THE ORIGINS OF SPORTS MEDICINE

– *Written by Emin Ergen, Qatar*

Sports medicine has always been difficult to define because it involves a wide scope of healthcare for professional athletes and recreationally active individuals. It provides them with diagnostic, curative, rehabilitative and preventive medical services. Athletes and active individuals demand expertise and sport-specific knowledge, for issues varying from musculoskeletal to environmental stresses; cardiological to dermatological and endocrinological to psychological. The moral, legal and health-related challenges (such as doping) surrounding professional athletes further contributes to the unique and complex picture presented to the doctors who treat them. Finally, prevention is an area of increasingly specialised interest, knowledge and expertise. Many believe that sports medicine will make its most significant contributions in the area of prevention. The benefit to health and quality of life from participation in physical activity – at all levels – is clearly apparent.

Over the last century, in many countries around the world there has been a growing need – and therefore interest – in sports medicine. This is due to increased participation in physical activity following many national projects promoting health and exercise. The aim of this article is to give a historical background to the areas of medicine and science which have developed into sports medicine and sports science. Attempting to identify the origins of sports medicine requires a look at mainstream medicine. Furthermore, as medicine is a scientific discipline, its relation to other areas – especially sports sciences, should be defined.

HISTORICAL ORIGINS OF MEDICINE AND SPORTS MEDICINE

The question "how to live healthily?" is very old. The issue of healthy living is directly related to diseases, diagnosis and treatment. Therefore, medicine is the oldest profession to address this problem and is considered to be the science of diagnosis, treatment and prevention of diseases.

These fundamental practices date back thousands of years. Medicine was probably first institutionalised by the Ancient Egyptians. The earliest known physician is an Egyptian, Imhotep (2980 BCE), whose name was given to a temple university in Men-Nefer (Memphis), where (the so-called 'father of medicine') Hippocrates studied. In those days, the fertile soil of the River Nile was called *ke-meth* (watered wet brown soil), while Ancient Egyptian physicians were known as *sunu* or *swnw* (pronounced 'sewnew'). *Sunus* were Kemetic (Ancient Egyptian) priest-magician-physicians or healers. The combination of the two terms; *ke-met sunu* is pronounced as *met-sunu* (*ke* is the article and not pronounced with *met*) which is very close to the Latin term *medicina* and may have been adopted by ancient Greek scholars, then transformed into Latin over time.

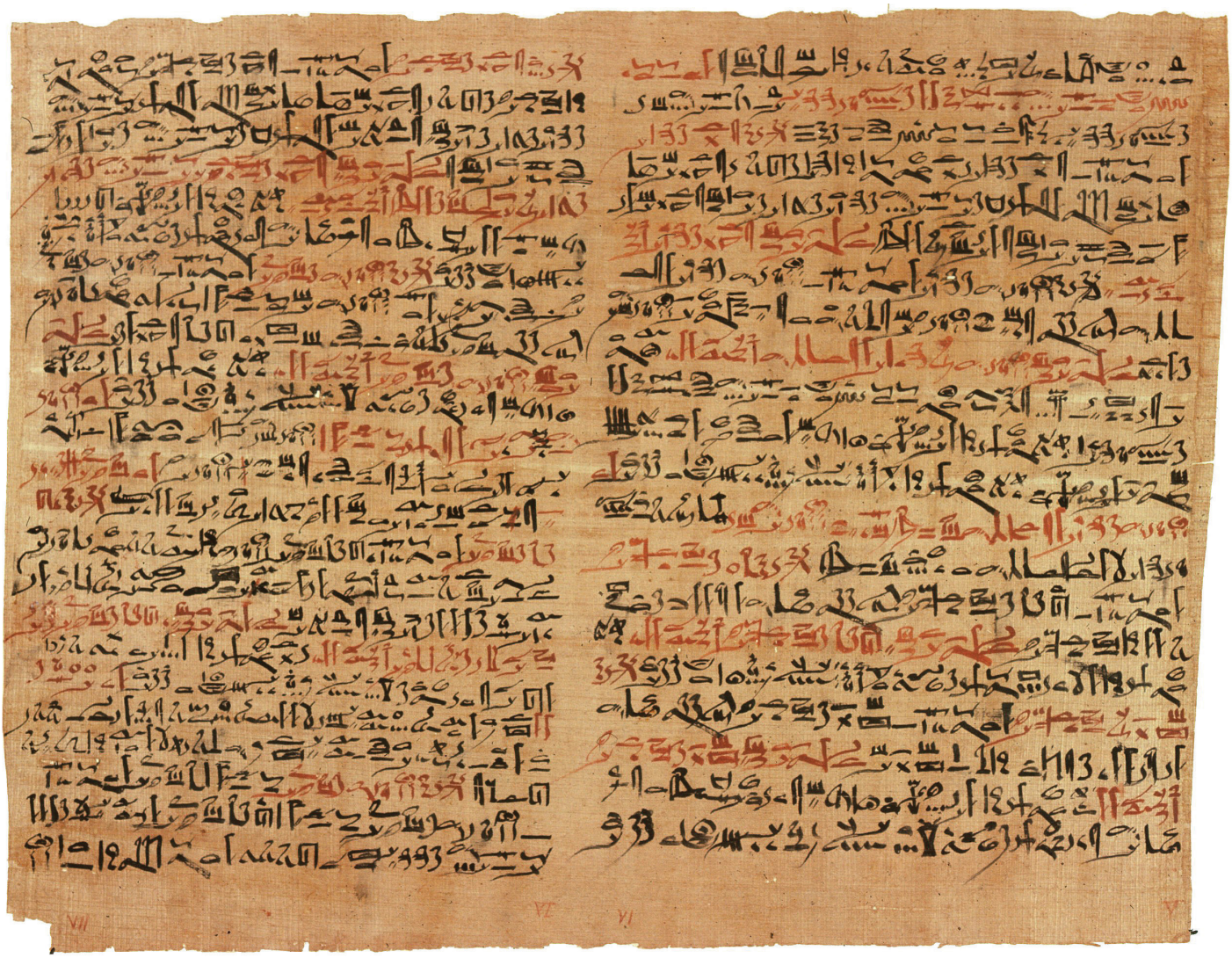


Image: The Edwin Smith papyrus, the world's oldest surviving surgical document. Written in hieratic script in ancient Egypt around 1600 BC, the text describes anatomical observations and the examination, diagnosis, treatment and prognosis of 48 types of medical problems in exquisite detail. Jeff Dahl, PD-Old-100 Wikimedia Commons.

In India, a collection of texts including therapeutic exercises called '*Arthava Veda*' can be found in written sources around 8th century BCE. Unfortunately, little is known of this rich cultural heritage. For example, Susruta (600 BCE) left important information on the relationship between health and activity. Susruta was an ancient Indian surgeon commonly credited as the author of the treatise *Sushruta Samhita*. He is dubbed the 'founding father of surgery' and the *Sushruta Samhita* is identified as one of the key historical commentaries on the medical science of surgery. He is said to have been a physician originally of South India, who practised in Varanasi and lived some time between the period of 1200 to 600 BCE. The *Sushruta Samhita* was translated into Arabic during the 8th century AD by Ibn Abillsaibial. The work was known as *Kitab Shah Shun al-Hindi* in Arabic or alternatively as *Kitab i-Susurud*. The 9th century Persian physician Rhazes was familiar with the text. Obesity was known to Susruta, who related it to diabetes and heart disorder. He recommended physical work to help cure it and its side effects.

The evolution of medicine has shown a distinct characteristic which is based upon – and entirely dependent on – human health. For example, wrapping a corpse with linens for mummification has probably lead to taping and bandaging for fixation of broken and injured extremities in later years. Relating medicine to exercise (more specifically sport), the first use of therapeutic exercise is credited to Herodicus in the 5th century BCE, who is thought to have been one of Hippocrates' teachers.

The Ancient Greek physicians including Hippocrates and Galenos and also the Islamic physician Ibn-I Sina (Avicenna), were able to dissociate medicine from religion to a more secular practice. These three pioneers of modern medicine served their profession well by documenting their observations and differentiating medicine from the metaphysic. That is why, in English, 'physician' refers to a medical doctor – someone who is studying the exact nature of a disease. In other words, physicians study matter and energy in physical terms related to health and health disorders.

The term 'science' is derived from the Latin word '*scientia*' which means 'knowledge of something'. More specifically,

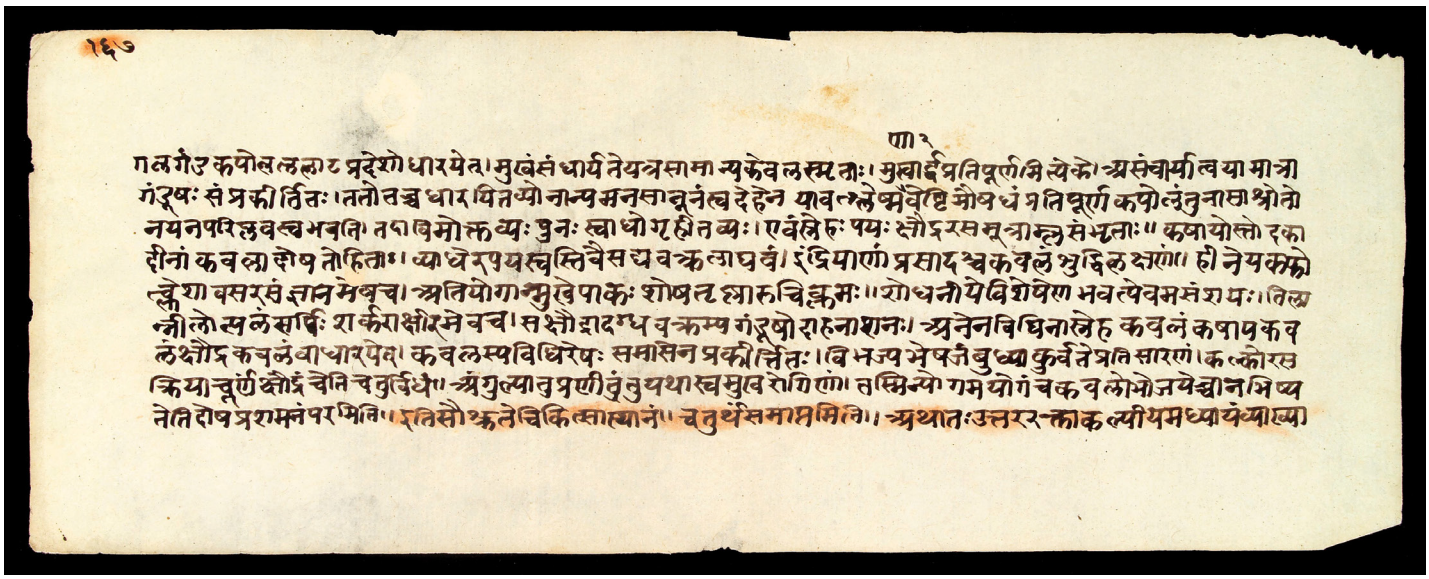


Image: Page of text from the *Susrutasamhita*, an ayurvedic textbook, on various surgical procedures and surgical instruments. The text presents itself as the teachings of Dhanvantari, King of Kasi (Benares) to his pupil Susruta. PD-Old-100 Wikimedia Commons.

'*scire*' or '*scindere*' in Latin means 'to know, distinguish or seperate something from another'. Until the Enlightenment, the word science referred to any systematic or exact recorded knowledge. Philosophy was moral science and others were natural sciences. More recently, science has come to be restricted to 'natural science' only, which is then divided into physical and biological sciences, with social science also included as a 'soft' science as it uses scientific methodology[1].

We have to ask ourselves whether medicine is a scientific discipline or not? Remember back to a childhood visit to a doctor and it may be argued that medicine is a clinical practice only. There is however, a heavy research component via clinical studies, therefore, some medical scholars have emphasised that medicine is: 'the art of healing using scientific methods'. The term 'doctor' in Latin is another word for describing a physician and means teacher – someone who teaches how to stay healthy or what to do when sick[2].

In the 2nd century AD, the first 'team doctor', Galen (also known as Claudius Galenos; 131 to 201 AD), was appointed as doctor of the gladiators in the Pergamum Kingdom. The physician only became involved if there was an injury. Whether or not there was good communication between the trainer-coach and the team physician back then is a matter of speculation, what was clear, however, was that from the very beginning, sports medicine has been multidisciplinary – with an obligation not only to treat injuries, but also to instruct and prepare athletes[1]. Galen went to Rome in 162 AD and made his mark as a practicing physician. He observed the effects of a sedentary lifestyle and the health consequences of inactivity, e.g. obesity. Galen's treatise '*On the exercise with the small ball*' (medicine ball today) has been welcomed by scholars of ancient sports for its description of ball games and also by scholars of ancient medicine for its discussion of the benefits of exercise. Galen argues that everyone should engage in games of this type.

He recommends: "take fresh air, get a good sleep, eat and drink properly, control emotions and empty bowels once a day!" He adds: "no activity is exercise unless you become breathless".

Of course, it is not only the ancient Egyptian physicians or Hippocrates and Galen who have contributed to the development of sports medicine. There are other famous physicians as well. Ibn-I Sina (Avicenna 980 to 1036), Gerolamo Mercuriale (1530 to 1606), Santorio Santorius (1561 to 1636) and Bernardino Ramazzini (1633 to 1714) were just some of the doctors who also practiced sports medicine by developing techniques to promote health and fitness and ensuring the safety and well-being of everyone who participated in athletic competition[3].

Avicenna (Ibn-I Sina) is an eminent name in medicine. He was Persian, born in Buhara (980 AD) and died in Hamedan (1037 AD). He became a doctor at the age of 19 and wrote 450 papers of which 240 are available today and 40 are related to medicine. His two famous books in medicine are *Kitabü's-Sifa* ('*Book of Healing*') and *El-Kanun fi't-Tib* ('*Law of Medicine*'). *El-Kanun fi't-Tib* was the main textbook in many European medical schools until 1650.

Ibn-I Sina (Avicenna) gives examples of healthy lifestyle (including exercises) in the *Law of Medicine*.

He also classified the sciences as:

- *El-ilm ül-esfel* (natural sciences)
- *Mabad-üt-tabia* (metaphysics)
- *El-ilm'üll-âli* (logic)
- *El-ilm ül-evsat* (mathematics)

Girolamo Mercuriale's book *De Arte Gymnastica* is considered to be the first comprehensive book explaining human movement, while Ramazzini can be regarded as the 'father of occupational medicine' for his work *De Morbis Artificum Diatriba* ('*Dieases of Workers*')[4].

Santorio Santorius was a friend of Galileo and Professor of Medicine at Padua, and was one of the first researchers on human metabolism. He used innovative techniques for his studies, recording changes in daily body temperature with the first air thermometer. He also measured pulse rates with Galileo's 'pulsilogium' (pulsiometer). Ever inventive, Santorius studied digestion by constructing a wooden frame that supported a chair, bed and work table. Suspended from the ceiling with scales, the

frame recorded changes in weight. For 30 years, Santorius slept, ate, worked and even engaged in sexual activity in the weighing contraption to regularly record how much his weight changed as he ate, fasted or excreted. He invented the term 'insensible perspiration' to account for differences in body weight, because he believed that weight was gained or lost through the pores during respiration. Often depriving himself of food and drink, Santorius determined that the daily change in body mass approached 1.25 kg. Santorius' book of aphorisms, *De Medicina Statica Aphorismi* (1614 AD), received worldwide attention and acclaim. Although he did not explain the role of nutrition in weight gain or loss, Santorius nevertheless inspired later researchers in metabolism, particularly during the 18th century.

August Bier (1861 to 1949), a pioneer of anaesthesiology and Arlie V. Bock (1888 to 1984), who studied circulatory and blood responses to exercise, were also key figures in implementing sports medicine as a formal field of study in Europe and the United States, respectively.

The list of other researchers who, although not directly related to exercise, contributed largely to human physiology in general includes:

- Luigi Galvani (1737 to 1798, muscular electrical potentials).
- Alessandro Volta (1745 to 1827, physiological tetanus).
- William Beaumont (1785 to 1853, digestion).
- James Lind (1716 to 1794, seamen's nutrition and immunity).
- Antoine Laurent Lavoisier (1743 to 1794, metabolism, nutrition and exercise physiology).
- Justus von Liebig (1803 to 1873, proteins in exercise and strength).
- Claude Bernard (1813 to 1878, homeostasis – metabolism during exercise).
- Edward Smith (1819 to 1874, closed circuit spirometry).
- Emil du Bois Reymond (1818 to 1896, neuromuscular physiology).
- August Chaveau (1827 to 1917, heat production during muscular work).
- Adolf Fick (1829 to 1901, myotonography).
- Russel Henry Chittenden (1856 to 1943, low-protein diet).
- Frederick Gowland Hopkins (1861 to 1947, vitamins and amino acids – won the Nobel Prize in Experimental Physiology).
- Francis Gano Benedict (1870 to 1957, metabolism and heat exchange during exercise).

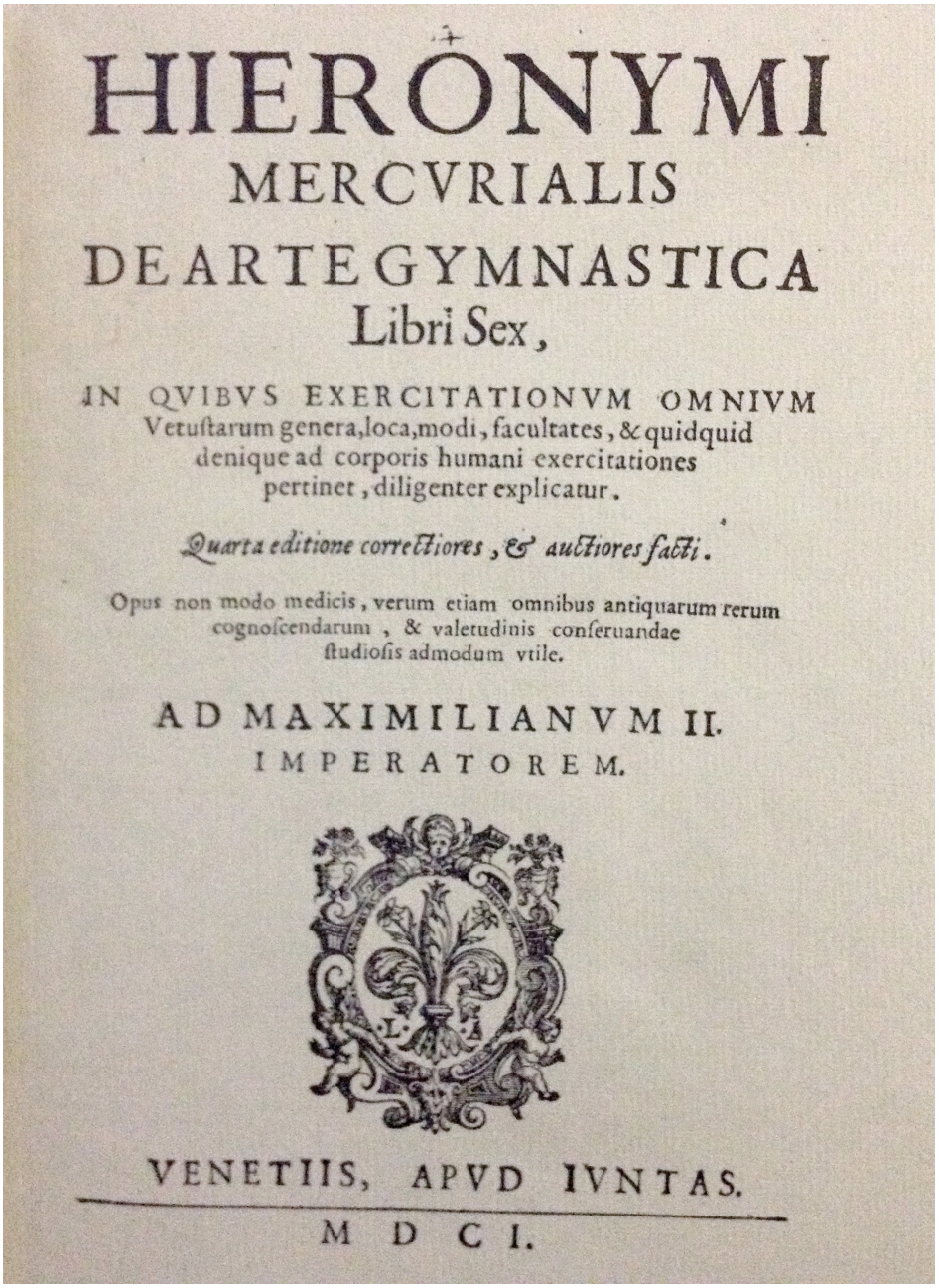
Image: Ibn Sina (Avicenna). PD-Old-100 Wikimedia Commons.

Italian physiologist Angelo Mosso (1846 to 1910) holds a significant place in the history of exercise physiology. At the first International Congress of Physiologists in Basel, Switzerland 1889, Mosso discussed his findings on muscular fatigue while demonstrating the function of an ergograph (work recorder). After receiving his degree in Medicine and Surgery from Turin, Italy in 1870, Mosso was able to study and interact with renowned physiologists Wilhelm Ludwig, Emil Du Bois-Reymond, Hugo Kronecker and Etienne Marey. By 1879, he was a Professor of Physiology at the University of Turin, where he conducted research pertaining to blood circulation, respiration, physical education, high-altitude physiology and muscular fatigue. Using traces recorded with the ergograph (concentric contractions of the flexor muscles of the middle finger that were volitionally or electrically stimulated), he was able to characterise muscle fatigue and associate its occurrence with central or peripheral influences. He showed that exercise would increase muscular strength and endurance while delaying the occurrence of fatigue – which he postulated was a chemical process that involved the production of toxic substances such as carbonic acid. The phenomenon of contracture was described and his collective studies led to the formulation of laws pertaining to exhaustion and to the 1891 publication of *La Fatica* (*Fatigue*). Besides *La Fatica*, Mosso is remembered as a scientist with a love for physiology, a concern for the social welfare of his countrymen and as one who sought to integrate physiological, philosophical and psychological concepts in his experimental studies.

At the same time, work was also being performed in North America, especially in the USA. The first article on exercise physiology was published in 1855 in the USA (Byford WH. On the physiology of exercise. Am J Med Sci 1855). Dudley A. Sargent (1849 to 1924), the Director of Hemenway Gymnasium at Harvard University, developed a system for physical examination including strength testing and anthropometric measurements. He also designed individual exercise programmes based on this data. His Sargent Jump Test is still in use today. Atwater and Bryant (1900) studied boat crew members from Harvard and Yale and found a typical diet consisted of 15.6% protein, 40.7% fat, 44.2% carbohydrates, totalling 4085 Kcal/day. The inception of the Modern Olympic Games in the 1890s and the formation of the International Olympic Committee in 1894 may have stimulated some interest in exercise physiology and sports physiology, in parallel to other medical disciplines, which also influenced the development of sports medicine.

In Europe, August Krogh (1874 to 1949), from Denmark (who was interested in science from an early age and wrote his first work with Christian Bohr, inventor of the tonometer), collected data relevant to 'the Greenhouse Effect'. Krogh and Bohr published work in 1904 demonstrating that when carbon dioxide binds to haemoglobin, it decreases the affinity of haemoglobin for oxygen (thus promoting unloading of O_2) – 'the Bohr Effect'. They showed that oxygen passes from alveolus to capillary via passive diffusion in 1906. Archibald V. Hill and Otto Meyerhof shared the 1922 Nobel Prize with their studies on muscle glycolytic metabolism[5,6]. All related to exercise physiology and sports medicine in particular.

The very first attempt to measure human gas metabolism, while performing quantified physical work, can be traced back to the year 1790. Developments in ergometery in the 19th and 20th centuries are well documented. Later, in 1929, Germans Hugo Wilhelm Knipping and Ludolph Brauer were the first to analyse cardiopulmonary function during exercise. But the first ergospirometry apparatus that met all scientific requirements was introduced in 1950s[7].


HIERONYMI
MERCVRIALIS
DE ARTE GYMNASTICA
Libri Sex,
IN QVIBVS EXERCITATIONVM OMNIVM
Vetuſtarum genera, loca, modi, facultates, & quidquid
denique ad corporis humani exercitationes
pertinet, diligenter explicatur.
Quarta editione correctiores, & auctiores facti.
Opus non modo medicis, verum etiam omnibus antiquarum rerum
cognoſcendarum, & valetudinis conſeruandae
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AD MAXIMILIANVM II.
IMPERATOREM.
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Image: Reproduction of *De Arte Gymnastica* by Girolamo Mercuriale. PD-Old-100 Wikimedia Commons.

The Harvard Fatigue Laboratory was established in 1927 as part of the Harvard Business School. Many people credit the Laboratory as the origin of exercise physiology in the United States. Director David Bruce Dill was interested in environmental effects on exercise performance and – among other topics – he studied the effects of altitude on exercise and thermoregulation during exercise. Dill was often a subject in his own studies – including some unpleasant scenarios – like walking across the desert with only a donkey and a dog for company. The Harvard Fatigue Laboratory was closed in 1947, however interest in exercise physiology continued during the second half of the 20th Century, when the American Physiological Society began publishing the Journal of Applied Physiology (JAP) in 1948. Krebs and Lipmann won the Nobel Prize in 1953 for their study on the Krebs Cycle and CoEnzyme A.

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A greater demand on sport, science and medicine influenced these spheres to come together in co-operation and merge into sports medicine and sports science.

The world's first sports medicine establishment took shape in Dresden, Germany, in 1911. The 'First Congress for the scientific investigation of sports and physical exercises' was held in 1912 (Oberhof, Germany) and the term 'sports physician' or 'sportarzt' (coined by Arthur Mallwitz) was first used in 1913. The first sports medicine journal was published by the French Society of Sports Medicine (SMEPS) in 1922. Further sports-related medical societies followed suit, publishing journals in 1921 in The Netherlands and in 1922, in Switzerland. Thirty-three physicians from 11 countries participating in the 2nd Winter Olympic Games in St. Moritz founded the 'Association International Medico Sportive' (AIMS). In 1934 the name of the organisation was changed to 'Fédération Internationale de Médecine Sportive (FIMS)'. FIMS was predominantly a European organisation until the IOC recognised FIMS as "the designated competent international organisation for biological and medical research to medicine and sport and medical care of athletes". FIMS was later recognised by the World Health Organisation (WHO) and the International Council of Sports and Physical Education (ICSPE) in 1960[8].

The establishment of further sports medicine societies followed. The Italian Sports Medicine Federation (FMSI) was founded in 1929. During the First Polish Sports Physicians' Congress (1937) in Worochta, the Polish Sports Physicians Association was established, while the Finnish Society of Sports Medicine was founded in 1939. In 1945, Charles University in Prague (Czech Republic) established the first institute of sports medicine in a medical faculty, led by Dr Jiri Kral. Previously, Jan Evangelista Purkyne (1850, Czechoslovakia) put forward the idea of the favourable effect of body training for human health. Along with several important research topics, the first wireless transmission of heart frequency and cardiological observations during sport events were studied this institute[9].

In addition to the above-mentioned countries, Scandinavian, Mediterranean and Balkan Countries also have longstanding traditions in sports medicine.

In 1958, after the 2nd World War, the first School of Specialisation in Sport Medicine was established in Milan, Italy, by Professor Rodolfo Margaria. Today, Italy is one of the few countries with a public system of pre-participation medical examinations for sports activities. In Italy, people playing sport organised by national federations or sports promotion bodies have to undertake a periodic medical visit to obtain a certification of eligibity to play. The screening tests and physical examinations are also sport-specific. They are listed in special decrees issued by the Ministry of Health, which regulate on competitive sport activity (1982), non-competitive sport activity (1983), competitive sport activity for disabled people (1993) and professional sport activity (1995). Since 1950, it has been mandatory for all professional and amateur athletes to obtain a medical certification for eligibility to play sport. In 1971, the Italian Government set about safeguarding the health of all those practicing sport at competitive and non-competitive level with laws (regularly updated) that regulate preventive pre-participation screening in competitive and non-competitive sports. Competitive athletes must undergo an annual preventive screening protocol including a past medical history, clinical evaluation, urinalysis, electrocardiogram at rest and after a step test, and pulmonary function tests. This evaluation can only be performed by a board-certified Sports Medicine Physician, who is legally responsible for the accuracy of the assessment and makes the final judgement on eligibility to participate in sport.

SPORTS MEDICINE AND SPORT SCIENCES

The division between science and sport had two major consequences. Firstly, at the end of the century, at a time when sport was gaining mass popularity, there was very little scientific interest in boosting athletic performance. Secondly, athletes and their coaches showed little knowledge of, or

interest in, contemporary science. Training techniques were thus explained according to 'scientific' notions about the physiology of exercise that gave wide latitude to the idiosyncrasies of various practitioners. Even after 1870, as British physiologists began to catch up with their French and German counterparts, the term 'scientific training' was used frequently to refer to the regimens devised by individual trainers who spoke in the most rudimentary scientific terms on the basis of personal observations. This ad hoc approach is evident in R.J. Lee's *Exercise and Training: Their Effects Upon Health* (1873), which scarcely advances beyond the generalities of Sinclair dating from almost of a century earlier. While maintaining that exercise is important for "the preservation of health and prevention of disease", Lee admits that physiologists had neglected training as a scientific field. The founder of performance physiology in Germany, Nathan Zuntz, published on a whole series of topics relevant to the biology of the athlete: circulation, respiration, energy metabolism, nutrition, muscular work and altitude physiology. In 1899 his son, Leo Zuntz, published the first major study on energy metabolism in cycling. In the 1920s, the Nobel Prize-Winning muscle physiologist Archibald V. Hill published several essays on the integration between his research and high-performance athletics.

It is clear that some studies in sports science have been triggered by physiologists and physicians. This inevitably does not apply to other sports science disciplines such as biomechanics. For example, the analysis of athletic movement was first made possible by 'chronophotography' invented by the great French physiologist Etienne-Jules Marey (1830 to 1904). As early as 1872, Marey's predecessor, the Anglo-American photographer Edward Muybridge, had photographed horses in motion and in 1879 Muybridge announced that he would apply this technique to "all the imaginable postures of athletes, horses, oxen, dogs and other animals in movement". Marey's chronophotography improved Muybridge's work by including the precise time intervals that separated these new and startling images of bodies and limbs frozen in time – thereby making human and animal motion both visible and comprehensible for the first time. In 1894, Marey stated his interest in producing instantaneous photographic images of "very strong and competent athletes" and at the 1900 Olympic Games in Paris, he used chronophotography to reveal the motions of the world's best athletes. The high-speed photographs and computer models that enable biomechanics experts to assist runners and throwers today can be traced back to Marey's work. Biomechanics, therefore, was initiated not with the help of physiologists or physicians, but by photographers.

Sports medicine is a well-established profession with a long historical background in health sciences. It can also be as regarded a scientific discipline in co-operation with sport sciences. Sport is a cultural phenomenon. Any related aspect in sport is observed, measured, evaluated, analysed and documented using techniques and methods by several scientific disciplines – so-called sports science(s). Coaching, like clinical medical practice, applies the information gained through studies in sports science. Both serve to benefit active people and professionals within two distinct perspectives: one pushes the limits, the other protects health within these limits[10].

References

1. *Appelboom T, Rouffin C, Fierens E. Sport and medicine in ancient Greece. Am J Sports Med 1988; 16:594-596.*
2. *Ergen E. Roots of sports medicine. Available from: http://archivosdemedicinadeldeporte.comarticulos/upload/revo1_162.pdf Accessed August 2016.*
3. *Peltier LF. Geronimo Mercuriali (1530-1606) and the first illustrated book on sports medicine. Clin Orthop Relat Res 1985; (198):21-24.*
4. *Buchanan WW. Bernardino Ramazzini (1633-1714) physician of tradesmen, and possibly one of the "fathers" of sports medicine. Clin Rheumatol 1991; 10:136-137.*
5. *Garrison FH. An introduction to the history of medicine, 4th.edition. WB Saunders, Philadelphia, 1929: 17-105.*
6. *Hollmann W, Prinz JP. Ergospirometry and its history. Sports Med 1997; 23:93-105.*
7. *Hoberman JM. History of the science of human performance in sport. Available from: www.sportsci.org/encyc/drafts/History_sport_science.doc Accessed August 2016*
8. *Tittel K, Wesseling J. 75 Years FIMS, Druckhaus GmbH 2005, Germany.*
9. *Novotny V. 50 years' of the Institute of Sports Medicine at the Charles University Medical School on the 650th anniversary of its founding. Sb Lek 1999;100:139-154.*
10. *Ergen E. From medicine and science to sports medicine and sport sciences: relations, definitions, historical roots. Available from: www.smas.org/2-kongres/papers/261.pdf Accessed August 2016.*

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