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NARRATIVE REVIEW

The developing understanding of Human Health and Fitness: 5. The Renaissance.

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Abstract

Many factors contributed to a sudden upsurge of knowledge during the Renaissance, including a westward migration of the Greek scholars who had been expelled from Constantinople, the emergence of wealthy research sponsors, the printing of technical books and a relaxation of the previously tight ecclesiastical control over institutions of higher learning. Renewed opportunities for human dissection allowed a better understanding of body structures and thus a clearer insight into such physiological processes as the circulation of the blood, respiratory gas exchange and muscular contraction. Initially, the dominant centres of health science were in Bologna and Padua, but new medical schools quickly appeared in France, the Netherlands and Britain. Leading scholars at these institutions rejected the mediaeval traditions of asceticism and began to think in terms of developing the physical body as well as the soul. Moreover, several prominent physicians promoted regular exercise as an important factor in maintaining good health. Despite the introduction of licensing schemes for physicians and surgeons, many forms of treatment remained bizarre, and most were ineffective. Primary schools multiplied, and began to offer a semblance of education not only to families of the elite, but also to a growing proportion of children from the general population. But in most of these institutions, academic instruction was limited to long hours of rote learning. A few teachers such as da Feltra, Mulcaster and Montaigne were notable exceptions to this rule, seeing physical education as an important and integral component of the child's learning process. In England, many university authorities rejected student involvement in games such as football, seeing such activities as unwarranted distractions from academic study and religious observance. In European courts, a vigorous interest in sport was carried over from the Middle Ages, although some forms of activity became more stylized and required less physical effort. For the social elite, a further factor reducing habitual activity was the replacement of active commuting by the use of sedan chairs. A large segment of the general population continued to toil for long hours in the fields as agricultural labourers, but a growing proportion of citizens moved into the cities, where newly established Guilds offered sedentary employment. Most aspects of public health still attracted little attention from either the government or the public, and high death rates from epidemics such as bubonic plague remained the norm. **Health & Fitness Journal of Canada 2012;5(4):15-29.**

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Background

Previous articles in this series (Shephard, 2011, 2012 a, b, c) have explored the growth in our understanding of human health and fitness from the dawn of history to the late Middle Ages. In the present article, we continue our narrative into the Renaissance. Rediscovery of the Greek and Roman cultural heritage began in Italy during the 14th century. It was stimulated in part by the largesse of wealthy research patrons,

such as the Medici family in Florence. There was also a westward migration of Greek scholars, displaced by the Ottoman conquest of Constantinople in 1453 CE (Burke, 1998; Strathern, 2003). The Greek refugees were able to translate classical manuscripts for their western hosts, and they brought with them an understanding of Arabic mathematics that spurred scholars to an interest in quantitative science. Over the next three centuries, the Renaissance spread progressively northward to other parts of Europe, bringing a rediscovery of Greek and Roman medicine, a resurgent interest in all forms of learning, and a critical review of established ideas that had been so vigorously defended by the Mediaeval church.

In many European countries, several other factors stimulated a recrudescence of scientific enquiry. The Renaissance saw the emergence of a substantial leisured middle class. Comfortably situated citizens enjoyed a new access to books, made possible by invention of the printing press (William Caxton. 1473 CE). Moreover, many of the new publications were printed in the vernacular, rather than in Greek or Latin. During the Middle Ages, the church had insisted that physical infirmity and ill-health were trials intended to prepare humankind for a heavenly redemption. Thus, health care was envisaged largely as a palliative service to those who were dying, and en route to their eternal reward. However, catastrophes such as the Black Death challenged this philosophy, greatly weakening the authoritarian control of the church over individuals, ideas, and entire universities (Shephard, 2012c). Furthermore, the emergence of spiritual and secular reformation movements led by individuals such as Jan Hus (1369-1415 CE), Martin Luther (1483-1546 CE), Henry VIII (1491-1547 CE), Huldrych Zwingli (1494-1531 CE), and John Calvin (1509-1564 CE) questioned all the tenets of the established church. The influx of these new ideas brought a new focus upon the maintenance and the promotion of good health. For the first time, there was hope that a keen study of the human body might not only assure salvation in some distant spiritual world, but that it might also enhance the quality of life on earth. When preparing their lectures and writing their texts, professors began to replace theologically grounded speculation by accurate observation and measurement; reason was substituted for blind belief. As in our modern world, the defence of academic freedom against any external controls that government, the church or merchant burghers might seek to impose was a critical factor in the burgeoning of knowledge and resulting gains in population health and fitness.

New curiosity about the universe and its workings challenged the “flat earth” views of the Old World. and it propelled Explorers such as Christopher Columbus (c1451-1506 CE) and Giovanni Caboto (c1450-1499 CE) westward to the discovery of Cuba and Newfoundland. Caboto reached the east coast of Canada in 1497 CE, and Giovani Antonio de Carbonariis founded the first Christian settlement there in 1498 CE. The Renaissance explorers quickly began to impose their ideas about health and other aspects of science upon the indigenous populations if North and Central America, dismissing and displacing the long-established mysteries of the sweat lodge and aboriginal healing. Alas, such initiatives were soon coupled with the importing of European infectious diseases and a lucrative trade in the “fire-water” that is still the scourge of many indigenous reservations. Occasionally,

physicians such as Nicolás Monardes (1493-1588 CE, author of *Joyfull News out of the New Found World*, as translated by John Frampton in1567 CE) (Barnard and McKenzie) and Francisco Hernández (1517-1587 CE) (Hernández et al., 2001) also brought North American herbal remedies back to Europe.

This section of the review focuses on the contributions of Renaissance science to our understanding of anatomy, the physiology of the circulation, respiratory gas exchange and muscular contraction, the emergence of schools of health science, the changing attitudes of scholars and physicians towards health and fitness, the development of public schools and their attitudes towards physical education, and secular changes in the physical demands of sport and daily life.

Contributions of Renaissance Science to Medicine and Health

The Humanist milieu of the Renaissance allowed a new generation of physicians to apply discoveries in chemistry and physics to the interpretation of body function, without fear of persecution from the church. The dissemination of new knowledge became an honourable mission, and the enhancement of health and fitness was set on a more solid scientific basis. The gradual transition from Latin to the vernacular and the availability of printed texts made the findings of leading medical scholars accessible to a wide range of enquirers. The understanding of health was fostered by a renewed freedom to engage in both animal and human dissection and a willingness to exploit the newly perfected lenses of Dutch opticians to explore the body's microstructure.

Early Christians had often regarded the living human body with contempt. But after death, the corpse was to be revered. Would not every particle be raised in glory as the last trump sounded? For the Mediaeval churchman, any dissection of the human body was out of the question. Even dissection of an animal could lay a surgeon open to accusations of sorcery and/or attempted divination, The lifting of these restrictions became one of the forces driving Renaissance medicine. At first, the main aim of anatomists was to illustrate descriptions already provided by classical scholars, but as their work of dissection continued, many errors and discrepancies were brought to light. Revisions to anatomical dogma allowed more accurate hypotheses to be formulated concerning such physiological processes as the circulation of the blood, respiratory gas exchange and muscular contraction.

Early anatomists. Medical students in Salerno had begun studying the anatomy of the pig as early as the 11th century, and in the 13th century Frederick II (1194-1250 CE), the last of the Holy Roman Emperors, finally gave permission for one human body to be dissected every five years. Early figures in the drive for a more precise description of human anatomy included de Luzzi, Varignana, Bertuccio, Linacre, and Estienne,

de Luzzi. Mondino de Luzzi became professor at Bologna around 1290 CE, and he was one of the first individuals to receive the permission of his University Senate to conduct public "anatomies" (Cushing, 1935). de Luzzi published his *Anatomia* in 1316 CE. The text was novel in that it was based on the dissection of human subjects rather than animals. Another unique feature of his laboratory, unprecedented in late Mediaeval period, was that he employed a female surgical assistant, Alessandra Giliani to prepared

the bodies for his lectures (Alic, 1986).

Varignana. Bartimeo da Varignana (died 1321 CE) was another noted anatomist who taught at Bologna during this same era.

Bertuccio. The surgeon Guy de Chauliac (1300-1368 CE) described a typical Bolognese anatomy class as conducted by his professor, Nicola Bertuccio (Burggraeve, 1840) in these words:

The body being placed on a table, he made four lectures over it. In the first the nutritive organs were considered, for they are most corruptible, in the second the spiritual members (i.e., lungs, heart), in the third the animate members (brain, etc.), and in the fourth the extremities"

Linacre Thomas Linacre (c1460-1524 CE) was an early English humanist who taught Erasmus and became first president of the British College of Physicians.

Estienne. The Parisian Charles Estienne (1504-1564 CE) authored *De dissectione partium corporis humani* some time before 1539, and he gave an early description of the valves in the hepatic veins.

Other pure and applied scientists from this same era made specific contributions to knowledge of the circulation (Leonardo, Servetus, Vesalius, Columbus, Caesalpinus, Fabricius, Sanctorius, and Harvey), the respiratory system (Paracelsus, Van Helmont, Boyle, Hooke, Lower and Mayow) and muscle contraction (Leonardo, Canape, Cardamo, Borelli and Glisson).

Circulation of the blood. Most historians now agree that credit for the discovery of the circulation of the blood should go to the Arabic physician Ibn Nafis (1210-1288 CE) (Shephard, 2012c). However, it remains unclear how far his views had percolated to 16th century Europe, where traditional views on the circulation of the blood were also being challenged.

Leonardo. Leonardo da Vinci (1452-1519 CE) made some 30 human dissections in the flickering candle light of the Roman *Santo Spirito* mortuary. He then used his considerable artistic skills to provide accurate sketches of various body parts, including the arterial tree. Unfortunately, this information remained unpublished until 1796 CE. Leonardo went on to explore hydraulic interactions between the heart and the blood vessels, and he suggested that the friction of blood against the rough inner surface of the ventricles generated the heat that he thought was necessary to convert the pneuma and the nutritive spirit into vital spirit (Shephard, 2012b). Since the isolated lungs could be kept inflated, he also argued that there could hardly be a direct connection between the blood vessels and the bronchi.

Servetus. The Spanish physician Michael Servetus (1511-1553 CE) studied in many Mediaeval centres of learning, including Toulouse, Bologna, Strasbourg, Basel, Paris, Lyons and Geneva. He criticized contemporary theological dogma in works such as *Errors of the Trinity*. Somewhat surprisingly, he introduced an important physiological concept into another theological tract, *Christianisimi Restitutio, that was* published posthumously. In this latter work, he pointed out that the colour of the blood changed as it passed through the lungs. Based on this observation, he resurrected earlier ideas of Ibn Nafis on the

circulation of the blood (Shephard, 2012c). Although Ibn Nafis did not discuss the pulmonary circulation specifically, some of his concepts may indeed have crossed the desk of Servetus when he was working as an assistant to Johann Guinter, an important translator of the ancient texts. Servetus wrote (Roy, 1929):

"The bright color is given to the sanguine spirit by the lungs, not by the heart....The communication does not take place through the median partition of the ventricle, as is generally supposed, but by a long and wonderful route; the blood is conducted through the lungs where it is agitated and prepared and where it becomes yellow and passes from arterial vein into the venous artery"

However, *Christianisimi Restitutio* contained a heavy dose of Anabaptist medicine, particularly a strong criticism of the Trinity and theories of predestination. Thus, it succeeded in arousing the ire of both the Pope and Calvin. Servetus was arrested and burnt at the stake in Geneva, holding a copy of the controversial text attached to his arm (Bainton, 1953; Cournand, 1964). Calvin quickly destroyed what he thought were all thousand printed copies of the book, but luckily he failed to trace three examples, which have survived to the present day.

Vesalius. The Flemish physician Andreas Vesalius (1514-1564 CE) became Professor of Anatomy at Padua. He received both credit and opprobrium for pointing out some important limitations to the physiological inferences that Galen had drawn from a teleological interpretation of his animal dissections (Shephard, 2012b). Vesalius based his *De humani corporis fabrica libri septem (Seven books on the anatomy of the human body)* on a meticulous dissection of criminals, particularly those condemned to death on the Montfaucon gibbet in the 10th arrondissement of Paris. His anatomical text was illustrated beautifully, probably by Jan Stephen van Calcar (1499-1546 CE), a pupil of Titian. The first edition of *De humani corporis fabrica libri septem* appeared in 1543 CE, the landmark year when Copernicus published his controversial treatise, *De revolutionibus orbium coelestium (Revolutions of the heavenly bodies)*. In the first edition of his anatomy text, Vesalius had accepted the Galenic tradition that blood (Akmal et al., 2010):

"*soaks plentifully through the septum from the right ventricle into the left*"

However, in the second edition he omitted this statement and he concluded instead:

"*I still do not see how even the smallest quantity of blood can be transfused through the substance of the septum from the right ventricle to the left ventricle*"

Possibly, some of these ideas were gleaned from a translation of the works of Ibn Nafis (1213-1288CE) (Shephard, 2012c) that was undertaken by Andreas Alpagos (born mid 15th century, died 1622CE). Alpagos returned from the Arab world in 1520 CE and on arriving in Padua he translated most of the Ibn Nafis *Commentary on Avicenna's Cannon* (Cournand, 1964).

Despite his gentle criticism of received anatomical wisdom, Vesalius was quickly assailed by his Parisian teacher Jacobus Sylvius (1478-1555 CE). The latter criticized his writings in language that

outshone the most crushing of current Canadian peer reviews. Vesalius was denounced as (Lutz, 2002):

"an ignorant, slanderous liar, inexperienced in all things, ungrateful and godless, a monster of ignorance, who with his pestilential breath was attempting to poison all Europe, and whose errors were so numerous that merely listing them would be an endless task."

Columbus. An assistant of Vesalius by the name of Realdus Columbus (1516-1559 CE) built on the descriptions of his tutor, providing a good description of the mitral valves in his *De Re Anatomica.* Columbus also confirmed an observation of the French physician Jean François Fernel (1497–1558 CE, the person who coined the term "physiology") that the arteries expanded during systole and shrank during diastole. Apparently independently of Servetus, Columbus described the aeration of the blood during its passage through the lungs, and he underlined the absence of pores in the inter-ventricular septum (Akmal et al., 2010):

"almost everyone believes that there opens a pathway for the blood from the right ventricle to the left ventricle and the blood is rendered thin so that this may be done more easily for the generation of vital spirits, but, they are in great error"

He stressed the presence of blood in the "artery-like" vein, although the persistence of Galenic ideas can be seen in his suggestion that the temperature of the blood in the left ventricle was *"intolerable to the exploring hand."*

Fabricius. Another Paduan anatomist, Hieronymus Fabricius Ab Acquapendente (1537-1619 CE) wrote a long treatise on the structure and function of the venous valves (*De venarum ostiolis)* (Smith et al., 2004). Unfortunately, he drew the mistaken conclusion that their primary purpose was to prevent a disastrous flooding of the extremities.

Caesalpinus. The erroneous nature of Fabricius's conclusions was soon demonstrated experimentally by a Pisan, Andreas Caesalpinus (1519-1603 CE), a student of Columbus. Caesalpinus pointed out that swelling of a vein always took place below and never above a ligature, an observation incompatible with the floodgate hypothesis. Caesalpinus coined the formal term "circulation" to signify the passage of blood through the lungs from the right to the left heart.

***Sanctorius*.** Santorio Santorii (1561-1636 CE) constructed a device to count pulse rates accurately. His *pulsilogium* was based on a small pendulum. The length of the pendulum thread was recorded by a dial, and the observer shortened the thread until the rate of oscillation matched the tempo of the patient's pulse beat (Levett and Agarwal, 1979). Sanctorius is perhaps most notorious for his quantitative studies in metabolism. He designed a special chair, and sat in it, weighing himself before and after eating over a period of some thirty years. He was puzzled by a discrepancy between the mass of food ingested and the increase in his body mass after correcting for visible excretions; he attributed this difference to "*invisible perspiration*."

Harvey. William Harvey (1578-1657) was a pupil of Fabricius, and subsequently became physician to the English King Charles I. In his short but celebrated treatise *"Exercitatio Anatomica de Motu*

Cordis et Sanguinis in Animalibus" (an anatomical study of the motion of the heart and of the blood in animals), Harvey outlined many of the anomalies in contemporary circulatory logic that he had high-lighted in his Lumleian lecture of 1616 CE. If the two ventricles had differing functions, why did they have an almost identical anatomical structure? How could the pulmonary vein carry air in one direction and fuliginous vapours and blood in the opposite sense without causing an intolerable confusion? If the idea of a flux in both directions was correct, why was there never any sign of air or vapour within the veins when they were opened? During systole, the heart did not absorb blood, as Vesalius had suggested. Rather, it expelled about a half an ounce of blood that the liver could manufacture. He bled a sheep, demonstrating that the heart expelled the entire blood volume in a matter of minutes. This implied that the blood must have circulated, a microcosm of that perfect circular motion seen in the movements of the planets. His final arguments for the circulation of the blood (Harvey, 1628) were an exercise in closely interwoven logic:

- *contraction rather than dilatation, of the heart coincides with the pulse, with the ventricles acting as muscular sacs that squeeze blood into the Aorta and Pulmonary artery.*
- *the pulse is produced by filling of the arteries and thus enlarging.*
- *there are no pores in the inter-ventricular septum.*
- *the same blood is found in the arteries and the veins.*
- *the action of auricles, ventricles and valves is the same, receiving and propelling liquid and not for air, since the blood on the right side of the heart, thoroughly mixed with air, is still blood.*
- *the blood sent to the tissues via the arteries to the tissues is not all used, but most of it returns through the veins.*
- *there is no to and fro motion in the vein; the blood strems constantly from the distant parts towards the heart.*
- *the dynamic starting point for the blood is the heart rather than the liver*.

Despite the cogency of his arguments, not all Renaissance scholars were convinced. Jean Riolan called him a *"circulator, an arrogant quack*" and stoutly maintained:

"I prefer to err with Galen than to accept Harvey's truth."

At Royal command, Harvey had the interesting assignment of autopsying a farm hand known as "Old Tom Parr." Parr had thrived on a diet of "*sub-rancid cheese and milk in every form, coarse and hard bread and small drink, generally sour whey*." He claimed to have joined the army in 1500, married at the age of 88 years, committed adultery when he was 102, and remarried when he was 122. He was seen threshing corn at an age of 130. He finally died at a reputed age of 152, apparently as a result of moving to London. Here, he became a sedentary celebrity. He relaxed his modest diet and was exposed to the heavy air pollution that was then characteristic of the city. His tomb is found in Westminster Abbey. His epitaph reads:

"Thomas Parr of the county of Sallop. Born AD 1483, lived in the reigns of ten monarchs: King Edward IV, King Edward V,

King Richard III, King Henry VII, King Henry VIII, King Edward VI, Queen Mary, Queen Elizabeth, King James and King Charles, aged 152 years, was buried here November 1653."

Harvey reported that at autopsy all of Parr's internal organs were still in a good state of health (Howell, 1987; Pitskhelauri, 1978). However, there is little objective evidence to substantiate his calendar age at death. Some historians suggest that Parr's records were confused with those of his grandfather, putting Parr's real age at death between 70 and 100 years (Doughty, 1988). Modern birth certification would have clarified such interesting but probably extravagant claims!

Respiration and gas exchange. Important names in Renaissance studies of the respiratory system included Paracelsus, Van Helmont, Boyle, Hooke, Lower and Mayow.

Paracelsus. Philippus Aureolus Theophrastus Bombastus von Hohenheim (1493-1541 CE) decided to give himself the name of Paracelsus, implying (with a characteristic degree of modesty) that he was greater than earlier authorities such as Celsus (c25 BCE- 50 CE, author of *De Medicina)*, and Galen (c.130-200 CE). Appointed as a Lecturer in Medicine at the University of Basel, Paracelsus proceeded to lecture in low German, a dialect that is still anathema in European universities; the peers of Paracelsus condemned such language as appropriate "*only to horses*." The University appointment in Basel was terminated with cause after Paracelsus had spent less than a year at his post. Apparently, he had arrogantly burned classical texts, including the Canon of Avicenna and the works of Galen during the course of his first lecture, and throughout the term he had poured public scorn upon his colleagues (Withington, 1964). This quotation gives a sense of his course content:

"I am Theophrastus, and greater than those to whom you liken me; I am Theophrastus, and in addition I am ***monarcha medicorum****, and I can prove to you what you cannot prove."*

and this was one appraisal of his medical confrères*:*

"Even the flies would disdain to sit on them except to make their dirt"

Paracelsus subsequently spent many years as a mercenary barber/surgeon and itinerant miner, settling in Salzburg shortly before his death. In Salzburg, he was appointed as both city physician and Professor of Medicine. His earlier travels had acquainted him with the basics of Eastern mysticism. To the Galenic four elements (Shephard, 2012b) and Arabic concepts of mercury (volatility) and sulphur (combustibility) he added a residue of "salt." In his view, mercury, sulphur and salt formed the *tria prima*, the three primary constituents of the human body (Read, 1961). He rejected Galen's idea that the heart was the source of vital heat. In his view, body heat came from digestion. The pulse and respiration served rather as cooling mechanisms, distributing this heat around the body.

In order to correct illness, Paracelsus suggested the prescription of chemical remedies that would rebalance the *tria prima* (a form of treatment that is sometimes termed *iatrochemistry*). He argued strongly against the compound mixtures prescribed by Galenic

physicians, and devoted much of his time to the alchemy of his age, distilling raw minerals into a mysterious, health-giving *arcanum,* a remedy that he carried in the knob of his sword (Paracelsus., 1894):

"All philosophers have hidden this arcanum as a most excellent mystery. This tingeing spirit, separated from the other two as above, you must join to the spirit of Luna, and digest them together for the space of thirty-two days."

Paracelsus also engaged in an assiduous search for the "philosopher's stone," looking for a process that would transmute base metals into pure gold. Because he insisted that all vital phenomena had a chemical basis, some have argued that he should be considered as the founder of modern biochemistry. Others termed him the "Medical Luther," because he believed that a transcendental spirituality could hold in check the technical hubris of science. During the Nazi era, he became revered as a right-wing cult-figure, particularly in Germany. In the view of the homeopathist August Bier (1861-1949 CE), Paracelsus was a personification of German medical science. With his populist, low German approach, he offered a view of health that was "*close to the people*" and "*not based on a lot of complicated theories*" (Berryman and Parks, 1992).

Van Helmont. Jan Baptist Van Helmont (1579-1644 CE) was a Flemish chemist and physiologist. He has been considered as the founder of pneumatic chemistry (a sub-discipline examining the physical properties of gases in relation to chemical reactions and the nature of matter). He introduced the word "gas" into our scientific vocabulary. Some historians suggest that the term was derived from the Greek word *chaos;* other possible candidate sources of the word include *vergesen*, or fermentation.

Like Paracelsus, Van Helmont sought a strictly chemical explanation of both health and disease, but he rejected the *tria prima* of Paracelsus. In his view, there were only two basic elements, "air" and "water." The 164 pound (74.5 kg) gain in mass of a tree that he observed over a five year study of its growth was due entirely to the incorporation of water into wood, bark and roots. He noted that the quality of "air" differed from time to time. "Gas" was not quite the same as steam. Likewise, the air produced by adding acid to limestone or fermenting malt was a "*gas sylvestre*;" it had a wild chaotic quality that could extinguish a naked flame and make the air within a closed cave irrespirable (Pagel, 2002):

"uncouth when restrained in a vessel, and escaping in its entirety when freed... although it is certainly not air"

The term *sylvestre* is perhaps borrowed from Paracelsus, who also spoke of *sylvestres*, or airy spirits (Pagel, 2002). Other concepts of Van Helmont, such as the difference between wood smoke and the smoke from a manure heap, may have been borrowed from a physician in Breslau (Daniel Stennert, 1572-1637 CE). Van Helmont concluded that a variety of ferments within the body decomposed intestinal food, turning chyle into blood, and changing the colour of blood in the lungs. He vigorously opposed the still omniprevalent practice of blood letting, proclaiming (Moon, 1931):

"*A bloody moloch sits president in the chairs of medicine."*

Boyle and Hooke. Richard Boyle (1627-1691 CE) was the child of a wealthy Irish colonist (the Earl of Cork). After private tutoring in Dublin, he was educated at Eton College. He had some desire to become an alchemist, and in 1689 CE he was successful in obtaining repeal of a law that prohibited the "multiplying" of gold and silver. However, he is best known for the enunciation of what we now term Boyle's law of gaseous volumes (Hunter, 2009). With his pupil Robert Hooke (1635-1703 CE, proponent of the law of elasticity), Boyle conducted some of the first animal and human experimentation. The two investigators built a small decompression chamber, and discovered that as air was pumped out of it, a flame within the vessel was extinguished. Various unfortunate small creatures that had been confined to the chamber (larks, sparrows and mice) all died as the air was extracted. Hooke himself next ventured inside a larger chamber; fortunately for his survival, the extraction pump was not very efficient, and apparently the only side-effect that he experienced was a little barotrauma, as an unpleasant pain developed in his ears. Hooke went on to demonstrate that the primary function of respiration was not to pump blood around the body but rather to supply it with fresh air. A dog could survive if air was blown into its lungs and escaped through pin-hole punctures at its surface. If movement of the aerating bellows was stopped, the animal survived for a brief period, but if the *menstruum* from the atmosphere was withheld for any length of time, the animal went into convulsions and died.

Lower. Richard Lower (1631-1691 CE) was a Cornish anatomist and physician, and an avid follower of Harvey's research (Franklin, 1931). Lower extended the experiments of Hooke on artificially ventilated lungs, showing that if dark blood was injected into the pulmonary artery, it emerged from the pulmonary vein a much brighter red, the change of colour being contingent upon continued ventilation of the lungs. He also demonstrated that the pumping action of a dog's heart languished as the animal's blood was progressively diluted by beer!

Mayow. John Mayow (1643-1679 CE) was another Cornishman, educated at Wadham College, Oxford (Partington, 1956). As a pneumatic chemist, he carried out further experiments on animals that were enclosed in glass vessels, observing that their survival time was halved if a lighted candle was introduced along with the animal. Mayow came close to the discovery of oxygen, speculating that the candle had burnt "nitro-aereal particles," derived from one of the acid components of nitre. The bell jar for his experiments was inverted over a water seal; thus, he was able to document a decrease of gas volume within the vessel as the experiment proceeded. We now know that this reflected the animal's respiratory gas exchange ratio and differences in the water solubility of oxygen and carbon dioxide. Mayow suggested that breathing facilitated a contact between air and blood, allowing a transfer of nitro-aereal particles into the blood. However, his explanations of the bell jar experiments did not get far beyond the idea that the store of nitro-aereal particles had been depleted by a combination of the candle flame and various fermentation processes within the animal's body.

Muscle function. For many centuries, health scientists accepted the traditional view that muscle contraction occurred as the muscles were filled with vital spirit,

transmitted via the nerve fibres (Shephard, 2012b). The work of several Renaissance scientists served to correct this erroneous notion and shed light on other important aspects of muscle function. We will comment on the contributions of Leonardo, Canape, Cardano, Borelli and Glisson.

Leonardo. Leonardo da Vinci constructed wire cages around the muscles to study the inter-play of muscular forces. Thus, he was able to differentiate the behaviour of muscles that acted across a single joint from those that acted over several joints (Tözeren, 1999).

Canape. Jean Canape published the text *Du mouvement des muscles (The Movement of Muscles)* in 1531 CE (Galen and Canape, 1541). This book is particularly noteworthy in that it recognized the contractile properties of muscle fibres and the functional significance of their architectural arrangement relative to the adjacent tendons (vanIngenSchenau, 1994).

Cardano. Girolamo Cardano (1501–1576 CE) was an Italian physician and mathematician who worked at the University of Pavia, in Lombardy. He was a close friend of Leonardo da Vinci (Cardano et al., 2003), but his interest in numbers seems to have been stimulated more by a propensity for gambling than by his contacts with da Vinci. In 1551, Cardano proposed the novel concept that muscular movement could be explained strictly on mechanical principles.
He was summoned to Edinburgh in 1552 CE, in order to treat "*Amulthon*," the Bishop of St. Andrews, for intermittent attacks of asthma. Cardano imposed a rigid 10-week regimen that included ten hours of sleep per night, regular garden walks, a light diet, frequent exposure to both heat and cold, and the occasional gravitational stimulus of hanging of the bishop by his heels (Tytler), Cardano claimed that these drastic tactics cured the Bishop of an "*unhealthy temperature in his brain."* The prelate's problems were in fact probably due to an excessive intake of food and other venal pleasures, and when Cardano left Edinburgh, he gave his patient strict instructions to persist with the prescribed regimen, apparently with good effect.

Borelli. Giovani Alfonso Borelli (1608-1679 CE) was an Italian physicist, mathematician and iatromechanical physiologist who was appointed as Professor of Mathematics in the University of Pisa. Together with the anatomist Malphigi (1628-1694 CE), he founded a short-lived Italian scientific society (*L'Accademia di Cimento),* and as a iatromechanician, Borelli argued that all of the puzzling phenomena of life and death would eventually be explained through the newly defined laws of physics (Thurston, 1999). He noted that muscular forces could be dissipated either by unfavourable leverage, or by the resistance of air or water. He likened the action of the heart to that of a piston, suggesting that the elasticity of the arteries served to accommodate the blood flow. He sketched (but probably never built) an early form of submarine, and he also proposed the development of a SCUBA apparatus for underwater exploration (Davis, 1955). His posthumously published text *De Moto Animalum (On the movement of animals)* provided an extensive analysis of locomotion in various species, describing the concepts of muscle tone and the antagonistic actions of certain muscles. But despite a broad range of interests, the

dissemination of his findings seems to have been constrained by the treatment that the Papacy meted out to a fellow mathematician, Galileo Galilei (1564-1642 CE). Perhaps for this reason, Borelli continued to support the established wisdom that muscle contraction reflected the turgescence of existing structures, brought about by an explosive interaction between vital spirits flowing from the brain and fluid already within the muscle. In support of this dogma, he demonstrated that when a muscle was sectioned, spirituous droplets squirted out from the tissue.

Glisson. Francis Glisson (1597-1677 CE) was a keen disciple of Harvey. He became Reader in Anatomy at the College of Physicians in London. For 40 years, he also held an appointment as Regius Professor of Physic at Cambridge University (Stirling, 2003). Throughout much of the Civil War, he chose to take refuge in the city of Colchester, but he later had the gall to sue Cambridge University for five years of unpaid salary! With the outbreak of the Great Plague of 1665 CE, he was living in central London, and he claims to have escaped infection during this epidemic because he regularly inserted a vinegar-soaked sponge into each of his nostrils before visiting his patients. Among other significant scientific accomplishments, he quickly debunked Borelli's notion of muscular turgescence. Use of an arm plethysmograph demonstrated that the limb muscles became smaller rather than larger as they contracted. Glisson further suggested that all viable tissue was irritable, and could react to appropriate stimuli.

Emergence of Schools of Health Science.

The influence of the medical schools in Bologna and Padua gradually spread northwards to other parts of Europe, and academically-oriented schools of health science emerged in Montpellier, Paris, Leiden and Edinburgh, with an accompanying development of professional colleges that regulated the minimum qualifications that were expected of those describing themselves as physicians and surgeons.

Montpellier. The Montpellier medical school claims to be the oldest continuing medical school in Europe (Demaitre, 1975). Its origin probably dates back to the middle of the 11th century. In 1180 CE, the lord of the city, Guilhem VIII, proclaimed that

"*anyone, no matter their religion or roots, could teach medicine in Montpellier*."

The school's official charter dates from 1289 CE. Although nominally placed under the Bishop of Maguelonne, in practice the Montpellier faculty enjoyed a considerable measure of academic freedom. Later, the school became somewhat elitist, and in 1529 CE it expelled Nostradamus from its ranks when it discovered that he had plied the "manual" trade of apothecary before beginning his medical studies.

The revolutionary government of the 1760s forcibly displaced the medical library from the church-run Hôpital St Eloi to the secular medical school. At the same time, the professors' salaries were greatly increased, and even medical students were offered a small stipend. However, financial difficulties arose almost immediately, as the central government failed to provide adequate

funding for these innovations.

The reputation of the Montpellier school suffered during the Enlightenment, when it broke with the iatrochemists and iatromechanicians to embrace the concept of Vitalism espoused by Francois Bossier de Sauvages (1706-1767 CE) (Williams, 2003). The primary hypothesis of Vitalism was that the functions of living organisms were based on an *élan vital*, something quite distinct from normal chemical reactions. Although Vitalism gained new force at Montpellier during the Enlightenment, this idea can be traced back to the view of Galen and other classical physicians that health depended on an appropriate balance of four vital humours, or forces (Shephard, 2012b),

Paris. The medical school in Paris also has a long history. Public teaching of medicine began there during the 12th century. The first recorded Professor of Medicine was Hugo of St. Victor, *physicus excellens qui quadrivium docuit* (eminent physician who taught at the crossroads). A Dean of Medicine was appointed as early as 1268 CE.

Leiden. The medical school in Leiden was founded by Wiiliam of Orange in 1575 CE. By the early 17th century it had become one of the dominant forces in European medical education. It is recognized particularly for the early efforts that Herman Boerhaave (1668-1738 CE) made to apply new scientific knowledge to the healing arts (Bromley, 1957).

London. Within the city of London, much of the early teaching in the health sciences was undertaken by the Guild of Surgeons (an organization that dates from 1368 CE, (Fu, 2000)) and by the College of Physicians. The latter was founded in 1518 CE, under a charter from Henry VIII. Thomas Linacre (1460-1524 CE) was appointed as it its first president. The establishment of the College of Physicians for the first time imposed standards of basic knowledge and competency upon those in Britain who claimed to be physicians. It also provided a forum for distinguished lecturers. Thus, in 1616 CE, William Harvey (1578-1657 CE) was appointed as Lumleian Lecturer for the College of Physicians.

During the Renaissance, qualified surgeons also began to tire of competing against the services offered by an ever-growing number of barbers. Thus, in 1540 CE Henry VIII sponsored an amalgamation of barbers and surgeons as the United Company of Barbers and Surgeons, with Thomas Vicary as its first Master. However, the barbers were still scorned by many of the surgeons. William Clowes (1544-1604 CE) viewed the barbers as a conglomeration of (Garrison, 1966):

""tinkers, tooth-drawers, peddlers, ostlers, carters, porters, horse-gelders and horse-leeches, idiots, apple-squires, broom-men, bawds, witches, conjurors, soothsayers. and sow-gelders, rogues, rat-catchers, runagates, and proctors of spittle- houses"

The first medical schools in London developed around religious institutions. St. Thomas's Hospital opened its doors in 1173 CE, although it did not become a formal medical school until around 1550 CE. St. Thomas's is remembered particularly for its nursing school, established by Florence Nightingale in 1860 CE.

Rahere, variously described in legend as a clergyman, courtier, minstrel and jester, also founded a small hospital at St. Bartholomew's Priory in 1123 CE; his intent was to treat poor people who were

sick. However, the initial endowment was so small that the *Hospitaller* (the equivalent of our modern hospital administrator) had to visit the adjacent meat shambles each day, begging for food to feed his charges, and in a parody of modern hospital over-crowding, several patients were often required to sleep in a single bed (Besant and Hallbauer, 1928). Despite these early initiatives, most of the well-known English medical schools did not emerge until the Enlightenment.

Edinburgh. Scottish surgeons and barber-surgeons received their charter of incorporation in 1505 CE and the Royal College of Physicians of Edinburgh was established in 1681 CE. However, a Faculty of Medicine was not founded until 1726 CE.

Attitudes of scholars and physicians towards health and fitness

Renaissance physicians in general showed little interest in public health or hygiene, and the need of children for regular daily physical activity was rarely considered as public schooling was introduced. But occasional scholars began to discuss the possibility of enhancing bodily function. We will look at attitudes towards health and fitness in both scholars and physicians, and we will explore the extent to which physical fitness was considered in planning the curricula of the emerging school system.

Public health and hygiene. The philosopher Desiderius Erasmus (1466-1536 CE) introduced the well-worn phrase "*prevention is better than cure*," but he was referring to education as a means of preventing human conflict, rather than an investment in public health as a means of preventing epidemics of disease. In fact, the outbreak and the management of the Great Plague shows that the Renaissance was not marked by any strong initiatives designed to contain disease and to improve population health. Two small exceptions were the introduction of cotton clothing and a growing use of toothbrushes.

The London "Plague" of 1665 CE claimed 68,596 lives over the course of a year. Preventive measures were no more effective than during the Black Death, three centuries earlier. Indeed, an ordinance confining people to their homes if one family member was infected virtually ensured the death of the remaining members of the household, Most physicians decided that discretion was the better part of valour, and left town rapidly. One exception was Dr. Nathaniel Hodges (1629-1688 CE), who valiantly remained at his post in Central London, attending hordes of victims. He fortified himself with "*heavy draughts of sack*," and later wrote *Loimologia*, a valuable account of this epidemic (Hodges, 2010). The spread of infection was checked finally by the Great Fire of London; this consumed most of the fleas in the plague-infested dwellings.

One important development during this era was the introduction of washable cotton clothing and sheets. This innovation greatly improved personal hygiene and curtailed the spread of insect-borne diseases. The supposed world traveller Jehan de Mandeville of Liège explained the origin of this fibre to his astonished audience as follows (Gaur, 1977):

"There grew there [India] a wonderful tree which bore tiny lambs on the endes of its branches. These branches were so pliable that they bent down to allow the lambs to feed when they are hungrie."

A second innovation that contributed to oral hygiene was the popularization of the bristle toothbrush, invented by the Chinese around 1223 CE. In general, hog bristles were attached to a bamboo stick (Kumar, 2011). Such devices became popular in England during the late 17th century, beginning with the aristocracy

Attitudes of scholars. During the Renaissance, the ancient Greek ideals which had glorified the human body found renewed acceptance by scientists, artists, and poets such as François Rabelais (1483-1553 CE), Leonardo da Vinci, MIchelangelo, Luther and Calvin. Once again, it became acceptable for scholars to talk about the physical body, to explore its workings, meanings, and capabilities, and even to contemplate enhancing its function.

Some historians have distinguished three categories of Reformation scholars: the verbal realists such as François Rabelais (1483-1553 CE), and Martin Luther (who sought a strong body that could help the mind in its search for piety), social realists such as Richard Mulcaster (who envisaged physical education as contributing to the development of an integrated personality) and the sensory (or scientific) realists such as Leonardo da Vinci and Michelangelo (who valued fitness for its contribution to health and thus the ability to learn) (Calderon, 1998; vanDalen and Bennett, 1971).

Leonardo da Vinci. Leonardo da Vinci (1452-1519 CE) offered an insight into Renaissance thinking, well-known to the current generation of kinesiologists, in his sketch of the "Vitruvian Man" (Maiorino, 1992). This famous illustration shows a naked male form in two superimposed positions. It summarizes the essential symmetry of the human body and, by extension, the symmetry of the universe as a whole.

Michelangelo. Michelangelo (1475-1564 CE) greatly influenced Renaissance impressions of the ideal physique through his sculptures and paintings. He saw the human form as the physical symbol of both soul and character. He believed that if the mind was strong and the soul pure, then the body should be depicted with a lean and muscular form. Physical beauty indicated an underlying spiritual and moral beauty (Nickerson, 2008).

Luther. Cranach's portrait of Martin Luther (1483-1556 CE) shows that by the time he had reached middle age (1529 CE) Luther was physically imposing, equal in stature to any of the secular German princes. But also, in stark contrast to many of the ascetic clerics of Mediaeval times, he was the epitome of a both a verbal realist and a *bon vivant*, fleshy and obese. Certainly, he had rejected the physical deprivations of an earlier age. He wrote approvingly of the recreational and moral value of physical exercise (Barnard, 1878):

"Accordingly, I pronounce in favour of ... the knightly sports of fencing and wrestling of which the one drives care and gloom from the heart and the other gives a full development of the limbs. And another argument for them is this, that they keep men from tippling, lewdness, cards and dice..."

Luther's philosophy was such that he showed no prudishness in discussing physiological processes, and in a letter to his wife written just before his death he confided that he was no longer aroused by the sight of prostitutes (Roper, 2010).

But apparently, he found little time for exercise in his personal schedule, and he did not accept our modern insistence on the virtues of a low body fat content.

Calvin. John Calvin (1509-1564 CE) was another Renaissance reformer who did not support the asceticism of the Mediaeval monks. Nevertheless, he sought to regulate normal active recreation in attempt to perfect moral discipline. He himself went for long walks and played bowls and quoits, and in the writing rules for his Geneva Academy he recognized that some play and sport were allowable for children. Thus, he recommended that students be allotted time for recreation on Wednesdays, although the instructor was to conduct it (Baker, 1988);

"*in such a way that all silly sports be avoided*"

Unfortunately, he never defined which sports he considered as "silly."

Attitudes of physicians. Although many Renaissance doctors had little interest in promoting regular exercise, we can identify a substantial roster of individuals who were active in promoting physical activity and fitness. Prominent names included Mendez, Mercuriale, Paré, Joubert and Duchesne.

Mendez. Cristobal Mendez (c1500- 1553 CE) was born in Spain, but spent much of his life in Mexico. There, he came under the scrutiny of the Spanish Inquisition because he of his interest in seals bearing Zodiacal inscriptions. His one known text is a short (72-page) volume entitled *Libro del Exercicio (Book of Exercises),* published in 1553. In this book, he came close to using our modern definition of exercise (Bouchard et al. 2012):

"exercise is a voluntary motion upon which ventilation becomes fast and frequent"

Mendez distinguished "natural" movements (of the lungs and pulse) from voluntary movements and he concluded that exercise was beneficial to health because it created heat, aided digestion, and rid the body of superfluities. And, anticipating our modern excuse of "lack of time" he pointed out that walking could be practiced both indoors and outdoors (Machline, 2004). He concluded:

"The easiest way of all to preserve health...is to exercise well."

Mercuriale. Girolame Mercuriale (1530-1608 CE) was an Italian physician who was educated in Bologna and Padua. He accepted the Chair of Practical Medicine at Padua in 1569 CE. He translated the works of Hippocrates, and also published a six-volume book on gymnastics (*De Arte Gymnastica*) (Agasse, 2000). He was at the forefront of the movement to persuade doctors to embrace exercise, and his text is sometimes cited as the first primer of sports medicine, although in fact it was antedated by the *Libro del Exercicio* of Mendez (above).

Mercuriale drew a clear distinction between preventive and therapeutic exercise, and he warned that there were dangers in overly strenuous military training and athletics. However, he replaced the passive exercise of many Renaissance experts with vigorous forms of physical activity that demanded heavy breathing and physical effort. His practical recommendations included walking, mountain climbing, running, jumping, rope climbing, wrestling, and ball games, with special diagnosis-specific

activities for convalescents and weaker older people

His reputation as a physician took a serious hit when he argued against the need for quarantine measures in Venice. This advice led to a high toll of deaths from an outbreak of bubonic plague. Ironically, the plague became the theme of his next textbook (*De Pestilentia*).

Paré. Ambrose Paré (1510-1590 CE) was military surgeon to a succession of French kings. He became very concerned about the condition of patients following battlefield surgery for gunshot wounds, and he found therapeutic value in an antiseptic treatment of wounded tissue with turpentine.

In the context of physical fitness, he was a strong advocate of exercise (Paré and vandenSpiegel, 1649). Because he was unable to express himself in Latin, his more Patrician colleagues sometimes spurned his views. But by the same token his use of the vernacular made his ideas available to apothecaries and barber/surgeons with a limited education. One of his most important suggestions was that specific and moderate exercise should follow rapidly upon the treatment of limb fractures (Paré and vandenSpiegel, 1649):

"The quality of exercise which we require...must be neither too slow and idle, neither too strong nor too weak...which may move all the members alike...the body should be so often exercised as there is desire to eat."

Joubert. Laurent Joubert (1529-1583 CE) was Chancellor of Montpellier University and personal physician to Catherine de Medici. Like Paré, he wrote in the vernacular, arguing that those who kept medical knowledge from the general public by writing in Latin were on a par with priests who opposed translation of the Bible. His *Erreurs Populaires (Popular Errors)* challenged many of the medical concepts of his contemporaries. He advocated that people should take an hour of exercise each day, and he introduced therapeutic gymnastics into the medical curriculum at his university (Joubert and deRocher, 1995).

"It is imperative to exercise for one hour every morning before breakfast. The best exercise is tennis, because it exercises equally, or very nearly so, every part of the body. If the weather is not fair enough for going outside, one can fence, vault, dance or wrestle..."

Duschesn*e.* The French-born pharmacologist Joseph Duschesne (1546-1609 CE) was also a product of Montpellier University. He was strongly influenced by the ideas of Paracelsus, commenting that chemistry (DuChesne and Hester, 1591):

"openeth unto us so many secrets of nature, and preparations of herbes, beastes and mineralls hitherto unknown..."

He became Royal Physician to Henry IV, and in the context of fitness he is best remembered for his *Ars Medica Hermetica*, written in 1648. In this volume, he recommended swimming and gymnastics to promote (Everly and Lating, 2002):

*"deliverance from superfluous humours, the regulation of digestion, the strengthening of the heart and joints, the opening up of the pores of the skin, and the stronger circulation of the blood in the lungs by strenuous breathing***."**

Schools, educators and curricula. Building upon the Mediaeval system of informal schooling at the parish church, song schools at cathedrals and almonry schools that were attached to monasteries, the Renaissance saw the emergence of guild schools, preparatory grammar schools, and full grammar schools (Leach, 1896). In Britain, the Bishop of Winchester, William Wykeham, founded the prestigious Winchester College in 1394 CE, and in 1440 CE Henry VI opened "*The King's College of Our Lady of Eton besides Wyndsor*." The original intent of Eton College was to educate 70 poor children, rather than future Prime Ministers!

By the 17th century, children from wealthy homes began their education at a "petty school." The boys then progressed to a grammar school, and the girls were educated further by personal tutors (or their mothers, in the case of poorer families).

The *Latijnse School* in Leiden, chartered by Count William III in 1323 CE, was known as the Old Gymnasium, and it may thus have espoused the classical pattern of active education espoused by the early Greeks. Other Renaissance scholars who appreciated the importance of developing both the body and the mind included Petrarch, da Feltra, Alberti, Vegio, Mulcaster, Burton and de Montaigne.

But during the Renaissance, curricula with a commitment to physical activity were the exception rather than the rule. The more traditional Dutch teacher Erasmus (1446-1536 CE) saw no place for sport or physical education when instructing children who were over the age of 6 years. The ideas of Erasmus were reflected in many of the prestigious Renaissance schools founded under his guidance, such as St. Paul's, in Central London. In his *Colloquies*, schoolboys asked their master for a holiday for games, and Erasmus replied (Erasmus and Johnson, 1878):

"they that labour hard had need of some relaxation; but you that study idly and play laboriously had more need of a curb than a snaffle."

Universities, also, sometimes expressed active opposition to the participation of their students in sport.

Petrarca (Petrarch) The Renaissance saw some renewed interest of Italian scholars in classical Greek gymnastics. The Poet Lauraeate Francesco Petrarca (1304-1374 CE) was an early tourist and mountaineer. Among other ascents, he climbed Mont Ventoux (1912 m), the Provencal "Bald Mountain" that is a prominent obstacle on the modern Tour de France. In his book *Invective Contra Medicum* (*Protest against the doctor*), which was written in collaboration with Domenico Silvestri and Pier Giorgio Ricci, Petrarca encouraged replacing medicines that poisoned the body by the natural remedy of exercise (Struever, 1993).

da Feltra. Vittorino da Feltra (1378-1446 CE) was an Italian physician from Mantua. He was perhaps the first to introduce formal physical education classes into the school curriculum. Even the name of his school, *Casa Giocosa* (Happy House), broke with the cheerless Mediaeval institutions in which grammar and Holy Writ were instilled by a combination of rote learning and relentless flogging of the duller students. As elsewhere, a study of Greek and Roman literature formed the basis of his curriculum, but he also taught history, philosophy, arithmetic, geometry, music, and astronomy. Moreover, he

recognized the need to combine mental training with individually prescribed exercise and games to encourage the physical development of his pupils (Monroe, 1909).

Alberti. Leon Battista Alberti (1404-1472) was perhaps best known as an architect, but as a typical "Renaissance man," he excelled in many fields. In what many think was an autobiography, the historian Ludovico Antonio Muratori (1672-1759 CE) reported that

"he excelled in all bodily exercises; could, with feet tied, leap over a standing man; could in the great cathedral, throw a coin far up to ring against the vault; amused himself by taming wild horses and climbing mountains."

Alberti advocated beginning exercise in early infancy, to strengthen the muscles, boost the circulation and adapt the nervous system.

Vegio. Maffeo Vegio (1407-1458) is hailed by many as one of Italy's finest Latin poets of the Renaissance. In "*De educatione liberorum et eorum claris moribus*", a six volume treatise on the education of children and their moral foundation, he distinguished between light recreational exercise and the heavier exercise that was intended to strengthen the body, and he advocated moderation in all physical activity.

***Richard Mulcaster*.** Richard Mulcaster (1531-1611 CE) was appointed as the first headmaster of the Merchant Taylor's Guild School, in London, in 1561 CE. He argued that high fitness levels would enhance intellectual learning (Hale, 1994; Hay, 1986), and he rounded out the elementary school curriculum with exercise as an important sixth principle. In his view (Mulcaster, 1581), all exercises were devised:

"either for games and pastime, for warre and service, or for suretie of health and length of life, though somtime all the three endes did concurre in one, sometimes they could not."

He listed in detail what he considered to be the best exercises for children (Mulcaster and Oliphant, 1903). His recommendations included walking, running, leaping, martial arts, wrestling and fencing, swimming, riding and ball exercises. In particular, he developed football as a team sport. He asked referees to guard against the rough play which to that point had been customary in soccer, and he emphasized that if played appropriately, this sport not only maintained health and promoted strength, but it also had a positive educational value (Mulcaster, 1581):

"the foteball strengtheneth and brawneth the whole body. It helpeth weake hammes by much moving and simple shanks by thickening of the flesh no less than riding doth."

Burton. The mathematician and astrologer Richard Burton (1577-1640) was an Oxford don who in his classic work "The Anatomy of Melancholy" sought to apply the principle of exercise to the treatment of his "Black Bile," possibly a bipolar disorder (Burton, 1613/1862)**:**

"*There is no greater cause of melancholy than idleness, no better cure than business*"

Montaigne. Michel Eyquem de Montaigne (1533-1592 CE) was an early French

humanist and essayist. He was educated on his family estate in Aquitaine, with a German tutor who had no knowledge of French and involved Michel in a rigorous Latin immersion programme. Montaigne's father was a great believer in exercise, and is reputed to have had sufficient strength to turn his body around on a table while supporting himself on his thumb (Compayre, 1971):

"there hardly ever was a man of his condition to equal him in all bodily exercises."

The German tutor familiarized young Montaigne not only with Latin, but also with Greek, through a combination of games, conversation and meditation. As an adult, Montaigne rejected the dualism of those Christian theologians who saw the body at war with the soul, arguing (deMontaigne, 2009):

It is not a mind, it is not a body that we are training; it is a man and he ought not to be divided into two parts."

Montaigne lacked the outstanding strength of his father. He could neither swim nor fence, but he became a fair runner and an excellent horseman. He argued that physical and moral education were closely linked. Without engaging in the orgy of 216 games and gymnastic exercises that a satire of Rabelais (1493-1553 CE) had proposed for Gargantua (Kinser, 1990), Montaigne argued that the earnest student should recognize:

"It is not enough to toughen his spirit, his muscles also must be toughened."

Universities. The mediaeval university curriculum generally comprised seven liberal arts: grammar, rhetoric, logic, arithmetic, geometry, music, and astronomy. The liberal education of the Renaissance sometimes supplemented this programme with games and exercises. However, sports such as football were not well regarded in Renaissance times. The pamphleteer Philip Stubbes (c1555-1610 CE) wrote (Stubbes, 1583):

"Any excercise which withdraweth us from godlines, either upon the sabaoth, or any other day els, is wicked & to be forbiden . . . as concerning football playing: I protest unto you, it may rather be called a friendly kinde of fight, then a play or recreation. A bloody and murthering practice, then a felowly sport or pastime."

Michael Dalton, Justice of the Peace for the City of Cambridge, argued that he and his fellow justices had the authority (Dalton, 1635):

"within Liberties, as without, (to) enter into any common house or place, where any playing at dice, Tables, Cardes...football, or other unlawfull game, now invented, or hereafter to bee invented, shall be suspected to bee used; And may arrest the keepers of such places and imprison them..."

The prestigious universities thus admitted any form of sport participation with some reluctance. Roger Goade, on becoming Vice-chancellor of the University of Cambridge in 1595 ordered (Cooper, 1843):

"That the hurtfull and unschollerlike exercise of Footeball... doe from henceforth utterly cease (except within places severall to ye Colledges, and that for them only that be of ye same Colledge)"

Archbishop William Laud (1573-1645 CE) became Chancellor of Oxford University in 1630 CE, and six years later he promulgated the Laudian Code (which incidentally provided a continuing basis for the University Statutes over the next two centuries). This code banned ball-playing in the private yards and greens of the townsmen, and students were enjoined to avoid (Ward, 1845):

"every kind of sport or exercise, whence danger, wrong or inconvenience may arise to others."

The Laudian Statutes also forbade either participation or the watching of other activities, such as fencing and rope dancing, particularly if gambling was involved.

Changing patterns of sport and habitual activity.

The Renaissance saw changing patterns of sport and physical activity in the general population, with influences from a movement of the population into large cities, a growing Puritanism, a ritualization of some sports, and the emergence of sedentary occupations.

Sports. In Italy, the Medici family were ardent supporters of sport. In allusion to this interest, their coat of arms depicted Guilanio preceded by a negro carrying his bow (Burckhardt, 1945; Young, 2009).
In England, the interest in vigorous leisure pursuits that had characterized the Mediaeval aristocracy generally persisted into the Elizabethan era and on into the time of the Stuart Kings, with a considerable influence from the Italian nobility. However, a strong negative influence arose during the brief period of the Puritan Commonwealth. In general, sport flourished at court rather than in Academia. Henry VIII enjoyed wrestling, fencing, running, throwing events and ball games during his youth. He was also an enthusiast of hunting and other forms of horsemanship, and he introduced the Italian skills of horse-training to his court (Trench, 1970). Elizabeth I also was an accomplished archer, and she enjoyed dancing and watching various other forms of sport. However, many forms of physical activity became more ritualized during the Renaissance, and some activities were restricted to those of adequate social standing.

Towards the end of the Renaissance, the general interest of European society in sport was sufficient that the French physician and student of ancient music Pierre Jean Burette (1665–1747 CE) wrote a history of sport; this book placed particular emphasis on the ball games and discus throwing of the classical era. Burette himself was sufficiently impressed with the benefits of exercise to use gymnastics extensively in the treatment of his patients (Waller, 2008).
Public attitudes towards football have been discussed above. I comment now on issues of social status and the popularity of walking, swimming, fencing and archery during the Renaissance.

Social status. During the Renaissance, Italian football (*calcio*) teams began to wear elaborate costumes, and much time was consumed in parading the players before the pavilions of rival teams. Moreover, participation became limited to those who were thought of appropriate social rank. Perhaps in part as an attempt to curtail the violence that had characterized early English soccer matches, according to Count Giovanni's *Discorso*, players were (Heywood, 1904):

"*neither artificers, servants, nor low-born*

fellows, but honourable soldiers, gentlemen, lords and princes"

Count Baldassarre Castiglione of Novilara (1478-1529 CE) was a Renaissance Italian who attached considerable importance to a socially appropriate choice of active pursuits by the aspiring courtier. In *Il Coregiano* (1528 CE), he recommended the adoption of *tenyse* and *vautynge*. These were seen as sports that were physically demanding, but that enhanced physique, making a man fast and nimble. In contrast, tumbling and rope-climbing were pursuits suitable only for humble jugglers (Castaglione et al., 1900). Moreover, he insisted that the skill and physical prowess of a courtly athlete was to be accompanied by modesty and even a hiding of personal ability (*del gratia, by the Grace of God*). Skills were to be displayed with the *sprezzatura* (disdain) typical of some of Shakespeare's characters such as Henry V, and Orlando in the opening scenes of *As You Like It*.
In England there were similar expectations of the nobility. The social elite were expected to show *loyautie* and *courtesie* when they engaged in sport.

The Stuarts and the Puritan repression.
In 1618 CE, James I promulgated a "*Declaration concerning Lawful Sports.*" In this measure, he rebuked the restrictions on physical activity that had been imposed by the Puritans (Oldys and Harley, 1745):

"unlawfully punishing of our good people, for using their lawful Recreation and honest exercises upon Sundays and other holidays, after the afternoon sermon or service." In his view, "t*he meaner sort...who labour hard all the week... should be allowed to engage in lawful recreations*" such as archery, leaping, vaulting and dancing.."*after evening prayers ended*," and this would make *"their Bodies more able for war."*

Activities allowed by the Declaration included May-games, Whitsun-ales, Morris-dancing, and the setting up of May-poles, but interestingly bull- and bear-baiting, and bowling were prohibited. Moreover, recusants (Roman Catholics who refused to attend the parish church) and others who missed Sunday services were denied the privilege of participating in Sunday games. Charles I reissued James' decree in 1633 CE, at the urging of Archbishop Laud (1573-1645 CE). However, many ministers with Puritanical leanings had little inclination to listen to Charles I, and they spurned Laud's edict to read the Declaration from their pulpits. In the Diocese of Norwich alone, thirty priests were suspended for disobeying this order.

During the Commonwealth era (1649-1660 CE), Cromwell and the Puritans quickly reversed the liberal attitude that the Stuart Kings had shown towards physical activity. The Puritan government moved rapidly from simply attacking Sunday sport to a broad assault upon all types of games and physical activities. In his spiritual odyssey *The Pilgrim's Progress,* the Puritan author John Bunyan (1628-1688 CE) admitted his recurrent wickedness as he returned to his favourite game of "Cat," a predecessor of baseball (Bunyan, 1666):

"I shook the sermon out of my mind and to my old custom of sports and gaming I returned with great delight."

The Sunday Observance Act of 1625 CE continued to exert a negative influence upon sport in both Britain and British

Canada for a long time. Under considerable pressure from the Puritans, an "*Act for Punishing Divers Abuses Committed on the Lord's Day, called Sunday*" was promulgated by Charles I, The legislation prohibited the frequenting of Bear-baiting, Bull-baiting, Interludes, Common Plays and other unlawful Exercises and Pastimes upon the Lord's Day. The net result was that all sporting activities of the general population remained seriously curtailed for a couple of centuries, until the introduction of a Saturday half-holiday offered a time other than Sunday when they could engage in physical activity and recreation. As highlighted in the film "*Chariots of Fire,*" the long shadow of Sunday observance extended as far as the Paris Olympic Games of 1924, when the Scottish contestant Eric Liddell refused to run a race because he believed that Sunday should remain a "day of rest."

In English Canada, the Presbyterian Church also remained a strong advocate of laws supporting Sunday as a strict, religious day of rest. In contrast, the Catholic Church in French Canada saw Sunday as a day not only to attend Mass but also to enjoy the physical opportunities of a day away from work. For this reason, Québecois members of the legislature sponsored an amendment to the Canadian Lord's Day Observance Act of 1906 CE allowing the Attorney General of each Province to decide upon a local implementation of this Bill.

Walking and swimming. Richard Mulcaster ((Mulcaster, 1581),above) commended moderate walking as the best type of activity to maintain good health:

"*nature her selfe seemeth to have appointed walking, as the most natural traine, that can be*" "*Walkinges which take their names of the motion how, be either swift or slow, vehement or gentle, much or little, moderate, or sore, long and outright, or short and turning: now bearing upon the whole feete, now upon the toes, now upon the heeles."*

He also considered swimming a good exercise, provided care was taken to ensure water quality. In marshy waters, infection might arise:

"because rotton, and corrupt vapoours, enter the pores of the bodie, together with the moysture"

Fencing. Italian skills in fencing were greatly respected during the Renaissance, and in 1540 Henry VIII established "Professors of the Noble Science of Defence" by Letters Patent. Fencing instructors taught the use of a variety of weapons, including the rapier, quarterstaff and broad-sword. Successful scholars were awarded degrees and as their skills augmented they became in turn (Strutt, 1968):

"Scholler," or probationer, secondly the "Free Scholler," ...then the Provost, or assistant Master; and lastly the Maister."

Archery. Archery had been a popular sport in the Middle Ages (Shephard, 2012c). In Renaissance England, it was still encouraged by the personal examples of both Henry VIII and Elizabeth I. In Act 33 of his Parliament, Henry VIII promulgated (Ascham, 1545):

"an acte for mayntenaunce of Artyllarie and debarringe of unlawful games", requiring every one under sixty, of good health, the clergy, judges, &c., excepted", to use shooting in the long bow", and fixing

the price at which bows were to be sold.

In 1545, Roger Ascham (c. 1515 –1568 CE), tutor to Princess Elizabeth published the book *Toxophilus ("Lover of the Bow"),* dedicating it to Henry VIII (Ascham, 1545). The objectives of this volume were to commend use of the long bow as a manly sport and to enhance National Defence. Nevertheless, archery showed a steady decline in popularity during the Renaissance, probably because the bow was becoming an obsolete weapon. A powder house already existed at the Tower of London by 1461 CE and in 1515 CE three gunpowder makers were employed there.

Habitual physical activity. In Renaissance Europe, the physical pursuits of the poorer citizens continued much as in mediaeval times (Shephard, 2012c). The peasants continued to engage in hard physical work in the countryside, but a growing proportion of the rural population were migrating to cities, where sedentary occupations such as tailoring emerged. I will comment specifically on the introduction of sedan chairs, which began to reduce the physical demands of commuting, at least for the wealthy.

Sedan chairs. Portuguese and Spanish explorers had introduced sedan chairs to Europe following their voyages to China. As Henry VIII became physically incapacitated, four strong men were appointed to carry him around London in such a conveyance. The term "sedan chair" first appeared in printed documents around 1512 CE. Given the unsanitary (and sometimes dangerous) condition of European city streets, wealthy burghers quickly opted to travel by sedan chair rather than on foot, and soon most well appointed homes had a chair standing in their front hall. Many sedan chairs were fitted with curtains. Thus, those attending the Bath Pump Room could return to their lodgings partially clothed and still sweating from the warmth of the spa waters. In his diary for 1668 CE, Samuel Pepys recounts that he and his family (Pepys et al., 2000) were collected from their rooms one by one at an early hour, carried by chair to the baths and after soaking for two hours:

"wrap in a sheet and in a chair home and there one after another thus carried . . . home to bed sweating for an hour . . ."

By 1634 CE, chairs for public hire became available even to less wealthy citizens, and the city of London established a licensing authority similar to that which now regulates taxi-cab fares in Canadian cities. Single journeys were priced at 6d, and a chair could be rented for an entire day at a fee of 4 shillings.

However, there is no record of sedan chairs being used in Canada,, probably because the length and breadth of Canadian cities during the 17th century was no more than a few hundred metres.

Conclusions

The effervescence of scientific enquiry during the Renaissance brought about a clearer physical and mechanical understanding of the universe and its contents. A coupling of the activities of pure scientists with a renewed interest in applied sciences such as anatomy led to an accurate description of the human body parts, and thus health scientists began to perceive the principles underlying circulation of the blood, respiratory gas exchange and muscular contraction. Prestigious schools of health science spread from Italy to France, the

Netherlands and Britain, and in England bodies regulating the professional practice of physicians and surgeons were established. Nevertheless, the treatment of many diseases remained inappropriate if not bizarre. Further, the average life expectancy of the general public showed little improvement over that seen during the Middle Ages, and epidemics such as a renewed outbreak of Bubonic plague continued to take a heavy toll on city-dwellers. Schools and universities became increasingly available to the general public. A few lone individuals advocated physical education as an important component of the learning process, but in most institutions tutors focussed strictly on academic topics. Particularly at the university level, the involvement of students in sport was actively discouraged, a trend exacerbated by the growing power of Puritan and Calvinistic clerics. Country-dwellers continued to follow a physically active lifestyle, but the seeds of sedentarism were sown among that growing fraction of the population who had migrated to the cities. Urban areas offered fewer recreational opportunities and favoured the emergence of less active forms of daily work. For the social elite, sport involvement continued in the context of court life, although some pastimes became stylized and demanded less physical effort. The trend to a reduction of habitual activity was exacerbated as city walking was replaced by the luxury of transportation in sedan chairs.

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References

Agasse, J.-M. (2000). *Girolamo Mercuriale: De arte gymnastica*. Paris, France: University of Paris: Sorbonne.

Akmal, M., Zulkifle, M., and Ansari, A. (2010). Ibn nafis - a forgotten genius in the discovery of pulmonary blood circulation. *Heart Views 11*, 26-30.

Alic, M. (1986). *Hypatia's heritage : a history of women in science from antiquity through the nineteenth century*. Boston, MA: Beacon Press.

Ascham, R. (1545). *Toxophilus*. London, UK Alex Murray

Bainton, R. H. (1953). *Hunted heretic; the life and death of Michael Servetus, 1511-1553*. Boston, MA: Beacon Press.

Baker, W. J. (1988). *Sport in the western world*. Urbana, IL University of Illinois Press.

Barnard, H. (1878). *Memoirs of eminent teachers and educators with contributions to the history of education in Germany* (Vol. 4). Hartford, Conn.: Brown & Gross.

Barnard, J., and McKenzie, D. F. (2002). *The Cambridge History of the Book in Britain, Volume 4; Volumes 1557-to 1695*. Cambridge, UK Cambridge University Press.

Berryman, J., and Parks, R. J. (1992). *Sport and exercise science: essays in the history of sports medicine*. Urbana, IL: University of Illinois Press.

Besant, W., and Hallbauer, O. (1928). *The history of London.* Bielefeld, Germany: Velhagen & Klasing.

Bromley, J. S. (1957). *The new Cambridge modern history* Cambridge, UK Cambridge Un iversity Press.

Bunyan, J. (1666). *Grace abounding to the chief of sinners*. London, UK George Larkin.

Burckhardt, J. (1945). *The civilization of the Renaissance in Italy*. London, UK: Penguin.

Burggraeve, A. (1840). *Précis de l'histoire de l'anatomie, comprenant l'examen comparatif des ouvrages des principaux anatomistes anciens et modernes*. Ghent, Belgium Hoste.

Burke, P. (1998). *The European Renaissance: Centre and Peripheries*. Oxford, UK: Blackwell

Calderon, J. (1998). *Foundations of Education*. Manila, Philippines: Rex Book Store

Cardano, G., Stoner, J., and Grafton, A. (2003). *The book of my life (De vita propria liber)* New York, NY New York Review Books Classics.

Castaglione, B., Hoby, T., and Raleigh, W. A. (1900). *The book of the courtier*. London, UK. : D. Nutt.

Compayre, G. (1971). *Montaigne and education of the judgment.* New York, NY: B. Franklin

Cooper, C. H. (1843). *Annals of Cambridge, Volume 2*. Cambridge, UK: Warwick & Co.

Cournand, A. (1964). Air and Blood. In A. P. Fishman and D. W. Richards (Eds.), *Circulation of the blood: Men and ideas* (pp. 3-70). Oxford, UK Oxford University Press.

Cushing, H. (1935). Ercole Lelli and his écorché. *Yale J. Biol. Med. , 9*, 197-223

Dalton, M. (1635). *The country justice, containing the practice of the justices of the peace out of their sessions*. Cambridge, UK: Printed by the Assignes of John More,Esquire.

Davis, R. H. (1955). *Deep diving and submarine operations, 6th ed.* London, UK: Siebe Gorman & Co.

Demaitre, L. (1975). Theory and practice in medical education at the University of MOntpellier in the thirteenth and fourteenth centuries. *J. Hist. Med. Allied Sci. , 30*, 103-123.

deMontaigne, M. (2009). *The Essays of Michel de Montaigne*. Newcastle-upon-Tyne, UK: Cambridge Scholars Publishing.

Doughty, B. P. (1988). Old Parr: or how old is old? *Southern Medical Journal, 81*, 906-908.

DuChesne, J., and Hester, J. (1591). *Breefe aunswere of Josephus Quercetanus Armeniacus, Doctor of Phisick, to the exposition of Jacobus Aubertus Vindonis, concerning the original, and causes of mettalles*. London, UK John Browne.

Erasmus, and Johnson, E. (1878). Book of Colloquies of Erasmus, Volume I on-line, http://www.gutenberg.org/files/14031/14031.txt accessed 27th February 2012).

Everly, G. S., and Lating, J. M. (2002). *A clinical guide to the treatment of human stress response*. New York, NY: Springer.

Franklin, K. J. (1931). The work of Richard Lower (1631-1691) *Proceedings of the Royal Socuie, 25*, 113-118.

Fu, L. K. T. (2000). The origins of surgery. 2: From barbers to surgeons. *Annals of the College of Surgeons Hong Kong, 4*, 35-49.

Galen, C., and Canape, J. (1541). *Du Mouvement des muscles*. Lyon, France Sulpice Sabon.

Garrison, F. H. (1966). *History of Medicine*. Philadelphia, PA W.B. Saunders

Gaur, M. (1977). *The textiles: woes and echoes of an ailing industry*. London, UK: P.P. S.I.

Hale, J. D. (1994). *The civilization of Europe in the renaissance* New York, NY: Maxwell-Macmillan International

Harvey, W. (1628). *Exercitatio anatomica de motu cordis et sanguinis in animali (reprinted in Founders of experimental physiology, eds. W. Blasius, J. Boylan and K,. Kramer, 1971)*. Munich, Germany J.F. Lehmann.

Hay, D. (1986). *The age of the renaissance*. London, UK: Thames & Hudson

Hernández, F., Varey, S., Chabrán, R., and Chamberlin, C. L. (2001). *The Mexican treasury : the writings of Dr. Francisco Hernandez*. Stanford, CA: Stanford University Press.

Heywood, W. (1904). *Palio and ponte: an account of the sports of central Italy from the age of Dante to the XXth century*. London, UK Methuen.

Hodges, N. (2010). *Loimologia: Or, an Historical Account of the Plague in London in 1665: With Precautionary Directions Against the Like Contagion*. Charleston, SC: Bibliobazaar.

Howell, T. H. (1987). William Harvey's report on Old Parr's autopsy. *Age Ageing, 16*, 265-266.

Hunter, M. (2009). *Boyle : Between God and Science*. New Haven, Conn: Yale University Press.

Joubert, L., and deRocher, G. (1995). *The second part of the Popular errors*. Tuscaloosa, AL: Universiy of Alabama Press.

Kinser, S. (1990). *Rabelais's carnival : text, context, metatext*. Berkeley, CA: University of California Press

Kumar, J. V. (2011). *Textbook of preventive and community dentistry (2nd ed.)*. Toronto, ON: Elsevier.

Leach, F. (1896). *English schools at the reformation 1546-8*. London, UK Constable.

Levett, J., and Agarwal, G. (1979). The first man/machine interaction in medicine: the pulsilogium of Sanctorius of Padua. *Medical instrumentation, 13*, 61-63.

Lutz, P. L. (2002). *The rise of experimental biology: an illustrated history*. New York, NY: Humana Press.

Machline, V. C. (2004). Cristobal Mendez. Medical ideas about the influence of joy and pleasure (rather than humor) upon health. *Revista de Humanides, Technologico deMonterrey, 17*, 115-128

Maiorino, G. (1992). *Leonardo da Vinci: the Deadalian mythmaker.* State Park. PA: Pennsylvania State University.

Monroe, P. (1909). *A text-book in the history of education*. London, UK: Macmillan

Moon, R. O. (1931). Van Helmont, chemist, physician, philosopher and mystic. *Proceedings of the Royal Society of Medicine, 26* 23-28.

Mulcaster, R. (1581). *Richard Mulcaster, Positions Wherein Those Primitive Circumstances Be Examined, Which Are Necessarie for the Training up of Children*. New York, NY. : Reprinted by Capo Press, 1971.

Mulcaster, R., and Oliphant, J. (1903). *The Educational writings of Richard Mulcaster (1532-16ll)*. Glasgow, Scotland: James MacLehose.

Nickerson, A. (2008). *A journey into Michelangelo's Rome*. Berkeley, CA: Roaring Forties Press

Oldys, W., and Harley, E. (1745). *The Harleian miscellany, or, A collection of scarce, curious, and entertaining pamphlets and tracts*. London, UK: T. Osborne.

Pagel, W. (2002). *Joan Baptista van Helmont: Reformer of Science and Medicine*. Cambridge, UK: Cambridge University Press.

Paracelsus. (1894). *The Hermetic and Alchemical Writings of Aureolus Philippus Theophrastus Bombast, of Hohenheim, Called Paracelsus the Great: Hermetic chemistry*. London, UK: J. Elliott & Co. .

Paré, A., and vandenSpiegel, A. (1649). *The workes of that famous chirurgion Ambrose Parey*. London, UK: R. Cotes and Willi Du-gard.

Partington, J. R. (1956). The life and work of John Mayow (1641-1679). *Isis, 47*, 217-230.

Pepys, S., Latham, R., and Matthews, W. (2000). *The diary of Samuel Pepys : a new and complete transcription*. London, UK: Harper-Collins.

Pitskhelauri, G. Z. (1978). William Harvey and the anatomo-pathological dissection he performed on Thomas Parr's corpse (on the occasion of the 400 years anniversary of W. Harvey's birth). *Sante Publique (Bucurarest), 21*, 141-145.

Read, J. (1961). *Through alchemy to chemistry*. London, UK Bell.

Roper, L. (2010). Martin Luther's Body: The "Stout Doctor" and His Biographers. *Am. Hist. Rev. 115*, 351-384.

Roy, P. S. (1929). Historical development of our knowldege of the ciurculation. *Annals of Medical History 1*, 141-154.

Shephard, R. J. (2012b). The developing understanding of human health and fitness: 3. The classical era. *Health Fitness J, Can.*

Shephard, R. J. (2012c). The developing understanding of health and finess. 4. Middle Ages. *Health & Fitness J. Can. , In press*.

Smith, S. B., Macchi, V., Parenti, A., and DeCaro, R. (2004). Hieronymous Fabricius Ab Acquapendente (1533–1619). *Clinical Anatomy, 17*, 540-543.

Stirling, W. (2003). *Some apostles of physiology* Kila, Montana: Kessinger Publishing.

Strathern, P. (2003). The Medici: Godfathers of the Renaissance (http://www.pbs.org/empires/medici/).

Strutt, J. (1968). *The sports and pastimes of the people of England (originally published 1801)*. Detroit, IL: Singing Tree Press.

Stubbes, P. (1583). *The Anatomie of Abuses: Contayning A DISCOVERIE, OR BRIEFE Summarie of such Notable Vices and Imperfections, as now raigne in many Christian Countreyes*. New York, NY: Da Capo Press, Fascimile reproduction, 1972.

Thurston. (1999). Giovanni Borelli and the study of human movement: An historical review *Austr. NZ J. Surg., 69*, 276-288.

Tözeren, A. (1999). *Human body dynamics: classical mechanics and human movement*. New York, NY Springer.

Trench, C. C. (1970). *A history of horsemanship* Garden City, NY: Doubeday.

Tytler, P. F. *History of Scotland [1149-1603], Volume 6*. Edinburgh, Scotland W. Tait.

vanDalen, D. B., and Bennett, B. L. (1971). *A world history of physical education*. Englewood Cliffs, NJ: Prentice-Hall.

vanIngenSchenau, G. J. (1994). Proposed actionsm of bi-articular muscles and the hindlimbs of bi- and quadripeds. *Human Movement Studies, 13*, 665-681.

Waller, R. (2008). An early eighteenth-century view of Greek athletics: Pierre-Jean Burette (1665-1747). *Journal for Eighteenth-Century Studies, 5*, 105-115.

Ward, G. R. M. (1845). *Oxford University Statutes: The Caroline code, or Laudian statutes.* London, UK: William Pickering.

Williams, E. A. (2003). *A cultural history of medical vitalism in Enlightenment Montpellier*. Farnham, Surrey, UK.: Ashgate.

Withington, E. T. (1964). *Medical history from the earliest times: a popular history of the healing art*. London, UK: Holland Press.

Young, G. F. (2009). *The Medici*. Whitefish, MT: Kissinger Publishing reprint of 1930 edition.