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## Journal of Equine Veterinary Science

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## Review Article

# Has the Golden Age of Equine Exercise Physiology Passed and if so, Have We Answered All the Big Questions?



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## ARTICLE INFO

## Article history:

Received 21 February 2015

Accepted 19 March 2015

Available online 21 March 2015

## Keywords:

Horse

History

Perspective

Future

## ABSTRACT

Equine exercise physiology is a discipline that emerged in the 1980s. It has enjoyed tremendous popularity. Areas of popularity in equine exercise physiology research have changed over the past 40 years for a variety of possible reasons, including funding, disappearance of research groups, and research interests. We are also now in a position where we can review earlier studies in a different, more informed light and consider which ones are still reliable and relevant and which ones may need to be considered differently based on more recent knowledge. Although traditionally popular areas in equine exercise research such as respiratory, cardiovascular, and muscular research have diminished, other areas such as biomechanics and locomotion and applied physiology have seen great growth. Although much has been achieved which has contributed to scientific understanding of the horse in relation to exercise and to welfare, some obvious areas remain poorly understood.

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## 1. Introduction

The purpose of this review article is to try to analyze the trends in equine exercise physiology, which is essentially a relatively new area of science, having developed in the 1980s, and to try and identify some areas that may have been overlooked, presented considerable challenges, or warrant review. As with any new field, a period of intense research where almost every study makes some contribution to knowledge is often followed by a period of reflection, consolidation, and sometimes review and repetition. Although some areas of equine exercise physiology, such as biomechanics and applied physiology, appear to have become more and more popular, areas such as basic physiology of muscle and cardiovascular and respiratory physiology have contracted. This review will examine the emergence of equine exercise physiology as a subject area,

look at the role played by the International Conference on Equine Exercise Physiology (ICEEP), examine what may have been the prime period for equine exercise physiology, review the relevance of some of the early studies, consider some of the principles that still remain core, and indicate some examples of areas for future further study (from the authors perspective).

## 2. The Birth of Modern Human and Equine Exercise Physiology

With the exception of humans, the exercise physiology of the horse has been scientifically studied and debated more than any other animal. The link between man and horse goes back through to times when the horse was used for transport, war, agriculture, and entertainment. Few ancient civilizations if any have not had horses as an integral component. The management of horses in these times would have been primarily based on “trial and error,” and “best practice” would have been handed down essentially by word of mouth. However, some notable texts on horsemanship that contain perhaps some of the first

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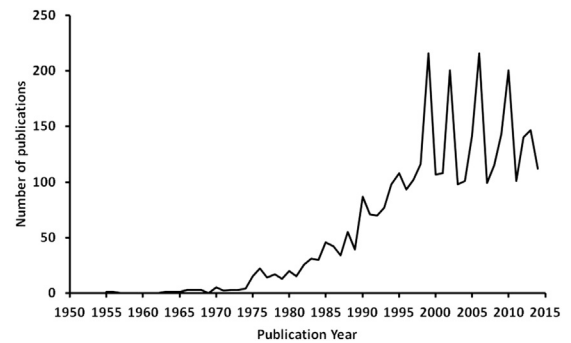
E-mail address: [dm@davidmarlin.co.uk](mailto:dm@davidmarlin.co.uk).

observations of “exercise physiology” do exist. One of the earliest and most recognized of these is *On Horsemanship* by Xenophon, which is believed to have been written around 350BC. In his section on advanced training, Xenophon discusses the potential impact of factors such as incline, speed, and going.

Even human exercise physiology is relatively new discipline. One of the first books on the subject was published in 1889, entitled *Physiology of Bodily Exercise* by LaGrange [1]. In the period 1920 to 1960, a number of scientists carried out some of the pioneering work in human exercise physiology. These included the scientists David Bruce Dill, Archibald Hill, and Sid Robinson at the Harvard Fatigue Laboratory, which was established in 1927 which over two decades produced over 300 scientific articles in the field. In Europe, Erling Asmussen and Marius Nielsen from Denmark also spent time working at the Harvard Fatigue Laboratory before returning to Copenhagen to work on human exercise physiology at the August Krogh Institute (part of the University of Copenhagen) [2]. Other scientists who became involved in the field of human exercise physiology in the 1950s and 1960s included Per-Olaf Astrand. One of Astrand’s earliest scientific publications was in collaboration with Bengt Saltin [3]. Saltin is one of the major contributors to the understanding of muscle metabolism in exercise.

One of the key events that paved the way for many groups to study equine exercise physiology was the construction of the first modern high-speed treadmill at Uppsala in the 1960s. However, in the 1950s and 1960s, there were only a few isolated studies of equine exercise such as those by Evans et al [4], John Holmes at the University of Bristol [5], and a article by Carlsson working with Swedish vet Sune Persson [6] it was not until the 1970s that the field of equine exercise physiology began to really attract interest and groups dedicated to the field began to form. Saltin working at the August Krogh Institute, although primarily interested in human exercise physiology, also collaborated with some other Scandinavian scientists including Swedish veterinary surgeon Arne Lindholm to publish one of the first articles on equine exercise physiology of this modern era [7]. Lindholm working with Saltin went on to publish the first studies demonstrating glycogen depletion patterns following exercise [8].

The birth and growth of equine exercise physiology as a field in its own right from the late-1970s and 1980s can be traced both through the establishment of groups such as those at Sydney (Rose and Hodgson), Washington State University (Bayly, Gollnick, Hodgson), Western College of Veterinary Medicine, Saskatoon, Canada (Leach), Kansas State University (Erickson, Gillespie), Virginia-Maryland Regional College of Veterinary Medicine in Leesburg (Thomas and Fregin), University of Glasgow (Snow), and laterally at The Animal Health Trust in Newmarket (Snow, Harris[Roger]), Uppsala (Persson, Lindholm, Essen-Gustavsson), and by the increase in publications in the field in the mid-1970s (Fig. 1). From 1975 to the late-1990s, the increase in publications was almost exponential. The horse was seen at this time as an interesting model for studying many fundamental aspects of exercise, not just with respect to the horse, but for the application and

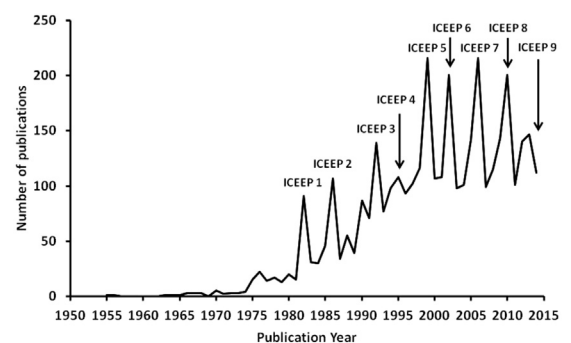


**Fig. 1.** Publications by year for equine exercise physiology. PubMed search using the terms “exercise” AND (horse OR equine or equidae or pony or Thoroughbred) for all records. Two records not shown (both published in 1929).

relevance to other species including man and funding bodies were willing to support major programs of work.

### 3. The Influence of the ICEEP

One of the key events in establishing the field of equine exercise physiology was the inaugural ICEEP, which was organized by David Snow, then at the University of Glasgow and before his move to the Animal Health Trust, and which was held in Oxford in 1982. This meeting was attended by 160 vets and scientists from around the world, and a proceeding was produced that was edited by David Snow, Sune Persson, and Reuben Rose. However, these proceedings of the first ICEEP and those of ICEEP 2 in San Diego (USA) in 1986 and ICEEP 3 in Uppsala Sweden in 1992 were published as books and as such were not indexed by any of the major indexing organizations such as ISI or PubMed. The articles from these proceedings have now been made available free of charge online via the ICEEP Web site [9]. These articles therefore although peer reviewed do not contribute to the numbers of publications in Fig. 1. However, when the publications from the first 3 ICEEP meetings are included, the contribution of the ICEEP meetings to the publications in the field can be clearly seen from ICEEP 1 (1982) through to ICEEP 8 (2010) (Fig. 2). The articles from



**Fig. 2.** Publications by year for equine exercise physiology including non-PubMed-indexed publications from ICEEPs 1, 2, and 3. PubMed search using the terms “exercise” AND (horse OR equine or equidae or pony or Thoroughbred) for all records. Two records not shown (both published in 1929). ICEEP, International Conference on Equine Exercise Physiology.

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