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RESEARCH ARTICLE

Comparison of Human Performance Laboratories in American and Turkish Universities

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Abstract

Although the physiology of exercise developed with a multidisciplinary approach is dynamic and exciting for the 21st century, it is important to know how to use the laboratory devices and equipments which is essential to conduct scientific researches in this field. Sixteen human performance laboratories in USA and thirteen human performance laboratories (HPL) in Turkey and the current status of the devices and equipments which exist in these laboratories have been examined in this study. The present material in the human performance laboratories was evaluated to provide the measurement based on 7 specific areas (1. Pulmonary functions 2. Muscle strength, endurance and flexibility 3. Walking analysis, biomechanics and movement analysis 4. Cardiovascular functions 5. Body composition 6. Reaction time and balance 7. Competition analysis systems for coaches) determined by the researchers and 43 devices and equipment which should be present in the laboratories were determined with the help of the survey conducted as a result of face-to-face interview. According to the results of the descriptive parameters of the current investigation it was found that devices and equipments that enable to examine lung function, muscle strength and stamina, body composition, isokinetic dynamometers, reaction time and balance tests were relatively prevalent in Turkish HPL while cardiovascular system analysis, gait analysis, biomechanics, motion analysis, video analysis and flexibility measurements were less common compared to American Universities. Consequently, there are similarities and differences between Turkish and American HPLs in terms of devices, measurement tools and equipments which are essential in exercise physiology field.

Keywords

Exercise physiology, Laboratory, Human Performance, HPL

INTRODUCTION

Exercise physiology is rooted in the fundamental disciplines of anatomy and physiology that discover the structure and functioning of the human body (Plowman et al., 2014; Kenney et al., 2012). There are two basic components to exercise physiology: the acute reactions of exercise in all forms of the body, and the adaptation of these systems to repeated or chronic exercises as exercise training (Wilmore and Costill, 1994; Kenney et al., 2012). As a result of acute exercise stress and chronic physical exercise, examining the specific challenges of the body's associated systems is one of the main principles of exercise physiology (Plowman et al., 2014). Thus, when the individuals are exposed to exercise physiology, exercise or physical activity also explores how the body's cardiovascular and Landers, 1987; Joyner and Green, 2009; Wahid et al., 2016), endocrine (Williams, 1996), and musculoskeletal system functions change and challenge homeostasis (Plowman et al., 2014; Kenney et al., 2012).

Although exercise physiology is a dynamic and exciting scientific discipline for the 21st century, the history of exercise physiology is incomplete and fragmented despite the harmonious efforts of distinguished authors (Berryman, 2003;

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Brooks et al., 2000; Kenney et al. 2012; Powersand Howley, 2004; Robergs and Roberts, 1997).

In the last 100 years, exercise physiology has turned into a multidisciplinary field with a group of physiologists who have specialized, as they intensify how the body works during physical activity and sport. When the physiological responses to exercise are assessed in the laboratory environment, the participant's physical effort should be checked to ensure a measurable exercise intensity. This is usually accomplished by using ergometers. An ergometer (ergo = work, meter = measure) is an exercise device that allows the control (standardization) and measurement of exercise intensity. Treadmills are an ergometer preferred by most researchers and clinicians, especially in the United States. For many years, the bicycle Ergometer was the primary tester and is still widely used in both research and clinical environments. Other ergometers allow athletes competing in specific sports or events to be tested closer to training and competitions. For example, an arm ergometer can be used to test athletes primarily using their arms and shoulders in physical activity. The arm ergometer has been widely used to test and perform paralyzed athletes below arm level. Rowing ergometer is designed to test the competitive rowers (Kenney et al., 2012).

An important part of the physiology of exercise relates to the reaction and adaptation of people to extreme cold, warm, depth and altitude. To understand and control the physiological stresses and adaptations that arise in these environmental boundaries, they have contributed directly to important social gains. Along with space racing, the field of exercise physiology has gained a new dimension. No doubt, further research in exercise and environmental physiology is essential to complete the greatest exploration goal of the 21st century (Kenney et al., 2012).

The first exercise Physiology laboratory and associate degree program in the United States started with the establishment of the Harvard Fatigue Laboratory (Kenney et al., 2012; Porcari et al.,2015).

This laboratory contributed to the field by conducting research activities of scientists from 15 different countries and by publishing hundreds of research articles in the areas of exercise physiology, which included exercise and aging, blood chemistry analysis methods and acute responses and chronic adaptations to exercise under environmental stresses (e.g., exposure to altitude, heat, and cold) (Porcari et al.,2015).

The physiology of exercise in Turkey began primarily in medical faculties under the umbrella of the department and gained widespread prevalence with the inclusion of the Department of Sports Medicine and Physical Education and sports colleges in time. One of the pioneers who provide the most important contribution to this issue in our country is Prof. Dr. Necati Akgün. The book he wrote about exercise and sports physiology is one of the important works laid out in the field. Especially with the expansion of the researcher group after the 1990s, there is a significant increase in the number of studies on the field. It contributed to theoretical and applied research on human performance with its contributions in both physical education and sports colleges and academicians of the Faculty of Sports Sciences (Kurdak, 2019). In this context, performance measurement laboratories have been established in many universities.

In this study; HPL of the universities Turkey and the United States have been examined in terms of existing measuring devices and the state of laboratories between the two countries has been revealed. While evaluating the current situation with this study, it is thought that there may be a guideline for this type of HPL that is considered to be the new establishment in the future.

MATERIALS AND METHODS

Research Group

The University has participated in the study from Turkey (13) and the United States (16), which is a HPL and stated in the following chart (Table 1).

Data Collection

There are few scientific based studies showing the status of Human Performance Laboratories. In this study, the current equipment of human performance laboratories in Turkey and the United States was investigated using a descriptive screening model. Both domestic data and international data were evaluated by the

researchers in person between the years 2014-2016 by contacting the responsible personnel of the the name of the 43 device, which is considered to be in the laboratories. Findings were obtained by evaluating the present material in the Human Performance laboratory with the measurement of 7 specific areas (1. Pulmonary functions 2. Muscle strength, endurace and flexibility 3.Walking analysis, biomechanics and movement analysis 4. relevant laboratories. It has been identified by researchers with the help of the questionnaire with Cardiovascular functions 5. Body composition 6. Reaction time and balance 7. Competition analysis systems for coaches) determined by the researchers. The data were collected using a survey during face to face interview method between 2014-2016.

Table 1. Universities Observed During Evaluation Period

American Universities (n:16)				**Turkish Universities (n:13)**			
Central	Bastyr	Whitworth	Pacific Lutheran	Çukurova	Gaziantep	Ordu	Uşak
Eastern Washington	Gonzaga	University of Idaho	Idaho State	Afyon Kocatepe	Mersin	İnönü	Selçuk
Brigham Young	Western Idaho	Montana State	Oregon Willamette	Kocaeli	Aksaray	Uludağ	Ankara
Montana	Linfield Collage	Pacific University	Grand Valley State	Hacettepe			

Statistical Analysis

Percentages of existing devices according to countries were determined using descriptive statistics method.

RESULTS

The percent distribution rates of device status used to assess pulmonary functions between two countries are shown below (Figure 1). Based on the results of the percent frequency results, the use of ergospirometer devices in Turkish Universities laboratory settings are more common while environmental chambers exist only in one American University.

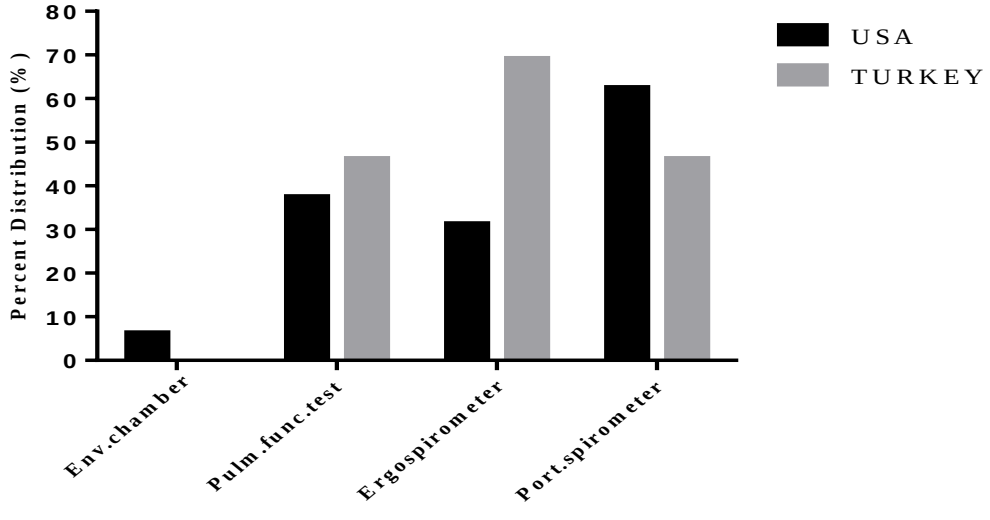
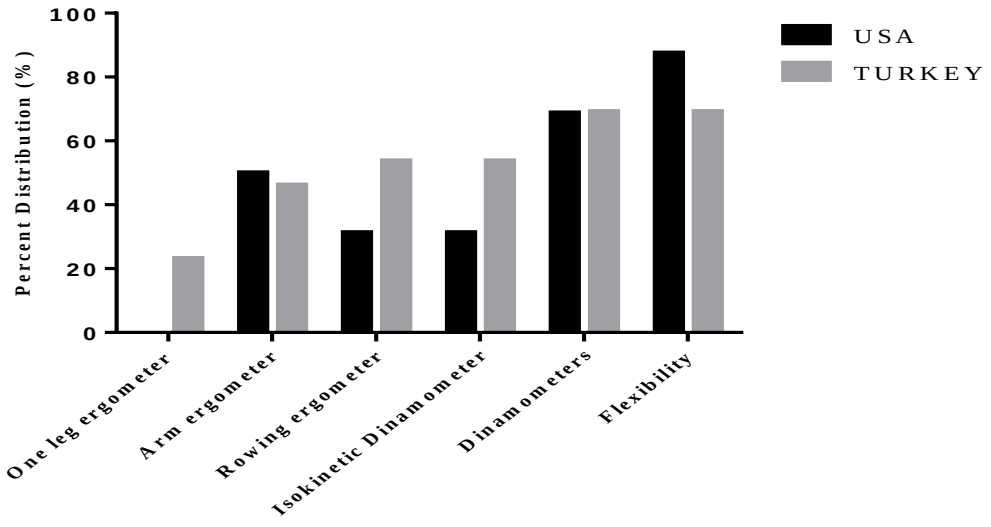


Figure 1: Device Status Used In Assessment of Pulmonary Functions.

Based on the results of the percent frequency results, the use of one leg ergometer devices in American Universities laboratory settings are more common while environmental chambers exist only in one Turkish University (Figure 2).



2: Device Status Used In Assessment of Muscle Strength, Durability and Flexibility

The percent distribution rates of walking analysis, biomechanics and movement analysis systems between two countries indicate that the motion analysis systems are more in common compared to Turkish Universities laboratory settings. On the other hand, only one Turkish university has an Alter-G treadmill system while all American Universities are superior in terms of motion capture analysis systems (Figure 3).

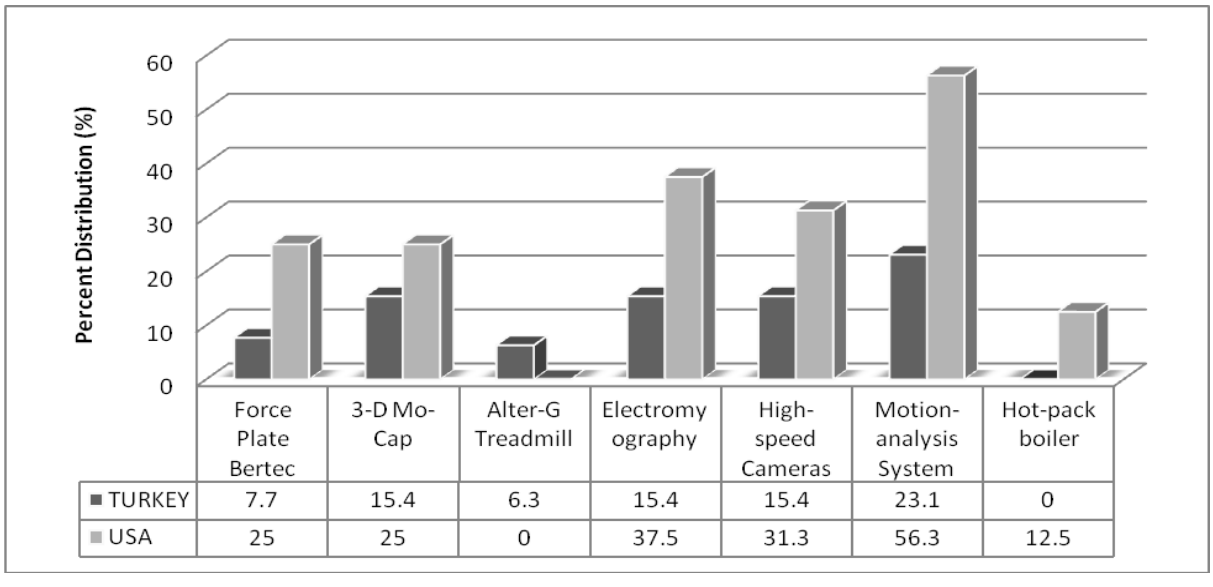


Figure 3: Device Status Used In Assessment of Walking Analysis, Biomechanics and Movement Analysis

Table 2 demonstrates the frequency distribution between Turkish and American universities in terms of the devices used in assessment of cardiovascular functions.

Table 2: Device Status Used In Assessment of Cardiovascular Functions (%)

Ergometer	Turkish University Settings	USA University Settings
Treadmill	76.9	100
Highspeed treadmill	15.4	56.3
Cycle ergonometer	84.6	87.5
Douglasback	15.4	18.8
Metaboliccart	46.2	93.8
Portable static metaboliccart	23.1	43.8
ECG	46.2	87.5
Defibrilator	15.4	68.8
Holtermonitor	23.1	0
Ecocardigram	7.7	18.8
GPS	30.8	25
Arm ergometers	46.2	50
Rowing Ergometers	53.8	31.3
Isokinetic Dynometers	53.8	31.3
Dynamometers	69.2	68.8
EMG	38.5	50
Telemetric System	46.2	37.5
Pulse clock	84.6	18.8
Lactate Analyzer	76.9	75
Metabolicmeter	7.7	31.3

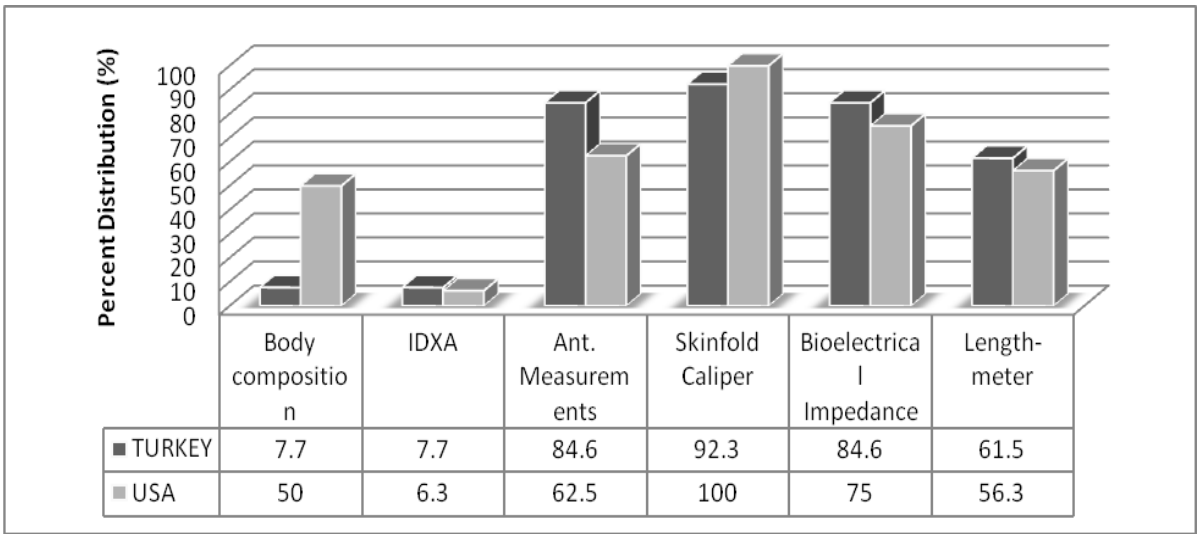


Figure 4: Device Status Used In Assessment of Body Composition

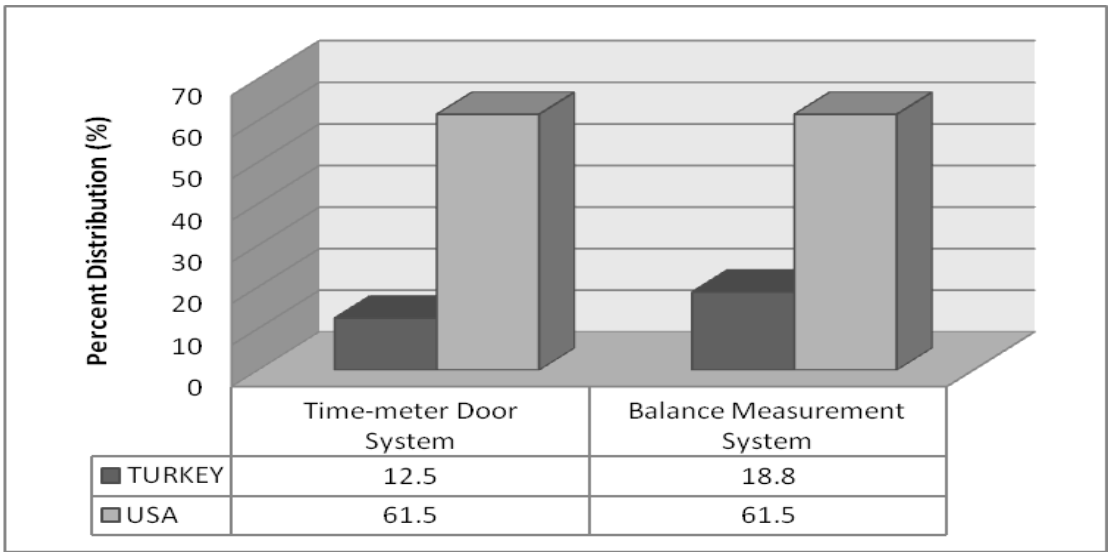


Figure 5: Device Status Used In Assessment of Reaction Time and Balance

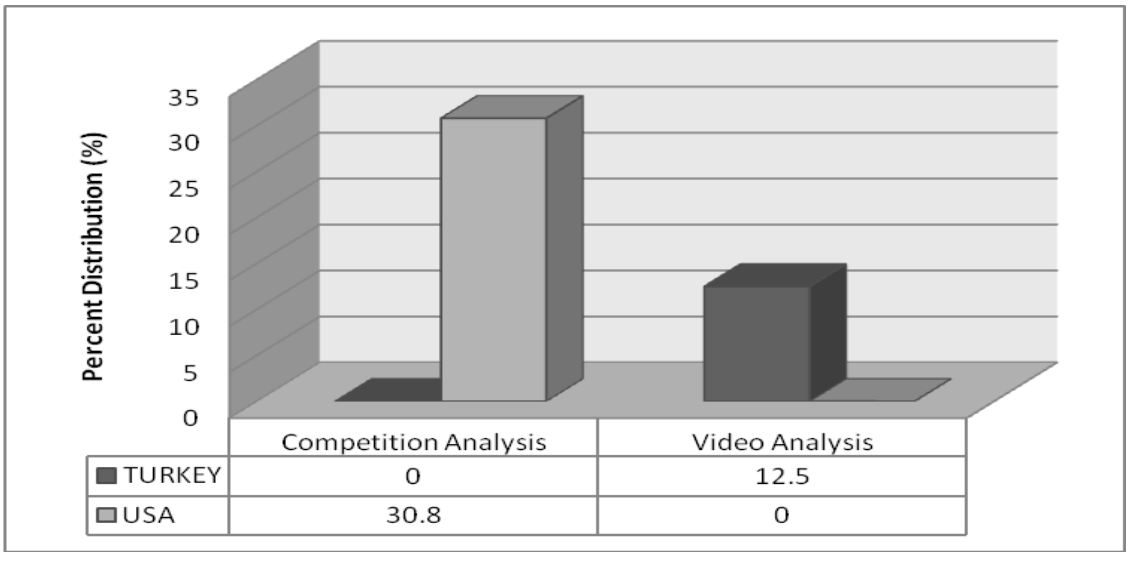


Figure 6: Device Status Used In Assessment of Competition and Video Analysis Systems For Coaches

DISCUSSION AND CONCLUSION

According to the Pub Med search more than 82,826 peer reviewed articles published in the past 10 years with the word "exercise" retrieved. When the rates of the classifications of these articles taken into the consideration, more than 3836 of these papers were linked to genetics; 45 to proteomics; 155 to genomics; 22 to epigenetics; 326 to signaling pathways while the term obesity were retrieved in 7357 articles; diabetes 6312; longevity 254; muscle 18,562; bone 4038; metabolism 24,033; nervous system 4505; hormones 6954; brain function 2644; circulation 3426; immune system 1281; respiratory 5734; and hematology 126 according to the results of the Pub Med search. These data shows the importance of the exercise physiology and the reason why a great deal of investigators focusing on these important topics in the last decade.

As a consequence of the immense interest within both scientific and athletic environments many scientific or technological research,

experiments, and measurements may be performed in university laboratory settings. These settings are composed of a combination of numerous disciplines, such as engineering, biomechanics, physiology, anthropometry, interaction design, visual design, user experience, and user interface design (Porter et al., 1990).

Due to the requirements of the objective measurements in both area the design of these products, processes, and systems require an precise evaluation as this engineering process involves the construction of human factors and ergonomics within the same domain as these determinants may lead to increase productivity, enhance safety and comfort with a specific focus on the interaction between the human and the equipments by reducing the human error (Wickens et al., 2003). Measurement of human performance is not only a method that is implemented in the field of sports. It is a well known fact that the results of the tests conducted in the laboratory environment contribute to the development of human performance. There is not enough work in the literature on the classification of HPL. However, HPL were evaluated within the working area of the exercise physiology process.

HPL is a very costly and highly sensitive area to conduct scientific researches. When the advantages of the equipment of the two countries were evaluated, it is seen that the equipments used in Turkey for lung function, muscle strength and stamina, body composition, reaction time and balance tests are relatively higher, but the quantity of equipments which used especially for cardiovascular system analysis, gait analysis, biomechanics, motion analysis, video analysis and flexibility tests were less common compared to American Universities. Muscle strength has an important role in human performance. Simple field tests can be used in the measurement of this parameter as well as in the laboratory environment using expensive devices such as isokinetic dynamometer. Although it is particularly expensive, it is noteworthy that the use of isokinetic dynamometers were found much higher in Turkey.

Additionally, competition analysis systems are considered to be more common in Turkey than in the United States. Due to the fact that the competition analyses in the United States are conducted by private companies it may be noted that the use of these programs in the American universities is less common. On the other hand, the video analysis systems are more common at HPL in the US universities and the great deal of these universities use this technology system mainly for the individual sports. However, Turkish laboratories have relatively more equipment in reaction time and balance performance measurements as these devices are cheaper and useful. However, HPL in Turkey have relatively less equipment in the field of biomechanics, walking and motion analysis could be associated the less number of qualified personnel in this field, or the equipment required for such measurements may be at high cost, and correspondingly this inadequacy indicates the need of advanced engineering knowledge in the performance and analysis part. Skinfold calipers are used to determine the body composition are present in all the HPLs observed in the US as they have more qualified personnel to perform measurements using this device and pay particular attention to this method of measurement in determining body analysis.

There is no special training area for the personnel who will perform performance tests or tenure position of technical personnel in Turkey neither in exercise physiology nor human performance field. However, it was found that there was a permanent technician in all HPL in each of the US universities, and these technicians were responsible for the use, calibration, maintenance and repair of all tools. In order to effectively use the HPL in Turkey, it is noteworthy to imply the need of qualified technical personnel in this field.

Conflict of interests: The author declares that there is no conflict of interests

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