Health & Fitness Journal
of Canada

Volume 6 **January 30, 2013** **Number 1**

SYSTEMATIC REVIEW
The developing understanding of Human Health and Fitness: 6. The Enlightenment.

Roy J. Shephard[1]

Abstract

This segment in an on-going review of our developing understanding of health and fitness discusses some important milestones of the English Restoration and the French Enlightenment. This was a period marked by growth in the prestige of health science centres in Leiden, London, and Edinburgh, and the appearance of the first North American medical colleges in Philadelphia and New York. However, Canada had to wait until the 19th century for its first medical schools to open in Montreal, Kingston and Toronto. New scientific discoveries during the Enlightenment included a clear description of circulatory anatomy and its basic hydrodynamics, a growing understanding of the properties of oxygen and carbon dioxide, experiments demonstrating the excitability of skeletal muscle and the development of simple dynamometers to provide accurate determinations of muscle strength. Some Enlightenment scholars saw a strong body as helping the mind in its search for piety, while others argued for a dualism of mind and body. For some, sport was important in its own right, and for others it offered a means of "knowing" the realities of both our bodies and the world in which we live. Among the newer sects of Christianity, Anabaptists argued for a simplicity of children's play, Congregationalists showed increasingly liberal attitudes to the involvement of their flock in sport and physical activity, and Methodists included valuable lifestyle advice in the medical tracts that they offered to the poorest members of their congregations. Some physicians promoted health through physical activity, fitness and an adequate diet, but many of the medical profession clung to bizarre beliefs in restoring the humoral or electrical balance of their patients. Faith healing, homeopathy and quack treatments such as Mesmerism found plenty of advocates. Occasional attempts were made to provide communities with clean drinking water and to promote vaccination, but in general population health was poor, both in Europe and in North America, with correspondingly short life expectancies. Scholars such as Comenius and Rousseau pressed for physical activity to be included in the school curriculum, but their suggestions were generally ignored, both in Europe and in the New World. Among the aristocracy, pursuits such as hunting, horse racing, horse trotting, yachting, rowing, boxing, dancing and visits to public gardens and spas all became opportunities for social display and spectatorism. The theatre, secular literature, musical soirées and visits to coffee houses provided further opportunities for the wealthy to engage in sedentary leisure behaviour. The early stages of the Industrial Revolution, with the introduction of first water and then steam power began to reduce the physical demands of many occupations, and the improvement of major highways allowed people to travel by coach rather than on foot or horseback. Nevertheless, the traditional lifestyle of early North American settlers persists in a few isolated groups of Amish and Mennonites. Even today, such communities offer a fascinating glimpse into likely patterns of physical activity and levels of physical fitness levels associated with subsistence agriculture before the Industrial Revolution. **Health & Fitness Journal of Canada 2013;6(1):82-118.**

Keywords: Age of Reason; Circulation; Lifestyle; Medical History; Medical Schools; Muscle; Physical Activity; Physical Education; Public Health; Quackery; Respiration; Sedentary Behaviour; Sport

From the [1]Faculty of Kinesiology & Physical Education, University of Toronto and [2]Exercise Sciences Research Group, Tokyo Metropolitan Institute of Gerontology, Tokyo, Japan. Correspondence: Roy J. Shephard, PO Box 521, Brackendale, BC, V0N 1H0.
E-mail: royjshep@shaw.ca

Background

Previous articles in this series (Shephard, 2011; Shephard, 2012a, 2012b, 2012c, 2012d) have explored growth in our understanding of human health and fitness from the dawn of history through to the Renaissance (Shephard, 2012d). In the present article,

we continue our narrative through the Enlightenment, or the Age of Reason. This era began around 1650 CE. Scholars such as Baruch Spinoza (1632-1677CE), John Locke (1632-1704 CE), Isaac Newton (1643-1727 CE) and Voltaire (1694-1778 CE) sought to replace earlier superstition and theological dictates by the power of logical, scientific reasoning. They began to envisage living creatures and even the universe itself in mechanical terms, without the need to postulate the intervention of either a benevolent or a capricious God-figure. The logical, mathematical treatment of data was seen as the exclusive source of authentic knowledge. This movement culminated in the publication of a 35 volume encyclopedia "*Dictionnaire raisonné des sciences, des artes et des métiers*" (Diderot and LeRonddeJambert, 1778).

A push towards universal public education brought instruction to a much greater proportion of Europe's children. A few of the Enlightenment scholars saw physical activity as helping to develop the child's mind, and the stirring of interest in gymnastics in some parts of Europe found a North American echo in the "English" schools of Benjamin Franklin. However, most teaching institutions still paid little or no regard to the benefits of regular physical activity.

The Enlightenment saw the first waves of European settlers reaching the shores of Canada and the United States. Some of the voyagers were economic migrants, but others had rebelled against a rigid theocracy in their homeland. The London-based Virginia Company began the development of Jamestown, VA, in 1607 CE, Champlain founded Québec City in 1608 CE, the Sieur de Laviolette established Trois Rivières in1634 CE, and Maisonneuve became the first governor of Montréal in 1642 CE. The early efforts of French settlers were focussed on the fur trade, which did not require the development of any large cities. In contrast, English Canada, like the United States, became populated by farmers rather than itinerant voyageurs, and the growth of English Canadian towns and cities was one factor contributing to the final conquest of the French settlers in 1759.

Contributions of the Enlightenment to science, medicine and health

In the humanist milieu of the Enlightenment, the dissemination of new medical knowledge was seen as an honorable mission. Most books were now published in the vernacular, making the findings of leading scholars accessible to a broad range of the population. A growing number of academically oriented Schools of Health Science opened their doors, and careful animal and human dissection fostered a much clearer understanding of human physiology. The newly perfected lenses of Dutch opticians allowed careful exploration of the microstructures of the body. Scientists also showed an eagerness to apply their new discoveries in chemistry and physics to the interpretation of physiological and biochemical processes. Accumulation of this new knowledge set the task of enhancing health and fitness on a more solid scientific basis.

Development of Schools of Health Science

During the Renaissance, various medical schools had already opened their doors in Italy, France, the Netherlands and Britain (Shephard, 2012c). St. Bartholomew's and St. Thomas's Hospitals were already established in

London, Scottish surgeons and barber-surgeons had received their charter of incorporation in 1505 CE and the Royal College of Physicians of Edinburgh had been founded in 1681 CE. However, many of the well-known British Medical Schools were not founded until the Enlightenment, and in the cities of North America there were no opportunities to study the Health Sciences until the late 18th century.

London. Many London teaching hospitals developed around earlier church-related healing institutions. Until 1900, they remained aloof from the formal governing structures of the University of London; I remember that at least one bishop served on the Board of Governors of Guy's Hospital even during the late 1940s. St. Thomas's Hospital began offering formal instruction to physicians around 1550 CE, and a small hospital had been established at St. Bartholomew's Priory as early as 1123 CE. However, medical teaching did not begin at "Bart's" until 1730 CE, when Eric Nourse inserted a brief announcement in the *Evening Post.* He advised prospective students (Waddington, 2003):

"I shall begin a course of anatomy, chirurgical operations and bandages on Monday, November 11th."

Guy's Hospital is another venerable London Medical School. It was established by Thomas Guy in 1721 CE, and despite the best efforts of the German Luftwaffe, some of its early Georgian buildings survived the assault of more than 150 bombs during the Blitzkrieg of World War II (Hale-White, 1951). Guy was a financier of somewhat dubious reputation. He had made his initial fortune by offering sailors a "loans till pay-day" scheme, coupled with the illegal importation of Bibles that had been printed off-shore. He multiplied this ill-gotten capital tenfold in 1720 CE, skillfully exploiting the investment opportunities offered by the "South Sea Bubble." Many historians thus suspect that the funding of Guy's Hospital was a "conscience money" project (although, in fairness to Thomas Guy, he had previously endowed public schools and alms houses in other parts of England). Guy's Last Will and Testament of 1725 CE left the generous sum of £220,124 2s 71/2d to the newly constructed hospital, although unfortunately the terms of the Will were rather ambiguous. It required that after construction, the building be used for patients:

"thought capable of relief by physick or surgery, but who by reason of the small hopes there may be of cure, or the length of time which .... may be required... are.... called incurable."

Initially, Guy's Hospital thus served as a chronic, long-term care facility for patients who had been discharged from St. Thomas's Hospital, an acute care facility on the opposite side of the street. However, Guy's physicians quickly manoeuvred to change this interpretation of the endowment, and Guy's also became a general hospital, accepting acute medical cases. From 1769 onwards, the two hospitals established a joint teaching unit. Medicine and Chemistry were taught at Guy's, while courses in Surgery were offered at St. Thomas's or at private clinics in London's West End (for instance, the Windmill Street School, founded by Samuel Sharp, a Guy's physician, in 1737 CE). One of the surgeons attending St. Thomas's, William

Chiselden (1688-1752 CE), used a *camera obscura* to obtain very precise illustrations for his anatomical texts.

As at the Medical School in Edinburgh (below), Guy's reputedly resorted to dealings with the local "Resurrectionists" in its efforts to keep students supplied with an adequate number of cadavers for dissection (Bailey, 1896):

"Returned to Vestry Clerk of Newington, by order of the Treasurer, one male and two females, purchased of Page, &c., on the 25th, who had broken open the dead-house to obtain them."

During his time at Guy's, John Collins Warren commented (Warren, 1860):

"Dissection is carried on in style: twelve or fifteen bodies in a room....The people called resurrection men [that is, body snatchers] supply us abundantly."

The extent to which 18th century Anatomy departments were involved in murder and grave-robbing remains controversial, even today (Mitchell et al., 2011).

Edinburgh. The Faculty of Medicine of Edinburgh University was organized in 1726 CE. It was modeled on the schools that had already been established in Bologna, Padua and Leiden. The associated Royal Infirmary initially had only four beds, and the admission of students to seminars was thus regulated using a ticket system (Kaufmann, 2003).

Edinburgh quickly became renowned for its understanding of human anatomy. The officially sanctioned dissection allowance of one executed criminal per year proved woefully inadequate for its growing programme of teaching and research. A brisk trade in body-snatching from local graves thus emerged, supplemented by the occasional murder. The distinguished anatomist Robert Knox is reputed to have paid the local Mafia a fee of 7 pounds 10 shillings per corpse (Rosner, 2009). Despite conviction of the original miscreants (Burke and Hare), the gruesome trade of the body snatchers persisted until the Anatomy Act of 1832 gave British teaching institutions access to an adequate number of cadavers.

Leiden. Herman Boerhaave (1668-1738 CE) became an influential teacher at the Medical School in Leiden. He is particularly remembered for introducing the concept of clinical instruction at the patient's bedside. Three of his students carried this teaching approach to medical schools across Europe: Gerard van Swieten to Vienna, Albrecht von Haller to Goettingen, and Alexander Monro to Edinburgh.

United States. In 1765 CE, the trustees of William Penn decided that the University of Pennsylvania (Philadelphia) should offer *"anatomical lectures" and a course on "the theory and practice of physik"* drawing upon the learning of three professors returning from European medical schools. The University of Pennsylvania thus became the first North American college to offer education in the health sciences (O'Malley, 1970). Bedside teaching was provided nearby, at the Pennsylvania Hospital (which had been founded by Benjamin Franklin). In 1847, the Professor of Medicine at the University of Pennsylvania became the first president of the American Medical Association. A second medical school was established at Columbia University, New York, in 1768. The New York institution,

also, faced accusations of grave robbing, and in 1788 a mob surged into the New York Hospital, seizing the school's four anatomists.

Nevertheless, the surgeon John Collins Warren (1778-1856 CE) found no hospital or official medical school in 1799, when he began his studies, so he travelled to Guy's Hospital in London, to profit from the experience of Astley Cooper. Rather than pay a fee of £25 to become a "walker" who merely followed Cooper on his ward rounds, he elected to pay £50, to become a "dresser" who was allowed to undertake minor surgery. Students in the surgical wards were still known as dressers when I attended Guy's in the late 1940s. Warren enjoyed the teaching and the anatomical models in the museum, but had a less favourable view of the region around London Bridge (Cooper 2012; Warren, 1860):

"*The air is thickened with smoke and vapors so that it is scarcely respirable, and as for the sun, no one can tell you when he was seen"*

Canada. Early Canadian health care professionals were trained primarily in France, and indeed in some parts of Quebec, physicians still find it advantageous to vaunt a French medical qualification. In 1823 CE, the McGill Medical School began life as the proprietary "Montreal Medical Institution," and six years later it became affiliated with McGill University. Queen's University Medical School in Kingston, Ontario, gained its Royal Charter in 1841 CE, and the University of Toronto opened a medical school in 1843 CE, However, 10 years later, the Toronto school suspended its teaching programme, transferring students to three proprietary institutions (Trinity Medical College, the Toronto School of Medicine and Woman's Medical College); the University Medical School did not reopen until 1887 CE, when it absorbed the Toronto School of Medicine. The French-language medical school at Laval University did not commence operations until 1878 CE.

New knowledge of circulation, respiration and muscle physiology

A combination of the instruction provided by the new Medical Schools, a new understanding of physics and chemistry and technological advances such as the perfection of the microscope brought about a more complete understanding of the physiological processes associated with the circulation of the blood, respiration and muscular contraction.

Circulation. Lower, Mallphigi, van Leeuwenhoek, Stensen, Floyer, Hales, and Bernouilli developed our understanding of the circulation through the use of newly perfected microscopes and timepieces and the application of physical principles to their studies of the movement of blood around the body.

Lower. Richard Lower (1631-1690 CE) was an early member of the Royal Society, best known for his studies of blood transfusion. He undertook careful dissections of the heart, noting the whorl-like arrangements of the ventricular muscle, and he described the oxygenation of the blood as it passed through the lungs (Lower and Franklin, 1989).

***Malphigi*.** Marcello Malphigi (1628-1694 CE) was born in Bologna, but later held Academic appointments in Pisa (where he came in contact with Borelli,

(Shephard, 2012d). While in Pisa, he and began to exploit the possibilities of the microscope. Using his naked eye, Harvey had been unable to discern any arterio-venous connections, and he had thus assumed that blood reached the veins simply by oozing through the walls of the small arteries. However, microscopic examination of the frog lung convinced Malphigi that the pulmonary tissues were not solid, as had previously been supposed. Rather, the lungs comprised a network of air-filled vesicles, crossed by small and tortuous blood vessels. This anatomical arrangement explained how air could enter the blood stream (Revéron, 2011), Malphigi observed that the pulmonary capillaries were populated by "*a host of red atoms*." Unfortunately, he mistook these globules for fat, but nevertheless he carried out some experiments on changes in the colour of the blood as it passed through the lungs. His subsequent investigations were limited, because shortly after making these important discoveries he was summoned to Rome, to become personal physician to Pope Innocent XII.

Van Leeuenhoek. Antonie Van Leeuenhoek (1632-1723 CE) extended the observations of Malphigi, and with the expertise of a citizen of Delft, he succeeded in grinding lenses and building microscopes with a magnifying power of up to x270 (Payne, 1970). He was thus able to provide much more accurate descriptions not only of the capillaries, but also of the microscopic structure of skeletal and cardiac muscle, and of single-celled organisms or "*animalicules*."

His descriptions of animalicules were at first queried by members of the British Royal Society, but an on-site visit to his laboratory in 1680 enabled Van Leeuenhoek to convince his most virulent critics that these organisms existed, and shortly afterwards he was appointed as a Fellow of the Society. Using his powerful new microscope, he was able to contribute to Public Health by checking the local water supply for the presence of unwanted animalicules.

***Stensen*.** Niels Stensen (1648-1686 CE) was the son of a Danish goldsmith. He developed a rigid, geometric concept of muscular contraction. His most important contribution was to recognize that the heart was simply a muscle, rather than the seat of natural warmth or vital spirit.

Floyer. John Floyer (1649-1734 CE) practiced as a physician in Lichfield, near Birmingham, England. He is best known for making diagnoses based upon accurate measurements of pulse rate, using a special watch that he had developed for this purpose (Floyer, 2010).

***Hales*.** The Reverend Stephen Hales (1677-1761 CE) was the colourful Perpetual Curate of the Thames-side Parish of Teddington, on the western outskirts of London. He had a strong interest in physiology, and he noted that the "fatty globules" which had been described by Malphigi and van Leeuwenhoek were only slightly smaller in diameter than the typical capillary. He thus hypothesized that the flow of blood must be slowed by the friction that it encountered when forcing the globules through the tissues. Some of his contemporaries made ridiculous guesses as to the necessary force; one estimate set the value as high as 100,000 pounds (45,450 kg, 446 MN) (Guerrini, 2003).

Hales wisely decided that rather than guessing, he would determine the force experimentally. He thus introduced a long glass tube into the femoral artery of his long-suffering mare. Apparently, he accomplished this using no anaesthetics other than the contents of his cellar (although interestingly, he was an ardent campaigner against the horrors of Gin Lane, as portrayed in William Hogarth's prints of 1751). Hales reported that the blood within his cannula rose to a height of 8 feet 3 inches (2.51 m, or the equivalent of 185 mm Hg). In contrast, when he inserted a similar tube into the animal's jugular vein, the blood rose to a height of about one foot (0.3 m, or 22 mm Hg) when the animal was quiet, increasing to 64 inches (the equivalent of 117 mm Hg) when the animal became restless. Presumably, the horse was in poor shape following these observations, so he next dissected out its heart, estimating the volume of the cardiac chambers and thus its cardiac output. He completed similar observations on other species, concluding (Smith, 1993):

"In the larger horse and ox, the BP is higher and the pulse slower than in the sheep and dog.... with blood loss the pulse quickens and weakens as the BP falls...horses died when the BP fell below 2 feet...Tis possible that such things as constringe the Vessels ... do also proportionally increase the force of the arterial blood and thus invigorate the Animal"

He also gave a clear description of the actions of the mitral and aortic valves (Lewis, 1994).

Hales was keenly interested in Public Health. He wrote a treatise on the design of windmill ventilators, intended to aerate such closed spaces as mine shafts and the cells of Newgate prison (Hales, 1743). He also commissioned the construction of a new supply of clean water for his parishioners. While continuing his church duties assiduously, he gained an international scientific reputation. Among other honours, he was elected a foreign member of the Royal Academy of Sciences in Paris and the Academy of Sciences in Bologna.

Bernouilli. Daniel Bernouilli (1700-1782) was a Swiss mathematician, although he was born in Groningen. His father was the originator of integral calculus. Daniel is particularly respected for his analyses of fluid dynamics, and he applied this new learning to the circulation of the blood. Multiplying the estimated stroke volume of the heart (1½ ounces, 43 ml) by heart rate, he obtained an estimate of cardiac output (Tipton, 2002). From determinations of cardiac lifting force and the length of the resulting impulse, he also corrected Borelli's earlier estimates of cardiac work-rate.

He applied a newly discovered probability model to a current Public Health issue, whether it was advisable to recommend small-pox inoculation. He was thus able to show that on a population basis, inoculation was by far the wisest policy. In 1766, he read the resulting scientific paper to the Royal Academy of Sciences in Paris (Beyersmann et al., 2011):

Essai d'une nouvelle analyse de la mortalité causée par la petite vériole et des avantages de l'inoculation pour la prévenir" (Essay on a new analysis of the mortality attributable to smallpox and the advantages of inoculation for preventing it.)"

Respiration. Clarification of the nature of respired air was essential to a better understanding of respiration and metabolic gas exchange. Becher and Stahl complicated such investigations by developing the *phlogiston theory*, but new advances became possible as Priestley and Scheele each, apparently independently, described the true properties of oxygen. Black defined the nature of carbon dioxide, and Lavoisier advanced convincing evidence of the erroneous nature of the *phlogiston theory*.

Becher. Johann Joachim Becher (1635-1682 CE) was a German alchemist and physician who laid the groundwork for the *phlogiston theory*. In a text entitled "*Physicae Subterraneae,*" he suggested that the four classical elements of fire, water, air and earth should be replacing by water, *terra lapidea* (vitreous earth), *terra fluida* (mercurial earth), and *terra pinguis* (fatty earth). In his view, the *terra pingua* had oily, sulphureous or combustible properties, turning into fire as it burned (Ede, 2006).

Stahl. Georg Stahl (1660-1734 CE) was Professor of Medicine and Chemistry in Halle. He believed that life had qualities beyond mere physics and chemistry; indeed, the physician's domain began where the physicists's ended. Living processes were directed by a person's sensitive soul; this knew more about the body and how to restore function than even the physician.

In terms of respiration, Stahl followed the reasoning of Becher, but renamed the *terra pingua* as *phlogiston* (from the Greek, "burning up"). Using this dubious chemical framework, Stahl sought to explain the earlier findings of Boyle, Hooke and Mayow (Shephard, 2012d). He maintained that a naked flame was rapidly extinguished in a closed bell-jar because the air became saturated with the *phlogiston* that had been emitted during combustion (Conant, 1950). The air inside the vessel would no longer support life because *phlogiston* was already present at saturation level. The role of respiratory air flow was to remove *phlogiston* from within the body, thus allowing combustion to continue.

Calx was the residue from the combustion of metals after *phlogiston* had escaped (Ede, 2006).

This seductive and loudly advocated theory continued to confuse even the two scientists Joseph Priestley and Carl Scheele who, independently, discovered oxygen. Somehow, they managed to constrain the explanation of their findings to the establishment's current ideas about *phlogiston*.

Priestley. Joseph Priestley (1733-1804 CE) was originally a Unitarian minister, but a stint as librarian to the Earl of Shelburne offered him an opportunity to pursue his interests in chemistry. He used a magnifying glass to focus the sun's rays upon some mercuric oxide, and he found that this compound soon began to emit a gas. This gas caused a candle to burn with increased intensity, and it also allowed a mouse to live inside a closed vessel for four times as long as it would have done if it had been breathing normal air (Crane, 1962).

Scheele. Carl Wilhelm Scheele (1742-1786 CE) was a Swedish pharmaceutical chemist. He discovered oxygen slightly before Priestley, but was robbed of the credit for this finding because he was slow in publishing his results *("A Chemical Treatise on Air and Fire*"). He

concluded that the atmosphere comprised a mixture of "fire air" (oxygen) and foul air (Dobbin, 1931). If bees were enclosed in a glass vessel, they died, the speed of their death being proportional to the number of bees within the vessel (Holmes, 1985). Moreover, the fire air was replaced by foul air over the course of the experiment; this did not cause any immediate change of gas volume, but the gas content of the vessel shrank dramatically if a solution of limewater was introduced.

Black. Joseph Black (1728-1799 CE) was a Scottish physician and chemist. He became Regius Professor of Medicine in Glasgow, and was closely associated with the *literati* of the Scottish enlightenment, people such as Adam Smith and David Hume. Black repeated the earlier work of Van Helmont on "*gas sylvestre*" (Shephard, 2012d), and he went on to describe what he termed a "fixed air," a substance that was produced by the burning of charcoal, the fermentation of beer, the treatment of limestone with acid, and by the act of breathing. This "fixed air" was denser than normal air, and it did not support life. It could readily be detected, since it formed a white deposit when bubbled into limewater. In one notable experiment, he produced a large quantity of the white deposit when a tray of lime water was placed in the roof ventilator of an over-crowded Presbyterian chapel (Editor, 1966).

Lavoisier. It was left to Antoine Lavoisier (1743-1704 CE), a French tax-collector, and later Inspector of the State-owned salt-petre works, to demolish the erroneous *phlogiston theory*. He did this with the help of his wife (who as part of her busy life also hosted house-parties of leading thinkers, translated the works of Priestley and other anglophone scientists for Antoine, and edited his memoirs).

Lavoisier underlined one of the previous observation of Stahl, namely that metals gained weight when they were burnt. If *phlogiston* was indeed liberated during combustion, surely the weight of the metals should have been reduced rather than increased? The stalwart disciples of Stahl were in no way discountenanced- they suggested that *phlogiston* was much lighter than air; indeed, it had a negative weight! However, Lavoisier pointed out that during combustion, not only did the mass of metallic oxides decrease, but there was also a release of "respirable air" (in 1777, he adopted the term *oxygène* for this gas). On the other hand, when animals breathed, there was a progressive loss of "eminently respirable air." He thus drew a parallel between combustion and respiration, and working with Pierre-Simon LaPlace (1749-1827 CE) he concluded that a slow combustion of carbon took place in the lungs. Over a 10-hr experiment, he was able to collect 3 g of carbonic acid from the respiration of a single guinea pig, and over 24 hours the same animal produced sufficient heat to melt 370 g of ice. Breathing thus served to rid the body not only of "fixed air" (carbon dioxide), but also of the heat associated with combustion.

In collaboration with Armand Seguin (1767-1835 CE), Lavoisier further demonstrated that when his colleague repeatedly pressed a pedal to perform a total 9195 foot-pounds of work (12.5 kN-m), this caused a two-fold increase in the oxygen usage of his body, with an associated increase of breathing and heart rate.

Unfortunately, as one of the nobility, Lavoisier found himself on the "wrong side" during the Napoleonic conflicts, and a revolutionary tribunal decreed:

"nous n'avons plus besoin des savants." "(We no longer need egg-heads)"

Mademoiselle La Guillotine quickly underlined this verdict for many French intellectuals. Lavoisier was executed for the alleged sale of adulterated tobacco.

A scientific contemporary of Lavoisier, Jean Hassenfratz (1755-1827 CE), objected that the lungs were no hotter than other parts of the body. He thus suggested that the process of combustion occurred throughout the organism, and in support of this view the Italian naturalist Lazarro Spallanzini (1729-1799 CE) noted that lowly animals without lungs were still able to consume oxygen, as could skin and muscle after they had been excised from the body.

Adair Crawford (1748-1795 CE) contributed to the idea that gas exchange was part of a widely distributed combustion process. Final proof that the tissues were the site of respiration came from Heinrich Magnus (1802-1870 CE), who used an improved vacuum pump to show that specimens of arterial blood contained more oxygen than venous samples.

Muscle. During the enlightenment, Moore, La Hire, Graham, Deaguilers and Régnier set in motion a search for better techniques to measure muscle strength, while Von Haller, Galvani and Volta made important contributions to our understanding of the excitability of muscle tissue.

Moore. Sir Jonas Moore (1617-1679 CE) was an English mathematician and surveyor, ordnance officer and astronomer, best known for draining the Lincolnshire Fens, constructing the Mole in Tangier, and establishing the Greenwich observatory. Involvement in major construction projects probably stimulated his interest in the measurement of muscular force. He used a capstan to compare the strength of men and horses, and he concluded (with a certain partiality) that five English labourers were equivalent to one horse, seven French men, or as many Dutch men.

La Hire. Philippe de La Hire (1640-1718 CE) was primarily a mathematician, but he is also recognized as the first person to make absolute measurements of peak muscle force. He reported that the thigh muscles could lift 140 *livre poids de marc*, or a mass of about 68.5 kg.

Graham. George Graham (1675-1751 CE) was a master clockmaker and inventor who became a Fellow of the Royal Society. He is credited with devising the first dynamometer to measure the strength of muscular effort. His instrument was apparently the precursor of the apparatus described by Desaguliers, but unfortunately details of its construction are no longer known (Pearn, 1978).

Desaguliers. John Theophilus Desaguliers (1683-1744 CE) was born at La Rochelle, France, but his father was a protestant minister, and following the Edict of Nantes (1685), the family emigrated to England. John Desaguliers quickly became a respected scientist. He highlighted one important obstacle when comparing strength from one region of

the world to another- there was as yet no internationally agreed system of weights and measures (Pearn, 1978):

"The French libre is betwixt one 11th and one 12th part greater than our pound Averdupoids."

Measurements of an individual's strength were further compromised by inconsistencies of posture during testing. He thus developed the Graham-Desaguliers dynamometer. The subject's static arm grasped a fixed handle, while the test arm pulled on a lever to lift an adjustable weight that was suspended from a second lever arm. Desaguliers thus estimated that in a young and robust man the combined force of the human biceps and brachialis muscles exceeded 560 pounds,

He soon found ergonomic applications for his careful observations of muscular strength, particularly in deciding upon the optimal loading of manual labourers:

"A Porter will carry 200 pounds and walk at 3 miles per hour.... A porter that carries coals will carry 250 lb, but then he does not go very far before he lays down his burden."

Desaguliers applied the principles of leverage to a functional analysis of the human limbs. He is also recognized for devising a system of ventilation to be used in sick rooms.

Régnier. Edmé Régnier (1751-1825 CE) was a Parisian mechanical engineer. He found favour as an applied scientist with the Revolutionary army. He designed a handgrip dynamometer not unlike that which is commonly used today, and the *Comité Central de l'Artillerie* pronounced it to be (Pearn, 1978):

"of ingenious design, mechanically simple and easy to use."

Régnier underlined one important aspect of handgrip force: it is not always possible to judge a person's overall strength simply from handgrip measurements.

von Haller. Albrecht von Haller (1708-1777 CE) was a Swiss anatomist and physiologist. Chronic ill-health caused him to favour books over the sports that occupied many of his childhood peers. He studied at Tübingen, Leiden and London, before becoming Professor of Medicine in the newly established University of Göttingen. He stressed the inherent irritability of muscle, pointing out that it could contract in response to a suitable stimulus, independently of any neural innervation. He thus distinguished the "inherent muscle force" from an "extrinsic nerve force."

He was a strong believer in homeopathy, as can be seen in his preface to the *Pharmacopoeia Helvetica* of 1771 (Dudgeon, 1853):

"Nempe primum in corpore sano medela tentanda est, sine peregrina ulla miscela; odoreque et sapore ejus exploratis, exigua illiu dosis ingerenda et ad ommes, quae inde contingunt, affectiones, quis pulsus, qui calor, quae respiratia, quaenam excretiones, attendum. Inde ad ductum phaenomenorum, in sano obviorum, transeas ad experimenta in corpore aegroro" ("Of course, firstly the remedy must be proved on a healthy body, without being mixed with anything foreign; and when its odour and flavour have been

ascertained, a tiny dose of it should be given and attention paid to all the changes of state that take place, what the pulse is, what heat there is, what sort of breathing and what exertions there are. Then in relation to the form of the phenomena in a healthy person from those exposed to it, you should move on to trials on a sick body").

Galvani. Luigi Aloisio Galvani (1737-1798 CE) was a Bologna physician and physicist. He discovered that the leg muscles of a frog could be induced to contract if an electrostatic spark from metal such as a scalpel blade touched either the gastrocnemius muscle or the sciatic nerve. In his *De viribus electricitatis in motu musculari commentarius* (*Commentary on the effect of electricity on muscular motion)*(Green, 1953) Galvani concluded that muscle movement was induced by an inter-play between the external negative charge of the muscle and positive electricity passing down the motor nerve. The theory that contraction reflected a ballooning of tissue from the entry of vital spirits into the muscle thus gave place to a concept of "*animal electricity*," an electrical fluid that was conveyed to the muscles via the nerves. Like others in this era, the career of Galvani ended ignominiously. In 1796, Bologna became a French dependency, and all Professors were required to swear allegiance to the new regime. Galvani refused to recognize the French government; he was thus deprived of all Academic and Public positions, and was denied the financial support for further research.

Volta. Count Allesandro Volta (1745-1827 CE) was a physicist and close colleague of Galvani. In opposition to Galvani, but in keeping with the positive thinking of many Enlightenment scholars, Volta decided that animal electricity was a physical phenomenon, induced by the rubbing of frog skin, rather than some inherent, God-given life-process (Bogdanov, 2000). Volta argued that the frog's leg was serving as a conductor of electricity, and he demonstrated that the electrical discharge could be conducted not only by a nerve, but also by brine-soaked paper. Disagreement with Galvani stimulated Volta to design the first electric battery.

Attitudes of scholars, churches and physicians towards physical activity and health

During the Enlightenment, a growing proportion of influential individuals in Academia and the church began to recognize the value of regular physical activity in developing the human spirit and optimizing human health. Much of the medical fraternity was more skeptical, but a few doctors also became strong advocates of an active lifestyle.

Scholars. Milton and Locke, both verbal realists, saw a strong body as helping the human mind in its search for piety, and Descartes argued for a rigid dualism of mind and body. However, Spinoza and Leibniz saw sport as important in its own right, and Berkeley and Hume argued that physical activity offered an important means of "knowing."

Milton. The English poet John Milton (1608-1674 CE) welcomed greater personal fitness, provided that if it offered the person concerned an increased opportunity for service to God and to humankind. In his essay "*Of education*," he recommended that boys should devote 3-

4 hours each day to physical exercise, mainly a military-type drill programme (Ainsworth, 1928). Indeed, he commented:

"Sportive Exercises on Occasion are not inconsistent with the Studies of Philosophy"

Locke. The philosopher and physician John Locke (1632-1704 CE), also, was a strong proponent of the physical body as opposed to the soul. He argued that motion of the body could give rise to both pleasure and pain (Locke, 1698). Expressing concern about the effeteness of many aristocrats, he advocated horse riding as (Locke, 1824):

"one of the best exercises for health which is to be had in those places of ease and luxury"

Locke also revisited the concept of recreation. This had come to be viewed simply as a recovery from illness, but Locke re-established its original Aristotlean meaning of relaxation (McIntosh, 1971):

"Recreation is not being idle...but easing the wearied part by change of business....A gentleman's more serious employment I look on to be study; and when that demands relaxation and refreshment, it should be in some exercise of the body, which unbends the body and confirms the health and strength."

Descartes. René Descartes (1596-1650 CE) was a French philosopher who spent much of his adult life in the Dutch Republic. Some consider him the father of modern philosophy, and many can cite his well-known dictum

"cogito ergo sum (I think, therefore I am)"

While serving in the Bavarian army, Descartes had a series of three visions convincing him that the pursuit of science would prove, for him, the pursuit of true wisdom. He emphasized the use of reason in developing the natural sciences, and saw the human body as some sort of machine, set in motion by an external God (*Deus ex machina*) (Descartes et al., 1996).

Spinoza. Baruch de Spinoza (1632-1677 CE) was raised in the Jewish community of Amsterdam, but because of what the Rabbi considered as outrageous views, by the age of 23 he became the subject of a *cherem* (a form of ex-communication). His books were also placed on the Catholic index of forbidden reading. In many respects, he laid the groundwork for Enlightenment philosophers. Indeed, Hegel once said (Duquette, 2003):

"You are either a Spinozist or not a philosopher at all."

Spinoza strongly opposed the mind-body dualism of Descartes, and tried to explain both physical and mental functioning as a finite expression of God. In his view:

"the order of states of activity and passivity in our body is simultaneous in nature with the order of states of activity and passivity in the mind."

He was not among those who denigrated self-realization through physical activity. He maintained (De Spinoza, 2003):

"it is the part of the wise man to use the world and delight himself in it as best he may, though not to satiety, for that is no delight."

Leibniz. Gottfried Wilhelm von Leibniz (1646-1716 CE) is perhaps best known for his invention of the infinitesimal calculus (an idea that some early scientists accused him of stealing from Sir Isaac Newton). Leibnitz was given free access to his father's extensive library in Leipzig from the age of 7 years, and he cheerfully accepted his first salary cheque as an alchemist in Nuremberg, although he apparently he began this work knowing nothing about the trade. He developed an early "stepped reckoner," or calculating machine, and he demonstrated this device to the Royal Society in London. Finally, he came to serve as political adviser, historian and librarian to the House of Hanover.

He had close contacts with other Enlightenment scholars, including Spinoza, but he was dismayed by their conclusions, which seemed at variance with his understanding of both Christian and Jewish orthodoxy. He himself saw no antagonism and no separation between body and soul. His metaphysical ideas were not antagonistic to physical activity or sport as such, although he himself was never particularly interested in sport. He conceived all substance as having an innate motive characteristic, the *vis viva* (*living force*), or mv^2, equal to twice our modern kinetic energy, another idea that some argue he stole from Newton (Ariew and Garber, 1989).

From the viewpoint of the present review, we may note that Leibnitz advocated establishing a medical authority, with powers to regulate both epidemiology and veterinary medicine. He also strove to establish a medical training program that was oriented towards public health and prevention rather than the treatment of disease.

Berkeley. George Berkeley (1685-1753 CE) was the Anglo-Irish Bishop of Cloyne. He developed the concept of immaterialism, explaining that in his view objects could not exist unless they were first perceived. His ideas had a major impact upon both Hume and the philosophy of sport, leading to the concept that the sensations induced by physical activity offered an entrée into human understanding of our world.

I recall that during my administration of our Faculty of Kinesiology at the University of Toronto, Professor Roselyn Stone taught a course in both our Faculty and in the Department of Philosophy of University College, entitled "*Movement as a means of knowing*." The ideas presented in this course were closely linked to the eurhythmics of the Swiss musical educator Emile Jacques Dalcroze (1865-1950 CE) and the philosophical ideas of the French phenomenologist Maurice Merleau-Ponty (1908-1961 CE).

Hume. David Hume (1711-1776 CE) was a leading Scottish Enlightenment philosopher and empiricist who sought to create a totally naturalistic science of humankind. He argued against innate ideas, suggesting that humans only had knowledge of the things that they had experienced. His concepts also fitted into the concept of "movement as a means of knowing."

Hume wrote little on sports, although he acknowledged (Brown, 1978):

"Societies and clubs for various sports and games must have their varying rules"

Churches. The seventeenth and eighteenth centuries saw a further splintering of Christianity into various sects such as Anabaptists, Congregationalists or Independents, and Methodists. Each of these religious groupings offered a distinctive philosophy both of working life and of recreation.

Anabaptists. The origin of the Anabaptists, or "rebaptizers," is a controversial topic. Their teachings probably began in central Europe with the Bohemian Petr Chelčický (c1390-1460 CE), and/or the Swiss preacher Conrad Grebel (c1498-1520 CE). Continuing offspring of the Anabaptists include the Moravians, the Swiss followers of Zwingli, and (best known in North America today) the Amish and Mennonite sects. These various groups have consistently advocated for a combination of Pacificism and simple living, with an emphasis upon spending time with the family and enhancing the quality of life rather than seeking to earn a large salary and to make conspicuous expenditures. Recently, they have become strong proponents of the "Hundred mile diet."

The need for a child to exercise is clearly recognized in Anabaptist writings, although a strong desire for simplicity extends even to their suggestions on the structuring of play (Kniss, 1975):

"It is perfectly normal for a child to want to play.... God gives the child extra energy so he can play and develop as a person.... Organized games which involve physical exercise are profitable for growing children also....My brothers and I often rode horses which were only sticks about five feet long. We would straddle the sticks and ride all around the barnyard. Those horses ran, bucked, kicked and even whinnied. They were real horses to us when we combined the sticks with our physical strength and imaginations. Now I like real horses due, in part, to the fact that I exercised my imagination that way when I was a boy"

***Congregationalists*.** Congregationalists separated from the Church of England in 1662, immediately following promulgation of the Act of Uniformity. This legislation required all English churches to use the rites and ceremonies of the Book of Common Prayer in their public services. Congregationalists commonly trace their roots to Robert Browne (1550-1633 CE), a well-connected prelate and relative of the Cecil family. Browne was arrested on 32 occasions, and was finally exiled in 1582. Many of his sympathizers, who were opposed to the ritual of the Anglican church, fled to the more liberal Netherlands. But they quickly became afraid of losing their English cultural identity, so in the year 1620 they undertook a perilous voyage on the "Mayflower," to establish an English-speaking settlement in Massachusetts. Congregationalism was the dominant religious belief of the new colony.

During the period of the English Commonwealth, the Puritans (many of whom either were or later became Congregationalists) disapproved of frivolous pastimes such as dancing. In North America, also, the Puritans opposed to bear-baiting not so much because it caused pain to the animals, but rather because it gave pleasure to the audience (Youngs, 1998). However, Congregationalists had no extensive formal creed. Perhaps for this reason,

they rapidly became the most liberal wing of Christianity, and they accepted the importance of sport participation much more quickly than other denominations. They recognized (McLeod, 2003):

"*A young Christian should attend the gymnasium as well as the prayer meeting...we have a physical as well as a spiritual nature*"

As we shall discuss in a subsequent section of this review, a Congregationalist named George Williams founded the YMCA in England, and in North American it was the Congregationalists who established Springfield College, a major centre for instruction in physical education.

Methodists. Methodism stemmed from the populist preaching of George Whitfield (1714-1770 CE) and John Wesley (1703-1790 CE), both in England and in North America. Small groups of devotees became committed to a personal life of pietism, evangelism, social activism and a holiness of heart and mind. Wesley was particularly concerned that health care was often only available to the wealthy members of society. He thus composed health advice for the poorer citizens in his "*Primitive Physick, or an easy and natural method of curing most diseases."* In this short work, he included the following comments on the Methodist lifestyle (Wesley, 1761):

"Observe all the time the greatest exactness in your regimen or manner of living. Abstain from all mixed, all high seasoned food. Use plain diet, easy of digestion; and this as sparingly as you can, consistent with ease and strength. Drink only water, if it agrees with our stomach; if not, good, clear small beer. Use as much exercise daily in the open air, as you can without weariness. Sup at six or seven on the lightest food; go to bed early, and rise betimes."

Physicians. A few Enlightenment physicians continued the Renaissance push to promote health by encouraging greater physical activity and fitness in their patients. Among this group, we find Heberden, Ramazzini, Hoffmann, Stahl, André, Burette, Protasov and Ambodik. Lind and Pringle also addressed the specific needs of preventive medicine in the Armed Forces. But unfortunately many doctors clung to outworn theories of disease and treatment. Booerhaave still based his teaching on the humoral theory, and John Brown explained all disease in terms of problems of excitabilty. Various forms of faith healing, such as the "King's Touch" remained very popular. Homeopathy was espoused by Hahnemann and von Haller (above), and overt, unprincipled quackery was exemplified by Graham's Temple of Healing and Mesmer's advocacy of animal magnetism. Voltaire (1694-1778 CE) concluded (Peck and Morgan, 2002):

"A physician is one who pours drugs of which he knows little into a body of which he knows less."

In England, the most successful physicians sported a gold-headed cane, awarded by the College of Physicians. The first to earn this token was John Radcliffe (1650-1729 CE), founder of the Radcliffe Observatory, the Radcliffe Hospital and the Library at Oxford. Other markers of professional status were the size of a doctor's wig and the elegance of his sedan chair.

William Heberden *(1710-1801 CE).* One notable English exponent of exercise at the beginning of the 19th century was William Heberden. He was the physician who gave a careful early description of angina pectoris and its relation to physical activity, noting the potential of helping the patient by a programme of therapeutic exercise (Heberden, 1772):

"They who are afflicted with it, are seized while they are walking, (more especially if it be up hill, and soon after eating....

I knew one who set himself a task of sawing wood for half an hour every day, and was nearly cured..."

Anne Hutchinson (1591-1643 CE, In the new world of North America, the few available doctors were much less elegant than in Georgian England. Often, they began their practice as scantily equipped ships' surgeons. Given the absence of medical schools, other practitioners acquired a smattering of knowledge by serving as apprentice, stable boy and personal servant to an existing physician.

At the outbreak of the American revolution (1775), less than 400 of the 3500 physicians who were practising in the United States held university degrees. Obstetrics was commonly the responsibility of midwives such as Anne Hutchinson. She was at first highly esteemed in the Boston region, but later she was banned from the colony because of her strident views on Women's rights.

Other early settlers in North America sought medical advice from members of the local clergy, such as Thomas Thatcher of Old South Church, Boston (who published his Smallpox Manifesto in 1677) and even John Winthrop (1587-1649 CE), the first Governor of the State of Massachusetts.

Benjamin Rush (1746-1813 CE), was one possible exception to the general medical ignorance of the New World. Rush was a Founding Father, U.S. Surgeon General and Professor of Clinical Practice at the University of Pennsylvania. He provided U.S. troops with opium (to combat nervousness), medicinal wine, emetics, and "bilious pills" with an undesirably high mercury content. However, in 1772, he delivered a "Sermon on Exercise," in which he advocated exercise and sport for old and young alike (Runes, 1947). He saw reular physical activity as a valuable component of treatment in his psychiatric practice (Rush, 1812):

"It has been remarked, that the maniacs of the male sex in all hospitals, who assist in cutting wood, making fires, and digging in a garden, and the females who are employed in washing, ironing, and scrubbing floors, often recover, while persons, whose rank exempts them from performing such services, languish away their lives within the walls of the hospital."

His "*Plan of a Federal University*" included exercises to enhance both strength and health (Runes, 1947).

Ramazzini. Bernardo Ramazzini (1633–1714 CE) was an Italian physician who today is best known for initiating studies of health and fitness in the work-place. In his text *Morbis Artificum Diatriba*. he noted that messenger runners avoided many of the health problems that were encountered by those who worked in sedentary occupations,

such as cobblers and tailors. He suggested (Ramazzini, 1713/2001):

"whenever occasion offers, we must advise men employed in the standing trades to interrupt when they can that too prolonged posture by sitting or walking about or exercising the body in some way."

He commented that millers were prone to herniae because they carried excessive loads. He strongly urged sedentary workers to exercise on their holidays (Bouchard et al., 2012); prophylactic measures recommended to increase the health of workers included bathing, frequent changes of clothing, adoption of a correct posture, physical exercise and covering the mouth when working in dusty trades. His credo continues to challenge industrial hygienists (Balfour and Scott, 1924):

"tis a sordid profit that's accompany'd with the destruction of health."

Hoffmann. Frederich Hoffmann (1660-1742 CE) was the son of the Municipal Physician of Halle, in Germany. He seems to have been an early example of a "born-again Christian." Educated at Jena, he became the first Professor Medicine at Halle, and in his six-volume *Medicina rationalis systematica***,** he drew a rigid distinction between the body and the soul. He sought to explain the physical body simply in mechanical terms (matter and motion). In a 9-volume *Basic Guide* to a long and healthy life he emphasized the restorative values of proper diet, exercise, clean air and sleep (Kuehn and Klemme, 2010).

Later in his career, he wrote several essays on exercise, which provided an initial stimulus to the writings of Guts-Muths (1759-1839 CE), particularly the text *Gymnastics for the Young* (Berryman and Parks, 1992). Hoffmann also had a great influence on the thinking of C. J. Tissot (1747-1826 CE). In 1781, Tissot published "*Medical and Surgical Gymnastics,"* a text that recommended limiting bed rest and carefully dosing exercise prescriptions in terms of time, place, duration and intensity. Tissot is often regarded as the founder of recreational therapy and adaptive sports medicine. For him, gymnastics was (Tipton, 2002):

"that part of medicine which teaches the way to restore or preserve health by means of exercise."

Stahl. In contrast to Hoffmann, Georg Ernst Stahl (1659-1734 CE) was an animist rather than a mechanist. He strongly believed that all movement derived from a vital force or soul (Cunningham, 1880). He is best remembered for the discarded *phlogiston* theory (above). However, he was also a prominent physician in Weimar and Prussia, and he agreed with Hoffmann that exercise was needed to keep the body free of ailments and to maintain good health.

André. Nicholas André (1658–1742), Professor of Medicine in the University of Paris, published a text entitled *L'orthopedie*. This gave the specialty of orthopedics its current name (Kohler and Fischer, 1999). André coined the word by combining the Greek *orthos* (straight) and *paidos* (child). In this book, he prescribed various exercises and splints as a means to correct deformities and enhance the physical appearance of a child.

Burette. Pierre Jean Burette (1665–1747 CE) was the son of the French composer and harpist, Claude Burette. He was himself an excellent spinet player, but he subsequently decided to pursue a Medical career, becoming Professor of Medicine and Chair of the Royal College of Medicine in Paris. He was greatly attracted to Greek concepts of sport and physical activity (Waller, 2008), and wrote an important text on this subject.

Protasov. In the Russia of 1765, a Strasbourg-educated Academician and Anatomist (A.P. Protasov, 1724-1796 CE) lectured on "*The Importance of Motion in the Maintenance of Health."* Protasov became physician to the portly Czar of that era, and he recommended that the monarch walk, run, and ride horseback in order to correct his obesity (Basmajian, 1983).

Maksimovich-Ambodik. N. Maksimovich-Ambodik (1744-1812 CE) is best known as the founder of Russian Obstetrics and Phytotherapy (Kosach, 1962). In the context of fitness, he wrote,

"A body without motion deteriorates and putrefies like still water,"

Lind. James Lind (1716-1794 CE) was a British naval surgeon. He was appalled to find that during a voyage of *HMS Salisbury* in the year 1747, 80 of the 350 crew members fell victim to scurvy. He confined the affected sailors to the forepeak of the vessel, and there he carried out an early controlled dietary study. He quickly discovered that scurvy was entirely preventable if the sailors were given a sufficient quantity of fresh fruit such as oranges (Lind, 1753).

Pringle. John Pringle (1707-1782 CE) recorded the sad sufferings of British Army personnel during the era of the Enlightenment. In his treatise "On the diseases of the army," he recommended making stronger attempts to ensure an adequate diet, clean water and personal cleanliness, and he did much to emphasize the vital role of prevention in Military Medicine (Hamilton, 1965).

Boerhaave. Herman Boerhaave (1668-1738 CE, above) clung to out-dated humoral theories of disease. Afraid to tax a sick organism, the most common advice that he gave to his patients was to rebalance the body humours by starvation and/or drastic purging.

Brown. John Brown (1735-1788 CE), hailed by some as the Paracelsus of Scotland, began his education in the Edinburgh Faculty of Divinity, but later transferred to Medicine. He published the Elementa Medicinae in 1780, vigorously criticizing earlier medical teachings. He believed that all disease reflected an imbalance of excitability in the body. Many medical conditions were asthenic in type, and they thus responded to strong stimulation, including plenty of food, horseback riding and heroic doses of powerful drugs. But a few conditions such as measles and smallpox were sthenic; these required treatment to reduce over excitement- purging, bleeding and the use of debilitants. His remedies reputedly killed more people than the Napoleonic wars! Nevertheless, he was a convincing instructor, and students continued to attend his lectures, even when he was finally consigned to a debtor's prison.

The King's Touch. The Stuart king Charles II revived the belief that the

"KIng's touch" could cure the King's Evil (scrofula, a tuberculous infection of the lymph nodes in the neck). Thousands of Londoners thronged the court, hoping to obtain an admission ticket on the appointed day, and according to Samuel Pepys:

"six or seven people were crushed to death by pressing at the churgeon's door for tickets."

Things were not necessarily easy, even if one managed to obtain an admission ticket (Pepys et al., 2006):

Tom Guy came to me and there staid to see the King touch people for the King's evil. But he did not come at all, it rained so; and the poor people were forced to stand all the morning in the rain in the garden. Afterward, he touched them in the banquetting house.

Hahnemann. The German physician Samuel Hahnemann (1755-1843 CE) is commonly credited with the idea of Homeopathic treatment. He began life as an itinerant physician, visiting villages in the mining area of Saxony. But later, he abandoned formal medical practice, recognizing the formidable extent of its ignorance (Singh and Ernst, 2009):

"My sense of duty would not easily allow me to treat the unknown pathological state of my suffering brethren with these unknown medicines. The thought of becoming in this way a murderer or malefactor towards the life of my fellow human beings was most terrible to me, so terrible and disturbing that I wholly gave up my practice."

Hahnemann's concepts of homeopathy are described in "*The Organon of the Healing Art,"* which was first published in 1810. However, the proposed new forms of treatment seem to have been just as suspect as the conventional Medical practice of his day. One striking idea was the "*Law of Opposites:"*

"that which can produce a set of symptoms in a healthy individual, can treat a sick individual who is manifesting a similar set of symptoms."

Graham. James Graham (1745-1794 CE), a medical school drop-out, became one of the more famous among the many quacks of the Enlightenment. His annual income reputedly reached a figure of £30,000. During his travels to North America, he encountered Benjamin Franklin, and became convinced that:

"electricity invigorates the whole body and remedies all physical defects"

Franklin himself had speculated that an electrical shock might cure palsy. Foreshadowing modern spas, in 1780, Graham opened a luxurious "Temple of Health" in London's West-End. The entrance fee of 6 guineas attracted only the wealthiest of clients. Electrical jolts were given to club members, using an assortment of elegant metallic crowns. Another popular feature of the spa was a lecture course on sexual rejuvenation. Here, patrons were given bottles of an `*aethereal balm'* by a scantily clad "*Rosy Goddess of Health and Hymen.*" The Goddess later became even more famous as Lady Hamilton, mistress of Lord Nelson. One supplemental option was to rent a "Celestial bed;" this was fitted with

huge magnets that purported to correct erectile dysfunction (Graham, 1780).

***Mesmer*.** Frank Anton Mesmer (1734-1815 CE) also practiced a great deal of quackery based on his supposed ability to assure the proper flow of a mysterious magnetic fluid throughout the patient's body. His fame became such that he claimed to mesmerize patients by remote control. Water basins, shrubs and even whole forests were magnetized, so that patients who touched the affected objects would be miraculously cured. But eventually, the fraudulent nature of his claims was exposed by contemporaries such as Franklin and Lavoisier.

Public health and hygiene

The Enlightenment saw some improvement of housing conditions for the poorer citizens of Europe. Many buildings were now constructed of brick and boasted glass windows. And Samuel Johnson (1709-1784 CE) was urging a pro-active response to the prevention of disease (Johnson and Murphy 1810):

"we must consider how many diseases proceed from our own laziness, intemperance or negligence; how many the vices or follies of our ancestors have transmitted to us; and beware of imputing to God, the consequences of luxury, riot and debauchery.".

A few scientists such as Hales (with his improved water supply for the village of Teddington), and Bernouilli (with his probability study of the merits of vaccination) also showed some interest in Public Health. However, the provision of clean drinking water, adequate sewage treatment and protection against communicable diseases remained the exception rather than the rule. Life expectancy provides one simple mathematical index of overall population health, and throughout the Enlightenment, the average lifespan remained brief, both in Europe and in the New World. Epidemics of beri-beri, smallpox, malaria and yellow fever wreaked great havoc among the early colonists. In 1610, for example, 310 of the 398 residents of Jamestown died of various diseases.

Drinking water. Although the quality of water in most large cities left much to be desired, Enlightenment, philosophers began to suggest that clean water for drinking and bathing were the inalienable rights of every citizen. The French scientist Philippe de la Hire (1640-1718 CE) sought to improve the water supply of Versailles, and he suggested that every household should install a sand water filter (Cech, 2010).

In 1804 CE, Paisley, Scotland became the first British city to establish a municipal water treatment plant. It used sand filters developed by Robert Thom (Baker and Taras, 1981). Nevertheless, as late as 1854 many of the residents of Broad St., in Central London, faced a massive outbreak of cholera because they were drawing water from a shallow well that was located close to a cholera contaminated cess-pit (Johnson, 2006).

Average lifespan. The average life expectancy of a European during the 17th and 18th centuries was short. At birth, a person could expect to live no more than 35 years. Many deaths occurred during the neonatal period, and others arose from acute infections or deaths during childbirth. A third to a half of the population succumbed before reaching

the age of 16 years. Those who survived to their mid-teens could probably expect to live into their 50s or even their early 60s, and at the age of 21 the aristocracy had a further life expectancy of 43-50 years (Lancaster, 1990); this was some improvement over the 25 years of further survival typical of the 14th century.

In colonial Willamsburg, survival prospects during the 17th century were even worse than in Europe. Many of the population succumbed to fevers, intestinal diseases, and in the case of African slaves harsh working conditions. A quarter of European children did not survive to their first birthday, and half of all marriages ended in the death of one partner before their seventh wedding anniversary. Detailed statistics are not available for early Canada, but isolation, accidents and harsh winters likely made Canadian prospects worse than in either Europe or the U.S.

Physical education

The idea of incorporating physical education into the programme of school instruction, although commonplace in ancient Greece (Shephard, 2012b), took some time to be accepted by Enlightenment thinkers. We will discuss here the views of some leading Educators, and the practical organization of school curricula in various parts of the world.

Views of educators. Despite the efforts of a few pioneers such as da Feltra, Mulcaster and de Montaigne, most Renaissance schools had offered little physical activity to their students (Shephard, 2012d). The Age of Reason brought some new thinking, spurred by a growing nationalism, and a sense of the moral influence of physical activity. Critical to this process were the contributions of Comenius and Jean-Jacques Rousseau.

Comenius. The Moravian Bishop John Comenius (1592-1670 CE) urged educators to take account of the nature of the child and make learning a pleasure. His own observations led him to the conclusion that children were not simply miniature adults, a viewpoint echoed more recently by the late Oded Bar-Or (Bar-Or, 1983). Comenius wrote that understanding comes

"not in the mere learning of the names of things, but in the actual perception of the things themselves."

One practical consequence of his theories was the preparation of an encyclopaedic picture book *'Orbis Sensualium Pictus'* (The World in Pictures) (Comenius and Hoole, 1728). In keeping with his Moravian background, Comenius argued that, just as the soul was nourished by books, so the body was nourished by movement, and he suggested that 30 minutes of exercise should be provided for every hour of academic study. He also commended light exercise to pregnant women, in order that they might bear vigorous offspring. He was invited to Sweden to promote a national system of education, but theological conflicts between his Moravian beliefs and the ideas of the Lutheran hierarchy stalled this endeavour.

Rousseau. The Age of Reason is particularly associated with the name of Jean-Jacques Rousseau (1712-78) CE.. He argued against the interference of either church or state in matters of education. In his view, there was a naturalism that

caused a child to develop and unfold intellectually, physically, and emotionally, much like a growing plant. The child differed from the adult in the quality of his or her mind (Rousseau et al., 2003):

"We are always looking for the man in the child.... without thinking what he is before he becomes a man. Children are... always in motion: a sedentary life is injurious." "Nature's intention is to strengthen the body before exercising the mind."

He placed a strong emphasis on health, and the unity of mind and body. Games and sports played an important therapeutic role, taking away:

"the dangerous inclinations that spring from idleness."

Until at least the age of 12 years, Rousseau argued that the emphasis of schooling should be on cultivation of the body and the senses, rather than the intellect (Dewey, 1996). Through the acquisition of physical skills, the pupil would learn both about the mechanics of the world and about himself. Physical activity also had an important role in character training (vanDalen and Bennett, 1971):

"The training of the body, though much neglected, is...the most important part of education not only for making children healthy and robust, but even more for the moral effect...."

Rousseau seems to have reignited an interest in sport and physical training in part for Nationalist ends. He served as policy adviser to the newly reconstituted state of Poland, and in this capacity he suggested that games would make children's hearts (Kraus, 1978):

" glow and create a deep love for the fatherland and its laws....The important thing is to get them accustomed from an early age to discipline, to equality and fraternity, to living under the eyes of their fellow citizens and seeking public approbation."

This Nationalist message found immediate echoes in the *Philanthropinum* of J.B. Basdow (1724-1790 CE) in Dessau. This primary school was built on rationalist philosophy and sought to bring children into contact with realities rather than mere words. As we shall discuss in a subsequent section of this review, the militaristic element of physical education became much more widely prevalent in Germany, Scandinavia and the U.S. during the 19th century.

School curricula. The philosophy and curricula of schools differed somewhat between Europe, the United States and Canada.

European schools. Until the early 19th century, most lower class children did not have the opportunity to attend schools beyond the age 10 or 11 years. Formal instruction then ended for all but a few of the "brightest" students. Teachers maintained order in the primary school room by a combination of bullying, beating, and ridicule. Many schools were staffed by minor clergy, who themselves were indifferently educated. Individual classes (usually all boys!) could have a roster of as many as 100 pupils. The school day was sometimes as long as 13 hours, with short breaks taken for meals.

In most cases, the system offered neither space nor time for physical activity. A typical curriculum was limited to reading, writing, religion, and, if the teacher had mastered it himself, basic arithmetic. Charles Dickens gives a vivid caricature of the pupils attending a privately-operated Enlightenment school with his description of Dotheboys Hall (Dickens, 1867):

"Pale and haggard faced, lank and bony figures, children with the countenances of old men. . . . There was childhood with the light of its eyes quenched, its beauty gone, and its helplessness alone remaining."

United States. The Pilgrim Fathers introduced a programme of formal education into the North American colonies soon after their arrival. In 1642, Massachusetts passed a law requiring both parents and apprentice-masters to ensure that every child in their care was taught to read. In 1647, this requirement was reinforced by the "Old Deluder Satan Act," so named because its main aim was to defeat Satan's attempts to keep men from knowledge of the Scriptures. This piece of legislation required all towns of more than fifty families to hire a schoolmaster, and all towns of 100 families had to hire a teacher who was capable of preparing students to attend Harvard University (Beckner and Dumas, 1968). The curriculum of the early U.S. schools usually included reading, writing and arithmetic plus intensive Bible study, but there was little provision for physical education.

The Academy or "English" school that Benjamin Franklin helped found in 1751 was the first of a growing number of secondary schools that sprang up in competition with the typical Boston "Latin" school, from which he himself had been a drop-out. The "English" schools were influenced by European concepts, including a strong emphasis upon physical education. Franklin wrote (Parton, 1867):

"The routine of the Latin school is established, the path is beaten flat and hard...It is far otherwise with the system based upon modern languages, mathematics, natural science, drill, military and gymnastic."

Canada. In 17th century New France, formal education was limited to a few towns. Several Catholic religious orders (Jesuits, Récollets, Ursulines, and the Congregation of Notre Dame) provided elementary instruction covering the catechism, reading, writing and arithmetic. Men destined for the priesthood received a more formal classical education at the *Collège des Jésuites* (founded in 1635 CE) or the *Séminaire de Québec* (founded c 1665). After the British Conquest of 1759-60 CE, the English authorities repeatedly tried to establish secular schools in Québec, but they were consistently out-manoeuvred by the Catholic Church authorities (Encyclopedia, 2012).

Most children in Upper Canada received little formal education until the efforts of Egerton Ryerson, beginning in the mid 1840s. Even when schools were opened, there was little in the way of formal physical education. Nevertheless, most children undertook a considerable amount of physical activity when they were out of school, helping their parents on the land, and indeed their classroom education was interrupted for several months each summer so that they could

contribute to agricultural work (Encyclopedia, 2012).

The changes introduced by the British public school system and the German *Turnverein* movement will be considered in a later article in this series.

Patterns of sport, habitual physical activity and fitness

Many factors conspired to decrease the habitual physical activity of wealthier citizens during the Enlightenment. Active transportation had already been curtailed by the introduction of sedan chairs (Shephard, 2012d), and this trend was exacerbated by the purchase of coaches to drive on newly-constructed and well-maintained turnpikes. Technical innovations also lightened the physical demands of daily work for many of the general population.

In the developing settlements of North America, involvement in sport and recreation was limited to a select few wealthy residents in the growing towns. For most of the population, life was a harsh struggle against isolation, a severe climate, dense forests and unfertile soil. The tasks of clearing the land, building houses and barns and cultivating crops with simple tools provided more than adequate daily activity. Minimum estimates of the likely energy expenditures of early settlers can be gauged from data for small religious sects such as the Old-order Amish and Mennonites who today still maintain traditional non-mechanical patterns of agriculture.

Sports. With restoration of the English monarchy and the elaborate courts of the French Enlightenment, many forms of sport became highly stylized and much less physically demanding, a trend which had already begun in the latter part of the Middle Ages and Renaissance (Shephard, 2012c; Shephard, 2012d). Boxing contests saw their first crude beginnings, and the common people continued their interest in primitive forms of football, cricket, hurling, animal baiting and folk dancing. Opportunities for passive recreation also increased substantially, particularly for the more wealthy members of society.

Hunting. The English found the former pleasures of hunting were suddenly curtailed in 1671, with enactment of a law that prohibited all freeholders from killing "game" even on their own lands. A penalty of £100 was imposed on anyone who was caught infringing this legislation. Hunting began to assume its modern, stylized form, with packs of hounds and elegantly dressed and well-mounted gentry.

Horse trotting. Much of the time, the aristocracy paraded their best horses at a gentle trot around the graveled walks of large private estates. Public horse-riding areas also appeared; for instance, the Stuart kings opened London's Hyde Park to public riding. William III installed 300 oil lamps along one carriageway in the park (Rotten Row), and this became a place for the wealthy to display their horses, carriages and well-dressed mistresses (RoyalParks., 2012).

Horse racing. The patronage of the Newmarket course by Charles II gave a fillip to horse racing in England. This trend was perpetuated when Queen Anne came to the throne. The aristocracy spent much of their time at the track, not only watching the racing, but also displaying their horses, carriages and fine clothing. Queen Anne established the Royal Ascot

race in 1711 CE. It became a particularly prominent event in the social calendar of the nobility. But in Anne's view (RoyalAscot, 2012), Ascot was also an ideal place

"*for horses to gallop at full stretch.*"

Yachting. Recreational yachting and regattas first became popular during the early 17th century. The trend started in the Netherlands, where wealthy burghers purchased small, open or half-decked craft, such as the round-sterned *kaag*. In the tradition of the Enlightenment, what at first were boisterous races gave place to formal waterborne parades and spectator events. Charles II developed a taste for sailing while he was exiled to the Netherlands, and on his accession to the British throne he built the first 25 in a long series of "Royal Yachts." Early *Jaghtschips* were swift, maneuverable 14-20 m sailing vessels, used for the hunting of pirates (*ter jaecht gaen*, to go hunting). Such craft quickly caught the fancy of the nobility, and were widely used for pleasure cruising on the River Thames (Gavin, 1932). The first yacht club was founded in Cork, Ireland, in 1720 CE, and the Royal Yacht Squadron at Cowes, on the Isle of Wight, was established in 1815 CE.

Rowing. Watermen had long provided transportation on the River Thames in Central London, and from 1715 CE onwards, a contest between apprentice watermen (Doggett's Coat and Badge Race) became yet one more important spectator event. Participants originally rowed a 4-seater ferry boat a distance of 7.4 km against a strong ebb tide, the prize being a coat awarded by the comedian and Drury Lane Theatre *impressario* Thomas Doggett (Dickens, 1887). The race still continues today, but in modern times contestants have used single sculling boats on a rising tide.

Boxing. James Figg opened a boxing "Amphitheatre" on Tottenham Court Rd, London, in 1719 CE, teaching "*Ye Noble Science of Defence*." It was at first a crude and brutal sport, with cudgel and fists (Anderson and Anderson, 2007), but nevertheless it offered a welcome alternative to the sword fighting of an earlier generation. Figg later moved instruction to a pub called the "*Adam and Eve*," on Oxford St. in London's West End.

Jack Broughton introduced formal rules for boxing in 1741 CE. These included the use of gloves for sparring (but not for actual contests). Boxing quickly became one more spectator sport for the gentry, with large sums wagered on the outcome of contests.

Strolling in public gardens. For the elite of the Enlightenment, walking (like other forms of physical activity) became an opportunity to be seen and to meet important people, rather than a method of transportation or a source of healthy exercise. In London, the development of several "Public Gardens" the south bank of the river Thames allowed this form of display. The Vauxhall Gardens were first mentioned by Samuel Pepys, in 1662 CE (Pepys et al., 1893):

"took boat and to Foxhall, where I had not been a great while; to the Old Spring Garden and there the wenches gathered pinks"

Vauxhall was soon up-staged by the more aristocratic Ranelagh Gardens, which was opened to the public in 1742

CE. For an admission fee of 2 shillings and sixpence, Horace Walpole commented (Turner, 1998) that at Ranelagh:

"You can't set your foot without treading on a Prince, or Duke of Cumberland."

Indoor strolling. A similar type of public display occurred indoors, as the well-dressed social elite paraded slowly around places such as the Bath Pump Rooms. This leisurely form of activity was immortalized by Jane Austen (Austen, 1818) in her "*Northanger Abbey*:"

"Friday, went to the Lower Rooms; wore my sprigged muslin robe with blue trimmings—plain black shoes—appeared to much advantage; but was strangely harassed by a queer, half-witted man"

The Palace at Versailles provided the 17th century French nobility with similar opportunities, both indoors (in the Long Gallery) and outdoors (in the extensive gardens of Versailles).

Dancing. Dancing remained a popular pastime during the Enlightenment, but there was a progressive transition from the lively jigs of an earlier era to slow, stately and courtly dances, supplemented by staged masques in which Royalty would play a figurative role (Bevington and Holbrook, 1998). The gavotte, popular with baroque musicians, first appeared in the 16th century, and in the 17th century the minuet offered opportunities for particularly slow, ceremonious, and graceful movement (Little, 2001).

In Quebec City, Louis-Théandre Chartier de Lotbinière organized a formal, courtly ball as early as 1667 CE. But in the smaller communities of French Canada, *gigues* and vigorous formation dances such as the *contredanse* continued to be the popular choice.

Lacrosse. In Canada, most of the early immigrants had little time or energy for sport. However, by 1740, some of the French settlers began participating in games of lacrosse. Such activity was undertaken despite the opposition of the Jesuit priests, who saw the First Nations playing lacrosse in an attempt to change the weather or to honour their dead. For the priests, lacrosse was an inherent part of the pagan culture that they were seeking to eradicate.

For at least a century, the First Nations easily beat French Canadian lacrosse teams. As late as 1844, a team of 5 Native Americans easily trounced a team of 7 French settlers (LacrossHistory., 2012). Nevertheless, lacrosse remained a source of vigorous physical activity for the participating Québecois.

Sedentary pursuits. A rapid growth in pageants and live theatre, an ever-growing number of printed books and magazines, disposable income for the purchase of musical instruments, and the development of coffee houses offered city dwellers an expanding range of sedentary pursuits during the Enlightenment.

Pageants and Plays. Richard Mulcaster was a strong advocate of pageantry (DeMolen, 1975), which:

"grew up around the procession, drawing to itself elements from the procession, folk-custom, the miracle play, historical, allegoric, chivalric and classical literature"

But in terms of drama, the strolling players of Shakespeare's youth quickly gave place to permanent repertory companies, often performing in well-appointed theatres. Several permanent theatres were constructed in London between 1576 and 1590 CE, including the "Rose," "The Theatre," the "Curtain," and "Newington Butts". The parish of Southwark was a favourite location for such institutions, since this territory lay just outside the jurisdiction of the City Fathers (Wickham et al., 2000),

All public theatres were closed from 1592 to 1594 because of an epidemic of bubonic plague, but most establishments quickly recovered from this setback. Authors such as Ben Jonson (1537-1537 CE) and Christopher Marlowe (1564-1593 CE) provided a growing choice of plays until a Puritan edict again closed all theatres in 1642. With return of the Stuart monarchy in 1660, the theatres reopened with even greater vigour, presenting rakish and sexually explicit "Restoration comedies" such as William Wycherley's T*he Country Wife* (1675) (Hughes, 1996).

Reading and musical performances. The development of printing made both personal reading matter and sheet music readily available to the wealthier members of Enlightenment society. Country houses accumulated extensive personal libraries. With the development of a wealthy middle class, music burgeoned as a source of evening entertainment, and freed from the constraints of the monastery, melodies became tuneful madrigals and folk songs, a new vehicle of personal expression. The range of available instruments expanded to include trumpets, cornetts, sackbutts, viols, lyres, harps, harpsichords, virginals and spinets. Drawing room concerts were frequently improvised when the wealthy retreated from the city to their country estates (Kottick, 2003; Montagu, 2002).

In Canada, traditional aboriginal music was provided by drums and rattles. Early French settlers brought a strong interest in fiddle playing, and fiddlers remained a fixture in lower-class drinking establishments over the next two centuries. But by the 1630s, French Canadian and aboriginal children attending the Ursuline school and convent Quebec City were being taught to play viols, violins, trumpets, drums, flutes and fifes (Amtmann, 1975). The Jesuits also imported an organ to serve their chapel in 1657 CE. At first, settlers were content to transmit the traditional songs of the *habitant* orally from village to village. But by the 18th century, regimental bands were performing at dances and festive occasions, and formal concerts followed the construction of a concert hall in Québec City in 1764 CE. However, instrumental music-making and sheet music remained the preserve of the aristocracy until the 19th century.

Coffee houses. Coffee was introduced to Europe during the 17th century. Coffee houses first appeared in Hungary and Venice during the 1640s. An entrepreneur named Jacob opened the first English Coffee House (the *Angel*) at Oxford in 1652 CE (Cowan, 2005). Despite the opprobrium of Charles II, who claimed that coffee houses were (Editor., 1817):

places where the disaffected met, and spread scandalous reports concerning the conduct of His Majesty and his Ministers"

the clientele of such institutions grew quickly, providing the city-dweller with a

further opportunity for sedentary leisure. Coffee houses were recognized as (Cowan, 2005).:

"places where people gathered to drink coffee, learn the news of the day, and perhaps to meet with other local residents and discuss matters of mutual concern."

For the price of a cup of coffee (usually a penny), the customer also gained access to a variety of pamphlets and newspapers, notably the *Tatler* and the *Spectator* of Richard Steele and Joseph Addison, respectively (Bramah, 1972). The latest medical and scientific discoveries were also a popular topic for coffee house gossip (Guerrini, 2003), shared with such celebrities as Dean Swift, Samuel Johnson, and Alexander Pope. The appraisal of medical science was at times scathing. Joseph Addison commented (Dickinson, 1899):

"We may lay it down as an axiom that when a nation abounds in physicians it grows thin of people... for the good of my native country I could wish that there might be a suspension of physic for some years"

The physician Richard Mead (1673-1754 CE), heir to the prosperous practice of John Radcliffe and a staunch advocate of "plague houses," would discuss the cases of apothecaries while enjoying a cup of coffee. His fee for this arm's length consultation was reduced from the normal price of one pound to ten shillings (Mead, 1762).

Habitual physical activity. The agricultural peasant of the Enlightenment continued a life of hard physical activity in the countryside of both Europe and North America. Some idea of the energy costs of traditional farming can be deduced from recent studies of Old-Order Amish. But a growing leisured middle-class now lived in the cities; leisure travel was facilitated by coaches, turnpikes and inter-urban highways, and elaborate styles of clothing militated against the adoption of an active life-style either by adults or children.

The application of first water power and then steam to such tasks as cotton-spinning and the weaving of woolens also drew a growing fraction of the working population into crowded cities. There, the physical demands of the workday were sometimes reduced, but long hours of work, grinding poverty and over-crowding left little opportunity for active leisure.

Traditional non-mechanized lifestyle. Old-Order Amish in rural areas of Southern Ontario still live something approaching the lifestyle of the 18th century settler. The Amish continue to avoid all use of automobiles and electronic devices. Even bicycles and roller blades are prohibited, although some communities now accept use of the mechanical harvester (invented by Cyrus McCormick, in 1834 CE) and the steel-bladed plough (introduced by John Deere in 1837 CE). The Amish thus maintain high levels of daily energy expenditure both in the fields and in their homes.

A study of 98 Amish adults living in the St. Jacobs region of Ontario (Bassett et al., 2003, 2004) found that 78% still made their living from traditional farming. Average step counts for this population were 18,425 per day for men and 14,196 per day for women, compared with typical figures of 7500 per day for urban North Americans. Self-reported daily

energy expenditures were 12.9 and 7.7 MJ for men and women respectively. The routine of Amish men comprised 10.0 h/wk of vigorous physical activity (PA), 42.8 h/wk of moderate PA, and 12.0 h/wk of walking. Corresponding figures for the women were 3.4 h/wk of vigorous PA, 39.2 h/wk of moderate PA, and 5.7 h/wk of walking. As with early settlers, almost no leisure activities were reported by the Amish.

Dietary records for traditional Ohio Amish have also suggested a high daily energy expenditure (15.0 MJ in men, 8.4 MJ in women) (Weale, 1980). However, many Ohio Amish no longer engage in farming, and in consequence their energy expenditures have dropped substantially.

Canadian Amish children were at least as active as their parents, with boys taking 17,200 steps/day (>20,000/day on weekdays) and the girls 13,600 steps/day (Bassett, 2008; Bassett et al., 2007 ; Esliger et al., 2010). Again, these figures were much higher than the averages of 11,000 and 10,000 steps/day typical of contemporary North American boys and girls, respectively. The Amish school programmes included no formal physical education, and because schools were small, the children often remained in a single classroom for the entire day. On the other hand, they spent much of their lunch break and two recesses in active games such as volleyball and softball, under the supervision of their teachers. The main sedentary period for the Amish children was on Sundays, when the children travelled a substantial distance to church by horse and buggy, and then sat through a long religious service (Esliger et al., 2010).

Traditional Mennonite families now use electricity, and some have purchased automated equipment for their farms, but nevertheless, their children also accumulate significantly more moderately vigorous activity (3 h/day in the boys, 2 h/day in the girls) than their counterparts in contemporary Canadian society (Tremblay et al., 2005; Tremblay et al., 2008).

A somewhat similar study examined people who were living at an historical park in Sydney, Australia for 8 h/day. This group mimicked the lifestyle of original settlers, walking 8-16 km/day further than the average modern citizen (Egger et al., 2001).

Highways and turnpikes. The highways of mediaeval Europe were in almost uniformly bad condition. Travellers had to contend with deep fords, ill-tended bridges, and frequent assaults by highwaymen. For much of the year, routes were passable only on horseback or by pack-train (Trevelyan, 1944). However, by the early 18th century, British turnpike companies were beginning to construct and maintain highways in an acceptable fashion (Albert, 2007). Coach journeys that previously had taken four or five days could now be completed in a single day. The Great North Road, built in 1812, speeded passengers on their 660 km journey from London to Edinburgh, while the Great West Road facilitated the journey of wealthy Londoners to the spa city of Bath. Ownership of one or more coaches quickly became the norm for the elite, and walking was frowned upon by those in high society. Lack of a coach was likely to confine a genteel young lady to her home (Bloom, 2004):

"coaches, barouche-landaus, and curricles are the crucial factors that will determine who goes where."

In 17th century Canada, the population density was insufficient to permit the construction of many roads. Most long journeys were still made by water. Propelling a canoe against the stream was in itself an arduous task, and journeys were all too frequently interrupted by rapids, where long overland portages of both canoe and baggage were required (Shephard, 2011). During the winter months, short journeys were made by horse-drawn sled, by *carriole*, or on foot (wearing *raquettes)*. However, by order of the *Conseil Superieur de Nouvelle France*, a 7 metre-wide roadway (the 280 km *Chemin du Roy)* was built to link Quebec City and Montreal in 1734-1737 CE. This road linked the many small north-shore villages that still line Highway 138 (CheminduRoy., 2012). Rough tracks or *rangs* also separated the parcels of land assigned to individual colonists.

In Ontario, travel outside of Toronto was long restricted to a network of footpaths that had been established by the First Nations. Thus, the Davenport Trail ran from the centre of Toronto to the Humber River. It only became a planked road in the mid-19th century. As in modern Afghanistan, change was brought about largely in response to military demands. The threat of a U.S. invasion stimulated Lord Simcoe to begin construction of two major highways (the 1900 km artery of Yonge St., northbound out of Toronto, begun in 1793 CE, and the westbound Dundas St. to Niagara on the Lake, begun in 1796 CE) (Hayes, 2008). In 1799, Asa Danforth also began building a road eastwards towards Kingston, at a cost of $99/mile, but for many years this route was poorly maintained.

Water power. In Britain, water powered the new inventions of Richard Arkwright (1732-1792), such as the cotton spinning frame and the carding machine. The general conditions in textile mills and these inventions in particular were very unpopular with both factory employees and the users of hand-looms; unrest culminated in the Luddite Riots of 1811-1812 CE, when much of the new equipment was destroyed. In Lancashire, Preston Assizes convicted a Mary Leicester to 12 months of imprisonment in Lancaster Castle (Fitton, 1989) for having:

"destroyed 20 each of the following machines: spinning frames, spinning engines, carding engines, roving engines, twisting engines, twisting mills, cotton wheels, and cotton reels."

Other rioters suffered transportation to Australia, or even execution.

Towards the end of the 18th century, water power began to give way to steam power, particularly in larger mills and factories. At first, steam was used simply to pump water into a reservoir driving the water wheel. Industrial hygienists still regarded water power as a more healthy option than the steam engine, because of the heat and humidity associated with the latter. Smaller operations, including blast furnaces and gristmills, continued to use water power during the 18th and 19th centuries (Fitton, 1989).

Steam Power. Thomas Savery was a British military engineer who spent much of his free time exploring issues in Mechanics. He invented a one horsepower steam engine in 1698 CE, but his device did not become very popular, because it had an unfortunate propensity to explode at inopportune moments. An ironmonger, Thomas Newcomen, brought out a more

reliable 5 hp steam engine in 1712 CE; his machine allowed the mechanical pumping of water from ever-deeper tin mine shafts in Devon and Cornwall. James Watt, an instrument-maker at the University of Glasgow, added several important design modifications, and by 1775 he was producing engines with five times the mechanical efficiency of the Newcomen device. Gradually, the introduction of machine tools allowed these engines to take over other heavy manual tasks such as the sawing drilling, planing and shaping of wood and metal.

Steam-driven traction engines next began to appear in the countryside; they took over many of the functions of horses and farm labourers, providing power for such operations as threshing and ploughing.

Physical Fitness. Little is known of levels of physical fitness during the Enlightenment, although portraits of wealthy Europeans point to widespread obesity. Harvey noted that powerful, muscular men had thicker and stronger hearts, and several Enlightenment scientists commented on the greater strength of individuals who were classed as "robust."

A growing number of children were now attending school, but most of these institutions did little to promote either health or physical fitness. Nevertheless, some evidence on the levels of fitness associated with traditional farming methods can be inferred from recent studies of Old-Order Amish and Mennonites.

Adults. The body fat levels of Canadian Old-Order Amish remain quite low, even in the 21st century. A study of Amish living in the St. Jacob's region of Southern Ontario classed 0% of the men and 8.9% of the women as obese (body mass index > 30 kg/m^2), and the mean percentage of body fat was only 9.4% in the men and 25.3% in the women (Bassett et al., 2003, 2004). In contrast with Canadian members of this sect, many of the Amish who are currently living in Northern Ohio have shifted from farming to occupations such as cabinet-making, quilting and crafts (Kraybill and Nolt, 1994), and they show much the same prevalence of obesity as the general U.S. population (Fuchs et al., 1990).

Children. Canadian Amish children typically assist with their parents' farming operations, and they show a very low prevalence of obesity (1.4%) when compared with other children in Canadian society (Bassett, 2008; Bassett et al., 2007). Likewise, Old-Order Mennonite children (who are allowed bicycles and travel in horse-drawn vehicles, but lack the electronic gadgets of most modern children) show lesser skinfold thicknesses, and a substantially greater grip strength than their urban peers, although they show no significant advantage in terms of step-test predictions of aerobic fitness relative to rural or urban children who are following a modern lifestyle (Tremblay et al., 2005; Tremblay et al., 2008).

Conclusions

A substantial growth in formal centres of Health Science education during the Enlightenment was accompanied by a growing understanding of the function of the heart, lungs and muscles. However, much of medical practice remained very primitive, and often physicians prescribed remedies that worsened rather than improved the health of their patients.

There was little appreciation of the need for public health measures and life expectancy showed little improvement over earlier eras. A growing proportion of children began to attend school; however, few received any formal instruction in physical education. There was a progressive diminution of active leisure among the elite, due to a ritualization of many sports, a growth of spectator activities, improvements in transportation and the emergence of sedentary pursuits such as visits to the theatre, the reading of secular literature, musical evenings and visits to coffee houses. Even in the lower strata of society, the advent of water and steam power gradually reduced the need for physical labour in industry. However, life in rural communities remained physically demanding; the activity patterns and fitness levels of this age are still seen in small populations that have maintained the agricultural traditions typical of the early 18th century.

Author's Qualifications

The author's qualifications are: Roy J. Shephard M.B.B.S, M.D.[Lond.], Ph.D., LL.D., D.P.E., F.A.C.S.M.

References

Ainsworth, M. O. (1928). *Milton on Education: The tractate of education with supplementary extracts from other writings of Milton*. New Haven, Conn, Yale University Press.

Albert, W. (2007). *The Turnpike road system in England: 1663-1840*. Cambridge, UK, Cambridge University Press.

Amtmann, W. (1975). *Music in Canada 1600-1800*. Cambridge, ON, Habitex Books.

Anderson, J. and Anderson, J. 2007. *The legality of boxing: a punch drunk love?* London, UK, Taylor & Francis.

Ariew, R. and Garber, D. (1989). *Leibniz: Philosophical Essays*. Indianapolis, IN, Hackett.

Austen, J. (1818). *Northanger Abbey*. London, UK, John Murray.

Bailey, J. B. (1896). *The diary of a Resurrectionist, 1811-1812*. London, UK, S. Sonnenschein.

Baker, M. N. and Taras, M. J. (1981). *The quest for pure water: A History of the Twentieth Century*. Denver, CO, American Water Works Association.

Balfour, A. and Scott, H. H. (1924). *Health problems of the Empire, past, present and future*. London, UK, W. Collins.

Bar-Or, O. 1983. *Sports Medicine*. New York, NY, Springer.

Basmajian, J. (1983). *Therapeutic exercise, 4th ed*. Baltimore, MD, Williams & Wilkins.

Bassett, D. R. (2008). Physical activity of Canadian and American children: a focus on youth in Amish, Mennonite and modern cultures. *Appl. Physiol. Nutr. Metab*. 33, 831-835.

Bassett, D. R., Schneider, P. L. and Huntington, G. E. (2003). Physical activity in an Old Order Amish community. *Med. Sci. Sports Exerc*. 35 (Suppl. 5), S130.

Bassett, D. R., Schneider, P. L. and Huntington, G. E. (2004). *Physical activity in an Old Order Amish community*. Med. Sci. Sports Exerc. 36, 79-85.

Bassett, D. R., Tremblay, M. S., Esliger, D. W., Copeland, J., Barnes, J. D. and Huntington, G. E. (2007). Physical activity and body mass index of children in an Old Order Amish community. *Med. Sci. Sports Exerc*. 39, 410-415.

Beckner, W. and Dumas, W. (1968). *Readings in secondary education: a foundations approach*. Scranton, PA, International Textbook Co.

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

Bevington, D. and Holbrook, P. (1998). *The politics of the Stuart court masque*. Cambridge, UK, Cambridge University Press.

Beyersmann, J., Schumacher, M. and Allignol, A. (2011). *Competing risks and multistate models*. Berlin, Germany, Springer.

Bloom, H. (2004). *Jane Austen*. Philadelphia, PA, Chelsea House.

Bogdanov, K. (2000). *Biology in physics: is life matter?* New York, NY, Academic Press.

Bouchard, C., Blair, S. and Haskell, W. L. (2012). *Physical activity and health*. Champaign, IL, Human Kinetics.

Bramah, E. (1972). *Tea and coffee. A modern view of three hundred years of tradition*. Tiptree, Essex, UK, Hutchinson & Co, Ltd.

Brown, R. H. (1978). *A Poetic for Sociology: Toward a logic of discovery for the Human Sciences*. Cambride, UK, Cambridge University Press.

Catholic Encyclopedia (2012). History of Education http://www.thecanadianencyclopedia.com/articles/history-of-education Accessed 15th February, 2012.

Cech, T. V. (2010). *Principles of water resources, 3rd ed*. Hoboken, NJ, John Wiley.

Chemin du Roy. (2012). http://www.lecheminduroy.com/fr/historique.php (accessed February 12th, 2012).

Comenius, J. A. and Hoole, C. (1728). *The orbis pictus of John Amos Comenius*. London, UK, J & B. Sprint.

Conant, J. B. (1950). *The overthrow of Phlogiston Theory: The chemical revolution of 1775–1789.* Cambridge, Mass., Harvard University Press.

Cooper, D.K.C. John Warren Collins (1778-1856): An American surgeon in London. (2012). *Br. Med. J.* 345, 42-43.

Cowan, B. W. (2005). *The social life of coffee: The emergence of the British coffeehouse*. New Haven Conn, Yale University Press.

Crane, W. D. (1962). *The discoverer of oxygen: Joseph Priestley*. New York, NY, J. Mesner.

Cunningham, A. (1880). *The medical enlightenment of the eighteenth century*. Cambridge, UK, Cambridge University Press.

De Spinoza, B. (2003). *Ethics*. Ware, Herts, UK, Wordsworth Editions.

De Molen, R. L. (1975). Richard Mulcaster and Elizabethan pageantry. In: *Shakespeare studies: An annual gathering of research criticism, reviews*. J. L. Barroll (ed.). Knoxville, TN, University of Tennessee. 8: pp. 29-82.

Descartes, R., Weissman, D. and Baum, W. T. (1996). *Discourse on the method and meditations on first philosophy*. New Haven, Conn, Yale University Press.

Dewey, J. 1996. *Democracy and education: an introduction to the philosophy of education*. New York, NY, The Free Press.

Dickens, C. (1867). *Nicholas Nickelby*. New York, NY, Hurd & Houghton.

Dickens, C. (1887). *All the Year Round, Volume 2*, August 13th 1887, p. 114. London, UK, Chapman & Hall.

Dickinson, W. H. (1899). *Medicine, old and new*. London, UK, Longmans.

Diderot, D. and Le Rond d'Alembert, J. 1778. *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*. Geneva, Switzerland, Pellet.

Dobbin, L. (1931). *Collected papers of Carl Wilhelm Scheele*. London, UK, G. Bell & Sons.

Dudgeon, R. E. (1853). *Lectures on the theory and practice of homeopathy*. London, UK, H. Turner.

Duquette, D. A. (2003). *Hegel's History of philosophy: new interpretations*. Albany, NY, SUNY Press.

Ede, A. (2006). *The chemical element: A historical perspective*. Greenwood, Conn, Greenwood Press.

Editor. European Magazine & London Review (1817). Fragmenta. *The European Magazine & London Review* 72: 424.

Editor, JAMA (1966). Joseph Black--rediscoverer of fixed air. *JAMA* 196: 362-363.

Egger, G. J., Vogels, N. and Westerterp, K. R. (2001). Historical changes in physical activity levels. *Med. J. Austr,* 175: 635-636.

Esliger, D. W., Tremblay, M. S., Copeland, J., Barnes, J. D., Huntington, G. E. and Bassett, D. R. (2010). Physical activity profile of Old order Amish, Mennonite and contemporary children. *Med. Sci. Sports Exerc*. 42: 296-303.

Fitton, R. S. (1989). *The Arkwrights: spinners of fortune*. Manchester, UK, Manchester UniversityPress.

Floyer, J. (2010). *The Pulse Watch: Vol. II. Or, an essay to discover the causes of diseases, and a rational method of curing them by feeling of the pulse*. Charleston, SC, BiblioBazaar.

Fuchs, J. A., Levinson, R. M., Stoddard, R. R., Mullet, M. E. and Jones, D. H. (1990). Health risk factors among the Amish: results of a survey. *Health Educ. Q.* 17: 197-211.

Gavin, C. M. (1932). *Royal Yachts*. London, UK, Rich & Cowan.

Graham, J. (1780). *The guardian goddess of health: or, the whole art of preventing and curing diseases*. London, UK, Rosy Heralds of Health.

Green, R. M. (1953). A Translation of Luigi Galvani's De viribus electricitatis. In: *Motu musculari commentarius (Commentary on the effect of electricity on muscular motion)*. Cambridge, Mass, Elizabeth Licht Publisher.

Guerrini, A. (2003). *Experimenting with humans and animals: from Galen to animal rights*. Baltimore, MD, Johns Hopkins University Press.

Hale-White, W. (1951). History of Guy's Hospital. In: *Guy's Hospital, 1725-1948.* H. A. Ripman (ed.). London, UK, Guy's Hospital Gazette Committee: pp. 7-56.

Hales, S. (1743). *A description of ventilators: whereby great quantities of fresh air may with great ease be conveyed into mines, goals, hospitals, work-houses and ships*. London, UK, W. Innys.

Hamilton, D. (1965). Sir John Pringle (1707-1782), Military Physician and Hygienist. *Rev. Int, Services Santé Armées de terre, de mer et de l'air* 38: 497-498.

Hayes, D. (2008). *Historical Atlas of Toronto*. Toronto, ON, Douglas & McIntyre Ltd.

Heberden, W. (1772). Some account of a disorder of the breast. *Med.Trans. Roy. Soc. Med.* 2, 59-67.

Holmes, F. L. (1985). *Lavoisier and the chemistry of life*. Madison, WI, University of Wisconsin Press.

Hughes, D. (1996). *English Drama, 1660-1700*. Oxford, UK, Clarendon Press.

Johnson, S. (2006). *The ghost map. the story of London's most terrifying epidemic – and how it changed science, cities and the modern world*. New York, NY, Riverhead books.

Johnson, S. and Murphy, A. (1810). *The works of Samuel Johnson, Volume, 9, Sermon 5*. London, UK, Talboy and Wheeler.

Kaufmann, A. (2003). *Medical teaching in Edinburgh during the 18th and 19th Centuries*. Edinburgh, Scotland, Royal College of Surgeons of Edinburgh.

Kniss, L. A. (1975). *Practical pointers for training your child*. Harrisonburg, VA, Christian Light Publications.

Kohler, R. and Fischer, L. P. (1999). Nicolas Andry (1658-1742) inventor of the term "orthopedics". *Ann. de Chirurg.* 53: 335-339.

Kosach, E. (1962). Nestor Maksimovich MAKSIMOVICH-AMBODIK-1st Russian professor of obstetrics. (150th anniversary of his death). *Zdravookhr Belorussia* 8: 80-81.

Kottick, E. (2003). *A history of the harpsichord.* Bloomington, IN, Indiana University Press.

Kraus, R. (1978). *Recreation and leisure in modern society: 2nd ed*. Santa Monica, CA, Goodyear Publishing.

Kraybill, D. B. and Nolt, S. M. (1994). The rise of micro-enterprises. In: *The Amish struggle with modernity*. D. B. Kraybill and Olshan, M. A. (eds.). Hanover, NH, University Press of New England: pp.149-163.

Kuehn, M. and Klemme, H. (2010). *The dictionary of eighteenth century German philosophers*. London, UK, Continuum.

Lacrosse History. (2012). http://www.e-lacrosse.com/laxhist4.htm (accessed 11th February 2012.

Lancaster, H. O. (1990). *Expectations of life: A study in the demography. Statistics and history of world mortality*. Berlin, Germany, Springer.

Lewis, O. (1994). Stephen Hales and the measurement of blood pressure. *J. Hum. Hypertension* 8, 865-871.

Lind, J. (1753). *A treatise on the scurvy*. Edinburgh, Scotland., Sands, Murray & Cochran.

Little, M. E. (2001). Minuet. In: *The New Grove Dictionary of Music and Musicians*. S. Sadie and Tyrell, J. (eds.). London, UK, Macmillan.

Locke, J. (1698). *An essay concerning human understanding*. London, UK, John Beecroft.

Locke, J. (1824). *The works of John Locke: in nine volumes, Volume 8*. London, UK., C. & J. Rivington.

Lower, R. and Franklin, K. J. (1989). *A treatise on the heart.* Oxford, UK, Classics of Medicine Library, Clarendon Press.

McIntosh, P. C. (1971). *Sport in society*. London, UK, C.A. Watts.

McLeod, H. (2003). Thews and sinews. In: *Non-conformity and sport.* D. W. Bebbington and Larsen, T. (ed.). London, UK, Sheffield Academic Press: 28-46 pp.

Mead, R. (1762). *The medical works of Richard Mead, M.D*. London, UK, C. Hitch and L. Hawes.

Mitchell, P. D., Boston, C., Chamberlain, A. T., Chaplin, S., V., C., Evans, J., Fowler, L., Powers, N., Walker, D., Webb, H. and Witkin, A. (2011). The study of anatomy in England from 1700 to the early 20th century. *J. Anat.* 219, 91-99.

Montagu, J. (2002). Renaissance instruments. In: *The Oxford Companion to Music*. A. Latham (ed.). Oxford, UK, Oxford University Press.

O'Malley, C. D. (1970). *The history of medical education: an international symposium*. Los Angeles, CA, University of California.

Parton, J. (1867). *Life and times of Benjamin Franklin, Volume 1*. Boston, MA, Ticknor & Fields.

Payne, A. S. (1970). *The Cleere Observer: A biography of Antoni van Leeuwenhoek*. London, UK, Macmillan.

Pearn, J. (1978). Two early dynamometers. An historical account of the earliest measurements to study human muscular strength. *J. Neurol. Sci.* 37, 127-134.

Peck, D. J. and Morgan, R. F. (2002). *Or perish in the attempt: wilderness medicine in the Lewis & Clark Expedition*. Helena, MT, Far Country Press.

Pepys, S., Bright, M. and Braybrooke, R. G. (1893). *The diary of Samuel Pepys, for the first time fully transcribed from the shorthand manuscript in the Pepysian library, Magdalene College, Cambridge*. New York, NY, Croscup & Sterling Company.

Pepys, S., Wheatley, B., Braybrooke, R. G. and Bright, M. (2006). *The diary of Samuel Pepys, 1660*. Teddington, Middlesex, UK, Echo Library.

Ramazzini, B. (1713/2001). De Morbis Articum Diatriba (Diseases of Workers). *Am. J. Publ. Health* 91, 1380-1382.

Revéron, R. (2011). Marcello Malphigi (1628-1694), founder of microanatomy. *Int. J. Morphol.* 29, 399-402.

Rosner, L. (2009). *The Anatomy Murders: Being the True and Spectacular History of Edinburgh's Notorious Burke and Hare and of the Man of Science Who Abetted Them in the Commission of Their Most Heinous Crimes*. Philadelphia, PA, University of Pennsylvania Press.

Rousseau, J. J., Archer, R. L. and Frost, S. E. (2003). *Jean Jacques Rousseau: his educational theories, selected from Émile, Julie and other writings*. Great Neck, NY, Barron's Educational Series.

Royal Ascot. (2012). *A short history of Ascot*. (http://www.ascot.co.uk/?page=About:History&type=StandaloneTemplate accessed 8th February 2012).

Royal Parks, U.K.. (2012). *Hyde Park history*. (http://www.royalparks.org.uk/parks/hyde_park/history.cfm, accessed 8th February 2012).

Runes, D. (1947). *Selected writings of Benjamin Rush*. New York, NY: Philosophical Library.

Rush, B. (1812). *Medical inquiries and observations on diseases of the mind*. Philadelphia, PA: B & T Kite.

Shephard, R. J. (2011). The developing understanding of human health and fitness. 1. Prehistory. *Health Fitness J. Canada* 4(4), 3-19.

Shephard, R. J. (2012a). The developing understanding of human health and fitness. 2. Early city life. *Health Fitness J. Canada*. 5(1), 27-46.

Shephard, R. J. (2012b). The developing understanding of human health and fitness: 3. The classical era. *Health Fitness J, Can*. 5(2), 3-29.

Shephard, R. J. (2012c). The developing understanding of health and fitness. 4. Middle Ages. *Health & Fitness J. Can*. 5(3), 18-46.

Shephard, R. J. (2012d). The developing understanding of Human Health and Fitness: 5. The Renaissance. *Health & Fitness J. Can*. 5(4), 15-29.

Singh, S. and Ernst, E. (2009). *Trick or treatment: The undeniable facts about alternative medicine*. New York, NY, W.W. Norton & Company.

Smith, I. B. (1993). The impact of Stephen Hales on medicine. *J. Roy. Soc. Med*. 86, 349-342.

Tipton, C. M. (2002). *Exercise physiology: people and ideas*. Oxford, UK, Oxford University Press.

Tremblay, M. S., Barnes, J. D., Copeland, J. and Esliger, D. W. (2005). Conquering childhood inactivity: Is the answer in the past? *Med. Sci. Sports Exerc*. 37, 1187-1194.

Tremblay, M. S., Esliger, D. W., Copeland, J., Barnes, J. D. and Bassett, D. R. (2008). Moving forward by looking back: lessons from long lost lifestyles. *Appl. Physiol. Nutr. Metab*. 33, 836-842.

Trevelyan, G. M. (1944). *English social history*. London, UK, William Clowes.

Turner, T. (1998). *Landscape planning and environmental impact design, 2nd ed*. London, UK, UCL Press.

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

Waddington, K. (2003). *Medical education at St. Bartholomew's Hospital, 1123-1995*. Woodbridge, Suffolk, UK, Boydell Press.

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

Warren, E. (ed). (1860). *The life of John Collins, MD*. Boston, Mass, Ticknor & Fields

Weale, W. V. (1980). *Eating patterns and food energy and nutrient intake of Old Order Amish in Holmes County, OH.* Ph. D. Thesis, Department of Human Nutrition and Food Management. Columbus, OH, Ohio State University.

Wesley, J. (1761). *Primitive Physick, or an easy and natural method of curing most diseases*. London, UK, W. Strahan.

Wickham, G., Berry, G. W. and Ingram, W. (2000). *English professional theatre, 1530-1660*. Cambridge, UK, Cambridge University Press.

Youngs, J. W. T. (1998). *The Congregationalists: student edition*. Westport, Conn., Praeger Publications.