overuse injury. The current study reported half of the acute injuries occurred to lower limb area whereas upper limb accounted one fourth of the total injury. Among overuse injuries lower limb accounted 43.09% of total injury whereas trunk and upper limb each accounted almost 30% of total injuries. Upper limb area suffered from maximum subacute injuries followed by lower limb and trunk. The study revealed that only one fifth of acute injuries were recurrent whereas almost halves of overuse injuries were recurrent. Subacute injures also exhibited a similar trend. Among non-recurrent injuries, maximum percentage of injuries were acute followed by overuse injury. On the other hand, overuse injuries accounted maximum recurrent injury followed by acute and subacute injuries.

5. Conclusions

The results of the current study have many practical implications. It gives an opportunity to investigate the patterns of injuries over different games and sports. Furthermore, during training we can consider the results of the current study to prevent sports injuries by applying preventive measures against injury pattern of particular games or sports. Knowledge of sports specific injury pattern can help coaches, physical educationist, or sports scientist to identify sports activities with high injury risk and can help them to develop targeted training methods to prevent future injuries.

The present study was subjected to some limitations. First, the institute where the research was conducted didn’t have a policy to equally distribute the students to different games and sports. Therefore, varied number of participations in different games and sports might have affected the reported injury number. In some sports there were higher number of participants which increased the probability of higher injury reporting whereas less participated sports had lower injury reporting. Second, there was gender imbalance among the number of students in the institute which also affects the reported injury number. Third and finally, some students didn’t prefer institute physiotherapy center for their treatment, instead they preferred outside specialist. These injury cases were not been reported and there was no way to track those cases. Therefore, the researchers were unable to include those cases in the current study. In addition to it, the current study does not address specific injuries, instead it focused primarily on the classification of injuries. Therefore, the researcher recommends to address such issues in future studies and suggests to prevent the limitations which have been mentioned earlier in the study.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Content Validity of Agility Test in Karate Kumite Category

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Abstract Background: Kumite is a category in karate match. It is a one-on-one match that requires complex physical aspects, one of which is physical agility. In a real match, kumite requires movements to shift the direction quickly when a karateka aims to hit his opponent. For that reason, there should be a program and an assessment to improve the physical agility of the karate athletes who compete in kumite category. The document analysis of this research found that there has not been any assessment tool for the agility aspect in kumite, while the existing agility test measuring tool was only designed for sports in general. Purpose: This research aimed to develop the construction of karate agility test for the kumite category. Design/methodology/approach: This is a developmental research which consisted of 3 stages. In the first stage, documents and research journals were analyzed to develop the construction of karate agility test for the kumite category. In the second stage, the Delphi technique was utilized and the experts were asked to assess he construction of karate agility test for the kumite category resulted in the first stage. In the third stage, the results of expert judgment with the Aiken formula were analyzed to test the content validity. The participants in this research were documents and seven experts. Results: It was found in the construction of the Kumite category karate agility test; item one, the content or material got a V value of 0.85; item two, the distance between the cone had a V value of 0.95; item three, the safety of the equipment used has a V value of 0.90; item four, the number of test replications had a V value of 0.90; item five, the clarity of the test procedure had a V value of 0.90; items six, the clarity of the test score had a V value of 0.90. Conclusion: The karate agility test construction for the kumite category had high content validity.

Keywords Content Validity, Agility Test, Karate, Kumite

1. Introduction

Agility is a biomotor component of physical condition which is essential for several sports. Agility has been defined as a person's ability to move, stop, then start the movement again quickly, or as a rapid whole body movement with a rapid change of direction in response to a stimulus . In the field of physical training, agility is the ability of a person to move from one place to another with the aim of changing body positions . Agility can be defined as the movement of the whole body in a fast activity with changes in speed or a person's ability to change direction at high speed accurately without losing balance . In other words, agility is someone’s ability to move quickly and change direction from side to side and backward. Agility is the key to success in high performance. With good agility, an athlete can move quickly. It can help an athlete to win a match or competition. Agility is a skill possessed by an athlete which is performed continuously to unexpected stimuli such as opponent movements, decision making and the ability to react to change places quickly and precisely. A karate coach should modify agility training in different ways to improve the athlete's agility . In karate, agility is indispensable for fast movements in performing techniques and tactics perfectly in various directions by maintaining balance of speed and body coordination..Karate is one of the most popular martial arts regularly practiced all over the world that involves defense and attack techniques with the aims of getting points from opponents .

Karate is a Japanese martial art originated from fight training which was then modified into a martial art and sport in 1921 . Karate has three elements that should be studied, namely kihon, kata and kumite. Kihon consists of basic movements that should be studied and perfected. Kihon training must be done properly and correctly. If it is not studied properly, the *kohai* (karate disciple) cannot proceed to the next steps. Kihon consists of hand position, push, punch, kick, good posture, jumping technique. The more often kihon is practiced with repetition of the same technique in a few years, the sharper the athlete's movement and control . Meanwhile, the kata is a predetermined movement consisting of a part of the fight without an opponent, or a series of moves from kihon which are combined into interesting moves. Kumite is a karate sparring/fight that applies the attack and defensive techniques which have been studied in kata technique. In its practice, the kumite has an aggressive nature which aims to get points from opponents during a match .

Kumite has two kinds of training, with and without opponent. If someone practices kumite systematically, it will create good moving structures, improve technique and physical agility to prepare for the real karate match . Martial art, especially the kumite category in karate, is a physical contact sport. Therefore, the physical aspect is essential to improve the athletes' achievement, because the good physical condition of the athlete will lead to the athlete's better and more effective movement and techniques, both for defense and offense. Karate, especially kumite, has the characteristics of sudden movements and explosive attacks. Therefore, a good physical aspect is essential to support these sudden and fast movements. One of the most important physical aspects is agility. Agility is a must-have-thing for kumite athletes because in a kumite match, the athletes should face moving opponents. Agility is required to perform fast, technical, and tactical movements perfectly by maintaining speed and coordination. However, there is a drawback in learning agility because the previous studies did not focus on developing agility tests specifically . In particular, field-based tests only measure general agility and do not focus on the sport that somebody specifically engaged in . Some of those field-based tests are the 505 agility test, T agility test, Illinois agility test, and 10 x 5 meter agility test . Moreover, individual sports such as martial arts or one-on-one ball games have a typical type of competition; therefore, the test must resemble the real match . There has not been any karate agility test for kumite category that resembled the techniques and movement patterns in a real kumite match. This fact is in line with some literatures stating that there has not been any agility test relating to the agility intervention conducted in the form of a match, especially for individual sport athletes . The previous research in taekwondo already designed an agility test. However, that test was only specialized for taekwondo elite athletes and obviously could not be used to measure the agility aspect in karate, especially in kumite category. So far, the karate agility test for the kumite category has not yet been found. Content validity is a measure where the content is an instrument that can be in the form of a construction or can be described as a measuring tool for measuring sport activities. The construction of the measuring tool has to be precisely built by taking into account its relevance, completeness, goals and objectives to design . Therefore, the validity test has been recognized that the validity of the instrument or a test instrument can be recognized so that it can be used properly to measure the karate agility in the kumite category. The design of a test in performance sports must be customized to each specific sport. Even though there are two categories in karate (kata and kumite), the movement patterns of both categories are very different. Due to the lack of research focusing on the karate agility test, especially in its kumite class, this research aimed to develop a measuring tool for the karate agility test in the kumite category and determine its content validity. It is expected that this research can be useful to measure the karate agility test in the kumite category.

2. Materials and Methods

This research used a development method by combining qualitative and quantitative approaches. This was a mixed research that combined two approaches, namely qualitative and quantitative in order to obtain more comprehensive and valid data . The mixed method is when an expert or researcher used a combination of qualitative and quantitative research methods with a single concept, or when a research is carried out sequentially or simultaneously with the aim of examining the research in depth . The participants in this research were documents and seven experts. The seven experts had the qualification of: 2 experts holding doctor degree in sports evaluation, and 5 experts holding national-certified karate masters with bachelor degree. There were 3 steps in this research. The first step was qualitative analysis of documents, text books and journals of relevant research results to develop the construction of karate agility test for kumite category. The second step was quantitative analysis using the Delphi technique, which was done by asking the experts to assess the construction of karate agility test for kumite category which have been produced during the first stage. The third step was analyzing the results of expert judgment using Aiken formula to test the content validity of the karate agility test for kumite category. The data were collected using questionnaires to be assessed by the rater using a rating scale of 4. The Aiken formula is as follows:

$$V = \sum s / [n (C-1)]$$

S = r – lo
Lo = lowest value
C = highest value
R = numbers given by the rater

3. Result

The results of the document analysis found the definition of the karate agility for the kumite category. The agility in kumite is the speed of footsteps and shifting directions after launching the gyakutsuki punch. In addition, the construction of the kumite category karate agility test is as shown in Figure 1 as follows:

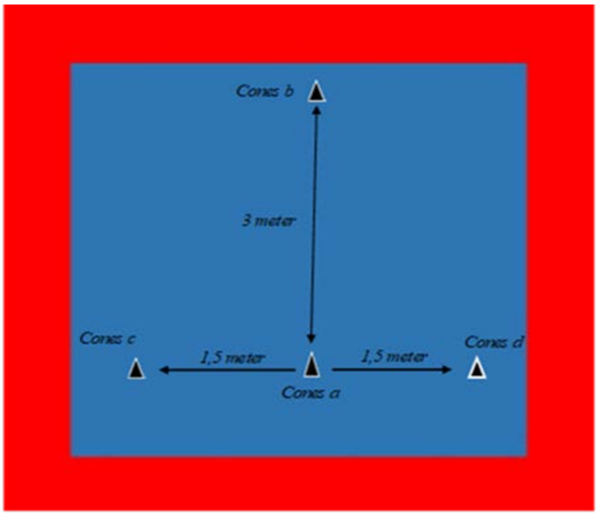

Figure 1. Construction of agility tests

Field size for the test

a. Distance between cone A and cone B is 3 meters
b. Distance between cone A and cone C is 1.5 meters
c. Distance between cone A and cone D is 1.5 meters

The equipment used for the tests are as follows:

a. The place used is a 6x6 meters karate mattress
b. 4 cones
c. 1 whistle
d. 1 stopwatch

Number of Testers

a. One person to give instructions
b. One person to hold the stopwatch
c. One person to record results

Test Procedures

a. The test's starting point was at the starting line at cone A while hearing the whistle
b. One tester had a whistle. He then turned on the stop watch along with the whistle-blow. The tester moved sideways towards cone B and held that cone.
c. After holding cone B, the tester performed gyakutsuki punch quickly. After that, he moved sideways to cone A and held that cone. After holding cone A, the tester performed gyakutsuki punch quickly. Then, he move quickly to the left towards cone C.
d. After holding cone C, the tester performed gyakutsuki punch quickly. Then, he move quickly to the right towards cone D. After holding cone D, the tester performed gyakutsuki punch quickly
e. After that, the tester ran towards cone A then held cone A and stop the stopwatch at the same time.
f. The score recorded was the fastest time of two repetitions. This test was done twice with 6 minutes of break.

The Result of Content Validation Test with Aiken Formula

Based on Aiken's calculation analysis, the V values are obtained as shown in the following table 1.

Jury	Item 1		Item 2		Item 3		Item 4		Item 5		Item 6	
	Score	S	Score	S	Score	S	Score	S	Score	S	Score	S
A	4	3	4	3	4	3	4	3	4	3	4	3
B	4	3	4	3	4	3	3	2	4	3	4	3
C	4	3	4	3	4	3	3	2	4	3	4	3
D	4	3	4	3	4	3	4	3	4	3	4	3
E	3	2	4	3	4	3	4	3	4	3	3	2
F	2	1	3	2	3	2	4	3	3	2	3	2
G	4	3	4	3	3	2	4	3	3	2	4	3
∑S	18		20		19		19		19		19	
V	0.85		0.95		0.90		0.90		0.90		0.90	

Based on table 1, item one or the conformity of the test material with the karate category of kumite had a coefficient value of V 0.85; item two or the conformity of the distance between cones had a coefficient value of V 0.95; item three or the safety of the equipment used had coefficient value of V 0.90; item four or the numbers of repetition had a coefficient value of V 0.90; item five, the clarity of the instrument procedure had a coefficient value of V 0.90; and item six or the test score clarity had a coefficient value of V 0.90. Hendryadi mentioned that if the Aiken value ranges from V0.41 to 0.60, it is said to have moderate agreement result. If the Aiken value was V 0.81 to 1.00, it was said that the raters strongly agreed to each other's opinion. Based on this opinion, it can be said that the karate agility test in the kumite category had high validity. In other words, all the experts highly agree.

4. Discussion

Physical is one of the most important things for karate athletes to achieve maximum performance. An athlete is an individual who is demanded to have excellent physical condition in order to win in competitions . The success of an athlete in winning a competition does not come from innate talent. Athletes train hard with the right formula and it takes 10 years of intensive training to be superior in any competition. Karate has two categories (kata and kumite), in which both of them have different characteristics. The kumite in karate is characterized by quick attacks that involve great strategies and tactics . Since kata and kumite matches have different competition conditions, a karate coach must apply different approach in training and assessment activities to optimize the result of competitions. Kata athletes usually prioritize the physical strength and power. Meanwhile in kumite , the athletes usually put forward physical agility because it is a combination of several biomotor components. If the kumite athletes have great physical agility, they will be likely to perform better in a match and can defend and attack more optimally.

Agility is very essential in karate, especially in kumite category, because all the movements made during the match require physical agility. Kumite athletes who have sufficient agility will find it easier to move, avoid opponents' attack, and counterattack quickly and accurately. For that reason, kumite athletes need to be able to measure how good their physical agility is. The agility can be improved through structured and programmed training. In addition, the agility improvement should be observed and measured. By far, there has not been any agility test for kumite category which resembled the movement patterns in a real kumite match. Therefore, karate, especially the kumite category, needs to have specific test to determine the athletes' performance improvement. The authors rarely found suitable agility test for karate, especially kumite, that resembled the movement patterns, techniques, and tactics performed in a real match. However, the authors found some researches on taekwondo agility test that resembled the real taekwondo match. However, that test was only specialized for taekwondo elite athletes and it obviously could only be used to measure the agility in taekwondo . For that reason, the authors wanted to develop a construction for karate agility test for the kumite category that resembled the movement patterns in a real kumite match in order to observe the kumite athletes' agility improvement when moving forward, sideways, and backward quickly. In addition, this test is also expected to make it easier for coaches to assess the ability of their athletes.

In addition, this research has defined the kumite agility as the ability to step sideways, forward, and change directions quickly after performing gyakutsuki punch. Agility has generally been defined as a person's ability to change direction quickly and accurately . This definition corresponds to the general definition of agility. However, the agility kumite in karate only uses step with punching techniques. Agility is one of the keys to winning in most sport competitions . Some literature explained that agility is the most important aspect of sports in general . Athletes' agility can be described as a combination of movement speed from body control, rapid change of direction, and acceleration while maintaining control of the body when moving forward, sideways and backward as a reflex to a stimulus. . Adequate agility is needed in sports such as football, basketball and hockey. It is also extremely needed in martial arts like taekwondo, judo, and karate because with great agility, the athletes can perform more difficult movements or advanced technical skills associated with rapid leg movement more easily . Agility is the motor ability of the body to make movements in various directions quickly and accurately in sports such as rugby, football, tennis and others. Some literature explained that the types of training running sideways, zigzags and running back and forth were the concepts of agility training types in general . Actually, the agility has simple explanation. Since long time ago, agility was defined as the ability to change direction or speed quickly and precisely . In practice, agility has the same initial and ending body position for changing direction and stop suddenly . Agility is a component that plays an important role in sports because it includes all fast, effective, and efficient body movements . The ability of an athlete to change direction quickly and stop suddenly is a fundamental parameter for high performance sports such as football, basketball, rugby, etc. Some literature explains that game sports (such as football, basketball, hockey, rugby) and martial arts have different agility characteristics . Agility is not only a matter of changing direction quickly, but it also concerns with the ability to maintain and control body position in a balanced manner by changing direction with a series of movements. Good agility will lead to increased balance and reaction time. Therefore, the training program for adolescent athletes should be designed to prioritize multilateral training with coordinating movement of the legs and hands in order to prepare the athlete so he has the perfect range of motion in the future. Physical agility training is useful for improving posture stability and balance. Meanwhile, integrative agility training will improve cognitive functions such as perception, mental and working memory to be smarter.

It was found in the construction of the kumite category karate agility test: item one, the content or material got a V value of 0.85; item two, the distance between the cone had a V value of 0.95; item three, the safety of the equipment used had a V value of 0.90; item four, the number of test replications had a V value of 0.90; item five, the clarity of the test procedure had a V value of 0.90; items six, the clarity of the test score had a V value of 0.90.

The above discussion resulted in the content validation for karate agility test in kumite category. The coefficient value was more than 0.78 and the test instrument was considered good. Then, the coefficient values between 0.41 and 0.60 can be said to have moderate agreement results, and the coefficient values between 0.81 and 1.00 can be said to have high agreement results . Based on this opinion, it can be said that the karate agility test in the kumite category had high validity. In other words, all experts had an almost perfect agreement.

5. Conclusions

The discussion concluded that the construction of karate agility test for the kumite category has high validity. With the documents of test instruments for the construction of karate agility test for the kumite category, the test have high content validity so it can help ensure the construct validity and giving trust to the reader and researcher regarding this instrument.

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The Availability of the 21st Century Skills in the Sport and Health for All Curriculum of the Undergraduate University Students in Al-Balqaa Applied University, Jordan

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Abstract The current study aimed at exploring the availability of the 21st century skills in the sport and health for all curriculum designed and introduced for the undergraduate university students in Al-Balqaa University, Jordan. The study adopted the descriptive analytical design. The study analyzed the objectives, activities and the assessment questions of the sport and health for all curriculums through using a researcher-developed checklist that included indicators for three major skills: the learning and innovations skills, information and technology skills, and life and work skills. The results of the study revealed that learning and innovation skills (59.73%) are available to a moderate degree, the life and work skills (38.38%) are available to a low degree, whereas the information and technology skills are available to a very low degree (1.87%). The results of the current study revealed that the mean score for the availability of the 21st century skills in the sport and health for all curriculum designed for the undergraduate students in Al-Balqaa university was 33.33%, which is a low degree of availability. The study concluded that there was a significant shortage of including the 21st century skills in the sport and health for all curriculums designed and introduced for the undergraduate university students in Al-Balqaa University, Jordan. The study recommended performing a thorough revision of the curriculum content and improving the content through integrating more of the 21st century skills in order to enable the students cope with the challenges of the 21st century.

Keywords 21st Century Skills, Life and Work, Information and Technology, Learning and Innovation, Physical Education

1. Introduction

Countries strive to achieve the best levels of life for their people, so it is noted that they are making efforts and devoting capabilities and wealth in order to build a sophisticated civilized society that interacts with the changes of this era [1]. The requirements of the age have become closely linked to the set of skills required by the work that the learner prepares, so the great goal of learning has become to support students in their scientific and practical lives, and as a result, educators have called for education to be able to provide learners with the skills necessary to succeed in their societies and work in the twenty-first century [2].

Since the school curriculum is considered the means of education to keep pace with large and successive changes, it is one of the most important systems that make up the educational system that reflects the philosophy of the society to which it belongs, and in this light Al-Anzi study [3] showed that the curriculum should be designed with great care in terms of choosing its components and the organization of its educational experiences and its production in form and content at various school stages [3]. The school curriculum is one of the most important means and methods by which to enhance values and gain various knowledge and skills [2]. Al-Melhem explained that developing curricula is an ongoing process that needs Continuous evaluation processes for the curriculum whose content is the most important component as a true translation of the goals, discovering its strengths and weaknesses, and providing a basis for reviewing and modifying them when needed [4]. This is called by the goals of the Human Resources Development Plan released by the Ministry of Economy and Planning to "continue to evaluate public education systems and build advanced educational curricula that seek to achieve the comprehensive growth of the learner who is able to succeed in his community and solve his problems." [4]

The 21st century skills are a necessary requirement that helps learners to adapt to the rapid changes that characterize this era [5]. They desperately need a set of skills that enable them to coexist with life and confront their problems in a positive way [4]. Since education is the first block that develops the personality of the individual and through which the personality of the society is formed, it was the first to search in the educational system to find out the reality of building the Saudi personality that possesses skills and enables him to work and life, and rely on communication with others on modern technologies and to possess skills Solve problems in creative ways [5].

Al-Shamrani [6] conducted a study aimed at highlighting the importance of integrating the twenty-first century skills in teaching basic subjects. The researcher used a set of activities in which students work quickly and collaborate with their teammates with their use of the twenty-first century skills in deciphering five puzzles related to the content of scientific subjects, it was applied to different groups of intermediate, secondary and university students. The results reached the effectiveness of integrating the skills of the twenty-first century in teaching basic subjects in making the learning environment better, as the skills of the twenty-first century helped students to participate and collaborate among students in an enjoyable and positive way [6].

In another study carried out by El-harbi et al that aimed to develop the English curriculum for the third preparatory grade in the light of the skills of the twenty-first century, the researcher used the descriptive analytical approach and the tool consisted of a list of criteria for the English curriculum for the third preparatory grade in the light of the skills of the twenty-first century. The results of the study concluded that the English language curriculum for the third grade did not meet the required competence in the skills of the twenty-first century (80%) or more in each element of the curriculum, in addition to the fact that the level of third-graders' acquisition of the skills of the twenty-first century did not also reach the required sufficiency [7].

The purpose of this study is to investigate to what extent are the 21st century skills are available in the Sport and health for all curriculum designed and introduced for the undergraduate university students in Al-Balqaa Applied University, Jordan.

Research significance

The significance of this study is highlighted in revealing the degree of inclusion of the skills of the twenty-first century in the curriculum of the Sport and health for all designed for the undergraduate university students through analyzing the content of the curriculum. The importance of this study is highlighted in the following: It increases awareness and interest in the skills of the twenty-first century and includes them in the general curricula in general and the undergraduate level curricula in particular. It provides a theoretical framework on the importance of 21st century skills for undergraduate university students. Moreover, the current study provides a list of the skills of the twenty-first century that can be used in facing new requirements for success in the society of the twenty-first century.

In addition, it is hoped that this study will contribute to satisfying students' needs of different skills that will help them meet the new requirements for success in the twenty-first century. Besides, it opens the way for intermediate school curriculum developers to learn about deficiencies and work to avoid them, as well as enhancing strengths by reorganizing the content of English language curricula and including it for the skills of the twenty-first century.

Research Methods

This study is a descriptive analytical research method through analyzing the content of the sport and health for all curriculum, quantifying the frequency and percentages of the 21st century skills and analyzing the availability of these skills in the analyzed curriculum.

Research population and sample

The research population was the sport and health for all curriculum designed and introduced for the undergraduate university students enrolled in the physical education specialization in Al-Balqaa Applied University in Jordan.

The curriculum is accredited from the Jordanian ministry of higher education and consists of six units distributed over 142 pages. All objectives, activities, assessment questions and content in the curriculum were included in the analysis process.

Research instrument

The researcher designed an analysis card in order to explore the availability of the 21st century skills in the objectives, activities and assessment questions in the sport and health for all curriculum designed for the undergraduate students in Al-Balqaa Applied University, according to the following steps:

1. The researcher prepared a list of the skills of the twenty-first century based on literature reviews and previous studies, relying mainly on the 21st century skills framework of the Learning Partnership for the 21st Century in the United States, which is an organization founded under the supervision of the US Ministry of Education and dozens of educational and political societies and a number of commercial companies.
2. Building the data collection instrument based on the 21st century skills.
3. Submitting the primary version of the data collection tool to a group of referees to assess the validity of the instrument.
4. The reliability of the data collection tool was ensured through the analysis of two different researchers and comparing the results of the two analyses using Holsti equation by calculating the degree of agreement and disagreement between the two analyses.
5. Preparing the final version of the data collection tool after taking in consideration the amendments recommended by the jury members.
6. Building the analysis card that was used to analyze the content of the sport and health for all curriculum and explore the availability of the 21st century skills.

Analysis criteria

The researcher relied on the frequency to quantify the indicators for each domain of the 21st century skills. This would indicate the power of presence of the value in each domain of the primary and secondary analysis domains, and its concentration percentage. This was reported as the best method to analyze the content of a curriculum.

Data analysis

The researcher used the following statistical processing tests: Holsti equation to test and ensure the reliability of the data collection tool, descriptive statistics (frequencies and percentages) to calculate the availability of each sub-skill. To determine the standard of judgment on the degree of availability of the 21st century skills, the scoring scale stated in the studies [8,9,10] was adopted as follows:

Table 1. Scoring of the degree of the availability of the 21st century skills in the analyzed curriculum

Percentage		Availability degree
%0	%20	Very low
%20	%40	Low
%40	%60	Moderate
%60	%80	High
%80	%100	Very high

2. Results and Discussion

2.1. The Availability of the 21st Century Skills in the Objectives of the Sport and Health for All Curriculum in Light of the Learning and Innovation Skills

The results shown in table (1) represent the frequencies and percentages for the indicators of learning and innovation skills in the objectives of the sport and health for all curriculum. The results indicate that the indicator "Enable the learner of self-realization" was ranked first by 14 frequencies and a percentage of 18.9%, followed by the indicator "Emphasizes the learner's self-learning strategy in accessing information" by 10 frequencies and a percentage of 13.5%, then the indicator "Develop the scientific method of thinking for the learner" with 4 frequencies and a percentage of 5.4%. In the fourth rank was the indicator "It enhances communication skills in a variety of contexts for the learner" with 2 frequencies and a percentage of 2.7%. with regard to the indicators "It develops the learner's ability to express his thoughts" and "It develops the creative thinking skill of the learner", they were not available in the objectives of the sport and health for all curriculum.

In addition, the results showed that the total frequencies of the indicators of learning and innovation skills in the objectives of the sport and health for all curriculum was 31 with a percentage of 41.9%, which indicates their availability in a moderate degree.

2.2. The Availability of the 21st Century Skills on the Objectives of Sport and Health for All Curriculum in Light of the Information and Technology Skills

There were no available indicators related to the information and technology skills in the objectives of the sport and health for all curriculum designed for the undergraduate university students at Al-Balqaa Applied University

2.3. The Availability of the 21st Century Skills on the Objectives of Sport and Health for All Curriculum in Light of the Life and Work Skills

The results shown in table (3) represent the frequencies and percentages for the indicators for the life and work skills in the objectives of the sport and health for all curriculum. The results indicated that the indicator “Increase learner awareness of lifelong learning” and the indicator “Promotes the learner’s responsibility towards the environment and society” were ranked first with 10 frequencies and a percentage of 13.51% for each indicator. In the second rank was the indicator “Develop the learner's planning and management skills” with 6 frequencies and a percentage of 8.1%, followed by the indicator “Develop the professional style of the learner” and a percentage of 5.4%. in the fourth rank was the indicator “The learner's sense of belonging and citizenship develops towards his homeland” and the indicator “Take into account the different social values of the learner” with three frequencies for each indicator and a percentage of 4.05%. finally, in the fifth rank were the indicators “It reinforces positive attitudes towards collaborative work” and “It instill Virtuous morals and manners in the learner to respect and appreciate others” with 2 frequencies and a percentage of 2.7% for each of them.

The total frequencies of the indicators of life and work skills in the sport and health for all curriculum were 43 times, with a percentage of 58.1%, which indicated that the life and work skills are available to a moderate degree in the objectives of the sport and health for all curriculum designed for the undergraduate university students in Al-Balqaa Applied University.

Table 2. Frequencies and percentages of the indicators of the learning and innovation skills in the objectives of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	Emphasizes the learner's self-learning strategy in accessing information	10	13.5	2
2	Develop the scientific method of thinking for the learner	4	5.4	3
3	It develops the learner's ability to express his thoughts	0	0	**5**
4	Develops the critical thinking skill of the learner	1	1.35	2
5	It develops the creative thinking skill of the learner	0	0	**5**
6	Enable the learner of self-realization	14	18.9	1
7	It enhances communication skills in a variety of contexts for the learner	2	2.7	4
	Total	31	41.9	**Moderate**
	Mean	4.43		

Table 3. Frequencies and percentages of the indicators of the life and work skills in the objectives of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	Develop the professional style of the learner	4	5.40	3
2	Increase learner awareness of lifelong learning	10	13.51	1
3	Promotes the learner’s responsibility towards the environment and society	10	13.51	1
4	The learner's sense of belonging and citizenship develops towards his homeland	3	4.05	4
5	Take into account the different social values of the learner	3	4.05	4
6	Develop the learner's planning and management skills	6	8.10	2
7	Develop the learner's time management skill	3	4.05	4
8	It reinforces positive attitudes towards collaborative work	2	2.7	5
9	It instill Virtuous morals and manners in the learner to respect and appreciate others	2	2.7	5
	Total	**43**	**58.1**	**Moderate**
	Mean	**4.7**		

The results shown in table (4) represent the availability degree of the 21st century skills in the sport and health for all curriculum designed for the undergraduate university students in Al-Balaqaa Applied University. The results revealed that the learning and innovation skills were available to a moderate degree (31, 41.89%), and the information and technology skills were not available, and the life and work skills were available to a moderate degree (43, 58.1%).

Table 4. The availability of the 21st century skills in the objectives of the sport and health for all curriculum

N	Subdomains in the objectives	Total	Percentage	Degree
1	**Learning and innovation skills**	31	%41.89	Moderate
2	**Information and technology skills**	0	0	Very low
3	**Life and work skills**	43	%58.10	Moderate
	Total skills	74	13.8	Low

The availability of the 21st century skills on the activities of sport and health for all curriculum in light of the learning and innovation skills

The results shown in table 5 represent the frequencies and percentages of the availability of the learning and innovation skills indicators in the activities of the sport and health for all curriculum. The results revealed that the indicator “Provides the learner with the ability to collect and analyze information.” was ranked first with 19 frequencies and a percentage of 7.36%, followed by the indicator “Encourages the learner to generate and ask many questions to judge things” with 17 frequencies and a percentage of 6.59%. In the third rank was the indicator “It links the educational and life situations of the learner” with 15 frequencies and a percentage of 5.8%, followed by the indicator “It gives the learner various opportunities to express his thoughts.” With 13 frequencies and a percentage of 5.04%. In the fifth rank was the indicator “Motivating the learner to interpret and clarify phrases and ideas.” With 12 frequencies and a percentage of 4.65%, followed by the indicator “Provides the learner with the ability to combine and connect ideas and to draw practical and scientific ideas” with 11 frequencies and a percentage of 4.26%, similar to the indicator “Emphasizes the learner's self-learning strategy in accessing information”. Moreover, in the seventh rank was the indicator “It places the learner in unfamiliar problems and situations.” And the indicator “Provides the learner with the ability to write expressions explaining his point of view.” With 10 frequencies and a percentage of 3.88% for each of them. In the eighth rank was the indicator “Encourages the learner to generate the most ideas, hypotheses and solutions.” With 4 frequencies and a percentage of 1.55%, followed by the indicator “It enhances communication skills in a variety of contexts for the learner.” With three frequencies and a percentage of 1.16% and the indicator “Provides the learner with the ability to analyze different opinions, perspectives, and events.” With two frequencies and a percentage of 0.77%. Furthermore, the rest of the indicators were not available in the activities of the curriculum.

The results showed that the total frequencies of the learning and innovation skills’ indicators was 132 times with a percentage of 51.16%, which indicated their availability to a moderate degree.

Table 5. Frequencies and percentages of the indicators of the learning and innovation skills in the activities of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	Emphasizes the learner's self-learning strategy in accessing information	**11**	**4.26**	**6**
2	It links the educational and life situations of the learner.	**15**	**5.8**	**3**
3	It places the learner in unfamiliar problems and situations.	**10**	**3.88**	7
4	Provides the learner with the ability to collect and analyze information.	**19**	**7.36**	**1**
5	Motivating the learner to interpret and clarify phrases and ideas.	**12**	**4.65**	**5**
6	Encourages the learner to generate and ask many questions to judge things.	**17**	**6.59**	**2**
7	Provides the learner with the ability to combine and connect ideas and to draw practical and scientific ideas.	**11**	**4.26**	6
8	It enhances communication skills in a variety of contexts for the learner.	**3**	**1.16**	9
9	It gives the learner various opportunities to express his thoughts.	**13**	**5.04**	**4**
10	Provides the learner with the ability to write expressions explaining his point of view.	**10**	**3.88**	7
11	Provides the learner with the ability to analyze different opinions, perspectives, and events.	**2**	**0.77**	10
12	Encourages the learner to generate the most ideas, hypotheses and solutions.	**4**	**1.55**	8
13	Encourages the learner to generate new ideas and unconventional solutions.	**0**	**0**	11
14	It promotes the learner’s use of various methods to solve a problem.	**0**	**0**	11
15	Ask the learner to distinguish similarities and differences.	**5**	**1.94**	8
16	It helps the learner to generate creative and unconventional ideas.	**0**	**0**	11
17	Encourages the learner to employ creative ideas on the ground.	**0**	**0**	11
	Total	**132**	**51.16**	Moderate
	Mean	**7.76**		

Table 6. Frequencies and percentages of the indicators of the information and technology skills in the activities of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	Deepening the learner's awareness of positive attitudes towards modern technologies.	0	0	4
2	It helps the learner to acquire new skills in the use of modern technologies.	0	0	4
3	It requires the learner to critically analyze the electronic content	1	0.39	2
4	Directing the learner to refer to more than one source to access the information.	0	0	3
5	Providing the learner with the skill to access information efficiently (time) and effectively (the source).	0	0	3
6	Direct the learner to use the most suitable tools for media production.	0	0	3
7	Motivating the learner to pass judgment on the quality of the media.	1	0.39	2
8	Motivating the learner to pass judgment on the effectiveness of multiple technological tools and techniques.	0	0	3
9	Instructing the learner to use various technological tools in teaching and learning such as (computers, multimedia, social media, etc).	3	1.16	1
10	Promotes positive learner attitudes towards different cultures.	0	0	3
11	It enhances the learner's ability to express and interpret in diverse and multicultural environments.	0	0	3
12	Development of the academic integrity of the learner in dealing with and transferring information through (citation, referring statements ..... etc)	0	0	3
	Total	5	1.94	Very low
	Mean	0.42		

The availability of the 21st century skills on the activities of sport and health for all curriculum in light of the information and technology skills

The results shown in table 6 represent the frequencies and percentages of the availability of the information and technology skills indicators in the activities of the sport and health for all curriculum. The results revealed that the indicator "Instructing the learner to use various technological tools in teaching and learning such as (computers, multimedia, social media, etc.) was ranked first with 3 frequencies and a percentage of 1.16%, followed by the indicator "It requires the learner to critically analyze the electronic content" and the indicator "Motivating the learner to pass judgment on the quality of the media." In the second rank with a single frequency and a percentage of 0.39% for each indicator.

In addition, the results revealed that the total of the indicators of the information and technology skills in the activities of the sport and health for all curriculum was 5 with a percentage of 1.94%, which indicated their availability in a very low degree.

The availability of the 21st century skills on the activities of sport and health for all curriculum in light of the life and work skills

The results shown in table 7 represent the frequencies and percentages of the availability of the life and work skills indicators in the activities of the sport and health for all curriculum. The results revealed that the indicator "Encourages the learner to discuss community issues and interests." was ranked first with 20 frequencies and a percentage of 7.75%, followed by the indicator "Encourages the learner to learn lifelong" and the indicator "Encourages the learner to work effectively with others." with 16 frequencies and a percentage of 6.2% for each of them. In the third rank was the indicator "Motivating the learner to plan to achieve the desired results." With 14 frequencies and a percentage of 5.43%, followed by the indicator "Guide the learner to invest in his strengths." With 11 frequencies and a percentage of 4.26%.

Moreover, in the fifth rank was the indicator "Connects past and future learner experiences." With 10 frequencies and a percentage of 3.88%, followed by the indicator "Develop the learner's ability to initiate and lead." With 8 frequencies and a percentage of 3.1%. In the seventh rank was the indicator "The development of the spirit of belonging and citizenship of the learner towards his homeland." With 7 frequencies and 2.71%, followed by the indicator "Encourages the learner to adapt to different roles and responsibilities." With 6 frequencies and a percentage of 2.32%, then the indicator "Instruct the learner to discover and reinforce his weaknesses." With 5 frequencies and a percentage of 1.94%.

In the tenth rank was the indicator "Guide the learner to project management with high efficiency." and the indicator "Develop a sense of responsibility and bear the results for the learner." With 3 frequencies and a percentage of 1.16% for each indicator, followed by the indicator "Encourages the learner to accept the opinions of others and their reactions in a flexible environment." And the indicator "It develops the learner's ability to manage time and complete tasks on time." With a single frequency and a percentage of 0.39% for each of them. For the rest of the indicators, it was found that they were not available in the activities of the sport and health for all curriculum.

The results revealed that the total of the indicators for the health and work skills in the activities of the sport and health for all curriculum was 121 times with a percentage of 46.89%, which revealed that they are available to a moderate degree.

The results presented in table 8 represent the availability degree of the 21st century skills in the activities of the sport and health for all curriculum. The results revealed that the learning and innovations skills were available in a moderate degree with 132 frequencies and a percentage of 51.16%, while the information and technology skills were available in a very low degree (1.94%). In addition, the life and work skills were available to a moderate degree (46.89%).

Table 7. Frequencies and percentages of the indicators of the life and work skills in the activities of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	It contributes to developing the self-monitoring of the learner, setting priorities and accomplishing the required without direct supervision.	0	0	12
2	Encourages the learner to adapt to different roles and responsibilities.	6	2.32	8
3	Enabling the learner to work effectively in an atmosphere of ambiguity and changing priorities.	0	0	12
4	Encourages the learner to accept the opinions of others and their reactions in a flexible environment.	1	0.39	11
5	Encourages the learner to learn lifelong.	16	6.20	2
6	Connects past and future learner experiences.	10	3.88	5
7	Develop the learner's ability to initiate and lead.	8	3.1	6
8	Guide the learner to project management with high efficiency.	3	1.16	10
9	Motivating the learner to perform multiple tasks during a specific time period.	0	0	12
10	Guide the learner to invest in his strengths.	11	4.26	4
11	Instruct the learner to discover and reinforce his weaknesses.	5	1.94	9
12	Develop a sense of responsibility and bear the results for the learner.	3	1.16	10
13	Motivating the learner to plan to achieve the desired results.	14	5.43	3
14	It develops the learner's ability to manage time and complete tasks on time.	1	0.39	11
15	The development of the spirit of belonging and citizenship of the learner towards his homeland.	7	2.71	7
16	Encourages the learner to discuss community issues and interests.	20	7.75	1
17	Encourages the learner to respond to different social values.	0	0	12
18	Encourages the learner to work effectively with others.	16	6.2	2
19	Instilling good morals and manners for the learner in respecting and appreciating others.	0	0	12
	Total	121	46.89	Moderate
	Mean	6.37		

Table 8. The availability of the 21st century skills in the activities of the sport and health for all curriculum

N	Subdomains in the activities	Total	Percentage	Degree
1	Learning and innovation skills	132	%51.16	Moderate
2	Information and technology skills	5	%1.94	Very low
3	Life and work skills	121	%46.89	Moderate
	Total skills	258	%48.31	Moderate

The availability of the 21st century skills on the assessment questions of sport and health for all curriculum in light of the learning and innovation skills

The results shown in table 9 represent the frequencies and percentages for the available indicators related to the assessment questions in the sport and health for all curriculum. The results indicated that the indicator "Encourages the learner to generate and ask many questions to judge things." And the indicator "It gives the learner various opportunities to express his thoughts." was ranked first with 25 frequencies and a percentage of 12.37% for each indicator, followed by the indicator "Giving the learner the ability to write expressions explaining his point of view." With 21 frequencies and a percentage of 10.39%.

In the third rank was the indicator "Providing the learner with the ability to collect and analyze information." With 20 frequencies and a percentage of 9.9%, followed by the indicator "Promote the learner's self-learning strategy in accessing information." And the indicator "Motivating the learner to interpret and clarify phrases and ideas." With 15 frequencies and a percentage of 7.42% for each indicator. After that was the indicator "Giving the learner the ability to combine and link ideas and to draw practical and scientific ideas." With 14 frequencies and a percentage of 6.93%, and the indicator "It links the educational and life situations of the learner." With 8 frequencies and a percentage of 3.96%. in the seventh rank was the indicator "Ask the learner to distinguish similarities and differences." With 7 frequencies and a percentage of 1.98%. for the indicator "Giving the learner the ability to analyze different points of view, opinions and events" it was ranked ninth with 2 frequencies and a percentage of 0.99%. The rest of the indicators related to the learning and innovation skills were not available in the assessment questions of the sport and health for all curriculum.

The results showed that the total of indicators related to the learning and innovation skills in the assessment questions of the sport and health for all curriculum was 156 times with a percentage of 77.23%, which revealed that they are available to a high degree.

Table 9. Frequencies and percentages of the indicators of the learning and innovation skills in the assessment questions of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	Promote the learner's self-learning strategy in accessing information.	15	7.42	4
2	It links the educational and life situations of the learner.	8	3.96	6
3	It places the learner in unfamiliar problems and situations.	4	1.98	8
4	Providing the learner with the ability to collect and analyze information.	20	9.9	3
5	Motivating the learner to interpret and clarify phrases and ideas.	15	7.42	4
6	Encourages the learner to generate and ask many questions to judge things.	25	12.37	1
7	Giving the learner the ability to combine and link ideas and to draw practical and scientific ideas.	14	6.93	5
8	It enhances communication skills in a variety of contexts for the learner.	0	0	10
9	It gives the learner various opportunities to express his thoughts.	25	12.37	1
10	Giving the learner the ability to write expressions explaining his point of view.	21	10.39	2
11	Giving the learner the ability to analyze different points of view, opinions and events.	2	0.99	9
12	Encourages the learner to generate the most ideas, hypotheses and solutions.	0	0	10
13	Encourages the learner to generate new ideas and unconventional solutions.	0	0	10
14	It promotes the learner's use of various methods to solve a problem.	0	0	10
15	Ask the learner to distinguish similarities and differences.	7	3.46	7
16	It helps the learner to generate creative and unconventional ideas.	0	0	10
17	Encourages the learner to employ creative ideas on the ground.	0	0	10
	Total	156	77.23	High
	Mean	9.2		

Table 10. Frequencies and percentages of the indicators of the information and technology skills in the assessment questions of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	Deepening the learner's awareness of positive attitudes towards modern technologies.	0	0	3
2	It helps the learner to acquire new skills in the use of modern technologies.	0	0	3
3	It requires the learner to critically analyze the electronic content	0	0	3
4	Directing the learner to refer to more than one source to access the information.	3	1.48	1
5	Providing the learner with the skill to access information efficiently (time) and effectively (the source.(	0	0	3
6	Direct the learner to use the most suitable tools for media production.	0	0	3
7	Motivating the learner to pass judgment on the quality of the media.	1	0.49	2
8	Motivating the learner to pass judgment on the effectiveness of multiple technological tools and techniques.	0	0	3
9	Instructing the learner to use various technological tools in teaching and learning such as (computers, multimedia, social media, etc(.	1	0.49	2
10	Promotes positive learner attitudes towards different cultures.	0	0	3
11	It enhances the learner's ability to express and interpret in diverse and multicultural environments.	0	0	3
12	Development of the academic integrity of the learner in handling and transmitting information through (documentation, the ratio of information to those who say it ..... etc(	0	0	3
	Total	5	2.48	Very low
	Mean	0.42		

The availability of the 21st century skills on the activities of sport and health for all curriculum in light of the information and technology skills

The results shown in table 10 represent the frequencies and percentages for the available indicators related to the information and technology skills in the assessment questions of the sport and health for all curriculum.

The results revealed that the indicator “Directing the learner to refer to more than one source to access the information: was ranked first with 3 frequencies and a percentage of 1.48%, followed by the indicator “Motivating the learner to pass judgment on the quality of the media” and the indicator “Instructing the learner to use various technological tools in teaching and learning such as (computers, multimedia, social media, etc) with a frequency of one and a percentage of 0.49% for each indicator. In addition, the rest of the indicators were not available in the assessment questions of the sport and health for all curriculum.

The results revealed that the total of the indicators related to the information and technology skills in the assessment questions of the sport and health for all curriculum was 5 indicators (2.48%), which indicated that they were available to a very low degree.

The availability of the 21st century skills on the assessment questions of sport and health for all curriculum in light of the life and work skills

The results shown in table 11 represent the frequencies and percentages of the available indicators related to the life and work skills in the assessment questions of the sport and health for all curriculum. The results revealed that the indicator “Motivating the learner to plan to achieve the desired results” and the indicator “Encourages the learner to discuss community issues and interests” were ranked first with 8 frequencies and a percentage of 3.96% for each indicator, followed by the indicator “Encourages the learner to learn lifelong” with 7 frequencies and a percentage of 3.46%, then the indicator “The development of the spirit of belonging and citizenship of the learner towards his homeland” with five frequencies and a percentage of 2.47%. in the fourth rank was the indicator “Connects past and future learner experiences” with three frequencies and a percentage of 1.48%. then were the indcator “Guide the learner to project management with high efficiency” and the indicator “The learner directed to invest his strengths” with two frequencies and a percentage of 0.99% for each indicator, followed by the indicator “Encourages the learner to adapt to different roles and responsibilities”, the indicator “Instruct the learner to discover and reinforce his weaknesses”, and the indicator “Encourages the learner to respond to different social values” with a single frequency and a percentage of 0.49% for each indicator.

The results showed that the total of the available indicators related to the life and work skills in the assessment questions of the sport and health for all curriculum was 41 times (20.29%), which revealed that they are available to a low degree.

Table 11. Frequencies and percentages of the indicators of the life and work skills in the assessment questions of the sport and health for all curriculum

N	Indicator	Frequency	Percentage	Rank
1	It contributes to developing the self-monitoring of the learner, setting priorities and accomplishing the required without direct supervision.	0	0	6
2	Encourages the learner to adapt to different roles and responsibilities.	1	0.49	5
3	Enabling the learner to work effectively in an atmosphere of ambiguity and changing priorities.	0	0	6
4	Encourages the learner to accept the opinions of others and their reactions in flexible environment.	0	0	6
5	Encourages the learner to learn lifelong.	7	3.46	2
6	Connects past and future learner experiences.	3	1.48	3
7	Develop the learner's ability to initiate and lead.	0	0	6
8	Guide the learner to project management with high efficiency.	2	0.99	4
9	Motivating the learner to perform multiple tasks during a specific time period.	0	0	6
10	The learner directed to invest his strengths.	2	0.99	4
11	Instruct the learner to discover and reinforce his weaknesses.	1	0.49	5
12	Develop a sense of responsibility and bear the results for the learner.	0	0	6
13	Motivating the learner to plan to achieve the desired results.	8	3.96	1
14	It develops the learner's ability to manage time and complete tasks on time.	1	0.49	5
15	The development of the spirit of belonging and citizenship of the learner towards his homeland.	5	2.47	3
16	Encourages the learner to discuss community issues and interests.	8	3.96	1
17	Encourages the learner to respond to different social values.	1	0.49	5
18	Encourages the learner to work effectively with others.	2	0.99	4
19	Instilling good morals and manners for the learner in respecting and appreciating others.	0	0	6
	Total	41	20.29	Low
	Mean	2.16		

Table 12. The availability of the 21st century skills in the assessment questions of the sport and health for all curriculum

م	Subdomains in the assessment questions	Total	Percentage	Degree
1	**Learning and innovation skills**	156	%77.23	High
2	**Information and technology skills**	5	%2.48	Very low
3	**Life and work skills**	41	%20.29	Low
	Total skills	202	%37.82	Low

The results shown in table 12 represent the total available 21st century skills (learning and innovation, information and technology, and life and work skills) in the assessment questions of the sport and health for all curriculum designed and introduced for the undergraduate students in Al-Balqaa Applied University. The results revealed that the learning and innovation skills were available to a high degree (n=155, 77.23%), whereas the information and technology skills were available to a very low degree (n=5, 2.48%). In addition, the life and work skills were available to a low degree (n=41, 20.29%).

The results shown in table 13 represent the total available 21st century skills (learning and innovation, information and technology, and life and work skills) in the objectives, activities and the assessment questions of the sport and health for all curriculum designed and introduced for the undergraduate students in Al-Balqaa Applied University. The results revealed that the learning and innovation skills were available to a moderate degree (59.73%), the information and technology skills were available to a very low degree (1.87%), whereas the life and work skills were avaialble to a low degree (38.38%). The results of the current study revealed that the mean score for the availability of the 21st century skills in the sport and health for all curriculum designed for the undergraduate students in Al-Balqaa university was 33.33%, which is a low degree of availability.

Table 13. The availability of the 21st century skills in the sport and health for all curriculum

N	Skills	Objectives	Activities	Assessment questions	Total	Percentage	Degree
1	**Learning and innovation skills**	31	132	156	319	%59.73	Moderate
2	**Information and technology skills**	0	5	5	10	%1.87	Very low
3	**Life and work skills**	43	121	41	205	%38.38	Low
	Total				534	%33.33	Low

3. Discussion

It is noted from the results related to the degree of availability of the 21st century skills in the objectives of the sport and health for all curriculum introduced for the undergraduate university students that learning and innovation skills, in addition to the life and work skills have been included in a moderate degree, while information and technology skills have been completely overlooked. The researcher attributes this result to the nature of the course content and its ability to activate the largest number of physical and mental processes by exciting learners and encouraging them to learn and innovate and support critical thinking[11]. As for the low and absence of information and technology skills, it may be attributed to the poor interest in the content of the course in media and technical means and their applications. The researcher attributes this to the fact that the curriculum development process has focused heavily on some of the skills of the current century, such as scientific thinking skills, problem solving and self-learning skills, without paying attention to a number of other skills related to information and technology [12].

The results of the current study are in line with the findings reported by [8] and [11] with regard to the availability of the learning and innovation and the life and work skills to a moderate degree. Whereas it differs with regard to the findings related to the information and technology, as [11,12] study reported its moderate availability, and this could be referred to the different nature of the curriculum analyzed in both studies.

In addition, the results of the current study are consistent with the findings of [13] study, which revealed the superiority if the learning and innovation skills and life and work skills with regard to the availability in the higher education curriculums over the information and technology skills, and with regard to the weakness of representation of information and technology skills in these curricula.

The results related to the availability of the 21st century skills in the activities of the sport and health for all curriculum revealed that the learning and innovation skills and life and work skill were available to a moderate degree, whereas the information and technology skills were available to a very low degree. This was referred to that the activities included in the curriculum were focusing on developing the learner's abilities in the different educational contexts and situations, in addition to directing and guiding the learners to the lifelong learning and discovering the strength and weakness points rather than focusing on using the technical skills and the media in the educational process.

The results of this study are consistent with the results reported by [4] who reported that there is a significant lack of including the digital citizenship skills in the physical fitness curriculum in Jordan. In addition, the results are in line with the findings reported by [14], which indicated that the availability of the knowledge experiences in the physical fitness curriculum was at a moderate degree.

On the other hand, the results of the present study are inconsistent with the results reported by [15], which revealed that there is a significant lack in including the creativity and innovation skills, the critical thinking skills and the problem solving skills in the English language curriculum introduced for undergraduate students in AL-Yarmouk university, and this could be referred to the difference in the curriculum context and content, in addition to the difference of the learning environment.

It is obvious from the previously presented results that the learning and innovation skills were available to a high degree in the assessment questions, whereas the life and work skills were available to a moderate degree and the information and technology skills were available to a very low degree.

The high degree of including the learning and innovation skills in the assessment questions of the sport and health for all curriculum might be referred to the connection between the assessment questions and the learning objectives, and its focus on the learning outcomes. The lack of life and work skills and the information and technology skills might be referred to the lack of employing learning experiences of the learner and the media means and technologies in the assessment questions of the curriculum content.

The results of the present study are consistent with the results reported by Hajja [16] that indicated a significant lack of including the information and technology skills and the life and work skills in the sport and health curricula introduced for the higher education students in Palestine. On the other hand, they are different in the degree of the availability of the learning and innovation skills. This might be attributed to the difference in the curriculum nature and context.

In general, the previously presented results revealed a significant shortage and lack of including the 21st century skills in the objectives, activities and assessment questions in the sport and health for all curriculum introduced for the undergraduate students enrolled in Al-Balqaa university. This is in line with the previous studies such as [4], [14],[16], which totally reported that there is a significant lack in including the 21st century skills in different curricula, and that the current curricula are characterized by the ignorance of key 21st century skills, and not focusing on preparing the learning to face the challenges of the 21st century.

4. Conclusions

In conclusion, the study revealed that there is low integration of the 21st century skills (learning and innovation, life and work, information and technology skills) in the sport and health for all curriculum designed and introduced for the undergraduate university students in Al-Balqaa university. This weak integration was referred to the nature of the curriculum and the lack of efforts to improve the curriculum. The study recommends performing a thorough revision of the sport and health for all curriculum in order to integrate the 21st century skills, which will enable the students to cope with the challenges of the 21st century skills.

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Developing a New Model of Resistance-based Strength Train and Its Effects on Junior Athletes' Tennis Serve Performance

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Abstract This study was aimed at developing a new model of resistance-based strength training for junior tennis athletes and examining its effectiveness on their serve performance compared to traditional model of training. It is a Research and Development study focusing on developing, validating, revising, and testing the model of training. In testing phase, effectiveness test was accomplished to examine the effectiveness of the new training model and compared to the effectiveness of the traditional model. There were 60 junior athletes contributing to this study. The data were gathered by distributing questionnaires to reveal the convenience and attractiveness of the model developed and using Collang Smart Tennis Racket Sensor Tracker Motion Analyzer to reveal the tennis athletes' serve performance. The data were analyzed by employing descriptive statistic and t-test. In terms of convenience and attractiveness, this study revealed that the use of resistance training for junior tennis athletes showed good results. T-test proved that this new model was more effective in improving players' serve speed compared to traditional model was. Thus, researchers concluded that the new model of resistance-based training can be implemented to increase tennis junior players' serve speed.

Keywords Junior Athletes, Resistance, Strength Training Model, Tennis

1. Introduction

Tennis is a popular sport and favored by people from all levels of society without being restricted by age, gender, social status, and some other backgrounds. This branch of sport keeps developing that can be seen by the number of annual tennis tournaments conducted both at national and international levels. Obviously, this phenomenon has impacted on intense competition among the athletes to participate in the tournaments in which, nowadays, professional and semi-professional sport gives slight potential for them to win; and, it becomes an intense pressure for the couches and athletes [1-3]. Therefore, the athletes should be well-prepared and well-trained to compete in every tournament by performing numerous training programs designed to achieve the targets.

To develop the athletes' skill and performance, numerous studies have examined various models of training such as by giving video modelling and imaging training that was empirically proved to have impacts on performance of tennis serve of 9-to 12-year old children [4], a different approach to the design of an effective strength training program in modern tennis conducted by [5] was proved to be effective to enhance basic and specific strength efficiently and be able to minimize and prevent injury. It means that the development of models of training or some various approaches should be done to improve the athletes' performance as the needs. So, strength performance is a crucial element for athletes that it needs strategies to develop a strength training for tennis players [6].

It is assumed that children should not be given strenuous training as it puts extreme stress on muscle growth that possibly harms their muscle [7]. However, this assumption has not been proved. Previous research showed various training modalities such as weight machines, free weights, body-weight exercises, sports-conditioning drills, with different formula set and repetition could adequately stimulate the enhancement of strength development for children [8,9]. By supervision and proper training program design, strength training can be beneficial and effective for children and youths' growth as long as it is supervised and performed carefully, and it will not cause injury.

One of strength development trainings for children and adolescents is resistance training. This type of training has been used by many couches because it could enhance strength and increase body composition, reduce fat mass, increase lean body mass, increase muscle strength and endurance, increase bone mineral density, and increase blood lipid profile [12,13]. In addition, this model of training can improve flexibilities and stimulate the increase of proprioception due to the increase of the activity of motor units recruitment that activates golgi tendon organ and muscle spindle [13]. Nevertheless, specifically, the implementation of resistance model of training to improve serve performance of tennis players has not been examined massively.

This study focused on the development of an approach of strength training model based on resistance that is unchallenging and interesting for children and adolescents. With this concept, it is expected that it would implicitly motivate them who usually get bored with monotonous strength training [14,15]. To examine the effects, researchers used Collang Smart Tennis Racket Sensor Tracker Motion Analyzer to analyse the athletes' serve speed. The use of this technology was expected to be validly able to examine the effects of the model of strength training based on resistance on measurable athletes' serve result. Some researchers, has recommended the utilization of technology in sport to help coaches evaluate their athletes' performance [16,17]. Moreover, this study was aimed at developing a new model of training to train athletes' strength based on resistance that was unchallenging and interesting for junior tennis athletes and to examine the effectiveness of the model of training compared to traditional models of training.

2. Materials and Methods

This is a Research and Development study conducted to create a certain product and examine its effectiveness [18,19]. This study developed a product in form of a model of strength training based on resistance for junior tennis athletes. Its procedure was begun by developing, validating, and revising and testing the model of training.

Draft of the design of the model of resistance-based strength training was created into 24 models. These models were discussed and validated by 3 coaches with national level of coaching license and with more than 2-year coaching experience. After validating, 18 models of resistance-based strength training were ready to be tested. These designs were made based on 3 major elements, namely: exercise model for the leg as shown in figure 1, exercise model for core stability as shown in figure 2 and exercise model for arm as shown in figure 3.

There were three stages in testing the model of the training, namely: small-scale testing with 20 samples (athletes), large-scale testing with 40 samples (athletes), and effectiveness testing by comparing experimental group given the treatment using resistance-based model of strength training to control group. In effectiveness testing, experimental group did train for 12 meetings (60 minutes for each meeting) by performing resistance-based strength training.

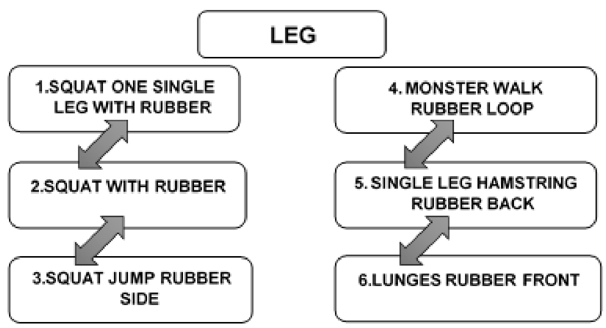

Figure 1. A Design of Resistance-Based Strength Training for Leg

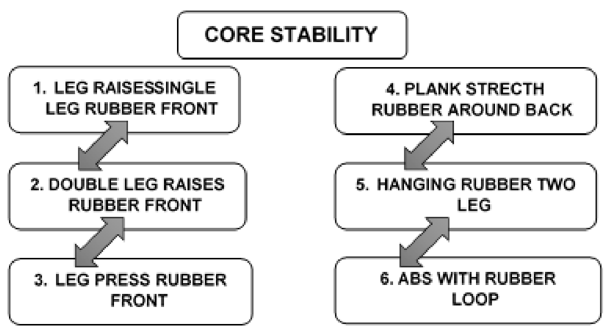

Figure 2. A Design of Resistance-Based Strength Training for Core Stability

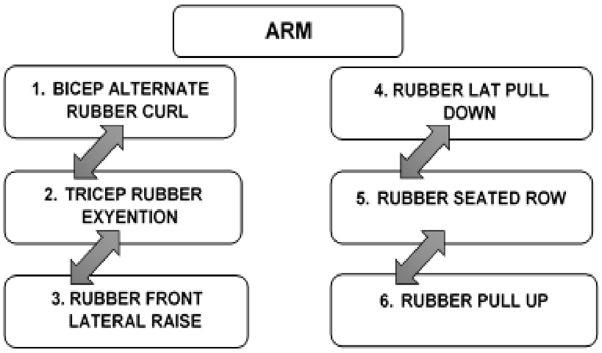

Figure 3. A Design of Resistance-Based Strength Training for Arm

Data of small - scale and large - scale tests were collected to investigate the level of easiness or convenience and attractiveness of the model and then analyzed by descriptive statistic. Meanwhile, data of effectiveness testing were collected by using instrument Collang Smart Tennis Racket Sensor Tracker Motion Analyzer [20] to measure serve speed. Next, t-test was conducted to examine its effectiveness between experimental group and control group.

3. Result

3.1. Result of Small-scale and Large-scale Tests

For small-scale test, 20 samples filled a questionnaire about convenience and comfort; while, for large-scale test, 40 athletes answered a questionnaire consisting of 18 questions regarding the use of resistance-based strength training model. The result is presented in the table 1 below.

Referring to the Table 1, for the result of small-scale test, the aspect of convenience reaches 325 from a total score 360 with a percentage of 90.27%; while, the aspect of comfort obtained 326 from 360 with a percentage of 90.55%. It indicates that resistance-based strength training model tested in small-scale could be categorized into good category. Next, for the result of large-scale test, the aspect of convenience gained 650 and aspect of comfort reached 659 from a total score 720 with achievement percentages of 90.27% and 91.52%, respectively. It indicates that the small-scale and large-scale tests show a good result meaning that the training model could be proceeded to the next stage, namely effectiveness testing conducted by comparing the model of resistance-based strength training to traditional training model.

Table 1. The result of small-scale and large-scale testing

	Aspect	Score Results	Score Maximal	%	Explanation (Category)
Small-scale test	Convenience	325	360	90.27	good
	Comfort	326	360	90.55	good
Large-scales test	Convenience	650	720	90.27	good
	Comfort	659	720	91.52	good

3.2. Result of Effectiveness Test

In accomplishing effectiveness test, this study used t-test to examine the increase of the samples ' performance of tennis serve. The result of t-test for experimental and control groups and the difference between the two groups are presented in the table 2 below.

Table 2. Result of t-test of experimental and control groups

Group	Average	T_{value}	t_{table}	p
Pretest Experiment	136.87	22.00	1.71	0.000
Posttest Experiment	159.20			
Pretest Control	132.60	19.54	1.71	0.000
Posttest Control	139.33			
Experiment vs Control		10.50	2.47	0.000

In the Table 2, the average results of pretest for experimental and control groups are 136.87 and 159.20, respectively, with a difference of 22.33. T-test shows that t-value (22.00) is higher than t-table (1.71). it indicates that there was a significant difference between pre-test and post-test results; therefore, it can be said that the treatment of resistance-based strength training model could statistically improve junior tennis athletes' serve skill. The similar result was also released from control group with average scores of pretest and posttest are 132.60 and 139.33, respectively, with a difference of 6.73. T-test for control group also indicates that there was an effect of the use of traditional model of training on the improvement of athletes' serve skill proven by the higher value of t-value than t-table.

Although both tests showed positive impacts on increasing tennis athletes' serve performance, experimental group more significantly impacted than control group. It can be seen from the difference of t-values between the experimental group and control group which are 10.50 and 2.47, respectively. Therefore, the use of resistance-based strength training model was proven to be more effective in improving the performance of junior tennis athletes in serving than the use of traditional model was.

4. Discussion

This study was aimed at developing a new model of strength training based on resistance and examining its effectiveness compared to traditional training model. Accomplishing some stages in developing this model, there were 18 models of resistance training using rubber band. These models had been validated by the experts, tested through small - scale and large - scale tests and examined its effectiveness.

Considering the result of small - scale and large - scale tests, the experts, (i.e. the couches) suggested that to attract and facilitate athlete in implementing the model of training, it would be better to match the color of rubber band with the basic skill of the athletes. In addition, to conduct the training more effectively, it is recommended to increase the number of matrass and rubber band according to the number of the athletes. It is in line with the research result conducted by [21] revealing that an interesting training can increase an athlete's motivation to train so that the training process is not monotonous but still maintains the same essence to achieve the training targets optimally. After fulfilling the experts' advices, a large-scale test was conducted and there were no significant difficulties and problems encountered during the testing so that the model of resistance-based strength training can be applied in training program for tennis athletes.

The effectiveness test between the two groups revealed that experimental group showed better result than control group did. This result is supported by the result of previous research revealing that a training program based on resistance could enhance the average speed of tennis serve for adolescent [22]. Another study conducted by [23] added that the combination of resistance band training was effective to increase the jump height, arm strength, speed and agility. Basically, strength training uses the principle of progressive overload, forcing the body (muscles, tendons, bones, etc.) to adapt in order to release a greater energy [24], moreover, resistance-based strength training could stimulate athletic development, tolerate the demands of training and long-term competence, and escalate the effect of health enhancement over time that keeps maintaining until adulthood [25].

Youths, whether they are athletes or not, can be successful in increasing their power and health safely and comprehensively by participating in a program that is supervised effectively. Coaches play important roles in determining and ensuring technique, forms, proper training development and guarantying athlete's safety. Therefore, model of resistance-based strength training is safe to be implemented and beneficial for children. Strengthening the result, the model of resistance-based training was effective to enhance tennis serving skill foe children and adolescent [26]. The finding of this study is also supported by [27,28] stating that coaches took a part in managing training pattern and safety so that the model of resistance training could be practiced optimally. Resistance training was also effective to escalate speed and accuracy in tennis training program [29].

5. Conclusions

Researchers concluded that: firstly, the new model of strength training based on resistance was successfully developed into 18 models of training which were attractive and facilitative to be implemented and had been validated by the experts. Secondly, the model of resistance-based strength training had been tested to improve the performance of junior tennis athletes in doing serve more effectively than the conventional model did. Therefore, it is highly suggested for both coaches and athletes to implement this model in training in order to enhance tennis players' performance of serve. For further research, researchers recommended to examine other aspects related to strength to reveal the impacts in wider scope.

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Effectiveness of the Multistage Jumping Rope Program in Enhancing the Physical Fitness Levels among University Students

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Abstract Several studies have shown that there has been a sudden decrease in physical activity levels among University students. This is alarming as physical inactivity is a known risk factor for many chronic diseases. Hence, Universities are in the best position to examine the personal and professional lifestyles among their students. The study was conducted in order to determine the effectiveness of the eight week multistage jumping rope training program in enhancing the physical fitness levels of Filipino university students. The study utilized a quasi-experimental research design and employed a purposive sample of 70 participants, who were screened using Physical Activity Readiness Questionnaire+ and were required to undergo a progressive eight-week jumping rope test. Cardiovascular endurance was assessed through volume of oxygen uptake or VO_2 max before and after the multistage jumping rope training program. Data was analyzed using frequency, percentage, mean, standard deviation and paired t-test. The results revealed a significant difference in the VO_2 max of males and females after the multistage jumping rope training program. The study affirms the effectiveness of the multistage jumping rope test in increasing the VO_2 max of the participants. Hence, integrating the said program in the school curriculum can significantly enhance their cardiovascular fitness.

Keywords Cardiovascular Endurance, Physical Fitness, Skipping Rope Test, University Students

1. Introduction

In recent years, the number of university students who have low physical fitness levels and observe unhealthy dietary patterns has increased dramatically [1]. Their physical activity behaviors are also affected by complex interaction of motivation and self-regulatory skills together with a distinct social and physical environment encompassing college life [2]. These includes increase academic workloads and substandard sporting facilities [3-4]

In the Philippines, studies have shown that Filipino youth have low physical activity and that they do not meet the recommended physical activity per week due to lack of time [2, 5]. This is alarming as physical inactivity is a known risk factor of many chronic diseases [6]. Hence, promoting physical activity among university students is crucial in order to ensure that they develop regular physical activity patterns which they can extend throughout their adult life.

One of the important indicators of physical activity is cardiovascular (or cardiorespiratory, cardiopulmonary) endurance. It is defined as the "combined ability of the pulmonary system to promote gas exchange between the outside air and the circulating blood through the capillaries in the lungs, the cardiovascular system to transport oxygen to the working muscles, and the muscular system to utilize the oxygen [7]. Moreover, it also has mental health benefits along with other long-term effects like improved ability to extract oxygen from air during exercise, increased sweat rate, reduced risk of cancer, and increased density and breaking strength of bones, ligaments, and tendons, among many others. Thus, when one has an ideal cardiovascular endurance level, it would take less effort for that person to fulfill daily routine especially difficult tasks that require more physical exertion [8].

Despite the importance of having a high level of cardiovascular endurance, Macfarlane and Tomkinson [9] revealed that there has been a global decline in the cardiovascular endurance test performance of children and adolescents (6 to 19- year-olds) at a rate of 4-5% per decade since 1970. The performance of Asian children has declined at an average rate of -0.44% per year since 1970. Specifically, the Philippines were among the countries that performed the worst, below the overall Asian average [9]. Since then, there was no update on the Philippines' status as it was not included in the follow up study after 25 years. Thus, the current physical fitness status, specifically cardiovascular endurance, of Filipino university students in general is not yet known.

Studies have shown that rope-jump test was shown not only to have improved physical fitness status of an individual but can also their coordination, balance, agility, rhythm, speed. Further, constant performance of the said activity may increase static or dynamic muscular strength and may contribute to the development of motor skills [10, 11]. Hence, an eight-week training program was to develop in order to determine its effectiveness in increasing the cardiovascular endurance of the subjects by measuring the VO_2 max.

2. Methods

2.1. Research Design

The study utilized a quasi-experimental research design in order to determine the effectiveness of an eight-week jumping rope training program on the cardiovascular endurance of the subjects using the 1-Mile Walk Fitness Test [12].

2.2. Research Participants

The study involved male and female students and whose age ranged from 18 to 20 years old, and were also non-smokers and non-alcoholics. A total of 70 bonafide first year level students who were enrolled from physical fitness class (HKD-01) - a prerequisite of all physical education course subjects was recruited through purposive sampling. All the participants were required to have a physical examination under the supervision of the university doctor and passed all screening test under the Physical Activity Readiness Questionnaire+ (PAR-Q+ 2019) [13].

2.3. Measurement and Instrumentation

2.3.1. The 1-Mile Walk Test

A 1-mile walk test is a fitness assessment that measures an individual's level of cardiorespiratory fitness or is referred to as the maximal oxygen consumption which is constructed on the quantity of the time it takes someone to finish a mile of brisk walking. This fitness test is applicable to individuals who are unable to run for having a low fitness level or even injuries. It induces an exercise heart rate of at least 120 beats per minute (bpm) at the end of the fitness test [8]. Following the protocol of Hoeger, W. & Hoeger, S. [12], a premeasured 1.0 mile course was selected where the test was conducted. Upon completing the 1-mile brisk walking, the participants were instructed to measure the time that it takes them to complete the course and to count their heart rate using the radial artery for 10 seconds and multiplied it by 6 to convert it to beats per minutes (bpm). In order to determine the time to walk, it was converted from a 00:00 value in order to allow for a numerical computation within the regression equation.

2.3.2. Computation for VO_2 max

Table 1 shows the fitness level classification of VO_2 max for Men and Women. The formula that was used to assess the cardiovascular endurance levels of the participants [12] is as follows:

Where: VO_2 max = ml/kg/min
Wt = Body weight in kilograms
Age = Age in years
Gender (G) = Zero (0) for females, One (1) for males
*Time (T) = Time to walk 1 mile (00:00)
^HR = Post Exercise Heart Rate (bpm)

VO_2max = 132.6 - (0.17 x weight in kg) - (0.39 x age) + (6.31 x gender [0 for females; 1 for males]) - (3.2 x time to walk 1 mile) - (0.156 x post-exercise heart rate [bpm]).

2.3.3. Multistage Jumping Rope Program

Table 2 shows the multistage jumping rope program for eight weeks which was held in a school gym. It started with the usual warm-up exercise which is dynamic stretching for 10 minutes except for the first week with only 5 minutes. The jumping rope test that was done is progressive to which 100 repetitions are added per week which starts at 100 in Week One and ends in 800 in Week Eight. All tests ended with a 5-minute static stretching for cool down.

2.3.4. Profile of the Participants

The profile of the subjects was collected in the study which includes the age in years, sex, height in centimeters, weight in kilograms, and resting heart rate (bpm).

Table 1. Fitness Level Classification for Men and Women

Fitness Classification for Male						
Age (year)	**Very Poor (under)**	**Poor**	**Fair**	**Good**	**Excellent**	**Superior (over)**
18 - 28	37.9	38.0 - 41.0	41.7 - 44.8	45.6 - 48.5	51.1 - 54.0	55.5
Fitness Classification for Female						
Age (year)	**Very Poor (under)**	**Poor**	**Fair**	**Good**	**Excellent**	**Superior (over)**
18 - 28	30.9-32.2	32.3 - 35.2	36.1 - 38.5	39.5 - 42.4	43.9 46.8	49.6

Source: Hoeger, W. & Hoeger, S. (2016)

Table 2. Multistage Jumping Rope Program

Week	Intensity (jumps/min)	Warm up: Dynamic Stretching	Exercise	Cool down: Static Stretching
1	100	5 mins.	100 repetitions per minute with 30-second rest	5 mins.
2	200	10 mins.	200 repetitions per minute with 30-second rest	5 mins.
3	300	10 mins.	300 repetitions per minute with 30-second rest	5 mins.
4	400	10 mins.	400 repetitions per minute with 30-second rest	5 mins.
5	500	10 mins.	500 repetitions per minute with 30-second rest	5 mins.
6	600	10 mins.	600 repetitions per minute with 30-second rest	5 mins.
7	700	10 mins.	700 repetitions per minute with 30-second rest	5 mins.
8	800	10 mins.	800 repetitions per minute with 30-second rest	5 mins.

2.4. Data Analysis

The data collected was analyzed using the SPSS version 21.0 (IBM Corporation, Armonk, NY). Descriptive statistics such as frequency, percentage, mean and standard deviation were used for the profile of the subjects while paired t-test was used to determine the subjects' VO_2 max before and after the multistage jumping rope program.

3. Results

Table 3 shows the profile of the subjects. It was revealed that the mean age of the participants was 18.27 (SD=0.61) while there were 37 (52.86%) female and 33 (47.14%) male participants. The mean height was 158.2 (SD=19.6), the mean weight was 72.12 (SD=38.09) while the mean resting heart rate (bpm) was 69.79 (SD=16.95).

Table 3. Profile of the Participants (n=70)

Profile	n (%)	Mean (SD)
Age (years)		18.27 (0.61)
Sex: Male	33 (47.14)	
Female	37 (52.86)	
Height (cm)		158.2 (19.6)
Weight (kg)		72.12 (38.09)
Heart rate (bpm)		(69.79 (16.95)

On the other hand, Table 4 depicts the comparative analysis for the pre-test and post-test mean VO_2 max of the subjects after undergoing the multistage jumping rope program. It was revealed that the pre-test VO_2 max among males was very poor, with a mean score of 36.1 (SD=8.68) while the pre-test VO_2 max among females was poor with a mean score of 32.53 (SD=3.90).

Focusing on the post-test result, it can be gleaned that the VO_2 max among males became good with a mean score of 47.62 (SD=8.95) after the Multistage Jumping Rope Program. On the other hand, the post-test VO_2 max among females was 37.34 (SD=3.71) which can be interpreted as fair.

The result of the paired t-test among males revealed a t value of -8.756 and a computed p-value of 0.000 while among females the result yielded a t value of -8.859 and p-value of <0.05.

4. Discussion

The objective of the study was to determine the effectiveness of the eight-week training program in increasing the cardiovascular endurance of the subjects by measuring the VO_2 max among University students. Currently, there is limited research whether jump-rope based program can be used as a training method to improve the physical fitness among University students [14]. The main findings of the study revealed that the 8-week training program significantly improves the cardiovascular endurance among the participants. Specifically, the VO_2 max among males changed from very poor to good; while for females, it changed from poor to fair after undergoing the training program.

The study indicates that the Multistage Jumping Rope Program is an effective method for improving cardiovascular endurance among University students.

Table 4. VO_2 max Before and After the Multistage Jumping Rope Program (n=70)

Variables	Pre-test		Pos-test		t-value	p-value
	Mean	SD	Mean	SD		
Male (n=33)	36.1	8.68	47.62	8.95	-8.756	*0.000
Female (n=37)	32.53	3.90	37.34	3.71	-8.859	*0.000

*p value is significant at 0.05 level

These findings are supported by the study of Partavi [14] who concluded that the 7-week rope jump training is and effective method for improving cardiovascular endurance among adolescent boys and Chao-Chien and Yi-Chun [15] who showed that the 12-week jumping rope training significantly influence the cardiovascular endurance among students who are intellectually impaired. Further, the study is consistent with previous literatures which reported that a rope-jump based training program significantly improves cardiovascular endurance [14, 16-19].

The findings of the study offered empirical evidence on the effectiveness of a jump-rope based program in enhancing the physical fitness among University students. Despite the positive findings of the study, there are some limitations that should be recognized. The study only included first year level students which was purposely selected and did not include other students, thereby limiting its generalizability. Also, other measures of physical fitness such as muscular strength and endurance, flexibility, agility, and speed were not included

5. Conclusions

The study affirms the effectiveness of the multistage jumping rope test in increasing the VO_2 max of the subjects. The school administrators are advised to adapt the Multistage Jumping Rope Program to improve physical fitness among University students. It includes providing adequate infrastructure to support such activities and create awareness of such programs. Further, integrating a jump rope-based program in the curriculum and afterschool activities is recommended.

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Contribution of Leg Power, Arm Power, Stomach Muscle Power, and Back Muscle Power on Jumping Services

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Abstract Background: Service jumping is one of the volleyball techniques which is very important to be trained in the game in order to complicate the opponent reception. Proposal: This research aims to determine the contribution of leg power, arm power, abdominal muscle strength, and back muscle strength to the volleyball athlete's jumping service ability. Method: This research is a correlational descriptive study. The subjects of this study were volleyball athletes from Bantul Regency club. The sampling technique used purposive sampling with a total of 42 respondents. Data collection instruments using measurement tests. Data analysis used multiple regressions. The results showed that there was a contribution of leg power to the volleyball athlete's jumping service ability (p value = 0.011) with a contribution of 28.7%. There was a contribution of arm power to jumping service ability in volleyball games (p value = 0.015) with a contribution of 20.4%. There was a contribution of abdominal muscle strength to the volleyball athlete's jumping service ability (p value = 0.018) with a contribution of 23.2%. There was a contribution of back muscle strength to the volleyball athlete's jumping service ability during games (p value = 0.031) with a contribution of 16.7%. There was contribution of leg power, arm power, abdominal strength and back muscle strength to the volleyball athlete's jumping service ability (p value = 0,000). The amount of contribution of leg power, arm power, abdominal strength and back muscle strength to jumping service ability is 89%. Conclusion: a volleyball training must be complete because its techniques include the whole body.

Keywords Leg Power, Arm Power, Abdominal Muscle Strength, Back Muscle Strength, Service Jumping

1. Introduction

Volleyball has established itself as a very popular sport among the people of Indonesia. The consequence of public opinion is people's demand for the optimal performance of volleyball players in Indonesia. Volleyball coaches and coaches are always required to carry out training programs that touch sports science in accordance with current sport developments [1].

Optimal performance can be achieved by coaching. The pattern of achievement sports development in general can be described as a pyramid form where the number of athletes with volleyball achievements is very small, because the population is spread throughout Indonesia with limited guidance in the regions. This indicates that the peak sports achievements will be achieved on the basis of potential and talented sports coaching activities so that the results are more optimal [2].

The basic techniques that must be mastered in volleyball games are service, blocking, and spikes mentioned techniques with the ball including service, passing, bait / set-up, smash, and block [3]. While some research revealed there are four basic techniques for playing volleyball. The first is passing, including passing up, passing down, and set-up bait. Second is service which includes lower hand service, and upper hand service. Third is smash, which includes normal smash, semi smash, and push smash. The fourth is a dam or block, which includes a single block and a friend block [4].

Service is one of the basic techniques that is very important and must be mastered by a volleyball player. Servicing is a blow to the opponent's area. based on that paradigm, service is the first opportunity to bring down an opponent and make the opposing team lose their rhythm. Servicing the ball simply over the net is not enough for a team that wants to win in the championship. There are several factors that characterize a team with good service. First is the determination of the right service for each player. Furthermore, for effective service, servers need to be mentally aggressive and have strong hand contact [5]

One popular type of service used by volleyball athletes is jumping service. The service movement jumps into three stages. First is the initial attitude, which is standing in the service area near the rear line facing the net, both hands holding the ball. The second is the implementation motion, which is toss the ball as high as approximately 3 meters slightly in front of the body, then lower the body by bending the knees to start jumping as high as possible then the ball is hit as high as possible like a smash. Beat the wrist as quickly as possible so that it produces a high topspin blow so that the ball as quickly as possible descends to the opponent's field. Third is the follow-up motion, which is after making a blow by reaching the ball as high as when flying when floating in the air, immediately landing on the field and immediately taking a position ready to receive returns or attacks from the opponent [6].

Good service skills require good physical conditions. Physical conditions needed in volleyball are power, strength, endurance, speed, flexibility and coordination. Performing jumping service techniques for volleyball requires the aspect of arm and leg power which is coordinated with the strength of the abdominal muscles and back muscles in an effort to prepare for hitting the ball during service jumping. Good coordination between the bio motor components will produce a good jumping service with a ball full of strength [7]. Jumping service is the most difficult service to do compared to other types of services. The jumping service is done by jumping like a smash. Coordination is an important factor in jumping. Coordination between hands and feet can produce effective service. Fast arm swings are needed in this service, whereas fast legs tend to produce fast arms. In addition, high tosses provide the opportunity for the server to produce speed by taking several steps before contact with the ball [8]

Jumping service if it is able to be done by the player perfectly can also be a tool to attack. The jumping service is not just the beginning of the game but also the beginning of the attack. The speed of the results of the service jumping service is usually harder and faster so that it will be difficult to return by the opponent, and will benefit the attacking team because it will generate points. The jumping service has a greater chance of generating points than the top service or the bottom service, although the percentage rate is not known with certainty [9]

The reality on the ground shows many cases of volleyball players who are unable to execute jumping services properly. This is seen during the game many service balls do not hit the target, some balls go too hard. This can be caused by lack of good motion coordination, lack of power and strength used in servicing so that service results are less than optimal. Ailure to service jumping, does not only occur in beginners or amateurs, even in many professional classes matches. A high level of difficulty because it requires good body coordination causes many players to fail to service jumping. Jumping service is the service with the highest error rate, it is due to the timing of the throw and when jumping near the ball [10]

Deficiency and ineffectiveness of the player in doing jumping services occur because of its complexity. Several factors cause the low level of success of players in service jumping. These factors include first, technical mastery, especially the basic ability of placing the service ball on the field. Second, players must have a high level of motor ability to support better ball placement. Jumping services require complex abilities while demanding qualified physical abilities and abilities. Athletes produce high-level strength when spiking or jumping and absorbing a lot of strength when flying, landing, or blocking a spike. Without strength, players will be weak during the game in an increasingly intense game. In addition, the capabilities possessed by players become not integrated [10]

Even though the failure rate of jumping service execution is quite frequent, there is an increase in the use of jumping services in volleyball matches. The use of jump serve in high-level volleyball tournaments from 1992 to 2002 increased from 20.8% to 99.2% [11]. The success of the jumping service will benefit the service team, because it will be the beginning of an attack on the opponent. The success of the jumping service will also be a scoring tool when the opponent is unable to return the jumping service performed by the player. Successful jumping services performed by players will support to score and achieve victory [12]. A jumping service that cannot be done properly by the player can be detrimental to the team. A jumping service failure causes the team to lose the opportunity to attack and score. Failure of the jumping service also adds to the opposing team's score so that it can be detrimental to the team because it provides additional scores for the opposing team.

Based on the writer's experience in the field, the team whose players are able to do jumping services will master the match. The team is able to attack and put pressure on the opposing team. Based on field observations, the percentage of successful jumping services in scoring around 85%.

Based on the background of the problems outlined above, it can be concluded that the success of the jumping service requires good coordination between bio motor components. Therefore, the authors are interested in conducting research on "Donation of Leg Power, Arm Power, Abdominal Muscle Strength, Back Muscle Strength Against the Ability to Perform Jumping Services on volleyball Athletes".

2. Materials and Research Methods

This research is a descriptive correlational survey method with measurement tests. The aims of this study were to find whether there is a relationship, and if there is a relationship, how close the relationship is and how meaningful the relationship is. This research is said to be a correlational category because looking for data whether there is a relationship between one variable with another variable, and if there is a relationship, then look for how far the relationship is with survey data collection using the measurement test method.

2.1. Operational Definitions of Research Variables

The dependent variable (Y) in this study is the ability to service jumping. Jumping service is the ability to hit the ball, which in this study was done by jumping (jump header) that is jumping up to hit the ball. Test was given the opportunity to serve three times. Value is the fall of the ball at the point of attack that has been given a previous score. Independent variables (X) in this study included leg power (X1), arm power (X2), abdominal strength (X3), and back muscle strength (X4).

Explosive Leg power

Power is defined as the speed at which work is performed and is a product of force and displacement. Developing muscle power then calls on several variables: Explosive force, displacement and time. Indeed, these three variables may be the very essence of what defines athletic performance. Leg power is the ability of leg muscles to direct energy to jump while performing maximum jumping service in a fast and precise time. Measurement of explosive leg muscle power with a vertical power jump test. Tests make the jump 3x as high as possible and should not start when jumping up. The measured result is the difference between the height of the jump and the height achieved by the unit of measurement cm.

Arm power

Arm power is the ability of the arm muscles to provide a flow of energy to generate thrust through swing when hitting the ball in the jumping service. Measurement using a medicine ball test, with the unit of measurement is the distance using the meter.

Abdominal muscle strength

Abdominal muscle strength is the ability of the abdominal muscles to make abdominal contractions to perform motion or support movement. Measurement of abdominal muscle strength is done with sit ups for 30 seconds. The assessment is the number of sit-ups with perfect movements that have been successfully tested for 30 seconds, with a unit of measurement that is the number of sit-ups that can be done.

Back muscle strength

Back muscle strength is the ability of the back muscles to provide resistance to the strength of the back muscles so that the service punch stays directed. Measurement using a back-up test for 30 seconds, with units of measurement that is the number of back-ups that can be done.

Development of the Strength

Comprehensive and well-planned volleyball training takes into account the development of all the required physicals qualities, and, among them, maximum strength and specific strength. Essential components of success, these two concepts must be worked on. Depending on the case, it will be either a separate work (indoor bodybuilding), or a development for an adapted outdoor practice: medicine ball, hurdles, plinths ... Strength training aims to give volleyers their greatest general physical possibilities, in order to put them in the best conditions to tackle or support specific training, and of course the competitive effort. Strength will be expressed in two ways in volleyball:

- hitting the ball (on smash and serve)
- jumps (smash and block)

The two strength development priorities will therefore focus on the upper body for the strike and on the legs for the jumps. The problem encountered at high level depends on the nature of the forces envisaged. These must be maximum throughout the match. However, this explosive force, which the volleyball player must have during a jump for example, must be able to be repeated significantly and this as close as possible to the maximum. These three aspects of strength (maximum strength, explosive and repetitive) must be worked on. The maximum strength sessions are made of exercises oriented towards a development of the constitutive factors (hypertrophy) or nervous (synchronization of the motor units).

Specific strength sessions are made of strength work coupled with the sporting activity itself. The explosiveness will be obtained by an adapted work of dynamic force.

Weight-Building Sessions

Each weight training session can have three modalities; they will be oriented:

- either towards maximum force,
- either towards the specific force,
- or towards general reinforcement for the purpose of prevention and protection of the volleyball player.

Upper Body: I made a choice on the main exercises for the upper body and I considered the following 3 exercises as the most interesting: - the pulls - the bench presses - the pullovers. The pulls are a balancing exercise for the upper body, because they mainly work on the antagonists of the muscles of the strike. Bench presses are the essential movement for strengthening the arms and shoulder girdle (mainly the pecs and triceps). Pullovers are great for typing.

Lower Body: For the lower body, the main exercises in weight training sessions are the ½ squat, side lunge and calves. The work of the ½ squat and the calves corresponds perfectly to the work of the muscles of the jump. Lunge work is more Liberal specific for all defense and reception work. It is, in my opinion, important to also work the abductors and adductors favoring lateral movements.

2.2. Population and Research Samples

The population in this study were all athletes in the volleyball club in Bantul Regency. The sampling technique in this study was purposive sampling, which is a sampling technique using certain criteria. The criteria for this research sample are as follows: (1) The volleyball club that actively participates in regional and national level competitions; (2) Has more than 20 members; (3) Apply the same type of exercise; (4) The trainer applies a jumping service exercise; (5) Players in the club usually do the jumping service in the match (seen from direct researcher's observation). The sample in this study amounted to 42 people.

2.3. Data Collection Instruments and Techniques

The research instrument is a tool used to measure natural or social phenomena encountered. The instruments in this study were as follows: (1) Vertical jump test to measure leg muscle power; (2) Medicine Ball test as a tool to measure arm power; (3) Sit ups to measure abdominal muscles; (4) Back up test to measure the strength of back muscles; (5) Rusell-Lange Volleyball Test to measure jumping service capabilities.

2.4. Data Collection Technique

Data collection techniques are a method used by researchers to collect data. This study uses a survey method with test and measurement techniques. Survey is a research approach that is generally used for broad and extensive data collection test is a series of questions or exercises and other tools used to measure the skills, intelligence knowledge, abilities or talents of individuals or groups.

Measurement of leg muscle power with a vertical power jump test. The use of vertical jump tests to measure leg muscle power because this test has been widely used by various studies both at national and international levels as a tool to measure arm muscle power. This instrument has also been tested for validity with a test validity value of 0.923 with a reliability value of 0.960 so that it is declared eligible for research data collection. The steps to carry out the vertical power jump test are as follows (Reiman and Manske, 2009, p.151): (1) standing test sideways toward the wall, legs closed, feet fully pressed to the floor; (2) One testicle hand that is close to the wall reaches up as high as possible, feet still attached to the floor. Record high achievement; (3) jump up test as high as possible and touch the board. Record the height of the jump; (4) Done 3 times; (5) The evaluation is the difference between the height of the jump and the height of the achievement. The value used is the best result with the unit of measurement cm.

Measuring the strength of the arm's power is done using the Medicine Ball test. The selection of the Medicine Ball test as a tool to measure arm power refers to Reiman and Manske (2009, p.131) which explains that the Medicine Ball test can be used to measure arm power. It is also strengthened by the validity of this test which has a test validity value of 0.744 with a reliability value of 0.827. The steps for implementing the Medicine Ball test are as follows (Reiman and Manske, 2009, p.131): (1) The equipment used is a rope, chair, measuring device and a ball; (2) Testi sitting in a chair in an upright position; (3) Testi holds the ball with both hands in front of the chest and under the chin. (4) The rope is placed on the chest of the testicle and held by the partner behind the testicle to avoid movement when the testicle pushes the ball; (5) The ball is pushed with full power to reach maximum distance; (6) The test is carried out 3 times; (7) Rating is the farthest distance from 3 times the ball is thrown, measured from the chair to the point where the ball falls.

Measurement of abdominal muscle strength is done by using a sit-up test. The use of sit ups to measure abdominal muscles is based on the opinion of experts namely Ismaryati (2009, p.119) which explains the strength of the abdominal muscles can be tested using sit ups. This test has also been widely used in various studies and scientific studies by previous researchers. This test has also been declared valid with a test validity of 0.933 with a reliability value of 0.963. The steps in taking data using sit-up tests are as follows (Ismaryati, 2009, p.119): (1) Testi perform sit-up tests; (2) The test is done repeatedly quickly without a break within 30 seconds; (3) The evaluation is the large number of sit-up movements that have been successfully tested for 30 seconds.

Measurement of back muscle strength is done by using the backup test. The selection of this test to measure the back-muscle strength in Reiman and Manske (2009, p.223) which mentions the use of back up tests to measure the strength of back muscles. This test has also been declared feasible based on the validity and reliability test which is obtained a test validity value of 0.968 with a reliability value of 0.984. The steps to measure back muscle strength using a backup test are as follows (Reiman and Manske, 2009, p.223): (1) perform test a backup test; (2) The test is done repeatedly quickly without a break within 30 seconds; (3) The evaluation is the large number of back up movements that have been successfully tested for 30 seconds.

Measurement of jumping service capabilities using the Rusell-Lange Volleyball Test. Use of this test to measure the ability of service jumping with the consideration that this test was developed by experts. According to Collins & Hodges (2001, p.288) this test has been widely used for research and training purposes. This test has been tested for validity with a validity test of 0.858 with a reliability value of 0.879. Steps for implementing the Rusell-Lange Volleyball Test. are as follows: (1) Test preparation to conduct the test by standing behind the restraining line; (2) serve jumping test services by aiming the ball at the target area that has been given a score; (3) Testes are given 3 opportunities to do jumping services; (4) The score recorded is the sum of the 3 service jumping scores.

2.5. Data Analysis Technique

Data analysis techniques used in this study are the normality test, linearity test, and multiple regression analysis. Normality test to determine whether the variables in the study have a normal distribution. The test used is the Kolmogorov Smirnov test. Linearity test is performed to determine the relationship between independent variables and dependent variables in the form of linear or not. Multiple regression analysis was used to test the contribution of leg power, arm power, abdominal muscle strength, back muscle strength to the ability to service jumping in volleyball.

3. Results

Normality Calculation

Normality calculation is done to test whether the analyzed data has a normal distribution of data or not. Calculation of data normality was performed using the Kolmogorov Smirnov test.

Table 1 shows the results of calculating the normality of leg power data obtained a KSZ value of 0.702 and a significance value of 0.708. In the arm power data, the KSZ value is 0.904 and the significance value is 0.388. The analysis results on the strength of the abdominal muscles obtained KSZ value of 0.642 with a significance value of 0.805. In the back-muscle strength data obtained KSZ value of 0.915 with a significance value of 0.373 and the jumping service data obtained the value of KSZ 1.168 with a significance value of 0.131. All pretest data obtained significance values greater than 0.05 (p> 0.05), it can be stated that the data of this study were normally distributed. This means that the distribution of research data meets the criteria for data normality curves as a condition of parametric statistical analysis

Table 1. Data Normality Test Results

Research variable	*Kolmogorof Smirnov Z*	Sig (*p*)	Decision
Leg Power	0,702	0,708	Normal
Arm Power	0,904	0,388	Normal
Stomach muscle power	0,642	0,805	Normal
Back muscle power	0,915	0,373	Normal
Service jumping	1,168	0,131	Normal

Linearity Calculation

Linearity test is used to test whether the relationship between each independent variable with the dependent variable has a linear relationship or not

Table 2. Linearity Test Results

Correlation	F count	Sig (*p*)	Decision
X1 → Y	0,708	0,769	Linier
X2 → Y	1,286	0,289	Linier
X3 → Y	1,965	0,066	Linier
X4 → Y	1,281	0,300	Linier

Table 2 shows that the linearity test results to test the relationship between leg power and service jumping obtained the calculated F value of 0.708 with a significance of 0.769. Linearity test results to test the relationship between arm power with service jumping obtained the calculated F value of 1.286 with a significance of 0.769. Linearity test results to test the relationship between abdominal muscle strength and service jumping obtained the calculated F value of 1.965 with a significance of 0.066. Linearity test results to test the relationship between back strength and service jumping obtained the calculated F value of 1.281 with a significance of 0.300.

The results of the linearity calculation of the relationship of X and Y variables obtained significance values greater than 0.05 (p> 0.05). Because the significance value is greater than 0.05 (p> 0.05), it can be stated that the relationship between variables X1, X2l, X3, and X4 with jumping service is linear.

Hypothesis test

Testing the research hypothesis is done by analyzing multiple regression or multiple linear regression.

Table 3. Results of Multiple Linear Regression Analysis

Variable	Regresion	r	t	Sig.
Leg Power	0,085	0,895	2,686	0,011
Arm Power	0,881	0,844	2,556	0,015
Stomach muscles strength	0,087	0,870	2,474	0,018
Back muscle strength	0,037	0,818	2,247	0,031
Constant	: -5,596			
Adjusted R^2	: 0,890			
F count	: 75,155			
Sig.	: 0,000			

Y = -5,596 +0,085 X1+0,881 X2 + 0,087 X3 + 0,037 X4 +e

T test (partially)

This t test is a test to show the effect of individual independent variables in the model on the dependent variable. If the significance value is less than 0.05 ($p < 0.05$), it can be concluded that the independent variable partially has a significant effect on the dependent variable. The first hypothesis proposed in this study reads "There is a contribution of leg power to the ability to service jumping in volleyball games". The results of the correlation analysis note the calculated r value of 0.895 with a significance value of 0,000. The results of the multiple regression statistical analysis on the t test of leg power variable obtained t value of 2.686 with a significance level of 0.011. Because the significance is less than 0.05 ($p < 0.05$), the hypothesis is accepted. This means that there is a significant contribution of leg power to the ability to service jumping in volleyball games.

The second hypothesis proposed in this study is "There is a contribution of arm power to the ability to service jumping in volleyball games". The results of the correlation analysis note the calculated r value of 0.844 with a significance value of 0,000. The results of the multiple regression statistical analysis on the arm power variable t test obtained t value of 2.556 with a significance level of 0.015. Because the significance is less than 0.05 ($p < 0.05$), the hypothesis is accepted. This means that there is a significant contribution of arm power to jumping service abilities in volleyball games. The third hypothesis of this study reads "There is a contribution of abdominal muscle strength to the ability to service jumping in volleyball games". The results of the correlation analysis note the value of r count is 0.870 with a significance value of 0.000. The results of the multiple regression statistical analysis on the t test for the variable abdominal muscle strength obtained t value of 2.474 with a significance level of 0.018. Because the significance is less than 0.05 ($p < 0.05$), the hypothesis is accepted. This means that there is a significant contribution of abdominal muscle strength to the ability to service jumping in volleyball games.

The fourth hypothesis in this study reads "There is a contribution of back muscle strength to the ability to service jumping in volleyball games". The results of the correlation analysis note the value of r count is 0.818 with a significance value of 0.000. The results of the multiple regression statistical analysis on the t test of the back-muscle strength variable obtained the value of t count 2,247 with a significance level of 0.031. Because the significance is less than 0.05 ($p < 0.05$), the hypothesis is accepted. This means that there is a significant contribution of back muscle strength to the ability to service jumping in volleyball games.

F test

The fifth hypothesis proposed in this study is "There is a contribution of leg power, arm power, abdominal strength and back muscle strength to the ability to service jumping in the game of volleyball". The F test was used to prove statistically that the entire research variable used in this analysis had a significant simultaneous effect. If the significance value of F is less than 0.05 ($p < 0.05$), the regression model is significant. The results of the analysis obtained a calculated F value of 75.155 with a significance of 0.000. Because the significance value is smaller than 0.05 ($p < 0.05$), the hypothesis is accepted. This means that there is an influence of leg power, arm power, abdominal strength and back muscle strength on the ability to service jumping in volleyball games.

Coefficient of Determination (R2)

The coefficient of determination is a tool to measure the percentage of the effect of the independent variable on the dependent variable. The magnitude of the coefficient of determination ranges from 0 to 1, the closer to zero the magnitude of the coefficient of determination of a regression equation, the smaller the effect of all independent variables on the dependent variable. Conversely the greater the coefficient of determination close to 1, the greater the effect of all independent variables on the dependent variable. The results of the analysis obtained the coefficient of determination (R2) of 0.890. These results indicate the contribution of leg power, arm power, abdominal strength and back muscle strength to the ability to service jumping in volleyball games by 89% while the remaining 11% is influenced by other factors not examined in this study.

Based on the calculation results it is known from the total contribution of 89%, leg power variable contributed 28.7%, arm power variable contributed 20.4%, stomach muscle strength contributed 23.2% and back muscle variable contributed 16.7%. It can be concluded that the variable that contributed the most was leg power.

4. Discussion

The results of statistical analysis prove there is a significant contribution of leg power to the ability to service jumping in volleyball games (p value = 0.011). This shows that leg power has an influence on the achievement of jumping service results. Leg power is an important element in jumping service. The leg power has a contribution to the ability to service jumping can be explained because the leg power is to make players able to jump when doing jumping services. Jumping or jumping is one of the most important movement components when doing jumping services. The existence of leg power gives the strength in the form of explosive power from the legs which will make the player able to jump as high as possible to reach the ball position. Leg power is also the beginning of the service movement. Leg power is the foundation of the movements of the other limbs during service. Strong leg power makes the foundation of the movement stronger and provides power when jumping. This supports the success of jumping service.

A jump during service jumping can be done if you get strong repulsion and speed obtained from leg power. Leg power provides strong repulsion with vertical speed so it is able to make high jumps and is able to reach the ball followed by ball service moves. Leg power is the ability of a group of muscles contained in a limb that functions to exert power during jumping in service jumping. Leap can be done because it gets a strong repulsion. The power to repel is obtained from leg power. Leg power functions as a booster boost force when performing repulsion to gain vertical speed to grab the ball in the air and over the net. The greater the force of thrust from the legs, the higher the jump and reach in the air to reach the ball that has been bolted so that a volleyball player will be able to do a good jumping service. The role of leg power to the jumping service is to apply pressure and sharpness to the shot made by jumping so that it can reach the highest ball position. Leg power that starts from the whole service movement, so that it becomes the foundation for the movement of other limbs [13]. Leg power influences the jump as a result of leg impulse. Athletes who have good leg power will be able to jump higher, and are more stable when in the air. Strong leg power will produce a hard and strong jumping service. The leg power has an influence on the jump as a result of the leg push needed when making the jump as much as possible to reach the ball in the air and over the net.

The results of the analysis of research data prove that there is a contribution of arm power to the ability to service jumping in volleyball games (p value = 0.015). This can be interpreted as the power of the arm contributes significantly to the ability to service jumping in volleyball games by 20.4%. The arm power contributes to jumping service can be explained because arm power provides a power boost to the ball being hit. The power in the ball, the ball flow will be harder so that it can reach the target precisely. Arm power also makes the ball go fast so the ball can aim at the target [14].

Arm power provides impetus and swing power when hitting the ball. Arm power serves to provide power when making a ball hit which is flowed through the arm swing. A volleyball player will have good arm power, the greater the power given by the arm, the harder and stronger the blow given by the arm, the harder and stronger the blow given to the volleyball will produce a harder and more precise jumping service.

Power will affect an activity that requires explosive motion. The combination of strength and speed plays an important role in most sports skills. Arm power is an important factor in service jumping. Arm power will put pressure on the ball that is hit with a ball flow harder and faster, so it will be difficult to return. Arm power in service jumping has the role of producing stronger, faster and sharper service. Supported by swinging the arm inward at high speed will produce a whack during the imposition of the ball [15]

Arm power that is produced from swinging the arm inward will produce a boost in the form of force boost when the hand is in contact with the ball. Arm power will exert maximum strength with a short time. This will result in a stronger, faster and sharper service. The stronger the power of the arm, the stronger the power impulse that is channeled to the ball. The resulting service also becomes stronger and more directional. The greater the power given by the arm, the harder and stronger the blow given by the arm, the harder and stronger the blow given to the volleyball, so that it will produce jumping services that are getting harder and more precise [16]. The results of the analysis prove statistically there is a contribution of abdominal muscle strength to the ability to service jumping in volleyball games (p value = 0.018). These results prove that abdominal muscle strength plays a role in the ability to service jumping in volleyball games.

The abdominal muscles have a positive impact to the jumping service which can be explained by the strength produced by the abdominal muscles which put pressure on the ball being hit. The presence of abdominal muscle strength resulting from the ball service becomes harder, faster and sharper. Abdominal muscles also provide endurance that causes the service punch to be directed. Muscle strength is the amount of energy that can be expended by someone. The energy in question is the result of contraction of a muscle or group of muscles while receiving a load, both from outside and inside. The role of the abdominal muscle strength to serve is a strong abdominal muscle will put pressure on the ball that is hit so that the speed of the service ball becomes hard, fast and sharp. Strong abdominal muscles will provide endurance to remain stable when in the air so that the service ball blows are directed and targeted.

The role of the abdominal muscle strength to serve is a strong abdominal muscle will put pressure on the ball that is hit so that the speed of the service ball becomes hard, fast and sharp. Strong abdominal muscles will provide resistance to the strength of the abdominal muscles so that the service stroke remains directed [17]

Abdominal muscles are one important component in performing jumping services. When doing the jump, the abdominal muscles support the player's body to remain stable. Abdominal muscles also provide energy flow both when in the air and when hitting the ball. The better the strength of the abdominal muscles, the better the flow of energy provided and the better the jumping service produced. Supported by the opinion mentions the role of abdominal muscle strength in service, ie strong abdominal muscles will put pressure on the ball that is hit so that the rate of the service ball becomes hard, fast and sharp. Strong abdominal muscles will provide resistance to the strength of the abdominal muscles so that the service stroke remains directed [16].

The results of the analysis of the research data showed there was a contribution to the strength of the back muscle jumping service ability in the game of volleyball (p value = 0.031). These results can be interpreted that the strength of the back muscles has an influence on the ability to service jumping. Back muscles are faced by service jumping which is to supply energy when servicing. Energy from the back muscles will produce movement and tension which gives the effect of pounding when making a punch. The energy supply will produce jumping service with a fast and strong ball flow. Back muscles are an important component in the attitude and movement of the spine. Back muscles increase the ability to move involving the muscles of the back of the body. Back muscles also have an important role in upper body motion. The strength of the back muscles is needed when performing jumping services to deliver energy supply to the upper body. The large energy flow that results from the strength of the back muscles gives the beat when making a punch. The function of the back muscles is the same as the abdominal muscles, namely as a support and enforcement of the body so that the position remains stable when in the air. A stable body position supported by a strong flow of energy to hit the ball will produce a hard and right on-target service jump. The stronger the strength of the back muscles, the greater the supply of energy given to the upper body. Energy will also be channeled through the arm which directly hits the ball. A large supply of energy to the arm will produce power to service.

The strength of the back muscles is needed when performing jumping services to deliver energy supply to the upper body. The large energy flow that results from the strength of the back muscles gives the beat when making a punch. Energy will be channeled to the arm which is continued to hit the ball resulting in a hard-jumping service stroke [18]

When doing jumping service, it requires coordination of jumps and hard swings when floating in the air. This can only be done if the upper body is able to sustain upper body movements properly, as well as supplying energy to the ball being hit. The jumping service requires energy, one of which comes from the strength of the back muscles to produce movement, tension, and lateral so as to give a beat to a blow. The higher the level of back muscle strength, the more energy supplied upwards will produce strength in the arms to serve [19].

The results of the analysis of the research data found that there was a contribution of leg power, arm power, abdominal strength and back muscle strength to the ability to service jumping in volleyball games (p = 0,000). This can be interpreted that leg power, arm power, abdominal strength and back muscle strength contribute simultaneously to the ability to service jumping in volleyball games by 89% while the remaining 11% is influenced by other factors not examined in this study. The variable that most influences the ability to service jumping in volleyball is the leg power variable contributing 28.7%.

The results of this study have the implication that to perform jumping services requires physical abilities that support the attitude and gestures including leg power, arm power, abdominal strength and back muscle strength. Players who have the ability in the physical component will be able to service jumping properly. The good service skills require good physical conditions. Physical condition and physical preparation can be one of the prerequisites that are very necessary in an effort to improve the achievement of an athlete.

5. Conclusions

There is a contribution of leg power to the ability to service jumping in volleyball games (p value = 0.011) of 28.7%. There is a contribution of arm power to the ability to service jumping in volleyball games (p value = 0.015) of 20.4%. There was a contribution of abdominal muscle strength to the ability to service jumping in volleyball games (p value = 0.018)) of 23.2%. There is a contribution of back muscle strength to the ability to service jumping in volleyball games (p value = 0.031)) of 16.7%. There is a contribution of leg power, arm power, abdominal strength and back muscle strength to the ability to service jumping in volleyball games (p value = 0,000). The amount of contribution of leg power, arm power, abdominal strength and back muscle strength to the ability to service jumping in volleyball games is 89%.

For coaches: maximize training programs to perfect jumping service capabilities by increasing leg power, arm power, abdominal strength and back muscle strength in players. For players: improving physical abilities including leg power, arm power, abdominal strength and back muscle strength to support the ability to service jumping through active training in accordance with the direction of the trainer. For further researchers: use the appropriate measurement instruments in accordance with the research variables in order to obtain accurate measurement results data

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The Formation of Human Movement and Sports Skills in Processing Sports-pedagogical and Biomedical Data in Masters of Sports

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Abstract Purpose: The urgent task of higher education is the formation of skills of processing sports-pedagogical and biomedical data in masters of physical education and sports. Recently, sufficient attention to the question of verifying the subordination of empirical data to the normal distribution law in biomedical and sports pedagogical studies was not paid. The purpose of the article is to increase the level of theoretical knowledge and practical skills in statistical data processing in masters of physical education and sports by the example of testing the hypothesis about the normal law of distribution of observed values. Methodology: Methods used at studying process are studying, analysis, systematization of scientific and special literature, generalization of scientific, educational and practical experience, pedagogical experiment. Findings: Methodological techniques that ensure the improvement of the quality of mathematics and statistical training of masters in physical education and sports have been highlighted. The use of professionally directed tasks, the presentation of a step-by-step algorithm for solving them along with the automation of computational procedures creates the conditions for the effective assimilation of educational material. There is the scheme of a practical class on the formation of skills to assess the normality of the empirical distribution. Contribution and Recommendation: Mathematical statistics is a powerful tool for studying patterns, and the use of statistical methods in sports-pedagogical and biomedical research ensures the development of sports sciences. It proves the versatility of proposed methods.

Thus, this research contributes to all elements, both sports and education.

Keywords Management, Process, Research, Statistics, Analysis, Form, Curve, Normality, Distribution

1. Introduction

Modern sports-pedagogical and biomedical research involves the processing of significant amounts of data in order to identify causal relationships and patterns and obtain reliable conclusions. A highly qualified specialist is distinguished by the ability to highlight those factors that have the greatest influence on the result of his activity, as well as the ability to analyze the consequences of such influences to determine the optimal strategy for his activity [1-2].

Thus, in the process of training masters of physical education and sports, it should be pointed that they must have not only the skills of pedagogical control over the state of physical development, the level of development of physical abilities, the degree of mastering of sports equipment, etc. [3-5], but also be able to correctly process and interpret obtained data in the course of professional activity [6].

At the same time, for future specialists in the social and humanitarian sciences, the application of statistical methods is often an extremely complicated and overwhelming task, and the processing of the results of their experimental activities often remains at an unsatisfactory level [7]. Since the automation of calculations greatly simplifies the perception of students of educational material and opens up great opportunities for the application of statistical methods without taking into account the level of mathematical preparation of students [8], the methodology for developing masters of physical education and sports in the processing of sports-pedagogical and biomedical data should be based on minimization of theoretical materials and application of information technology.

Currently, scientists are paying attention to the formation of the ability of future specialists in physical education and sports to act effectively and professionally under conditions of significant influence of random factors. So, ways to solve the problems of using the methods of mathematical statistics in sports and educational studies of masters of physical education and sports are highlighted [9], an algorithm for analyzing personal data in sports and pedagogical studies is presented [10], a methodology for preparing students of higher education in physical education institutions to apply the method of expert assessments is proposed [11].

However, many issues related to the mathematical and statistical training of highly qualified specialists in the field of physical education and sports still remain unresolved. In particular, the problem of improving the methodology for their preparation for data analysis continues to be relevant and requires further research in this direction.

The purpose of the article – to increase the level of theoretical knowledge and practical skills in statistical data processing in masters of physical education and sports by the example of testing the hypothesis of the normal law of distribution of observed values.

Research tasks

To prove necessity of increasing the level of mathematical and statistical training at analysis and processing of sport and pedagogical, medical and biological data for masters of physical education and sport.

To stress methods that help to form masters' skills of processing sport and pedagogical, medical and biological data.

To make model of practical class about forming skills of normality of empirical distribution and check effectiveness of proposed methods during masters learning process.

In the process of generalization practical experience, we proposed the following *hypotheses*: if, during the formation of skills of evaluation disnormality we use created method, we will get increasing the effectiveness of control process of mathematical and statistic training among the masters of physical education and sport. In this case, the level of their learning mathematical and statistical disciplines and readiness to use received knowledge will raise. In addition, we will get increasing level of skills to analyze the results of researches. This method involves avoiding the details of mathematical and statistical evidence, highlighting a number of criteria and available methods for estimating the form of distribution of variables using IT and presenting a clear algorithm for the implementation of calculations in MS Excel

2. Material and methods

Research methods:

- empirical: questionnaire, pedagogical experiment. Pedagogical experiment continued during the year. At constant stage, we used questionnaire, where students had to evaluate the level of their motivation to learning of mathematical and statistical disciplines and readiness to use mathematical and statistical methods of data processing for results of their own researches. As a result of questionnaire, we found out that masters of physical education and sport have decreased motivation and are not ready to do analysis of research data individually.

The formative experiment was used to determine the effectiveness of the proposed approach to the formation of skills of analysis and processing of sports-pedagogical and medical-biological data in masters of physical education and sports. Masters were divided into 2 groups. Control group (CG) included 34 people; experimental group (EG) had 33. Masters of CG studied discipline "Analysis and processing of scientific researches in watering kinds of sport/track and field using informational communication technologies" in traditional way, masters of EG did practical tasks that were made according to the proposed scheme. At the same time, this method was used in the process of training at other higher establishments and other specialties. After learning discipline, according to the results of stage control, we checked the level of students' skills and did repeated questionnaire.

- methods of statistical of data processing: frequency analysis, we did comparing of particles using Fisher's test, that depends on realization conditions of using ratio test. Empirical processing data was handled at computer program MS Excel.

3. Results

It is known that the use of a large number of statistical methods suggests that the data to be processed are distributed normally. Indeed, often empirical data do not deviate from the normal distribution law (otherwise, the Gauss law) in the analysis of sports-pedagogical and biomedical information, when the average values of the studied indicators dominate in the distribution, and extreme values are quite rare. The main feature that distinguishes the normal distribution law among others is that it is a limiting law, which other distribution laws approach if they are widespread [12]. It is proved that the sum of a sufficiently large number of independent quantities subject to arbitrary distribution laws is approximately distributed according to the normal law, and this condition is fulfilled the more precisely the more variables are added.

Any statistical analysis of data should begin by testing the statistical hypothesis that the empirical data is subject to the normal distribution law. However, the question of checking data for the degree of deviation from the normal distribution law often remains unattended by specialists in sports pedagogical and biomedical research [13]. It indicates the need to find ways to improve the quality of mathematical and statistical training of future physical education specialists and Sports while studying in the higher educational establishments.

A characteristic feature of the process formation skills for assessing the normality of the empirical distribution masters of physical education and sports is the minimization of theoretical exposition regarding the mathematical basis for assessing the form of distribution of indicators, which are widely represented in the scientific literature [14-17]. But they are often inaccessible without appropriate mathematical or technical training. Pedagogical experience shows that a detail learning of the theoretical material about the parameters of the normal distribution, their properties and the detailing of mathematical and statistical statements may cause students' reluctance to further study of the theme. On the other hand, the use of professionally directed tasks and the presentation of a step-by-step algorithm for solving them along with the automation of computational procedures creates the conditions for the effective mastering of educational material and thereby ensures the improvement of the quality of mathematics and statistical training in masters of physical education and sports.

As a result of the systematization of special and scientific and methodological literature [18-19] and the generalization of our own pedagogical experience, we proposed a practical class for the formation skills to test hypotheses about the normal law of distribution of observed values for masters of physical education and sports (Fig. 1).

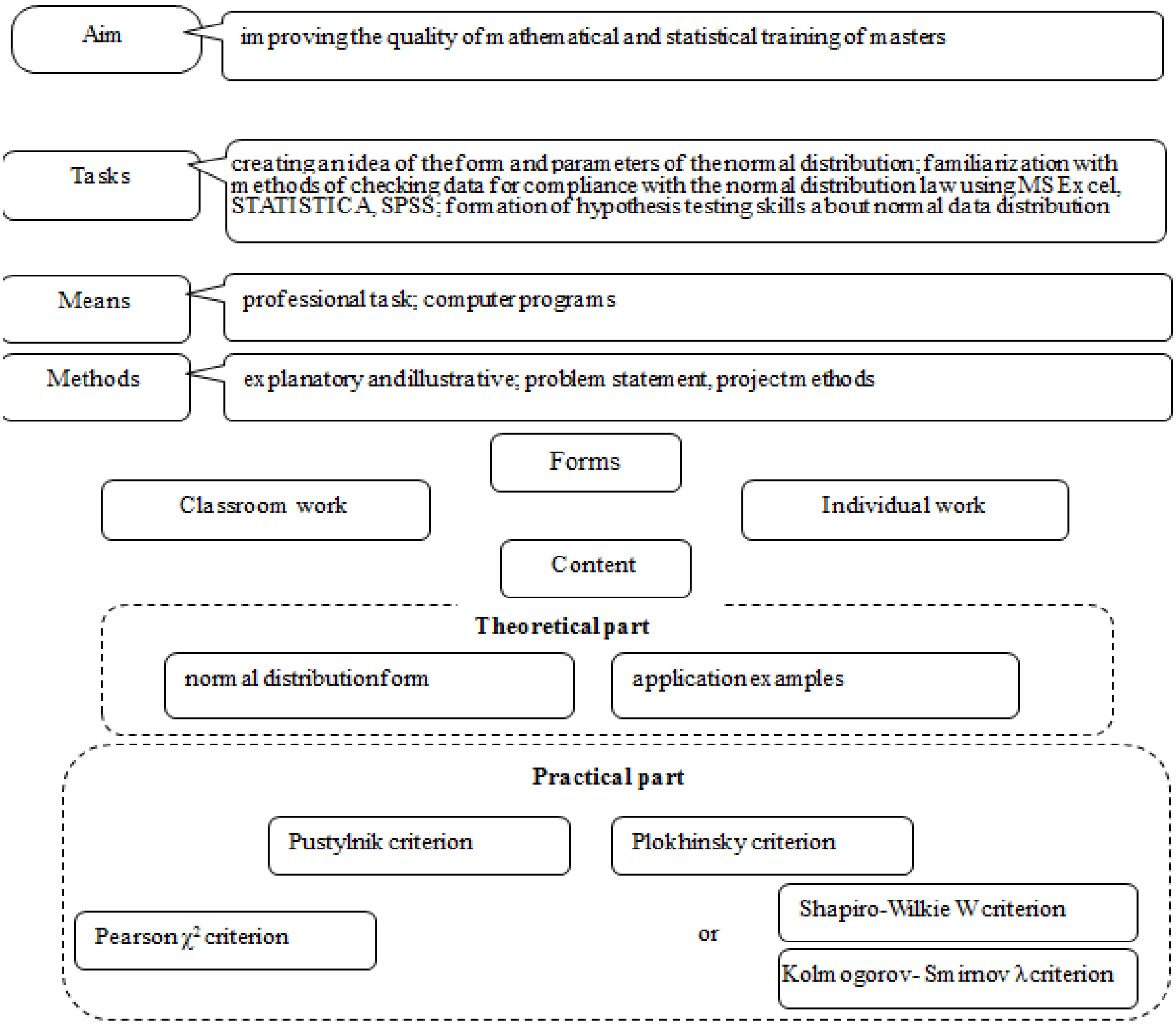

Figure 1. Scheme of a practical class of the formation skills for assessing the normality of empirical distribution

We give an example of the application of the selected teaching methods in the course of the classroom work of the masters of physical education and sports on the topic "Testing of statistical hypotheses. The normal law of distribution" in the course "Analysis and processing of scientific researches in watering kinds of sport/track and field using informational communication technologies".

First of all, we focus students that choosing a particular statistical criterion depends on the nature of the distribution and the processing of experimental data should always begin with an assessment of the nature of their distribution. We also inform that the variation in the homogeneous group is characterized by a normal curve, and if you visualize the density curve of the normal distribution, then it has a symmetrical hill shape.

We point that there are specific methods, which are used to check the normality of the distribution (Pustylnik and N.A. Plokhinsky criteria), and universal methods that are used to solve other statistical problems (Pearson χ^2, Shapiro-Wilkie W, Kolmogorov- Smirnov λ criteria).

Propose to do task. Establish empirical data subject to the normal law of distribution.

Given: information on the results of the assessment of mental performance by the total number of scanned marks of 19 students.

Decision. We enter the data into the MS Excel table and use the COUNT () function to calculate the sample size.

We introduce a custom formula using formulas that give an approximate estimate of the distribution form. When entering the formula, we rely on the presented algorithm (Fig. 2).

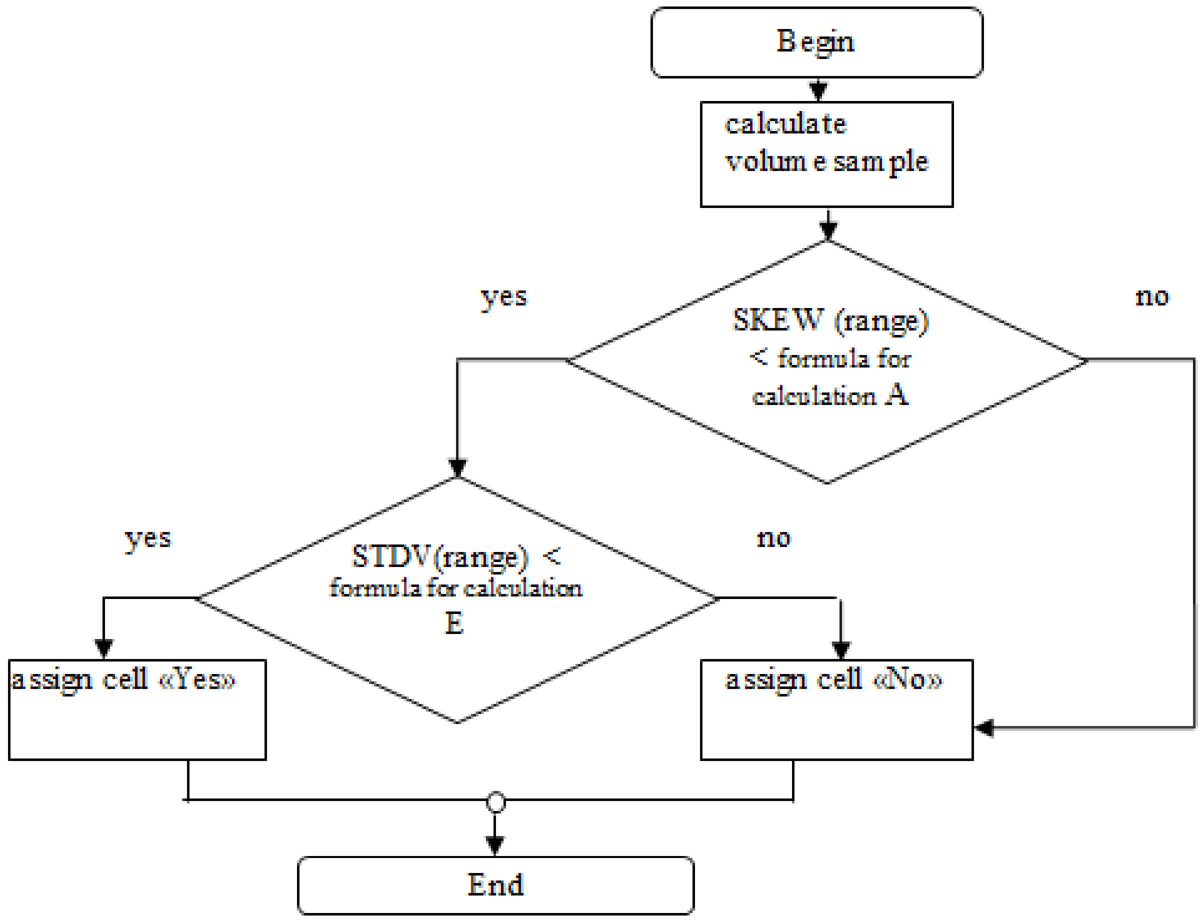

Figure 2. Algorithm of inputing formula for approximate estimation of normality distribution

As a result, we received an answer to the posed question: the first sample, "The sum of the considered characters" is subject to the normal distribution law.

We suggest students to check the normality of the distribution of the source data using the Plohinsky criterion and compare the results.

In the second part of the practical class, we evaluate the normality of the distribution by the Pearson criterion χ^2. We emphasize that this criterion is the most powerful criterion. It is used for comparing two or more distributions and applicable to both numerical and nominative data [20]. We formulate the statistical hypothesis H_0: "The distribution under study does not differ from the normal one."

We present an algorithm for evaluating the normality of an empirical distribution by the Pearson χ^2 criterion:

I. Enter the source data in the MS Excel table and organize them in a convenient form.
II. Using the standard function AVERAGE () we find the average value of the sampled data.
III. Using the standard function STDEV () we find the standard deviation.
IV. Using the Histogram of the Data Analysis add-in procedure, we find the frequencies of the interval series.

Note! If you do not specify the boundaries of the interval, the program automatically calculates the step of the interval series k.

V. Using the NORMDIST () function, we find the value of the theoretical frequency $n\ p_i$ of the hit of the sample elements in the *i-th* grouping interval for the accepted hypothesis about the normal distribution of the population, where p_i is the theoretical probability of the hit of the sample elements to the interval, and it is calculated by the formula

$$p_i = P(x_{i-1} < X < x_i) = F(x_i) - F(x_{i-1}), \quad (3)$$

there is a difference between the values of the considered and preliminary values of theoretical normalized values

Note! The formulas for calculating the theoretical probability of falling of the first and last values in a given interval have the form

$$p_i = P(-\infty < X < x_1) = F(x_i), \quad (4)$$

$$p_i = P(x_{i-1} < X < +\infty) = 1 - F(x_{i-1}) \quad (5)$$

VI. We find the theoretical frequencies by the formula, multiplying each value of the theoretical probability by the sample size.

Note! The sum of all theoretical frequencies is 1.

VII. We calculate the Pearson criterion χ^2 by the formula

$$\chi^2_{\text{розр}} = \frac{\sum_{i=1}^{n}(m_i - \text{np}_i)^2}{\sum_{i=1}^{n}\text{np}_i} \tag{6}$$

where m_i – frequency.

VIII. Using the CHIINV (), we calculate the critical value of the χ^2 criterion for a given significance level α = 0.05 and the number of degrees of freedom df, where

IX. df = number of private intervals-1 number of parameters.

X. Compare the critical and calculated values of χ^2. If the calculated value is more than the critical value, then the hypothesis that the general population submitted to the normal distribution law is rejected.

Objective: To establish empirical data based on the sum of scanned characters of 106 students that obey the normal distribution law.

Decision. We will enter the data into the MS Excel table and with the help of the AVERAGE () and STDEV () functions.

To automate the process of dividing data into intervals, run the Histogram of the Data Analysis add-in. To do this, in the window, make links to the column "Sum of considered characters", and also use the Output interval switch, set the place for the results of the performed operations, and also set the histogram output. After entering the initial data, we obtain the interval series and its visual representation. The table in the "Pocket" column (the studied value *x*) contains the boundaries of the intervals, and in the "Frequency" column the frequency of the random value falling into the corresponding interval.

We construct a series containing theoretical frequencies. To do this, we find p_i, as well as the theoretical (expected) frequency.

Make column «p_i» and write down formula NORMDIST (x_i) - NORMDIST (x_{i-1}) into first cell. Set value x for function argument (in our case it is sum of reviewed characters, average and standard deviation s.

For first cell formula is

$$p_1 = \text{P}(-\infty < X < 538) \\ = NORMDIST(538; 827{,}48; 138{,}8; 1)$$

For next ones –

$$p_2 = \text{P}(538 < X < 592{,}6) = \\ NORMDIST(592{,}6; 827{,}48; 138{,}8; 1) - \\ NORMDIST(538; 827{,}48; 138{,}8; 1) \text{ and so on.}$$

After entering the formula in another cell, we will autocomplete it. Accordingly, the last cell will have the form

$$p_5 = \text{P}(1029.4 < X < +\infty) = 1 - P(-\infty < X < 1029.4) \\ = 1 - NORMDIST(1029.4; 827{,}48; 138{,}8; 1)$$

Since in this case the frequency of the first "pocket" is small (equal to 2), we combine the first and second intervals and the corresponding theoretical frequencies.

We form a column for calculating the Pearson criterion and enter the appropriate formula and perform auto-completion (Fig. 3).

Using the SUMM () function, we find that the Pearson matching criterion χ^2 is 22.14, and using the CHIINV () function, we calculate that its critical value that is 14.07.

Comparing the calculated critical value of the χ^2 criterion, we state that the calculated value is more than critical. Thus, the hypothesis that the general population obeys the normal distribution law is rejected.

An independent study is carried out to check the statistical hypothesis of the normality of the distribution by the Kolmogorov-Smirnov or Shapiro-Wilkie criteria of depending on the sample size and comparing the results according to the Pearson criterion. At the end of the class, students get marks according to the results of practical work.

№	Sum of considered characters	Pocket	Frequency	p_i	np_i	Frequency	np_i	$(np_i-m)^2/np_i$
1	838	538	2	0,01851	1,962044			
2	643	592,6	4	0,026796	2,840325	6	4,802369	=(I3-J3)^2/J3
3	583	647,2	10	0,051697	5,47988	10	5,47988	3,728453716
4	709	701,8	4	0,085608	9,074475	4	9,074475	2,837662126
103	980	756,4	13	0,12168	12,8981	13	12,8981	0,000804987
104	890	811	11	0,148451	15,7358	11	15,7358	1,425273327
105	953	865,6	21	0,155456	16,47833	21	16,47833	1,240751679
106	1064	920,2	16	0,139731	14,81151	16	14,81151	0,09536567
average	827,48113	974,8	4	0,107805	11,42736	4	11,42736	4,827509531
standard deviation	138,803474	1029,4	15	0,071391	7,567451	15	7,567451	7,300052214
		Еще	6	0,072875	7,72472	6	7,72472	0,385083029

Figure 3. An example of solving Pearson criterion χ^2 in program MS Excel

The practical class contains a brief theoretical part, and the main part is aimed at mastering the practical skills of processing and analysis of sports-pedagogical and medical-biological data using specific and universal criteria using various computer programs.

As result of implementation this approach to the process of management mathematics and statistical students training of masters in physical education and sports, we got that 18% masters of experimental group (EG) have high and 53% - good level. At the same time 3% of students of the control group (CG) showed high level of knowledge, 19% of students from control group have good level knowledge. It should be noted that at the end of the experiment, particle of students from experimental group with sufficient level is more statistically significant than it is in control group ($p<0,05$).

Particle of students from experimental group with high and good level of motivation to learning mathematics and statistics knowledge among masters of the experimental group became more statistically significant than it is in control group ($p<0,05$).

Besides, research showed, among masters of experimental group the level of readiness to apply mathematics and statistics methods in the process of preparing master project are more statistically significant ($p<0,05$).

Received results prove the effectiveness of the proposed approaches to management of the process mathematics and statistical students training of masters in physical education and sports.

4. Discussion

During the pedagogical and scientific activities of various kinds of specialists, questions arise related to the statistical processing of data. Experts agree that only a sufficient level of mathematical and statistical literacy can solve research problems [21-22].

At the same time, masters of physical education and sports often experience difficulties in mastering statistical methods of data processing. This indicates the need to apply innovative teaching methods aimed at simplifying the process of perception of educational material from statistical data analysis.

The normal distribution law has a wide range of applications in the field of sports-pedagogical and biomedical research and among other laws it occupies a special position, we believe that in the process of mathematical and statistical training of masters in physical education and sports, we should dwell on the problem of expanding theoretical knowledge and the formation of practical skills and abilities to assess the degree of deviation of the data obtained during the experiment from the normal distribution law.

V.V. Pavlova [21] points to the low quality of training of future humanitarian researchers for the use of mathematical statistics, states that the effectiveness of the learning process increases provided that the priority of pedagogical support and student support on the path to the introduction of mathematical and statistical literacy, the phased introduction of educational material on probability theory and mathematical statistics in the content of education, as well as the integration of a competency-based approach into the organization system the educational process of the magistracy and graduate school.

In the process of searching for teaching methods that contribute to the generalization and systematization of students' knowledge in the study of mathematical statistics, after introducing the basic concepts of the theme A.O. Rozumenko [23] offers students a general guideline rule (algorithmic prescription), revealing the contents of a statistical test of statistical hypotheses, after processing of which emphasis is placed on differences in the choice of criterion. In addition, the author also points out the effectiveness of creating and using a table in which the methods of statistical verification of the considered parametric hypotheses are systematized.

Outlining ways to overcome the teaching problems of students understanding of mathematical and statistical processing of the results of psychological experiments, V.V. Gorbunova [24] drew attention to the desirability of using descriptive statistics and methods of statistical inference for quantitative analysis and verification of the significance of the results of their own experiments. According to the author, it is a combination of theoretical knowledge with the practice of planning and conducting their own experimental research that is an effective factor that motivates students to master mathematical and statistical knowledge.

Analyzing the experience of training future economists in Germany, N.V. Shulga [1] focuses on the effectiveness of teaching methods aimed at strengthening the practical component of the stochastic training of future economists and the visualization and computerization of the learning process.

Taking into account the advanced pedagogical experience, as well as on the basis of systematizing the results of our own pedagogical activity, we have proposed methodological methods for the formation of skills in analyzing sports-pedagogical and biomedical data of masters in physical education and sports. They are concentrating students' attention on the practical component of testing the hypothesis of subject observance given the normal distribution law without detailing of theoretical information. At the same time, the use of computer programs creates the conditions for overcoming the problems that may arise during complex calculations. This approach contributes to the creation of "success situations", which positively affects the motivation of masters to use statistical analysis in the course of their own experimental studies.

Approbation of these methodical techniques in the process of management mathematics and statistics students training of other specialties for courses “Informational systems in management” for bachelors and “Informational systems and technologies in management of organizations” for masters gave positive results. It proves the versatility of proposed methods.

Approbation of these methodical techniques in the process of management mathematics and statistics students training of other specialties for courses “Informational systems in management” for bachelors and “Informational systems and technologies in management of organizations” for masters gave positive results also. It proves the versatility of proposed methods.

5. Conclusions and Perspectives of Further Research

1. Mathematical statistics is a powerful tool for studying patterns, and the use of statistical methods in sports-pedagogical and biomedical research ensures the development of sports sciences. Thus, the urgent task of higher education is the formation of skills of processing sports-pedagogical and biomedical data in masters of physical education and sports.
2. Recently, sufficient attention to the question of verifying the subordination of empirical data to the normal distribution law in biomedical and sports pedagogical studies was not paid. However, neglecting the data indicated by the data processing stage inevitably leads not only to a decrease in the quality of data analysis, but also to a distortion of all the results and declared conclusions and forecasts. Evaluation of the distribution form is the first stage of high-quality data processing. Its neglecting negates all further stages of statistical analysis. So, the problem of increasing the level of mathematical and statistical training for masters of physical education and sport, including of the formation of their skills to establish normal distribution in the masters of physical education and sports remains unresolved.
3. In order to improve the quality of mathematical and statistical training of masters in physical education and sports during the formation of their theoretical knowledge and practical skills of processing and analysis of sports-pedagogical and medical-biological data, it is advisable to use specific methods. Among the most effective methods we can point the use of professionally-oriented tasks, introducing a step-by-step algorithm for solving them, as well as the automation of computational procedures.
4. A practical class has been developed as an example of the formation of skills for estimating the normality of the empirical distribution, which includes the goal, tasks, means, methods and forms, as well as its content. It should be noted that the practical class contains a brief theoretical part, and the main part is aimed at mastering the practical skills of processing and analysis of sports-pedagogical and medical-biological data using specific and universal criteria using various computer programs. The proposed method is based on a step-by-step algorithm for the implementation of calculations by IT.
5. Implementation of these methodical techniques in the process of management mathematics and statistics students training of masters in physical education and sports proved their effectiveness.
6. Implementation of these methodical techniques in the process of management mathematics and statistics students training of other specialties for courses “Informational systems in management” for bachelors and “Informational systems and technologies in management of organizations” for masters proved their effectiveness. It shows the versatility of proposed methods.

Further research is to design the universal technology of forming mathematical and statistical competence of masters.

Compliance with Ethical Standards

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed Consent Informed consent was obtained from all individual participants included in the study. All subjects of the institutional survey gave consent for anonymised data to be used for publication purposes.

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The Effectiveness of a Personalized Virtual Fitness Trainer in Teaching Physical Education by Applying the Artificial Intelligent Algorithm

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Abstract Inactivity has been the main cause of obesity which has affected many people worldwide. Studies show that fitness is an important goal for a healthy lifestyle and has been used as a measurement for health-related quality of life. A fitness trainer can motivate and teach users to do fitness activities. However, to use a human fitness trainer may involve high cost and is not suitable for a certain school setting. A personalized virtual fitness trainer has the potential to replace a human trainer whenever possible. It can help physical education teachers in schools to motivate students to exercise. This study discussed the design and development of an AI-based application coined as an Intelligent Virtual Fitness Trainer (IVFIT) as an attempt to provide a personalized physical learning experience for school students. This app is developed to (1) demonstrate five workout activities for 30 minutes; (2) teach the user three types of dances for 22 minutes, and (3) demonstrate five basic self-defense moves. These training scenarios were administered to a physical education class consisting of 23 students in which the recommendation of the fitness trainer is done using a calculation of artificial intelligence algorithms. The percentage of prediction error was calculated after each activity to measure the effectiveness of the app in giving recommendations. Subsequently, a teacher observation test was conducted to determine students' perceptions of the effectiveness of the proposed VFT application. Overall, students found the VFT application to be effective in stimulating higher levels of involvement in physical activity without teacher supervision. It can be concluded from the study that a personalized virtual trainer can assist in assigning a suitable virtual trainer for specific users and can be used for physical education activities.

Keywords Physical Education, Personalized Education, Training, Fitness, Personal Trainer, Trainers, Case-based Reasoning, Algorithm, Artificial Intelligence

1. Introduction

World Health Organization (WHO) has listed 10 threats to global health, which are: (i) Air pollution and climate change, (ii) Non-communicable diseases (NCD), (iii) Threat of a global influenza pandemic, (iv) Fragile and vulnerable settings, such as regions affected by drought and conflict, (v) Antimicrobial resistance, (vi) Ebola and high-threat pathogens, (vii) Weak primary care, (viii) Vaccine hesitancy, (ix) Dengue and (x) HIV [1]. The major risk factors of NCD are usually caused by tobacco use, physical inactivity, harmful use of alcohol, and unhealthy diets [2]. The NCD is the largest killer with an annual death estimation of 38 million worldwide and mainly occurs in the developing countries. [3].

People who have higher excessive weights will have a higher percentage to have a heart attack, diabetes, and other diseases. [4] reported that obesity contributed to two-third of the leading causes for fatal cases of non-communicable disease worldwide. With that, a lot of studies have been done to help humans in controlling obesity problems and find the most suitable solutions to reduce health-related issues caused by obesity. An individual excessive amount of weight can be reduced to the normal level by following The correct amount of physical activities [5]. Regular physical activities also can improve the quality of health and prevents chronic diseases [6].

Fitness is an important goal for a healthy lifestyle and has been used as a measurement of health-related quality of life [7]. School students are usually encouraged to work on their fitness to promote healthy weight loss behaviors. Teaching physical education at the school level may still not be enough to provide the required fitness-related information, especially on the type of exercises that students need to perform. One of the methods to introduce and teach fitness activities to the students is by using a fitness instructor or trainer [8]. A good fitness trainer program also can contribute to the effectiveness of physical education in the educational institution[9]. However, providing a quality personalized fitness experience for students is a challenging task. This is because a lot of information (e.g. activity level, body mass index [BMI], basal metabolic rates [BMR], medical conditions, and calorie intakes) needs to be analyzed to personalize the composition of the physical stimulus.

The process of providing a personalized trainer for every student requires time and money. Thus, the technology of artificial intelligence (AI) can be used to accelerate the process of personalization by calculating the most suitable fitness regime for the specific student's needs or preferences. This study objectively discussed the application of AI technology in providing a suitable recommendation of a virtual fitness trainer based on the user-submitted attributes.

2. Personalized Trainer

Nowadays, many health and fitness applications are being built to provide a more comprehensive virtual coaching or virtual trainer experience. However, some commercialized exercise games (combining exercise with gameplay) are not optimized for specific user groups and do not adequately consider the preferences or needs of every user [10]. Despite the availability of a great number of health and fitness applications on the market, the diversity of these applications is still limited. This is why VFT can be used to make physical training part of the school curriculum.

There are pieces of evidence in supporting the effectiveness of virtual trainers that have improved human fitness[11]. Virtual trainers that look like carton avatar, in general, have been openly accepted by the users. Several studies such as [12] and [13] have used intelligent virtual agents for fitness activities. Liang [14], for example, has used a VTF to teach Tai-chi app for the elderly, and Karkar [15] has developed a game-based aerobic VR trainer that gave points for the calories burned from the activities. VFT also can be used for other activities such as teaching CPR [16] and pregnancy exercise simulation [17].

Despite these efforts, there is still a lack of research on the personalization of physical movements that the virtual trainer displays following the user's demands. There is also a lack of evidence about the effectiveness of VFT in facilitating primary school students' learning of physical activities and skills. Nevertheless, most of the available personalized virtual trainers are used to input information from the user in terms of sensor data logging input [18], game-based design [19], as well as a step counter and muscle activities [7]. Typically, the use of wearable devices to personalize physical activities according to preferences is costly. This led fitness experts to suggest the use of several crucial pieces of information, such as the user's body mass and activity level for a fitness program to be effective [20]. Unfortunately, this information was not routinely collected when assigning the exercise to the user.

This study argues that a virtual fitness application can be improved by implementing personalized training programs where the physical activities are tailored to the specific user's needs. In particular, a detailed design of virtual trainers can facilitate the development process of a personalized fitness exercise program. In this case, we used an AI algorithm to calculate and personalize the VFT. A case-based reasoning (CBR) algorithm was used in developing the proposed VFT application mainly because it requires less computing time. The working process of this algorithm is based on how humans think, process information, and link previous experiences to provide effective solutions [21]. The idea of CBR comes from the way cognitive psychology research posits that humans rely on prior knowledge or experience to solve problems [22]. The main strength of the CBR algorithm is the ability to use the positive and negative results from the case database to improve the quality of the recommended solution. In this study, the CBR algorithm was applied to identify the most suitable VFT based on a set of reference cases stored in the database. The following section describes the design and development of the personalized VFT application.

3. The APP

A mobile application was developed and uploaded to the app store to achieve the objectives of this study. This app is an AI-based application coined as an Intelligent Virtual Fitness Trainer (IVFIT). The application consists of three parts: (1) obtaining and processing students' health information, (2) display of the personalized VFT, and (3) providing a list of trainers that the user can choose from. The users can select their virtual trainer through a personalized function that was designed to recommend the most suitable trainer based on the information provided by them. The feedback received from the user after performing the physical is recorded by the application to continuously improve the personalization of VFTs. Table 1 presents a list of movements performed by each trainer in the proposed VFT application. There were five main trainers used to stimulate students' learning of different movements. The types of training programs were specifically developed to take into consideration the different preferences of the user groups based on their BMI value. When the BMI value was increased, the performance demands of the task were increased. Fig. 1 shows one of the input pages for the information collection process from the users and Fig. 2 shows the VFT's provided by the app.

Table 1. The Trainers with Activity, Durations, and Bmi

Virtual Trainer and Names Given	Activity name	Duration (minutes)	BMI
Trainer 1 (Sharky)	Sharky workout dance	3.20	<15
Trainer 2 (Granny)	Granny salsa dancing	3.19	15.1-18.5
Trainer 3 (AJ)	Workout with AJ	3.13	18.5-24.9
Trainer 4 (Malcolm)	Combat movement for fitness	3.34	25-29.9
Trainer 5 (Scarlet)	Zombie fighting	3.29	>30

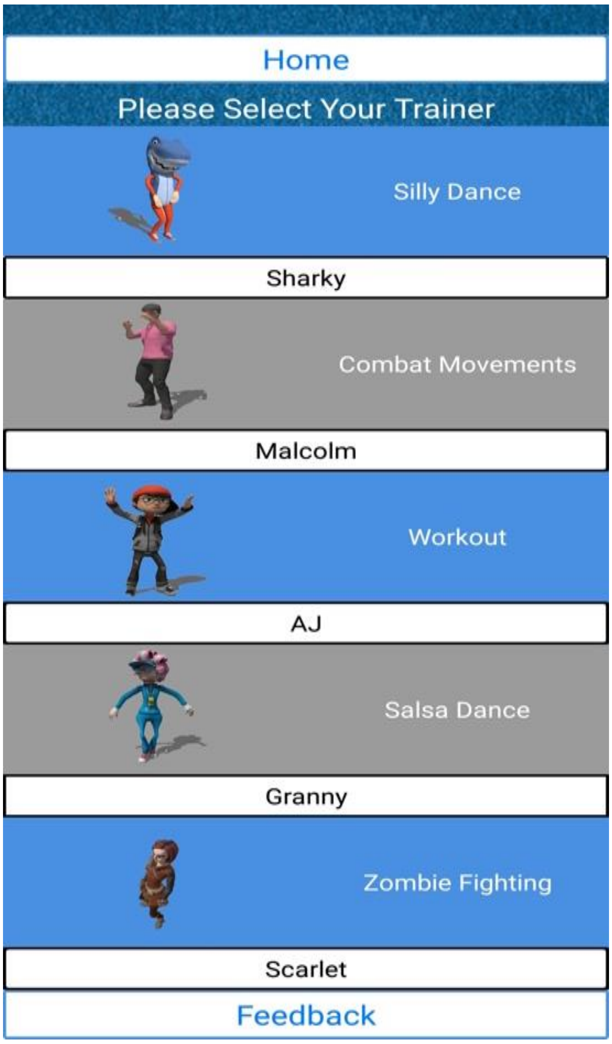

Figure 1. The information collection page

Figure 2. All the VFT trainers

3.1. The CBR Calculation

The process of problem-solving in CBR consists of retrieving similar cases based on the following: (1) retrieval of previous experiences with similar problem descriptions, (2) the reuse of solutions from the retrieved cases, (3) revision of the solutions, and (4) retaining the new solutions [23]. In general, the most crucial part of the CBR cycle is the retrieval process in which the correct cases are retrieved from a given database [24]. The effectiveness of the CBR was determined based on the usefulness of the retrieved cases [25]. Bejarano [26] stated that a successful retrieval process is achieved when the system retrieves cases that are similar to the problem descriptions. The characteristics of the retrieved cases must be relevant to the user's request. This process is guided by calculating the association of similar values between the new and previous cases [27]. The retrieval process works by determining how close the current case is to the predefined ones [28]. In this study, a set of references was obtained from ten sets of data that were used for calculation purposes.

The retrieval of the selected cases was achieved by calculating the local and global similarity values of cases [29]. Whenever a new case was submitted by the user, the application retrieved cases that closely matched the user's request. The process of recommending VFT was established during the 'reuse' process. The reuse process offers a way to retrieve solutions to the case ID identified during the 'retrieval' process [30]. The solution generated from this process is presented to the user through the user interface model [31]. The 'revision' process was established in this study when the suggested solution from the 'reuse' process was relevant to the user needs. If the provided solutions did not fit or meet the user needs, then the system used the feedback to refine and update the case's status and features in the database. The updated information was retained in the database for the next recommendation to be more accurate.

3.2. The Reference Database

The reference database was set up in this study based on the following attributes: (1) case ID, (2) weight, (3) height, (4) activity level, (5) gender, and (6) age. The personalization process of VFT from calculating the BMI value was suggested by fitness experts. The reference database consisted of 10 sets of data. The reference database was used to feed the CBR algorithm with information necessary for selecting the VFT based on the similarity calculation value discussed above. A case with the highest global similarity value was considered a reference case. Fig. 3 shows the architecture of the application.

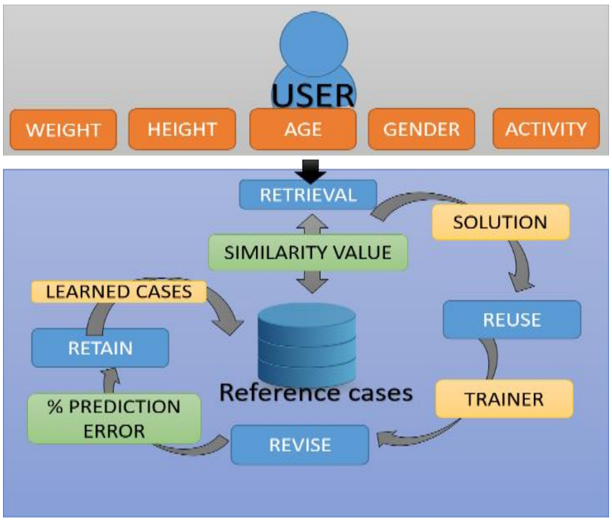

Figure 3. The architecture of the VFT application

4. Methodology

This study was executed in two phases: (1) the design and development phase (discussed above), and (2) the evaluation phase. We used a survey to estimate the percentage of the prediction error. A total of 23 participants were asked to use the proposed application by which the accuracy of the personalization process was calculated based on the new data submitted.

4.1. Demography of the Respondents

All the respondents were from the same class aged from 19 to 23 years old and have never used a fitness app before the experiment has been carried out. These students were asked to supply the application with information about their age, weight, height, gender, and activity level. This information was labeled as 'new' and then used for further analysis. Then, an interview was conducted with six students from the same age group to better understand their perceptions about using the proposed VFT in physical education. All the participants in this study were recruited using a random sampling technique.

4.2. Data Collection and Analysis

The data are collected by asking the user to use the app on their mobile phones. The experiment runs for a week and the data were collected and stored in the app. After the users submitted their data by filling their information in the pages on the app, the app directly calculated and displayed their suggested trainer by using the CBR calculation. The result of the suggestion was then collected and analyzed to know the prediction error using regression analysis.

5. Result

A descriptive analysis was used to analyze the percentage of the prediction error of the 23 participants (12 female and 11 male). The majority of the participants (70%) responded that they considered themselves very active in their daily life. The remaining participants (30%) responded that they performed little or no exercise daily. The mean BMI score was 24.5 (with a maximum value of 40 and a minimum value of 13.2) which can be considered normal for this study. The different attributes describing each participant were collected for the testing purposes of the personalization process. These variations were considered important to estimate the percentage of the prediction error, to give an insight into the effectiveness of the proposed application.

5.1. The Regression Analysis of Prediction Error and Global Similarity

Actual data were used to measure the effectiveness and accuracy of the prediction of the proposed application. The percentage of prediction error was based on the users' inputs. It is also tested whether the prediction error value could be reduced with the increase of the global similarity value. Participants' information such as gender, age, activity level, height, and weight were collected individually and then processed by the CBR algorithm. Then, the predicted and actual results were compared to get the prediction value. The following equation was used to estimate the prediction error in this study:

$$Percentage\ of\ Prediction\ Error = \frac{Actual - Prediction}{Actual} \times 100 \quad (1)$$

By assuming that no assumptions have been violated, two outliers were eliminated from the collected new cases. The $R2$ result of 21.4% indicates that the total variation in the dependent variable (percentage of error prediction) can be explained by the independent variable (global similarity score). With a p-value < 0.035, it can be said that there was a statistically significant effect of the global similarity score on the percentage of prediction error, which was also considered a good fit for the data as in the equation below.

$$\text{Percentage of prediction error} = 281.48 - 2.75\ (\text{global similarity}) \quad (2)$$

This also indicates that the higher the global similarity value, the lower the percentage of prediction error in the proposed application. Since only the solution of the most similar cases was presented to the user, the percentage of prediction error can be further maximized.

5.2. Observation Result

A total of six exploratory unstructured interviews were conducted with a convenience group of primary school students (ages between 7 and 12 years; three male and three female). An interview involves keeping the meaning of the phenomenon open and continuing to ask questions [32]. Based on this, we attempted to strike a balance between allowing the story to emerge and directing the interview. The interviews with students started with the question, 'how do you like using the VFT application in performing physical activities?' The majority of students expressed their excitement about using the VFTs to perform different physical exercises. For example, four students stated that their use of personalized VFT enabled them to try out all the physical movements with their friends. This type of scaffolding (virtual trainers) is believed to provide strong and timely support for the students as they have the choice of using several trainers to perform the same activity. All of the participants showed a preference for virtual fitness motion as compared to the actual classroom. This indicated that the students were highly motivated to perform the movement cooperatively and without teacher supervision. One participant stated that the visual appeal of the trainers was the main factor in driving his decision to use the VFT applications. Overall, the students found that using the proposed VFT application stimulated their involvement in physical activity without needing to have a teacher present. Since this study focused on the utilization of personalized learning algorithms which has been mentioned earlier, the focus is on how the app can suggest virtual trainers by using predefined information. This technology can help teachers in conditions where an assisted system is needed to help teachers in making judgments and can act as a potential helper in the future.

6. Discussion

Emerging Trends in the area of health education show that there is an increase in the development of applications that are more personalized and accurate. Studies have shown that by having a personal fitness trainer, people can easily follow fitness and weight loss programs [10]. Nevertheless, the design and development process of the virtual trainers must adhere to the specific guidelines of fitness experts to make the physical activities more effective and stimulating.

This study described the design and development of a VFT application to help users perform fitness activities and specific movement. The CBR algorithm was used to provide an accurate calculation of the virtual trainers' characteristics to the end-users. All the important attributes (e.g., weight, height, age, gender, and activity level) needed to personalize the virtual trainer for each user were identified and used along with two important values for fitness activity (BMI and BMR values). The five VFTs developed in this study were evaluated individually by the user to perform a series of fitness-related activities.

This app has several distinguished differences and the results from this study can be used by developers and educators in physical fitness education to design and develop a good and effective virtual fitness trainer app. Personalization can solve the problems of assigning suitable fitness trainers to the users based on the users' predefined attributes. This is aligned with the study done by [33] that personalized health-related app can help to encourage physical activity.

7. Conclusion

The results of the percentage of prediction error showed that the higher the global similarity value, the lower the percentage of prediction error in the proposed VFT application. The observation results of users while using the application revealed that they felt more engaged in performing physical activities when they used VFTs, without a need for teacher presence.

Although the trainers have been designed carefully, there are still more improvements to be made with the proposed application. It is believed that the percentage of prediction error can be further reduced by using more data and by performing more iterations so that the recommendation results are more appropriate. Besides, when the application personalizes virtual trainers, users will be more engaged and involved with the physical activity. This is because using personalized trainers can help meet users' needs. The use of an intelligent tutor such as a personalized trainer that can enhance productivity and support learning is a growing need in the field of education [34]. This study offers new insights into the design of virtual trainers in physical education, which is yet to be tested in actual settings.

8. Limitations and Further Study

This study is limited to testing the functionality of the app for a specific group of users only. To deploy the app for a bigger group of users, more testing and added functions should be included for the app to be fully utilized to maximize the functionality. Future studies are advised to test the physical activities with a larger sample size. Furthermore, future studies may also consider adding more specifications to the design of virtual trainers in a way that reflects a vision of a future scenario for physical education learners. More trainers can be added to the app to make it more interesting and cater to a different group of people.

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The Relationship of Limb Muscle Power, Balance, and Coordination with Instep Shooting Ability: A Correlation Study in Under-18 Football Athletes

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Abstract The purpose of this study was to examine the relationship between leg muscle power, balance, coordination, and shooting skills in soccer. Participants in this study used 89 soccer athletes with an age range of 15-18 years (M = 17.6; SD: 1.30). The research instrument used a coordination test (soccer wall volley test), balance test (modified bass test), leg muscle power (standing long jump test or broad jump), and shooting skills test. Data collection techniques, namely by measuring tests and measurements by the implementation procedure. Data analysis in this study was using Pearson correlation and regression analysis with the help of the IBM SPSS 24 application. The results showed that: 1) There was a relationship between leg muscle power and shooting ability using instep; 2) There is a relationship between balance and the ability to shoot using the instep; 3) There is a coordination relationship with the ability to shoot using the instep; and 4) There is a relationship between leg muscle power, balance, and coordination with the shooting ability using the instep. Recommendations for further research are suggested to involve other independent variables (X) that are relevant to this study, such as leg length, running speed, and angle of impact.

Keywords Limb Muscle Power, Balance, Coordination, Shooting, Soccer

1. Introduction

Football is a sport that is increasingly favored by all levels of society [1]. Football can be played by anyone, both men and women, young and old [1], [2]. Through this sports activity, there are many benefits, especially in physical, mental, and social growth. The sport of football is currently experiencing very rapid development, as evidenced by the emergence of professional and amateur football clubs and football athletes both at the school and college levels [1], [3]. Supported by the frequent holding of club tournaments and students and student events from regional to national levels.

Since the sport of football develops in various countries, skills are needed to master the sport. Football is a complex sport because it requires special techniques and tactics [4]. Every player should be able to master the basic techniques of playing football. Players must be equipped with good basic techniques, players who have good basic techniques tend to be able to play football well too. There are several basic techniques in soccer, such as receiving, shooting, passing, chipping, heading, and dribbling. Also, every football player must be equipped in terms of physical condition, because the game of football is different from other sports [5]. The characteristics of the sport of football are that it requires endurance, speed, endurance, coordination, strength, and agility for a relatively long time.

There are various techniques and movements that players can do on the field so that on the field there are various combinations of techniques and movements that support players in possession of the ball to achieve a victory [6], [7]. In reality on the field, the game of football is dominated by mastery of fast passing balls between players and good shooting skills. For example, professional football teams can control the ball very well, flow the ball fast, pass accurately, dribble well, shoot well, support each other's teammates, open space for movement, solid cooperation, and also own individual skills. the players make this team a good team [8].

In the game of football, the dominant thing to do is to kick, which is passing and shooting or shooting. This technique looks easy, but it requires concentration and the right time to take a shot that is taken towards the goal or becomes a goal [9], [10]. Often people see in football matches, shooting is a powerful weapon to score goals. In soccer, shooting can be done in various ways, namely by using the instep, toe, inner foot, and heel. Nonetheless, instep shooting is more effective and more done by players.

That's because, to shoot well, one has to be able to do complex movements. To shoot well, people must have good physical abilities, therefore people are required to be able to shoot well under the pressure of the game, tight space, physically tired, and limited time. Physical is the basis of athletic achievement because technique, tactics, and mentality can be developed properly if they have good physical qualities. [11], [12]. Researchers see that movement can be done if the player has good coordination, balance, and leg muscle power.

The factors that cause the less than optimal shooting accuracy in soccer games are the lack of awareness of the athletes to practice basic techniques of shooting the ball at the goal [13]. The game of football is not only the basic technique of playing football, but there are still other important elements, namely the element of the physical ability which consists of strength, endurance, explosive power, speed, flexibility, agility, coordination, and balance [1], [14]. Many motor skills support the implementation of football, including coordination, agility, flexibility, speed, and balance

To achieve maximum results in shooting accuracy, coordination training is very important and absolutely must be owned by a football player [6], [15]. The better the eye-foot coordination, the better the shooting accuracy will be. In general, this is because coordination is needed in every form of movement in sports. In particular, in the game of football, a player is required to make very complex movements. This very complex movement can be done well if a player has good coordination of the eyes, hands, feet, and all parts of the body [4].

Shooting in football requires one to have a good balance. This is because in shooting people only rely on one leg and the other leg swings to kick the ball with the help of hands to balance the body [16].

Leg muscle power is needed to support the leg so that it can kick the ball hard [17]. The rapid flow of the ball that is kicked by the player will make it more difficult for the opponent's goalkeeper to block the ball, so the chances of a goal will be greater [8].

Based on the description above, the researcher wanted to examine the relationship between leg muscle power, balance, coordination, and shooting skills in soccer. As for the theme of the problem, the researcher describes the following four research questions:

1) Is there a relationship between leg muscle power and the ability to shoot using the instep?
2) Is there a relationship between balance and the ability to shoot using instep?
3) Is there a relationship between coordination and the ability to shoot using the instep?
4) Is there a relationship between leg muscle power, balance, and coordination with the ability to shoot using the instep?

2. Materials and Methods

2.1. Research Method

This study used a quantitative research approach, then the design used was a correlational research design [18], [19]. The research design is as shown in Figure 1 as follows.

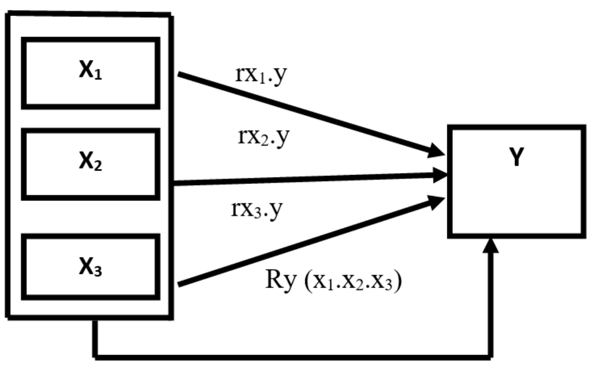

Figure 1. Research design

2.2. Participant

Participants in this study used 89 male soccer athletes with an age range of 15-18 years (M = 17.6; SD: 1.30).

2.3. Instruments

The research instrument used to measure four variables amounted to four instruments, as follows. Leg muscle power, using a standing long jump test or broad jump instrument [20]. Balance, with modified BASS balance test, with validity 0.46 [21], [22] and reliability 0.75 [23]. Coordination, using the soccer wall volley test instrument [24]. Shooting skills, with a shooting test instrument [25].

2.4. Data Collection Technique

The method used in this research is a survey with data collection techniques using tests and measurements [18], [26]. Before the measurement is carried out, the instrument used is carried out using an indication to determine whether the tool used is still good or not. The research begins with warming up the testicles to reduce the risk of injury during the test. Previously, the researcher gave instructions that must be done by the participants so that there were no errors during the test. After that, measurements were taken for each variable.

2.5. Data Analysis

Data analysis in this study is to use two analyzes. Research questions 1-3 are with the Pearson correlation analysis. Research question 4 is a multiple-regression analysis. All analyzes were performed with the help of the IBM 24 SPSS application.

3. Results

3.1. Hypothesis Testing: Pearson Correlation Analysis

The Karl Pearson Product-moment correlation analysis is used to test the hypotheses. Hypothesis 1 – 3 are as follows:

Hypothesis 1: There is a significant relationship between leg muscle power and the ability to shoot using the instep.

Hypothesis 2: There is a significant relationship between balance and the ability to shoot using instep.

Hypothesis 3: There is a relationship between coordination and the ability to shoot using the instep.

Table 1. Product-moment correlation result

Variable	r	R^2	p<0.01** (2-tailed)
X1.Y	0.705	0.232	0.000**
X2.Y	0.773	0.256	0.000**
X3.Y	0.803	0.345	0.000**

The correlation coefficient r_{x1y} shows the value of 0.705, which indicates that leg muscle power and the ability to shoot using the instep. The determination coefficient ($R^2{}_{x1y}$) is 0.232, which means that the leg muscle power variable has an effect of 23.2% on the ability to shoot using the instep variable, and the rest is influenced by other variables (factors). The significance value of r_{x1y} is 0.000 and less than 0.05 ($p <0.05$; $0.000 <0.05$); thus, Hypothesis 1 is accepted. This means, that there is a significant relationship between leg muscle power and the ability to shoot using the instep.

The correlation coefficient r_{x2y} shows the value of 0.773, which indicates that balance and the ability to shoot using instep. The determination coefficient ($R^2{}_{x2y)}$ is 0.256; the balance variable has an effect of 25.6% on the ability to shoot using instep, and the rest is influenced by other variables (factors). The significance value of r_{x2y} is 0.000 or less than 0.05 ($p <0.05$; $0.000 <0.05$); therefore, Hypothesis 2 is accepted, meaning that, there is a significant relationship between balance and the ability to shoot using instep.

The correlation coefficient is r_{x3y} with a value of 0.803, which indicates that coordination and ability to shoot using the instep. The determination coefficient ($R^2{}_{x3y}$) is 0.345, which means that coordination gives a 34.5% effect on the ability to shoot using the instep variable, and the rest is influenced by other variables (factors). The significance value of r_{x3y} is 0.000 and less than 0.05 ($p <0.05$; $0.000 <0.05$), so Hypothesis 3 is accepted. This means that there is a significant relationship between coordination and the ability to shoot using the instep.

3.2. Hypothesis Testing: Multiple-regression Analysis

The multiple regression analysis is selected to analyze the proposed fourth hypothesis, which 4-states that:

Hypothesis 4: There is a significant relationship between leg muscle power, balance, and coordination with the ability to shoot using the instep.

The multiple regression analysis is used to test Hypothesis 4. The following is the result of the analysis. Table 2 shows the results found.

Table 2. Multiple-Regression Analysis

Variable	Regression Coefficient (b)	Sig.	Conclusion
Leg Muscle Power	0.012	0.000	Significant
Balance	0.021	0.000	Significant
Coordination	0.018	0.000	Significant
Constant = 3.322			
R^2= 0.706			
F_1 = 12.511			
Sig.= 0.000			

Based on the test result, the calculated F value of 12.511 is obtained with a significance level of 0.000. Because the significance value of r_{x123y} 0.000 is less than 0.05 ($p <0.05$; $0.000 <0.05$), Hypothesis 4 is accepted. Therefore, there is a significant relationship between leg muscle power, balance, and coordination with the ability to shoot using the instep.

The R^2 test result in this study obtains a value of 0,706. This shows that teacher performance is influenced (70.6%) by leg muscle power, balance, and coordination, while the rest (29.4%) is influenced by other variables (factor) not included in this study.

4. Discussion

4.1. Leg Muscle Power (X1) with Instep Shooting Ability (Y)

Leg muscle power is the tension exerted by the leg muscles against the tension or load with maximum effort to move the muscles. Every athlete in any sport is required to have good physical condition to support the desired achievement. The physical condition can be improved by practicing. One of the factors that play a role in the achievement of shooting football is the physical condition, including the power of the leg muscles [27]. In other words, to achieve a kick there must be an element of physical condition, especially the leg muscle power used to lift the thigh and exert a repulsive force when kicking the ball. The power of a person's leg muscles plays an important role in increasing the frequency of a person's running steps because the frequency of steps is the multiplication of the leg muscle power and the muscle speed in walking.

The findings in this study explain that students who have good leg muscle power will have good shooting skills using the instep. Also, the results showed that leg muscle power is important for every player to have and improve in increasing the ability to shoot using instep.

The results of this study are following the theory, that the ability of a football athlete in shooting football is influenced by leg muscle power because the combination of strength and maximum speed gives an optimal effect on ball kicks [16], [27]. This leg muscle power is used when running dribbling and kicking the ball, with strong leg muscles the kick will be stronger. A football player must have strong feet, strong ankles, strong knees, and strong legs to carry a heavy body.

4.2. Balance (X2) with Instep Shooting Ability (Y)

Balance is a person's ability to control the muscle nerve organs so that they can control movements properly and correctly [21]. The findings in this study explain that students who have good balance will have good shooting skills using the instep. Also, the results showed that balance is important for every player to improve the ability to shoot using instep.

When shooting in a running condition, the body is unbalanced because it is carried out with one-foot support and holding all limbs, it is necessary to have maximum body balance so that the shooting is carried out at the desired target. This is reinforced by theory, that without having a balance, football players will not be able to shoot properly and accurately, so balance is a component that a football player needs to have [16], [21]. Besides, the existence of balance will be able to increase strength and endurance, and also can easily control the position of the body when making kicks and also after taking kicks. Like kicking long or close range.

4.3. Coordination (X3) with Instep Shooting Ability (Y)

Coordination is a combination of the motion of two or more joints, which are related to each other in producing one movement skill [28]. The findings in this study explain that students who have good coordination will have good shooting skills using the instep. Also, the research results indicate that coordination is important for each player to improve the ability to shoot using the instep.

This research is reinforced by a theory that in football, especially when shooting at goal, coordination that plays an important role in coordination. Because without coordination, it would be difficult to shoot the goal accurately. One form of eye-body-foot coordination, when the eye sees the target, the body and legs respond to the kick so they can get good accuracy [16].

Therefore, the ability to coordinate is important for a soccer athlete to have in combining the harmony of movement with the ball so that the ball with the foot can be perfect, including in shooting [16], [28].

4.4. Leg Muscle Power (X1), Balance (X2), and Coordination (X3) with Instep Shooting Ability (Y)

The results of this study indicate that there is a significant relationship between the three independent variables (coordination, balance, and leg muscle power) and the dependent variable (the ability to shoot using instep). This is because the training program to improve shooting skills uses the instep, through coordination, balance, and leg muscle power exercises first. These three components are the main factors for improving the ability to shoot using the instep.

To be able to shoot well, players must have good physical abilities. Therefore, players are required to be able to shoot well in a narrow space and time. This is because to do a good shooting, players have to do complex movements, these movements can be done if the player has good coordination, balance, and muscle power.

The results of this study are reinforced by a theory that the physical component of leg muscle power is very decisive in shooting, besides that coordination and balance are also important components because in football often kicks, both long-distance kicks and kicks towards the goal, so that players are capable of doing. The full power of shooting hard for a long time is supported by good leg muscle power [16]. Players must have the necessary skills (shooting, ball control, coordination) to build and run the game during matches [24].

5. Conclusions

The Conclusions showed that: *First*, There was a relationship between leg muscle power and the shooting ability using the instep. This is reinforced by the results of the p-value <0.005, which is p = 0.000 The results of this study are following the theory, that the ability of a football athlete in shooting football is influenced by leg muscle power because the combination of strength and maximum speed gives an optimal effect on ball kicks [16], [27]. *Second*, there is a relationship between balance and the ability to shoot using the instep. This is reinforced by the results of the p-value <0.005, which is p = 0.000. This is reinforced by theory, that without having a balance, football players will not be able to shoot properly and accurately, so balance is a component that a football player needs to have [16], [21]. *Third*, there is a coordination relationship with the ability to shoot using the instep. This is reinforced by the results of the p-value <0.005, which is p = 0.000. The ability to coordinate is important for a soccer athlete to have in combining the harmony of movement with the ball so that the ball with the foot can be perfect, including in shooting [16], [28]. And *Fourth*, there is a relationship between leg muscle power, balance, and coordination with the shooting ability using the instep. This is reinforced by the results of the p-value <0.005, which is p = 0.000. The full power of shooting hard for a long time is supported by good leg muscle power [16]. Players must have the necessary skills (shooting, ball control, coordination) to build and run the game during matches [24].

Recommendations for further research are suggested to involve other independent variables (X) that are relevant to this study, such as leg length, running speed, and angle of impact.

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Conflict of Interest

All authors state that there is no conflict of interest in this study.

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Immunoglobulin-A (IgA) Improvement through Sports and Frirage Massage

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Abstract **Background:** All massages, including sports massages and frirage massage can reduce muscle tension, improve blood circulation, increase aggressiveness, increase nerve delivery, and reduce blood pressure and pulse rate. The aim of this study was to evaluate the effect of sports massage on changes in IgA levels. **Method:** This research is an experimental study with a pretest-posttest design. The research sample was 27 subjects divided into three groups: Technique collection data with blood drawing in vena of the three groups before and after treatment. **Results** showed that the sports massage treatment results in P > 0.05, which means that there is no positive effect of sports massage treatment on increasing IgA immunity. In the frirage massage treatment, P > 0.05 was obtained, which means that no positive effect on the increasing of immune IgA was found. Likewise in the control group the P value was not significant with a P value > 0.05. This means that the one way ANOVA statistical test found that the two treatment groups, namely the sports massage and frirage massage groups did not have a significant effect on increasing IgA levels in the blood. When seen in the data on the mean results of the sports massage treatment group of 36.22 mg / dl, the frirage massage treatment was 32.44 mg / dl, but after being tested by one way ANOVA showed that the two groups were not significant. **Conclusion:** Sports massage to athletes performed heavy work and or exercise at high intensity may increase IgA.

Keywords Massage, High Intensity, Weight Training, Antibody IgA

1. Introduction

Massage therapy is one of many forms of rehabilitation treatment that has long been used as an additional treatment for various mental and physical conditions [1]. In recent times, massage has gained more popularity in clinical wards because of its application to different ranges of patients from children and also in professional people in the competitive sports field and sedentary people from all walks of life. The best way to describe massage practices is as the mechanical manipulation of body tissues by applying rhythmic pressure [2]. One of the starting mechanisms of massage is through stimulation of different mechanoreceptors nervous system found on the skin (e.g. Meissner and Pacinian corpuscles, Merkel disc ends, Ruffini and free nerve ends) [3]. The pressure given to this receptor is then translated into different effects. More specifically, it can activate pathways that send signals along long nerve fibres and myelin to the limbic region of the brain or can affect release such as substance P or serotonin which is considered responsible for mediating 'relaxing effects [4]. This evidence shows that emotional well-being and neuronal modulation are key elements for the effectiveness of massage therapy. The catecholamine's released on lymphoid organs under central nervous system level control are known as regulators of the immune repertoire. To test the possibility that the mediation of the effects of massage therapy increases catecholamine. Immunofluorescence analysis of the thymus section for catecholamine nerve fibres shows a significant reduction in fluorescence intensity in both cortical and cortico-medulla junction areas in rat samples as treated with effleurage massage compared to controls [5].

Sports massage is very well known in Indonesia and almost all experts in massage therapy for national athletes have practiced them so that all athletes have benefited a lot from sports massage in which the manipulation techniques include effleurage, petrissage (squishing and pressing), shaking, friction, tapotemen (beating, hacking, clapping), walken (variation of effleurage), vibration, stroking, skin-rolling, and chiropractice.

Sports massage is a massage that is specifically used or given to healthy people, especially sportsmen. The target of sports massage is certain parts of the body of a healthy person. The types and methods of massage are preferred to improve the smooth circulation of blood [6] Sports massage is known as manual therapy, manipulative therapy, or manual manipulative therapy, this is a physical treatment mainly used on the neuromusculoskeletal system to treat pain and disability. The most common technique includes squeezing and muscle manipulation, joint mobilization, and joint manipulation. [7] argues that sports massage is a specific application of massage techniques, hydrotherapy protocols, various principles of flexibility motion and strength used to achieve certain goals when treating an athlete that is divided to before competing and after competing. Massage increases muscle fulfilment and reduces worse conditions in cross-coupling coupling, vertical jump, speed, and reaction time [8]. The purpose of application of sports massage in general is: (1) to improve blood circulation, especially the urge to venous blood to the heart. The continuity of blood circulation will then accelerate the process of removing the residues of incineration and the spread of food extracts to tissues; (2) to stimulate nerve, especially peripheral nerves to increase sensitivity to stimulation; (3) to increase muscle tension (tone) and muscle elasticity to enhance work power; (4) to cleanse and smoothen the skin; (5) to reduce or eliminate nervous tension and reduce pain, in order to be able to put the patient to sleep [9] Sports massage can cause multi-direct changes in the metabolism of selected biological compounds. Stimulation massage increases the functional state of neuromuscular devices and activates energy production which shows the formation of mechanisms needed for 'emergency' adaptation [10]. Effleurage massage therapy can reduce pain and disability of Myofacial Trigerpoin Syndrome in the upper trapezius muscle [11]. Mark Rapaport in his study states that the time needed for effective massage was 45 minutes [12]. Sports massage which is also known as the manual therapy and manipulative therapy is a physical treatment mainly used on the neuromusculoskeletal system to treat pain and disability where the types and methods of the massage are preferred at improving muscle relaxation, the blood circulation [13], recovery between training or high intensity competition sessions, reducing the possibility of tissue damage, decreasing heart rate, improving the blood circulation and pressure, reducing muscle tension, increasing joint motion, and reducing pain, as well as multidirectional changing in the metabolism of important biological compounds, improving the functional state of neuromuscular devices and activating energy production. Therefore the massage can help the athlete achieves the effectiveness and the rate of the recovery [14].

In the recent 7 years in Indonesia, there is a new fitness massage method named frirage massage from Faculty of Sports, Yogyakarta State University in which the manipulation techniques only friction and effleurage which are carried out simultaneously. Frirage massage is a hand movement for massaging given to healthy people, especially sportsmen, which employ only the 2 main manipulations namely effleurage and friction using only the thumb and it has the same purpose as sports massage. The two manipulations begin with a.) the supine position and starting from the left leg, namely the back of the foot and toes, front calf / lower leg, groin / upper thighs, followed by the right leg, the foot and fingers -finger, front calf / lower leg, groin / upper thigh, the upper arm area, the back of the hand, palm, forearm, upper arm, abdomen and chest, forehead and face area., b.) the prone position starts from the left leg, namely the soles of the feet, ankles, lower limbs, upper limbs, followed by the right leg namely the soles of the feet, ankles, lower limbs, upper limbs, then the buttocks, back, shoulders, neck and neck.

Frirage massage, which is a massage done only with the thumb, uses the combination of two manipulation techniques, namely friction and efflurage simultaneously so that it is named “frirage” [3] Frirage masssage is one of the applied science in the field of therapy and rehabilitation, both for the interests of sports medication, health education, and eastern medication (alternative medication) which can be useful to help cure before medical treatment or after medical treatment as a prevention and treatment for injuryb [15]. Frirage massage can only be done with right and left thumbs depending on your preference and it is performed by moving your thumb to go forward towards and ends to the index finger while the other fingers act as footing for support. This movement is very easy to do and you will not easily get tired. In its development, frirage massage has been divided into 4 fields based on: namely 1) frirage massage for infants, 2) frirage massage for joint injury and muscle shear, 3) frirage massage for organ dysfunction, and 4) frirage massage for fitness and or rehabilitation.

The two types of massage, namely sports massage and frirage massage, can improve muscle performance, reduce pain, and increase aggressiveness, this increasing must also have an effect on increasing immunity. The possibility of this immune system is what makes it fitter and more aggressive to feel healthy, the immune system is called immunity. There are five different types (classes) of immunoglobulins or antibodies in human blood: IgG, IgA, IgM, IgD and IgE [14-15]. IgG is present in the largest amount, followed by IgM and IgA. IgD is much lower, and IgE is present in only minutes. IgM and IgG mainly protect us from infection in our body tissues, organs and blood. Immunoglobulin A (IgA) is an antibody that plays an important role in mucosal immunity. IgA exists in two forms, four-chain monomers in the blood and eight-chain structures, or dimers, in exocrine glandular secretions from mucous membranes, including mucus, saliva, and tears (OpenStax College., 2013: 959) are also secreted from mucosal epithelium. and neutralizes microbes in the lumen of mucosal tissues, such as the respiratory and digestive tracts [15].

According to B cells in different anatomical sites switch to different isotypes, partly because of the cytokines produced at those sites. In particular, B cells in mucosal tissue switch to IgA, which is the class of antibodies most efficiently transported through the epithelium to mucosal secretions, in charge of defending against microbes that try to enter through the epithelium. Switching to IgA is stimulated by transforming growth factor-β (TGF-β), which is produced by many cell types, including T helper cells, in the mucosa and other tissues. Cytokines also stimulate switching to IgA. Because these cytokines are produced by myeloid cells, they can stimulate the IgA response in the absence of T helper cells [15].

According to [16] one of the mechanisms by which massage initiates its effects is through stimulation of the nervous system different mechanoreceptors found in the skin (e.g. Meissner and Pacinian corpuscles, Merkel disc tip, Ruffini and free nerve endings). The pressure exerted on these receptors is then translated into different effects. More specifically, it can activate a pathway that sends signals along long nerve fibers and myelin to the limbic area of the brain [17] or can affect the release of substances such as P or serotonin which are thought to be responsible for mediating the 'chain effect. or relax [18]. Together this evidence suggests that emotional well-being and neuronal modulation are key elements for the effectiveness of massage therapy [19] argue that catecholamines released in lymphoid organs under the control of the central nervous system level are known regulators of the immune repertoire. To examine the possibility that the mediating effect of massage therapy increases catecholamines, [20] measured noradrenaline concentrations and fluorescence intensity and density of noradrenergic nerve fibers in both thymus and spleen. Immunofluorescence analysis of the thymus section for catecholamine nerve fibers showed a significant reduction in fluorescence intensity in both cortical and cortico-medullary junction regions in rat samples treated with effleurage massage compared to controls. This is in line with the opinion of [21. 22], the fact that large noradrenergic nerve plexuses predominate in the subcapsular cortex and corticomedullary junction, where thymocytes reside are more mature. Reinforced by the results of [19], previous studies conducted in humans showed that effleurage massage increases vagal activity through stimulation of pressure receptors which ultimately signals the limbic system or reduces the release of norepinephrine in the bloodstream causing overall regulation of sympathetic activity. Interestingly, research and other research groups have shown sympathetic nerves which innervate lymphoid tissue as one of the main pathways of the nervous and immune systems communicating to maintain body homeostasis [23, 24] Most importantly according to [26, 27] the evidence suggests that the homeostatic cross-talk is responsible for "information processing. "such as behavioral conditioning or changes in external environmental factors and their translation into specific immune responses.

Giving effleurage massage to mouse samples showed a tendency to increase the number of thymocytes in T cells in lymphoid organs, this will result in increased excitability triggering the production of excess IgA immune [19].

In Indonesia, there has been no research on increasing immunity in the form of IgA through sports massage and frirage massage in athletes, although almost all therapists who graduated from the Sports Faculty of Yogyakarta State University apply this kind of massage. Furthermore, based on observational reports and information from students and athletes who have been treated using both types of massage, there are very significant changes in feelings of being fit, healthy, fit, and energetic. Of course, all these reports are sketchy and unproven.

On the basis of the foregoing, the researcher wants to prove the truth in a laboratory that IgA type immunoglobulin can be increased through sports massage and frirage massage.

In this study, group sports massage and frirage massage have applied for 45 minutes after a one-hour break of high-intensity physical activity in the form of circuit weight training. After a phase of frirage massage, the participant rested for one hour and then completed the blood test taken in the cubital vein to determine the modulation effect of frirage massage on IgA antibody levels.

Immunoglobulin levels in normal IgA serum are 69 - 382 mg/dl, or 49 - 269 IU / ml [28] while in this study, the normal levels of IgA antibodies were determined at 40-350 mg/dl.

In sports massage and frirage massage there are similarities and also typical differences found at the time of implementing the phrase. The similarity of two massages is 1) in terms of its purpose, both are to promote blood circulation, relax muscles, remove metabolic remnants, stimulate nerve edges, and reduce nervous tension, 2) in terms of the technique, both have friction, effleurage, tapotement, and walken, 3) in terms of targets, both are aimed for the common people and sportsmen, 4) the direction of both massage is towards the heart, 5) in both message, manipulation begins with legs, and 6) massage time ranges 45-60 minutes.

Table 1. Asspect of Sports Massage and Frirage Massage

Aspect	Sports Massage	Frirage Massage
Specific Goal	Stimulating comfortable and fit feelings	Stimulating comfortable and fit feelings
Main Technique	The main technique is effleurage	The main techniques are effleurage and friction
Tool	The surface of hands, fist, fingers	Thumbs
The number of Manipulation	9 manipulations	2 manipulations
Direction of Movement	Starting from upper limb to the lower	Starting from foot sole to upper parts of the body
Initial Position	Face downward	Supine position
Pressing Rhythm	Adjusted to the muscle size	Adjusted to the muscle size

Table 1 showed the strong aspect between two different of massage: Sports massage and Frirage massage. Sport massage was based on effleurage technique while frirage m based on effleurage and friction. On the hand of tool sport massage used surface hand, fist and fingers in case frirage massage used Thumbs only. Differences of the two massage are also seen in the movement direction while that sport massage starting from upper limb to the lower but frirage was vice-visa. The initial position was different, for sport massage face downward and supine position for the frirage massage. Finally, the number of manipulations was different: 9 manipulations for sport massage and 2 manipulations for the frirage massage. Nevertheless, were some similarities like: comfortable and fit feelings. A very striking difference can be seen from his movement techniques, sports massage has reliable manipulation, namely effleurage carried out using the entire surface of the palm. The pressure in the sport massage is so soft and smooth that effleurage throughout the body gives warm and comfortable feelings for the massaged person [29].

2. Materials and Research Methods

2.1. Procedure

This research is an experimental study with a pretest-posttest design [30] the procedure in this study 1. The subjects were measured blood pressure, respiratory rate, total pulse per minute, 2. The strenuous activity was done in the form of weight training with the circuit method, 3. After doing the load training the circuit is immediately measured again blood pressure, respiratory rate and pulse per minute, 4. Immediately taking 17 mL of blood through the cubital vein., 5 Divided into 3 groups, namely group 1 who will be treated with sports massage, group 2 who will be treated with frirage massage, and group 3 who will not be treated as control, 6. Rest for 1 hour. 7. Giving massage treatment for 45 minutes to the two treatment groups, 8. The second blood was drawn with a cubital vein of 17 mL to all treatment and control groups, 9. The results of the blood collection were taken to Prodia's laboratory on Jl. Bintaran Kulon No 28 Yogyakarta to analyze IgA levels in the blood.

Weight training procedure with the following circuit: physical activity training that is a circuit weight training of 12 sessions and repetition 10 times / set as many as 3 sets at high intensity for 60 minutes, the training load of each muscle is 30% from 1 RM, each session lasted for 30 seconds, breaking intervals between training sessions was 60 seconds session, exercises were performed for 3 sets, and breaks between sets were 3-5 minutes. This is used as a basis for substituting tiring workout before being treated with massage.

Table 2. Implementation Guidelines for Sports Massage and Frirage massage

1.	Programme	Sports Massage	Frirage Massage
2.	Frequency	2 blood tests in every treatment	2 blood tests in every treatment
3.	Intensity	The pressure intensity depending on the muscle size	The pressure intensity depending on the muscle size
4.	Time	45 minutes, divided into 9 kinds of manipulation = 2700 seconds: 48 total manipulation = 32 seconds: 3,375 seconds/repetition = 7-8 repetition / manipulation	45 minutes, divided into 2 kinds of manipulation with 25 repetitions
5.	Type	Figures and massage order attached	Figures and massage order attached

Table 2 showed the volume of each type of massage. Both of two massage sport massage and frirage massage were based on frequency, intensity, time, and type. Firstly, they had 2 blood tests in every treatment in the hand of frequency. For both of the two massage the pressure was based on the side of muscle. It has been seen a strong different on the hand of manipulation time while that sport massage has 48 manipulations in 2700 seconds for the first time and 32 manipulations in 3375 seconds for the second time. For the frirage massage only 2 types of manipulations with the same time with 25 repetitions.

Meanwhile, masseurs are professional therapists from the Therapy Clinic of the Sports Faculty of Yogyakarta State University.

The procedure for implementing the treatment in the two experimental groups was as follows:

Procedure Sports Massage		
A. Face down (26 minutes)		
Area of Contact	**Kinds of Manipulation**	**Duration**
1. Upper Limbs	Effleurage 1, 2, 3; Petrissage 1, 2; Effleurage 1.2.3. (Closing)	Time 11 minutes
2. Lower Limbs	Eflleurage 1.2; Petrissage; Shaking, Effleurage 1,2. (Closing)	
3. Feet and soles	Effleurage 1,2; Petrissage, Effleurage 1,2. (Closing)	
4. Waist and back	Effleurage 1, 2; Friction, Walken, Seterika, Tapotement (Beating, Clapping, Hacking), Effleurage 1,2. (Closing)	Time 15 minutes
5. Butt	Effleurage, Friction, Walken, Tapotement, effleurage (Closing)	
6. Nape and Shoulders	Effleurage 1, 2; Petrissage, Shaking, Effleurage 1,2 (Closing)	
	Total Time A	26 minutes
A. Supine Position (19 Minutes)		
1. Upper Limbs	Effleurage 1, 2, 3; Petrissage 1, 2; Effleurage 1.2.3. (Closing)	Time 10 minutes
2. Lower Limbs	Eflleurage 1.2; Petrissage; Shaking; Effleurage 1,2. (Closing)	
3. Instep and Foot	Effleurage 1,2; Petrissage; Shaking; Effleurage 1,2. (Closing)	
4. Lower and Upper Arms	Eflleurage 1,2; Petrissage; Shaking 1,2; Effleurqage 1,2. (Closing)	Time 8 minutes
5. Backs of Hands and Palms	Effleurage; Shaking; Effleurage (Closing)	
6. Chest and Stomach	Effleurage; Walken; Shaking; Effleurage (Closing)	
7. Forehead and Nose	Effleurage Forehead; Effleurage on the nose and down the temples	Time 1 minutes
	Total Time B	**19 minutes**
	Total Sum of Time A + B	**45 minutes**

Procedure Frirage Massage		
Supine Position (20 Minutes)		
Area of Contact	**Kinds of Manipulation**	**Duration**
Backs, Fingers Legs and Feet.	With your thumb, work on areas 1, 2, 3 and 4.	Time 10 minutes
Front calves and knees.	With your thumb, work on areas 1, 2, 3 and 4.	
Front thigh and groin.	With your thumb, work on areas 1, 2, 3 and 4.	
Backs Right hand and Left	With your thumb, work on areas 1, 2, 3 and 4.	Time 10 minutes
Palm of the hand	With your thumb, work on areas 1, 2, 3 and 4.	
Forearm Massage starts on the outer arm from the wrist to the elbow area.	Do this with the thumbs on the outer forearms in areas 1, 2, and 3 followed by on the inner forearms in areas 4, 5 and 6.	
Upper arm Massage starts from the elbow area to the shoulder area, the position of the arm bent over the chest.	Do this with the thumb on the outer upper arm in areas 1, 2 and 3, followed by the inner upper arm in areas 4, 5 and 6.	
Stomach Massage starts from the right abdomen from the bladder border rib area.	Do it with the left thumb followed by the lower middle stomach starting 2 fingers from the navel to the point of the stomach	
Chest The massage starts from the right side by applying the ribs to the clavicle area.	Do it with the thumb from the edge along the chest from the bottom outwards continued upwards around the inside of the chest.	
	Total Time A	20 Minutes

Prone Position (25 Minutes)		
Area of Contact	Kinds of Manipulation	Duration
Left foot. Massage starts from the left leg in the way shown in the picture.	*a) Only with the thumb* *Perform friction and effleurage (frirage) straight ahead towards the heart with the thumb striking the edge (1) middle (2) and the concave part.*	Time 10 minutes
Left ankle The grip for the ankle area is adjusted according to the direction or target of the manipulation.	With the thumb, the lateral (outer) part of the ankle, do it with the right hand, on lines 1, 2 and 3.	
3) Lower limbs	With your thumb, start from the calcani to the back of the knee crease	
4) Upper limbs	With your thumbs, starting from the top of the knee to the crease of the thigh, apply the movement to the upper, inner and outer sides of the thigh.	
5) Butt	With the thumb, start from the bottom of the buttocks towards the upper buttocks, hitting the top, outer side and a little inside	Time 15 minutes
6) Back	With the thumb starting from the top of the buttocks to the nape of the neck along the side of the vertebrae, starting from the bottom again around the back muscles to the nape of either the right side of the vertebrae or on the left	
7) Shoulders	With your thumbs starting from the shoulder muscles to the nape	
8) Nape and Neck	With the thumb, start from the muscle beside the cervical spine up to the back of the ear	
	Total Time B	25 Minutes
	Total Time A + B	45 minutes

2.2. Participants

This experimental research was conducted using the pretest-posttest design. The number of samples as research subjects was obtained in accordance with the inclusion criteria of 1) male, 2) the age range of 19-21 years, 3) were not athletes of district, regional, national and international, 3) willing and able to carry out tasks in this study, 4) willing to be the sample, and 5) the status of 4th semester students of the Study Program of Sports Science and Health of Faculty of Sports, Yogyakarta State University class 2016. The research subjects are 32 males and during the research there were 5 subjects who could not continue the study, so that the overall subjects were 27 male students of the study programme of IKOR Yogyakarta State University, Indonesia. Prior to the research, the subjects signed consent letters, the willingness to be the subject of research. During the research the subjects divided into 3 groups, namely the groups of sports massage (X1), frirage massage (X2) and control (X3) treated with the placebo massage or control.

2.3. Data Collection

In this study, the taking of IgA serum in the form of blood was through the cubital vein performed twice. The first was before carrying out heavy workout of weight training circuit with a 7 mL and the second was one hour after massage. The IgA antibody was determined by the ELISA (Enzyme-Linked Immunosorbent Assay) method carried out by indirect sandwich using Siemen Healthcare Diagnostics Inc., SIEMENS. Data were interpreted using Elisa Reader with 95% sensitivity. The level of immunoglobulin in normal serum IgA is 40-350 mg/dl [31].

Statistical Analysis

Normality (Shapiro-Wilks), homogeneity (Levene Test), and T-test of data were undertaken by using SPSS V.19.0 suit off program.

2.4. Research Formulations

On the basis of background of the study above, the problem is formulated as follows:

1. Does sports massage have effects on changes in IgA antibody levels?
2. Does frirage massage have effects on changes in IgA antibody levels?
3. Which of sports and frirage massage is most effective on changes in IgA antibody levels?

3. Results

Table 3 showed the characteristics of three groups which are sports massage, frirage massage, and group control. In this table the result of pre-test and posttest of IgA IMUN has been presented. Therefore, it was found a difference between their means and standard deviation (SD).

3.1. Data Analysis

The normality test of immunoglobulin A (IgA) levels data indicates that data is normally distributed with p > α 0.05.

Table 4 showed that in statistics, normality tests are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed. In this table the result showed that P value was > 0.05 and it can conclude that data were normal distributed.

Table 5 showed that homogeneity test of immunoglobulin A (IgA) levels data were analyzed by using the Levene's technique. It is obtained that F > α 0.05, meaning the working hypothesis is rejected and the null hypothesis is accepted. Thus it can be concluded that the final data of the population variants in the treatment group is homogeny.

Table 3. Descriptive Data Group Experiment and Control

KET	SPORTS MASSAGE		FRIRAGE MASSAGE		CONTROL	
	IgA IMUN		IgA IMUN		IgA IMUN	
	POST	PRE	POST	PRE	POST	PRE
	337	302	258	232	192	194
	307	258	275	221	388	361
	320	284	229	205	197	187
	237	208	242	203	307	298
	250	205	226	193	220	211
	242	214	166	147	178	174
	220	183	316	272	229	228
	304	259	207	182	209	213
	276	254	217	189	316	325
Sum	2493	2167	2136	1844	2236	2191
Mean	277.0000	240.7778	237.3333	204.8889	248.4444	243.4444
Median	276.0000	254.0000	229.0000	203.0000	220.0000	213.0000
Variance	1735.250	1603.694	1834.500	1221.361	5125.778	4514.778
Std. Deviation	41.65633	40.04615	42.83106	34.94798	71.59454	67.19210
Minimum	220.00	183.00	166.00	147.00	178.00	174.00
Maximum	337.00	302.00	316.00	272.00	388.00	361.00
Range	117.00	119.00	150.00	125.00	210.00	187.00

Table 4. Tests of Normality

EXPERIMENT	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SPORTS-MASSAGE	.170	9	.200*	.956	9	.757
SPORTS-MASSAGE	.209	9	.200*	.923	9	.414
SPORTS-MASSAGE	.206	9	.200*	.930	9	.481

Table 5. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.	Sig
PRE-TEST IgA	4.039	2	24	.031	Sig F > α 0.05
POST-TEST IgA	2.670	2	24	.090	Sig F > α 0.05

Table 6. One Way Anova

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
SPORTS MASSAGE	Between Groups	5904.222	1	5904.222	3.537	.078
	Within Groups	26711.556	16	1669.472		
	Total	32615.778	17			
FRIRAGE MASSAGE	Between Groups	4736.889	1	4736.889	3.100	.097
	Within Groups	24446.889	16	1527.931		
	Total	29183.778	17			
CONTROL	Between Groups	112.500	1	112.500	.023	.880
	Within Groups	77124.444	16	4820.278		
	Total	77236.944	17			

Table 6 showed that the sports massage treatment results in P > 0.05, which means that there is no positive effect of sports massage treatment on increasing IgA immunity. In the frirage massage treatment, P > 0.05 was obtained, which means that the frirage massage treatment did not have a positive effect on the increase in immune IgA. Likewise in the control group the P value was not significant with a P value > 0.05. This means that the one way ANOVA statistical test found that the two treatment groups, namely the sports massage and frirage massage groups did not have a significant effect on increasing IgA levels in the blood. When seen in the data on the mean results of the sports massage treatment group of 36.22 mg / dl, the frirage massage treatment was 32.44 mg / dl, but after being tested by one way ANOVA showed that the two groups were not significant.

Although the results show that the two treatment groups are declared insignificant, it can be seen whether the increase in IgA levels in the two groups is more effective as followed table 7.

The results of the discussion in Table 7. The Least Significance Difference (LSD) Technique the Mean Difference between Treatment Groups of Each Dependent Variable explains the differences in the increase in IgA immune levels:

Because the results of the calculation of the significance of sports massage with frirage massage is less than α 0.05 (0,000 <0.05), there is a significant difference between sports massage with frirage massage on increasing levels of IgA immune. Because the sports massage with the frirage massage results of the Confidence Interval For Difference results does not contain zero (0) and has a positive (+) value, the sports massage is greater for an increase in IgA immune levels compared to the frirage massage.

The results show that: Sports massage is more effective in increasing IgA antibody levels than frirage massage (0,000 <0.05).

4. Discussions

The best way to describe the practice of massage to mechanically manipulate body tissue is by applying rhythmic pressure. Furthermore, one of the mechanisms giving to massage impacts is by stimulating mechanoreceptors nervous system found in the skin (eg. Meissner and Pacinian corpuscles, Merkel disc tip, Ruffini and free nerve endings). The pressure applied to the receptors activates pathways that send signals along nerve fibres and myelin to limbic regions of the brain [32, 33] or affects the release of such substances P or serotonin considered responsible for mediating 'relax', These suggest that emotion and neuronal modulation are key elements for the effectiveness of massage therapy. Catecholamine released in lymphoid organs under central nervous system control is known as regulators of the immune repertoire [34].

Table 7. Multiple Comparisons

LSD

Dependent Variable	(I) EXPERIMENT	(J) EXPERIMENT	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
POST-TEST IgA	SPORTS-MASSAGE	FRIRAGE MASSAGE	39.66667	25.37938	.131	-12.7138	92.0471
		CONTROL GROUP	28.55556	25.37938	.272	-23.8249	80.9360
	FRIRAGE MASSAGE	SPORTS-MASSAGE	-39.66667	25.37938	.131	-92.0471	12.7138
		CONTROL GROUP	-11.11111	25.37938	.665	-63.4916	41.2694
	CONTROL GROUP	SPORTS-MASSAGE	-28.55556	25.37938	.272	-80.9360	23.8249
		FRIRAGE MASSAGE	11.11111	25.37938	.665	-41.2694	63.4916

*. The mean difference is significant at the 0.05 level.

IgA levels in the blood increase with moderate exercise , sports massage and the frirage massage applied with weight circuit training for 1 hour and rest of 1 hour cannot increase immune. This can all occur because it is suspected that weight training is considered too heavy so that it results in psychological and physiological pressure, this is reinforced by the results of research from [35] who conducted a study to determine the response of s- IgA on top 10 Brazilian professional futsal players after 2 very competitive matches separated by 7 days. Unstimulated saliva was collected for 5 minutes before and after the match. S-IgA is measured. The results showed that competitive match training triggered a decrease in the s-IgA levels of top-level futsal players, which suggests an increase in susceptibility to infection was mediated by the training stimulus. This decrease indicates that athletes are at increased risk of developing upper respiratory tract infections. This conclusion is reinforced by Rosa Adriana Jarillo-Luna, et al [36] that intense psychological and physical stress can increase susceptibility to infection by various pathogens in the upper respiratory tract. [37] studied Decreased salivary immunoglobulins after intense interval exercise before and after training, the results showed that IgA and IgM concentrations relative to total protein decreased after each exercise session; IgG concentrations relative to total protein did not change after exercise. IgA, IgM, and IgG flow rates decrease 50-65% after interval training. No training effect on the immune parameters was measured, although the total work done in the five attacks 60 seconds increased after training. These data suggest that salivary IgA and IgM output decreases after brief supramaximal interval training, and that the reduction in output is due, at least in part, to decreased salivary flow. In addition, there appears to be a specific effect of intense exercise at greater IgA concentrations than those caused by decreased salivary flow alone.

In addition to cell proliferation, the recovery phase from exercise, especially after very long endurance-based exercise, is characterized by a marked change in the functional capacity of some blood leukocyte populations. Neutrophilic bactericidal activity is strongly influenced by the intensity and duration of exercise. For example, 1 hour cycling at 50 vs. 80% $\dot{V}$o2max increased respectively and reduced the oxidative blast activity of neutrophils [38]. During the early stages of recovery after exercise, neutrophilic bactericidal activity continues to increase after 40 minutes to 1 hour of moderate intensity exercise, whereas it remains disrupted after tiring or prolonged exercise (86). NK cell cytotoxicity after exercise attacks of relatively short duration tends to remain unchanged on a per cell basis during recovery [39] but may decrease after very long attacks [40]. T cell proliferation in response to mitogen stimulation usually decreases during and after exercise, regardless of exercise modality, intensity, or duration [Prolonged exercise can also reduce T-cell movement and displacement [41], lipopolysaccharide-induced cytokine secretion by monocytes [42] and the percentage of T cells that produce effector cytokines in response to mitogen stimulation [43]. Thus, a general trend during exercise recovery is that brief, moderate-intensity exercise has little effect on (or perhaps even enhances) cellular immune function, whereas prolonged bouts (> 1.5 hours) of strenuous activity appear to reduce the normal functioning of all major activities. immune cell subtypes. This effect can make athletes susceptible to disease during recovery from vigorous competition or training [44].

Studies over a short period (2–4 weeks) of excess function have reported decreased resting neutrophil degranulation [45] lymphocyte proliferation, and antibody production [45]. Neutrophil counts, plasma cytokine concentrations, CD4-to-CD8 T-cell ratio, and salivary IgA concentrations varied more (or did not change) in response to borderline function [46, 47, 48, 49]. Athletes who show signs of nonfunctional overreach and / or frequent upper respiratory disease with lower salivary IgA concentrations [50, 51, 52]; decreases cytokine production by monocytes, neutrophils, and dendritic cells [53] and more activated lymphocytes (CD25 +) [54]. Changes in differential blood cell counts, lymphocyte subsets, and NK cell counts after an extended period of intense training varied [55, 56, 57]. Studies of athletes demonstrating the features of overtraining syndrome (including disease) have not revealed a consistent or characteristic immune profile [58, 59].

On the basis of the foregoing, the treatment of sports massage and frirage massage has not been able to increase IgA levels in the blood because it is suspected that including a rest time of only 1 hour.Then the massage for 45 minutes results in inhibiting T cell movement, secretion of cytokines induced by lipopolysaccharides by monocytes and cell percentage. T which produces effector cytokines in response to mitogen stimulation which results in little effect on cellular immune function, on the other hand, circuit weight training only once including massage treatment in each group also only once.

5. Conclusions

1. Massage eexercises cannot significantly increase IgA antibody levels after strenuous exercise.
2. Frirage massage cannot significantly increase IgA antibody levels after strenuous exercise.
3. Sports massage was more effective in increasing IgA antibody levels after strenuous exercise than frirage massage and the control.

It is recommended to expand and increase the number of samples in order to draw more precise conclusions from the research results. Blood draws should be done before getting any activity. Data collection in the form of blood tests to measure IgA antibody levels was only done twice.

Firstly before strenuous exercise and secondly after resting for 1 hour after massage, which should be measured four times before doing strenuous activity, after resting for 1 hour of strenuous activity, after massage, and 1-2 hours after massage in order to get precise results in research. Data collection should not only be done in one day, but preferably for 2 weeks and training and measurements should be carried out three times a week to obtain more objective and accurate results.

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Combined Effects of Weight Training and Aerobic Exercise Accompanied by Normal and Low-Calorie Diets on Fat Percentage of Young Women

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Abstract Sports with a combination of weight training and aerobics are expected to be an alternative to increase students' desire to exercise and reduce fat more effectively. Therefore, this study aims to determine the potential of combined aerobic exercise and weight training to be an alternative to reducing body fat combined with a normal diet program with a low calorie diet program. This research is a quantitative quasi-experimental research with pre-test and post-test control group design. With a total of 60 participants, which were divided into two groups, namely the experimental group using the low calorie diet program and the control group using the normal diet program. All data obtained were searched for the mean and the differences between the two body fat reduction programs using independent sample t-test. The combination of aerobic exercise and weight training can reduce participants' body weight, body fat and waist circumference, both in the normal diet and low-calorie diet groups. However, the low calorie diet program is more effective than the normal diet. This is evidenced by the significant reduction in body fat and strengthened by the independent sample t-test which is seen from the t value which is greater than the t table and the significance value obtained is less than 0.025, namely 0.012 for weight loss, 0.011 for a decrease in the percentage of fat, and 0.010 for a decrease in waist circumference. It is concluded that there is a difference in the decrease in the percentage of fat in the normal diet and low calorie diet groups.

Keywords Aerobics, Normal Diet, Low Calorie Diet, Weight Training

1. Introduction

Obesity and overweight are increasing both in developed countries like the USA and Europe and in developing countries such as in Asia, namely Iran, Sri Lanka and Bangladesh including Indonesia. Over the past 3 decades, in general, adults who are overweight and obese throughout the world have increased significantly [1]. The problem of obesity also affects children. In the United States, in the range 2011-2014, as many as 17% of cases of obesity are commonly found in children, and 5.8% are classified as cases of extreme obesity found in young people aged 2-19 years [2-5]. The National Health Research Data (Riskesnas) in 2016 shows that the adult population over 18 years who are overweight or obese is 20.7%. That number shows a rapid increase from 2013 when the overweight population reached 15.4%. A Global Burden of Diseases study published in the journal Lancet in 2014 revealed that there were 10 countries with the highest obesity rates in the world and Indonesia ranked 10th.

Obesity is a pathological state because of the accumulation of excess fat than is needed for bodily functions [6, 7].There are so many risks of health problems that can occur in children or adolescents who are obese. Children with obesity can experience problems with the heart and blood vessel (cardiovascular) systems, namely hypertension and dyslipidemia (abnormalities in cholesterol) [8-11]. Children can also experience liver function disorders where there is an increase in Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) and an enlarged heart. Gallstones can also be formed and diabetes (diabetes mellitus). In the respiratory system, disorders can occur, which affects lung function, snoring during sleep, and often experience obstruction of the airway (obstructive sleep apnea). This will make the child less concentrated on capturing his lessons because he is sleepy and will later be feared, which can affect his performance in school [12].

Some ways to deal with obesity include exercise, diet and psychological therapy. Provision of dietary therapy in obese patients aims to reduce energy intake and increase expenditure so as to achieve ideal body weight. For people who are obese, it is recommended to reduce their food intake by 200-300 kcal / day, with a standard diet of around 1000-1200 kcal / day [13-16]. A low-calorie balanced diet must be balanced with exercise. Regular and continuous physical exercise with a gradual increase in load can reduce the percentage of body fat so that body weight also decreases [17, 18]. Based on this opinion, exercise is the best way to lose weight. According to experts, the type of exercise that is most suitable for obese individuals is aerobic activity. Aerobic activities are sports that burn fat when the activity is carried out. Aerobic activities include all types of bodily activities that use high amounts of oxygen. Treadmills, up and down stairs, swimming, cycling, aerobics are aerobic activities and support fat burning. Burning fat activities need to be done with a specific heart rate target of 50% -75% DNM (maximum pulse rate) for a period of 45-75 minutes so that fat in the body can be burned [19]. That's when the body release fat cells in fat bags as a source of energy.

Weight training is a method of resistance training using weights as a tool to improve physical condition, including physical fitness and general health. Identical weight training to build muscle leads to formation for bodybuilders, but research shows that weight training can play a role in the process of reducing body fat. Weight training is a superior way to reduce body fat and keep fat back in stock [20, 21]. Muscles make metabolism more active. The more muscle you have, the faster your metabolism rate, the more calories you burn, so it is easier for your body to get a slender, firmer appearance. "Combining aerobic exercise with weight training is much more effective at reducing body fat. Combining weight training (weight training) with other sports, will produce maximum fat burning. The trick, weight training (weight training) for 30-45 minutes to burn calories from carbohydrates. Use these moments to do sports in addition to weight training with a heart rate of about 65%. This will optimize the burning of body fat [22].

When undergoing a diet program, exercise is one of the crucial factors. High school students who are still in their teens tend to be lazy to exercise because it drains a lot of energy and causes fatigue. Obese adolescents tend to prefer regulating diets without doing exercise to reduce body fat. The form and type of exercise also determine the enthusiasm of teenagers to exercise. Sports with a combination of weight training and aerobics are expected to be an alternative to increase students' desire to exercise and reduce fat more effectively. Therefore, this study aims to determine the potential of combined aerobic exercise and weight training as an alternative to reducing body fat combined with a normal diet program with a low calorie diet program.

2. Materials and Methods

This research is a quasi-experimental research with pre-test and post-test control group design. That was done to investigate causal hypotheses about causes that could be manipulated by comparing one or more experimental groups that were treated with one comparison group that was not treated [23, 24]. The design of this study was applied because it was in accordance with the objectives of the study, whose the aim was to find out the potential of combined aerobic exercise and weight training as an alternative to reducing body fat. This research uses descriptive statistics in the form of mean, min, max, category and uses inferential statistics. The inferential statistics used are independent sample t-tests and anova.

Table 1. Pretest and Posttest Non-Equivalent Control Group Design

Group	Posttest	Treatment	Posttest
Experimental	O_1	Normal Diet	O_1
Control	O_2	Low Calorie Diet	O_2

Subjects in this study were taken from three senior high school students in Padang City, as many as 110 female students, with details of 36 students in senior high school 1 Padang, 36 students in senior high school 11 Padang, and 38 students in senior high school 11 Padang who were overweight 20% of the BMI standard (obesity). The sampling was based on cluster sampling technique. In cluster sampling two or more elements or two units or more are included in the sample at each sample location [25]. The inclusion of two or more units / elements in each sample location intensified sampling efforts at each sample location. Cluster sampling was chosen because it can facilitate research to collect data from a large research area. In the experimental group there were 18 students and in the control group there were also 18 students of senior high schools 1 and 9 Padang, while for senior high schools 11 Padang, in the experimental group there were 19 students and in the control group there were also 19 students. In the experimental group using a low calorie diet program and in the control group using a normal diet program.

According to Indonesian Government regulation no. 36 of 2009, that adolescent girls must have an ideal body weight level (listed in table 2) and this is a very credible reference for teachers or trainers so that students live well. The obesity category in this study is based on the ideal weight in accordance with Law no. 36 of 2009 concerning Health which can be seen in table 2.

Table 2. Weight categories of Indonesian female adolescents

		Height		
		150 – 160	161 – 170	171 – 180
Weight	Small	43-46 and 48-51	49-53 and 54-58	56-60 and 61-66
	Moderate	45-50 and 50-56	51-57 and 56-63	58-65 and 64-71
	Large	48-56 and 54-61	55-63 and 60-68	62-70 and 67-76

Meanwhile, the participants' responses in adjusting training protocols and equipment can be seen in table 3 below

Table 3. Categories of participant responses to training protocols and equipment

Category	Interval
0.0 – 20.0	Very Easy
20.1 – 40.0	Easy
40.1 – 60.0	Enough
60.1 – 80.0	Difficult
80.1 – 100.0	Very difficult

All samples performed a combined weight training and aerobic exercise. Weight training is done for 15-25 minutes with a load of 30% -75% of 1 RM (Maximum Reps or Best Achievement) and 10-15 reps are performed 2-3 sets of each muscle. Weight training means Lat Pull Down, Shoulder Press, Deadlift and Squat. Then proceed with aerobic exercise by walking on the treadmill for 12-25 minutes with an intensity of 60% -75% DNM (Maximum Pulse), the treadmill used in this study is the electric treadmill OB-1057 with a maximum speed of 10 km / hour with a size of 40 cm x 140 cm. Given a good knowledge of using electric treadmill tools OB-1057, it is used by adjusting the speed starting from the lowest and increasing to a maximum pulse intensity of 60-75% for 12-25 minutes, then using a barbell with a weight of 2.5 kg to perform movements Sholder press where the participant sits in a perfect position, then the hands form a 90 degree seat and when pushing the hands up the participants exhale and when the hands go down the participants inhale until their hands form a 60 degree angle with the body, for exercises using Lat Pull Down by sitting on the Lat Pulldown tool and grasp the bar in an overhand grip slightly over shoulder width. The arms should be perfectly straight and the torso and Pull the shoulder blades down and back, and pull the bar toward the chest. Pause for a moment, then return to the starting position slowly. Take a breath when inhaling the exhalation bar and when returning to the starting position take a breath. While squats are done by opening your feet shoulder width apart, forming a 90 degree squatting position, flat back position and resting on your heels; repeat continuously until you are according to the given target; breathe when going down; take a breath and go up and exhale.

The research treatment was given as many as 16 meetings for 1 month, which had to be followed by the sample. Before starting the exercise the sample was given one week for adaptation to the training equipment and protocol. The low-calorie diet group was instructed to adjust the diet according to the principles of a low-calorie diet by limiting energy-dense foods, such as pastries that contain lots of simple carbohydrates and fat and fried foods. This diet maintains a balance of carbohydrates, fats, protein and vitamin and mineral needs. Energy intake is reduced by 500 Kcal per day from normal needs. Normal protein or slightly above normal requirements, namely 1 - 1.5 g / kg body weight / day or 15 - 20% of normal needs. Fat 15-20% of total energy. Carbohydrates are slightly lower, namely 55 - 65% of the total energy requirement for consumption. Percentage of body fat was measured before and after exercise using the Biometrical Impedance Analysis (BIA) tool, a measurement method with a scale and a handle-shaped device (Schutz, 2002; Kyle, 2004; Lee, 2008; Sivapahty, 2013; Gontarev, 2014; Abulmeaty, 2016). Here the researchers used the Biometrical Impedance Analysis (BIA) tool with the OMRON HBF 375 type.

A nutritionist is tasked with making a low-calorie diet and a normal diet for 30 days, which will be applied to the sample. One example of a normal diet used in this study is as follows: breakfast: 2 slices of whole wheat bread, 2 boiled eggs and 1 cup of coffee; Lunch: Brown rice, 2 chicken breasts, 2 cups of carrots; Dinner: Brown rice, 2 chicken breasts, a bowl of spinach; Snack: a handful of almonds. For a low calorie diet, eat the following menu, Breakfast: Fruit slices with yogurt + 1-2 pieces of whole wheat bread and 1 boiled egg; Lunch: Boiled chicken breast with mashed potatoes + a bowl of spinach; Dinner: vegetable salad and low fat milk + 3 tablespoons oatmeal + 1 boiled egg; Snack: a handful of almonds. An explanation of the sample was given by a nutritionist before carrying out the research and was instructed to commit to running the food menu program. The consumption of sample foods will be recorded through daily questionnaires collected before the training process begins. Samples that do not run the research protocol will be excluded from the research process. After the data is collected then the data is compiled, then the data is processed using the independent sample t-test and ANOVA analysis technique with SPSS 21.

3. Results and Discussion

The research findings are described in this section. For the response of participants in trying to adapt to training equipment and protocols, it can be seen in Table 4 below

Table 4. Results of participant responses in trying out training equipment and protocols

Category				Mean	Min	Max
Response	**Range**	**f**	**%**			
Very easy	00.0 – 20.0	0	0.0			
Easy	20.0 – 40.0	2	1.8			
Enough	40.1 – 60.0	88	80.0	54.8	39	96
Difficult	60.1 – 80.0	13	11.8			
Very difficult	80.1 – 100.0	7	6.4			
Total		110	100			

From table 4, which came from 110 respondents from the senior high school in Padang City after they were obtained and the results using the SPSS 21 application program, the participants trying the equipment and training protocol had the dominant result is good with a percentage of 80.0% of the 88 participants from a total of 110 participants. From 110 students, the mean results were 54.8, the maximum value was 96, and the minimum value was 39.

Meanwhile, the results of the pretest (see table 5-7) and posttest (see table 8-10) in showing the differences in weight training and aerobics in reducing body fat through normal diet programs and students' low calorie diet programs are presented as follows.

Table 5. Pretest results of participants with a height of 150 – 160

Indicator	Groups	Category	Mean
Weight (Kg)	Experiment	Large	58.3
	Control	Large	58.4
Fat Percentage	Experiment		34.4
	Control		34.9
Waist size	Experiment		86
	Control		86

Table 6. Pretest results of participants with a height of 161 – 170

Indicator	Groups	Category	Mean
Weight (Kg)	Experiment	Large	65.7
	Control	Large	65.8
Fat Percentage	Experiment		34.6
	Control		34.7
Waist size	Experiment		87
	Control		87

Table 7. Pretest results of participants with a height of 171 – 180

Indicator	Groups	Category	Mean
Weight (Kg)	Experiment	Large	74.2
	Control	Large	74.3
Fat Percentage	Experiment		34.5
	Control		34.6
Waist size	Experiment		88
	Control		88

From table 5-7, it can be seen that there is no difference between the experimental and control classes, namely both have large weight / obesity categories.

Table 8. Posttest results for participants with a height of 150 – 160

Indicator	Groups	Category	Mean	Min	Max
Weight (Kg)	Experiment	Moderate	50.3	2	8
	Control	Large	56.4	1	2
Fat Percentage (%)	Experiment		23.4	7	11
	Control		28.9	4	6
Waist size (cm)	Experiment		81	1.5	5
	Control		82	1	4

Table 9. Posttest results for participants with heights 161 – 170

Indicator	Groups	Category	Mean	Min	Max
Weight (Kg)	Experiment	Moderate	50.3	2	8
	Control	Large	56.4	1	2
Fat Percentage (%)	Experiment		23.4	7	11
	Control		28.9	4	6
Waist size (cm)	Experiment		81	1.5	5
	Control		82	1	4

Table 10. Posttest results for participants with a height of 171 – 180

Indicator	Groups	Category	Mean	Min	Max
Weight (Kg)	Experiment	Moderate	65.1	3	9
	Control	Large	71.6	1	3
Fat Percentage (%)	Experiment		22.6	7	12
	Control		27.7	3	7
Waist size (cm)	Experiment		83	2	5
	Control		84	1.5	4

The results of descriptive statistics show that there is a gradual decrease in body weight, fat percentage and waist circumference. The decrease of each variable occurs gradually from pretest to posttest. The effect of treatment on the percentage of fat was analyzed by comparing the pretest and posttest data in the normal diet and low calorie diet groups. All statistical processing uses the IBM SPSS Statistics 24 program.

From table 8-10, we can see that the experimental class is superior in reducing body fat, both from body weight, fat percentage, and circumference owned. In the experimental class, the weight loss was 8 kg, while the control class was 3 kg, the percentage of body fat was also outperformed by the experimental class by being able to reduce it by 11%, while the control class was able to reduce it by 6%. Then for waist circumference the experimental class was also outperformed by 5 cm while the control class was 4 cm. Based on this, it can be seen that the use of weight training with aerobics assisted by a low calorie diet program is more effective than the use of weight training with aeribok combined with a normal diet program. However, this has not been able to strengthen the difference between the use of weight training with aerobics assisted by a low calorie diet program with a normal diet program, so inferential testing is carried out using ANOVA (Tables 11-14) and independent sample t-test in table 15.

Table 11. Results of a normal diet with a combination of weight training and aerobics in Padang City Senior High School

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	358.847	2	179.423	14.237	.000
Within Groups	18009.426	1429	12.603		
Total	18368.273	1431			

Anova test was used to see differences in the normal diet program at three different schools in Padang City. The results of data analysis in table 11 on the normal diet program obtained a significance value of 0.00 or more smaller than 0.05 with a significant level of 0.05. So it can be concluded that there is a significant average difference between participants in senior high school 1 Padang, participants in senior high school 9 Padang, and participants in senior high school 11 Padang measured based on the diet program carried out.

In connection with the difference in the average between the three schools in Padang City for the normal diet program, to see the significant difference in the average success of the normal diet program carried out by the participants, the Tukey post hoc test was carried out. Based on the results of the analysis that has been done, the results are as shown in table 12 below:

Table 12. Post hoc using Tukey on a normal diet program

Normal Diet Program			
Tukey HSD^{a,b}			
SEKOLAH	N	Subset for alpha = 0.05	
		1	2
Senior High School 1	36	26.7349	
Senior High School 9	36		28.0876
Senior High School 11	38		28.1086
Sig.		1.000	.997

Based on Table 12, it can be concluded that there is a significant difference in the group average between senior high schools in Padang City. Furthermore, there is also a significant difference in the group mean between senior secondary schools in 9 Padang cities and senior high schools in 11 Padang cities. The smallest group average in senior high school in Padang City is 26.7349, followed by senior high school in 9 Padang cities with a group average of 28.0876 and the largest average senior high school 11 in Padang is 28.1086.

Table 13. Results of a low calorie diet with a combination of weight training and aerobics in Padang City Senior High School

ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	550.384	2	275.192	8.097	.000
Within Groups	48568.529	1429	33.988		
Total	49118.913	1431			

Anova test was used to see differences in low calorie diet programs in three different schools in Padang City. The results of data analysis in table 13 on the low-calorie diet program obtained a significance value of 0.00 or less than 0.05 with a significant level of 0.05. So it can be concluded that there is a significant average difference between participants in senior high school 1 Padang, participants in senior high school 9 Padang, and participants in senior high school 11 Padang measured based on the diet program carried out.

In connection with the difference in the average between the three schools in Padang City for the normal diet program, to see the significant difference in the average success of the normal diet program carried out by the participants, the Tukey post hoc test was carried out. Based on the results of the analysis that has been carried out, the results are as shown in table 14 below:

Table 14. Post has been using Tukey on a low calorie diet program

Low Calorie Diet Program			
Tukey HSD^{a,b}			
SEKOLAH	N	Subset for alpha = 0.05	
		1	2
Senior High School 1	36	34.0418	
Senior High School 9	36		35.2789
Senior High School 11	38		35.4279
Sig.		1.000	.918

Based on Table 14, it can be concluded that there is a significant difference in the group average between senior high schools in Padang city. Furthermore, there is also a significant difference in the group mean between senior secondary schools in 9 Padang cities and senior high schools in 11 Padang cities. The smallest group average in senior high school 1 in Padang City is 34.0418, followed by senior high school 1 Padang city with an average group of 35.2789 and the largest average senior high school 11 Padang City is 35.4279.

Table 15. Results of the Independent sample t-test for participants' weight loss

	T	Df	Sig	Std. Deviation	*95% confidence interval*	
					Lower	*Upper*
Weight loss	14.163	110	0.012	2.51	12.236	.4120
	14.163	76.321	0.012	1.83	11.935	.5615
Decrease in fat percentage	14.271	110	0.011	2.73	12.344	.4235
	14.271	77.641	0.011	1.92	11.998	.5715
Decrease in waist circumference	14.359	110	0.010	2.61	12.297	.4310
	14.359	76.952	0.010	1.88	11.976	.5698

From table 15 the value obtained (t count) can be seen. The value of t table can be seen in the t table with a significance value of 0.025 (2-sided test) with 110 degrees of freedom (df). In this study, the t table results were 1.98177. However, the t value can be seen in table 10. (Column t) is 14.163 for a reduction in body weight, 14,271 for a decrease in fat percentage, and 14,359 for a decrease in waist circumference. The criteria for testing the hypothesis in this study if the t table value is smaller than the t count or the sig value obtained is smaller than the specified (0.025), then there is a difference [32]. Therefore, based on the results obtained, t count is greater than t table; there is a comparison between the two ration methods used. And it is reinforced by the significance value which is below 0.025, namely 0.012 for weight loss, 0.011 for a decrease in fat percentage, and 0.010 for a decrease in waist circumference. So it can be concluded that there is a significant difference between the control group using the normal diet program and the experimental group using the low-calorie diet program with a combination of weight training with diet-assisted aerobics. It can be seen from table 7-9 that the average value of the participants' fat reduction was 11%, which means that weight training combined with aerobic field assisted by a low-calorie diet program is effective in reducing body fat.

Based on the results that have been obtained (see table 3-10), the combined weight training with aerobic exercise which is assisted with a low calorie diet program is more effective than the combined weight training with aerobic exercise that is assisted with a normal diet program. In addition to exercising, by consuming foods that are low in calories, will make the remaining calories in the body into energy, thus accelerating the decline in the weak body, because calories out more than calories that enter the body. To find out which diet has the most effective effect, the analysis is continued by using the independent sample t-test with the result that the t value is greater than t table, then it is concluded that there is a difference in decreasing the percentage of fat in the normal diet and low calorie diets.

Fat can be reduced from the body by making it a source of energy. One way that energy can be produced in large quantities is to do physical exercise or exercise. However, not all physical exercise can burn fat into energy. The use of fat as energy will occur after the use of glucose as energy is not possible [33]. Changes in fat are influenced by the amount of energy expended versus the amount of energy consumed. Therefore, if energy expenditure is still low, but excessive levels of food consumption, weight gain will occur [34].

Fats produce enormous amounts of energy, this is because the amount of fat is stored in the human body. It's just that its use requires a long time because of so many processes and requires a variety of enzymes. Energy stored as fat in adipose tissue is used as a source of fuel by the body after the available energy is obtained from depleted glucose [35-37]

Exercise is a systematic process or work done repeatedly over a long period of time by increasing the training load gradually and has an individual nature. Each set of movements in the exercise is designed to improve abilities by involving energy generation and muscle activity and adapting to repetitive stimulation [38-40]. The series of movements that continues to increase in physical exercise, certainly requires great energy. The use of fat requires oxygen as a burning compound, so that efficient physical exercise to reduce fat levels is aerobic physical exercise. Aerobic exercise is an exercise that uses energy that comes from burning with oxygen so that it requires oxygen.

As stated in previous theoretical studies, combined training in weight training and aerobics is an effective form of exercise in reducing body fat percentage. Because weight training (weight training) at the beginning aims to utilize sugar energy (glycogen) which is still available in the liver and muscles more optimal, so that when doing the next exercise, aerobic exercise, the body already uses fat as the main source in minutes the first. This is in accordance with Virtuoso (2019), who stated that "Weight training is a superior way to reduce body fat and keep fat from being piled up again. Muscles cause metabolism to become more active. The more muscle you have, the faster your metabolic rate, the more calories you burn, making it easier for your body to get a slender, firmer appearance" [41]. Research with moderate intensity running exercises has shown subcutaneous fat has the most reduction, followed by subcutaneous hand and body sequences. The exercise is a moderate intensity running activity. Running movements that prioritize leg movements to move the body position cause the legs to move continuously. Continuous leg muscle movement causes leg muscles to use fat as an energy source and reduce foot subcutaneous fat [42, 43].

The study was conducted to compare aerobic exercise with aerobic and weight training combined exercises. Research conducted on 20 obese adults shows that both forms of exercise have a significant effect on decreasing body weight, BMI, and body fat percentage. The exercise is done 4 times a week for 8 weeks. Aerobic exercise is done using a treadmill with a target of 70% HRM training monitored by using a wireless heart rate monitor. Aerobic combination training and weight training done with aerobic exercise for 30 minutes then proceed with 10 times repetition and 2 sets of weight training. Expenses takes 70% of RM [44].

Other studies have been conducted on 119 obese samples aged 18-70 to determine the effect of weight training and or aerobic exercise on body fat. Aerobic exercise is done equivalent to 12 miles / week calories with an intensity of 60-80% VO2max; weight training is done 3 times a week; 3 sets per day with 8-12 reps per set; combination training is done with a combination of aerobic exercise and weight training. The study was conducted for 8 weeks. Body composition was measured using a Dual Energy X-ray absorptiometry machine (DEXA). The results showed the aerobic exercise group and the combination exercise group significantly reduced body mass and fat mass compared to the weight training group. However, the increase in lean body mass occurred significantly in the weight training and combination groups [45]. Previous research concluded that a combination of aerobic exercise and weight training can help reduce body fat and also help increase muscle mass so that the body becomes fitter.

To reduce the percentage of fat, a balance must be maintained between calories in and calories out. If the incoming energy is the same as the energy expended, then the weight will be maintained, if the incoming energy is greater than the energy expended, then the rest will be stored as fat so that the weight will increase. A low calorie balanced diet is a diet whose energy content is below normal requirements, enough vitamins and minerals, and enough fiber is useful in the process of weight loss [46, 47]. This diet limits energy-dense foods, such as cakes that contain lots of simple carbohydrates and fats and fried foods. In this diet while maintaining the balance of carbohydrates, fats, proteins and mineral vitamin requirements. This is consistent with the opinion (Ross, 2004; Allard, 2007; Anding: 2001; Zalilah, 2006; Layman, 2005) that "with a balanced low-calorie diet effectively decreases weight, BMI, skinfold thickness, fat mass percentage, increases percentage fat free mass, reduce waist to hip ratio, and serum leptin levels" [48-52]. So this low calorie diet is better in an effort to reduce body fat.

The study showed no significant differences between the normal diet and low calorie diets, because the control of research samples in the regulation of nutrition that has not been strict. Regarding the diet menu given because researchers have not been able to fund the nutritional needs of the sample during the study period, so that only a dietary reference from the nutritionist is given to each sample in accordance with the division of the designed diet group, then controlled by doing a food recall. Of course, in the implementation of food recall to the sample there were some deficiencies in getting data due to the competence of the research team who carried it out so that their ability to dig information from the sample was not perfect.

4. Conclusions

The combination of aerobic exercise and weight training can reduce participants' body weight, body fat and waist circumference, both in the normal diet and low-calorie diet groups. However, the low calorie diet program is more effective than the normal diet. This is evidenced by the significant reduction in body fat and strengthened by the independent sample t-test. According to the t value, it is greater than the t table and the significance value obtained is less than 0.025, namely 0.012 for weight loss, 0.011 for a decrease in the percentage of fat, and 0.010 for a decrease in waist circumference. It is concluded that there is a difference in the decrease in the percentage of fat in the normal diet and low calorie diet groups.

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An Experimental Model on Multiple Regression Analysis in CMJ and SJ Jump Tests on 10 -14 Years Old Players of Tirana Football Club

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Abstract In vertical jump performance, the goal of the task is simply to jump as high as possible. In many sports, the height at which an athlete can jump is often of critical importance, as well as the maximal force applied during the vertical jump. In the absence of resistance to air and other external forces, the projection of the center of gravity COG of the whole body is completely determined by the vertical velocity at the moment of takeoff and the acceleration due to gravity. However, this quality does not fully describe the full jump and height achieved. This study aims to use the multiple regression method in both CMJ and SJ vertical jump tests, to understand whether vertical jump performance for Hmax and Fmax respectively parameters, can be predicted based on anthropometric variables such as: age, height, and body mass, as well as biomechanical variables such as: vmax, F.tot.rel, EFI and efficiency. Multiple regression method allows to determine the overall fit of the model and the relative contribution of each of predictor to the total variance explained. The equations of regression for this team emerged these parameters as the best predictor of the main variables for each test: for Hmax in CMJ test: vmax and body mass; and for Fmax in SJ test: body mass and Pmax/kg.

Keywords Counter Movement Jump, Squat Jump, Multiple Regression Analysis

1. Introduction

Locomotion and neuromuscular function are important factors in understanding and assessing motor performance. The assessment of motor function through jumping movements using force plate measurements are used as an indicator of motor function, [5]. Vertical jump ability is required for success in a number of sports [4]. A study has found that the ability to generate lower body power is a key component for success in many sport activities [7]. There are a variety of strength training methods that are used to develop athletic performance [12], such as sprinting and jumping. Strength training exercises can be classified as general, special or specific, depending on their biomechanical structure and effect on the neuromuscular system, as reported in studies some studies [3; 4]. Applied to the vertical jump, general strength training exercises are those that are aimed at increasing the maximal strength of the muscles involved in jumping [4]. Vertical jump performance is dependent on contractile properties of muscle as well as the augmentation to the concentric work that occurs due to the stretch shorten cycle, as is shown by some studies [5; 8]. A vertical jump that is preceded by a rapid SSC cycle is called a countermovement jump (CMJ), as opposed to a jump that is not immediately preceded by a prestretch, for example a squat jump (SJ) [4]. The usage of arms during a CMJ has been shown to increase takeoff velocity, ground reaction force (GRF) and the height of the center of gravity (COG) prior to takeoff [11]. Various types of strength-training modalities have been utilized in order to improve lower body power as can be measured by vertical jump [7]. Body weigh jumping refers exclusively to non-weighted lower body plyometric exercises, such as squat, countermovement and drop jumps. Body weight jump is also highly practical, because it requires little or no equipment, and can be performed in almost any location and requires limited technical ability [1]. Some studies have shown that both the individual plyometric and weight training programs increased vertical jump performance, but the combination program showed the greatest improvement of vertical jump performance, [2; 5; 10].

The application of the laws of physics to human movement allows a scientific description of this motion. According to the second Newton's law, the ground reaction force $F_z(t)$ and the body weight are related to the vertical accelerating during vertical jump as follow:

$$\sum F_Z = m\frac{dv_z}{dt} = F_Z(t) - mg \tag{1}$$

So, the velocity at takeoff phase is given as:

$$v_{t_0} = \frac{1}{m}\int_{t_1}^{t_2}[F_Z(t) - mg]dt \tag{2}$$

Based on the energy conservation law, the mechanical energy of the COG in the peak of height can be expressed:

$$E_{K_{t_0}} + E_{P_{t_0}} = E_{K_h} + E_{P_h} \tag{3}$$

Solving the equation the vertical velocity at takeoff is related to the jumping height as follows:

$$H_{jump} = -(\frac{v_{take-off}^2}{2g}) \tag{4}$$

Some studies have found that jumping ability can be improved in several methods [4; 5], which includes general and specific exercises.

2. Material and Methods

The participating subjects were taken from Tirana football club team, through the application of test measurements performed on a force plate Leonardo Mechanograpy GRF [9], at the Sports University of Tirana, in Biomechanics laboratory. Subjects participating in were 29 boys aged 10-14, mean (12.1 ± 0.62) years old. Informed consent was obtained from the parents of subjects, in order to consider them as participants of the study. The subjects were tested in two forms: CMJ (counter movement jump) test – test for maximal height, performed with arm swing, and SJ (squat jump) test- test for maximal force, jump without arm swig with arms closed to the waist. The study period includes three phases. The study period includes three phases. The initial phase: before training measurements, middle: after six months and the final phase: nine months after training measurements. The program was based on combined general and specific strength training improving maximal jump height and maximal output strength training which included: plyometric, izokinetic and kinetic chanin exercises. Statistical analyses were performed using SPSS version 20. During the processing of the results, multilpe regression method was used. This method allows to determine the overall fit of the model and the relative contribution of each of predictor to the total variance explained. Statistical significance was set for all statistical procedures at $p \leq 0.05$.

3. Results

Table 1 gives the descriptive statistics of the anthropometric parameters and generates also the variables obtained during the three measurements of CMJ and SJ test, which are used to find the best predictor in multiple regression analysis.

Table 1. Statistical descriptive of anthropometric parameters and variables on three different phases of CMJ and SJ tests

Measurement		Parameter	Mean±SD	Rank	Min. Value	Max. Value	Variance
Anthropometric characteristics		Age (years old)	12.10 ± 0.62	4.00	10.00	14.00	0.38
		Height (m)	1.54 ± 0.94	0.40	1.36	1.76	0.01
		Body mass (kg)	46.55 ± 9.74	38.40	31.90	70.30	94.81
		BMI (kg/m^2)	19.30 ± 2.37	8.71	15.58	24.29	5.63
CMJ test	Phase I	H1max (m)	0.37 ± 0.05	0.21	0.27	0.48	0.003
		V1max. (m/s)	2.31 ± 0.17	0.73	1.87	2.60	0.03
		E.F.I.1	102.03 ± 14.25	50.00	75.00	125.00	203.03
	Phase II	H2max (m)	0.42 ± 0.57	1.16	0.33	0.49	0.003
		V2max. (m/s)	2.40 ± 0.15	0.50	2.14	2.64	0.02
		E.F.I.2	109.38 ± 10.95	35.00	92.00	127.00	119.96
	Phase III	H3max (m)	0.45 ± 0.05	1.21	0.35	0.56	0.003
		V3max. (m/s)	2.51 ± 0.13	0.56	2.23	2.79	0.02
		E.F.I.3	114.97 ± 10.26	36.00	100.00	136.00	105.25
SJ test	Phase I	F1max (kN)	1.07 ± 0.25	0.97	0.69	1.66	0.06
		P1max./kg	37.66 ± 4.13	14.60	29.04	43.64	17.02
	Phase II	F2max (kN)	1.19 ± 0.27	1.16	0.81	1.97	0.07
		P2max./kg	40.14 ± 4.32	16.46	30.48	46.94	18.64
	Phase III	F3max (kN)	1.40 ± 0.28	1.15	0.97	2.12	0.08
		P3max./kg	41.58 ± 4.55	17.45	31.08	48.53	20.72

3.1. Results of Multiple Regression to the First CMJ Test

In the first CMJ test, the multiple regression method is used to understand if the performance of vertical jump test to measure the maximum height (Hmax) can be predicted based on anthropometric variables such as age, body height, body mass and also in the biomechanics variables as maximum velocity (Vmax), the total relative strength (F.tot.rel), Esslinger Fitness Index (EFI) and efficiency of movement.

3.2. Adjusting the Overall Model

Multiple regression methods allow determining the overall fit of the model and the relative contribution of each predictor in complete variance to explain. At CMJ test should be known the percentage of variation of test performance on the dependent variable (Hmax) that can be explained by anthropometric and biomechanics parameters as a whole, but also the "relative contribution" of each of the independent variables in explaining variance. By application of the method of multiple regression for the anthropometric and biomechanical data obtained for the first CMJ test, table 2 is generated.

Table 2 gives a summary overview of the model. → R value represents the coefficient of multiple correlations. R can be considered to be a measure of predict quality (Hmax). A value of R = 0.742 in this case shows a good level of prediction. Value R^2 is also the coefficient of determination, which is part of the variance in the dependent variable that can be explained by the independent variables; values R^2=0.555 shows that independent variables taken on this model can explain 55% of the variance of the variable independent, so Hmax.

Table 2. Summary of the overall model.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.742[a]	.550	.428	.03944

a. Predictors: (Constant), E.F.I, body height, body mass, age, Fmax.rel, Vmax.

R^2 value adjusted is used to report and accurately interpret the model as a whole, then R^2=0.428 vale adjusted accurately explains 42.8% of the variance of Hmax in the CMJ test.

In the Anova table, value F Fisher test whether the full regression model fits well with the data. For this parameter, the value of Fischer's, $F(6, 22)=4.490$ and $p= 0.004$. $p <0.050$ means that the regression model fits well with the data.

3.3. CMJ Test- The Model Coefficient Calculation

The regression coefficients table offers the information needed to predict the dependent variable (Hmax) by independent anthropometric and biomechanics variables as well as to determine the statistical model significance (based on the value of the column t and sig column. value p). Based on beta coefficients (β), the general form of Regression equations for predicting Hmax is:

$$H_{max}(predicted) = y = -0.214 + 0.001(Age) + $$
$$+ 0.055(Body\ length) - 0.002(Body\ mass) +$$
$$+ 0.26(v_{max}) - 0.011(EFI) \quad (5)$$

This equation gives an analysis of the overall prediction, but provides no information on the best predictors. The coefficient table also tests for statistical significance of each of the independent variables, so it tests if the coefficients are equal to zero in the population. Exploratory study provides information on which independent variables are the most important and best predictors of the regression model.

3.4. Finding the Best Models on CMJ Test

Table 3 provides a summary of exploratory models, indicating which variables are included in the model step by step.

Table 3. Summary exploratory model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.673[a]	.452	.432	.03929
2	.735[b]	.541	.505	.03667

a. Predictors: (Constant), Vmax

b. Predictors: (Constant), Vmax, body mass

According to the model A) → Vmax is the best predictor alone. For this variable, R= 0.673, R^2 = 0452 and the first step estimates 45.2% of the variance of the independent variable. F and p value reported by Anova are: F (1, 27) = 22,314, p <0.001

According to the model B), Vmax and body mass are the best predictor model. So, body mass is the second best predictor and added after Vmax and which is included in the model. For both variables, R= 0.735, R^2=0.541 and the second step calculates the 54.1% of the variance of the two respective variables. The corresponding values are: F(2,26)=15,308; p<0.001.

Both models together have significant results, since both of them p<0.001.

3.5. Results of Multiple Regression to the Second SJ Test

In the second SJ test, the multiple regression method is used to understand if the performance of the vertical jump test to measure the maximum force (Fmax) can be predicted based on the anthropometric variables such as: age, body height, body mass and also on the biomechanical variables such as: maximum vertical jump height (Hmax), maximum velocity (Vmax), Esslinger Fitness Index (EFI) and efficiency of movement.

3.6. Finding the Best Model on SJ Test

A summary of exploratory models indicating which variables are included in the model step by step is shown in table 4.

Table 4. Summary of exploratory model.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.497[a]	.247	.219	.24565
2	.594[b]	.353	.303	.23215

a. Predictors: (Constant), Body mass

b. Predictors: (Constant), Body mass; Pmax/kg

According to the model A), → Body mass is the best predictor alone. For this variable, R=0.497, R^2=0.247 and the first step estimates 24.7% of the variance for the independent variable. F(1, 27)= 8.58 and p=0.006.

According to the model B), Body mass and Pmax/kg are the best predictors model. So Pmax/kg is the second best predictor added after body mass and that was included in the model. For both variables, R=0594, R^2=0353 and the second step calculates 35.3% of the variance of these two variables. F (2, 26) = 7079 and p = 0.00.

Both models together have significant results, since for both models p < 0.050.

4. Discussion

4.1. The Regression Equation for the Best Predictors on CMJ test

The beta coefficients array (β) gives the corresponding values for a better predictor model; therefore, based on them regression equation can be constructed. Table 5 noted that β coefficients vary depending on the predictors are included in the model.

Table 5. Beta coefificients on CMJ test.

Coefficients[a]						
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.220	.142		-1.544	.134
	Vmax	.267	.057	.673	4.724	.000
2	(Constant)	-.193	.133		-1.445	.160
	Vmax	.286	.053	.721	5.354	.000
	Body mass	-.002	.001	-.301	-2.235	.034

a. Dependent Variable: Hmax.

The regression equations for both models involved in exploratory study are as follows:

Equation according to the model A)

$$Y = -0.22 + 0.267(v_{max}) \tag{6}$$

This is the weight of an equation that includes: Vmax as the best predictors of this model. According to this equation, for any speed increase of 1m/s there is an increase of Hmax with 0.267 m or 26.7 cm.

Equation according to the model B)

$$Y = -0.193 + 0.286(v_{max}) - 0.002(Body\ mass) \tag{7}$$

These are the weights for an equation that includes: Vmax and body mass as the best predictors of this model. According to this model, for any increase in speed of 1m /s there is an increase of Hmax with 0.002 m or 0.2 cm. From the inverse analysis, very small changes of R^2 between the initial step and exploratory study are seen, and this is why models A and B exclude other predictors as not very important in the regression model.

4.2. The Regression Equation for the Best Predictors on SJ Test

Table of beta coefficients (β) gives the corresponding values for a better predictor model; therefore, based on them, regression equation can be constructed. From Table 6, it is noted that β coefficients vary depending on the predictors are included in the model.

Table 6. Beta coefficients on SJ test

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.740	.227		3.267	.003
	Body mass	.014	.005	.497	2.977	.006
2	(Constant)	-.126	.473		-.268	.791
	Body mass	.015	.005	.526	3.322	.003
	Pmax.kg	.020	.010	.326	2.057	.050

Dependent Variable: Fmax.

The regression equations for both models involved in exploratory study are as follows:

Equation according to the model A

$$y = 0.74 + 0.014(Body\ mass) \tag{8}$$

This is the weight of an equation that includes: body mass as the best predictors of this model. According to this equation, for any increase in body mass of 1kg there is also an increase of the Fmax with 0.014 kN or 14N.

Equation according to the model B)

$$y = -0.126 + 0.015(Body\ mass) + 0.02(P_{max} / kg) \tag{9}$$

These are the weights for an equation that includes: Body mass P.max/kg as the best predictors of this model. According to this model, for any increase in body mass of 1kg there is also an increase of Fmax with 0.014N and for every 1 Watt/kg added to Pmax/kg there is an increase of Fmax with 0.02 kN, or 20N.

5. Conclusions

Combined general and specific strength training is effective as power training for improving maximal jump height and maximal output in CMJ and SJ tests. The strength exercises develop and improve the psychophysical, coordinative and locomotive condition, enabling the subject to both mentally mobilize and having a higher muscular tonification, by gradually increasing the moving efficiency; and the performance is improved. Multiple regression method applied to CMJ and SJ tests for Tirana futball team allows to determinine the overall fit of the model and the relative contribution of each of predictor to the total variance explained. In both tests, it was found how much of the variation in the test performance of the depended variable can be explained by anthropometric and biomechanical parameters as well as the relative contribution of each independent variable in expaining the variance. Multiple equations of regression for this team emerged these parameters as the best predictor of the main variables for each test: for Hmax in CMJ test: vmax and body mass; and for Fmax in SJ test: body mass and Pmax/kg. Clearly, the jumping technique strongly affects the mechanical output muscles, as the motors that generate explosion maximal force and also maximal jump height. Finally, all strength exercises in Tirana Football team players have improved the biomechanical parameters, including the sportive technique.

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