



Short Communication

A Scoping Review of Equine Biomechanics Revisited[☆]Agneta Egenvall^{a,*}, Anna Byström^b, Agneta Lindsten^c, Hilary M. Clayton^d^a Department of Clinical Sciences, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Uppsala, Sweden^b Department of Anatomy, Physiology and Biochemistry, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Uppsala, Sweden^c SLU University Library, Swedish University of Agricultural Sciences, Uppsala, Sweden^d Department of Large Animal Clinical Sciences, East Lansing, MI

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ABSTRACT

As techniques for equine biomechanical research have become more accessible and affordable, the literature published in this area has exploded. Literature reviews have become more popular of late and, more specifically, several literature reviews in areas related to equine biomechanics have been published. A scoping review is a relatively new approach, where a general aim is to map the body of literature on a topic area, accounting for criteria for inclusion and exclusion. However, problems can arise both in performing the review and in critiquing the findings. In this manuscript, the authors repeat a published scoping review of equine biomechanics aiming to map 'the existing literature in the field of equine movement analysis'. The search criteria from the previous study were reviewed and the performance of the search criteria was iteratively studied to find as many relevant papers as possible. The results yielded 77% more publications than the original review mainly as a consequence of not limiting the search strategy to papers including "equine" or "horse" in the title. The importance of using appropriate and inclusive search terms is highlighted together with evaluating the findings within the context of the discipline and time frame of the review.

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1. Introduction

Equine biomechanics has been considered of interest for centuries [1] but it was only in the later part of the twentieth century that technical developments facilitated progress in this field. Initially, measurement techniques and analytic methods were tedious and time-consuming. More recently, improved hardware and software have facilitated larger and more sophisticated studies. This has resulted in a considerable body of literature. Comprehensive reviews are useful to summarize the status quo, highlight areas of progress and identify deficiencies in knowledge.

Scoping reviews are a relatively new approach for systematic reviewing, that is becoming increasingly popular. The goal of a

scoping review is to map the body of literature on a topic area, taking account of any stated criteria for inclusion and exclusion of papers [2]. This approach can be contrasted to systematic reviews where the purpose is to sum up the best available research on a specific question [2]. Meta-analysis also involves a systematic literature search, but in this case the results from papers that are found are reanalyzed using specific statistical techniques, to weight the results and account for publication bias, with the goal of presenting statistical evidence for various findings across studies [3].

We were intrigued by a recent broadly stated scoping review [4] performed with the following objectives: 'a scoping review was conducted with the aim of mapping the existing literature in the field of equine movement analysis', limited to the years 1978 to 2018. The low number of papers found ($n = 510$) and initial scanning of the accompanying supplementary material [4], suggested to us that several papers were missing. This prompted us to try to formulate a more inclusive search, apply it to the same time period, and compare the numbers and titles to the study by Egan et al. (the comparison study) [4]. Our aim was to investigate how the search strategy influences the relative coverage of the literature, to highlight the importance of this methodological aspect when performing a scoping review.

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Ethical Statement: There were no animals or humans involved in the literature study. Hence, ethical approval was not necessary.

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2. Materials and Methods

Our search replicated the comparison study [4] in that it aimed to find all equine biomechanics peer-reviewed papers published between 1978 to 2018, with the following exclusions: non-horse and non-English language research; reproductive research, cell-specific pathology, cadaver/in vitro studies (where unsupported by live data), maxillofacial kinematics, and rider kinematics (only). Similar to the comparison study [4] we excluded conference abstracts.

We used the following search strategy:

TS = (equine or horse or horses or "equus caballus" or thoroughbred* or trotter or trotters or pony or ponies or foal*) AND

TS = (energetic or biomechanic* or kinematic* or "ground reaction force*" or inertia* or electromyograph* or asymmetr* or treadmill or "motion capture" or "tendon strain" or temporospatial* or "saddle pressure" or "saddle force" or "rein tension" or "center of pressure" or "centre of pressure" or "force plate*" or "pressure plate*" or "centre of force" or "center of force" or "center of mass" or "centre of mass") AND

TS = (movement* or locomotion or locomotor or gait or gaits or trot or canter or transition* or shoeing or lameness or stance* or balance or "postural sway").

This search strategy was arrived at through evaluating the search criteria iteratively to find as many relevant papers as possible. The final search was refined by only including 'article' or 'proceedings paper' document types and ran in Web of Science Core Collection (1555 hits), Medline (1293 hits), and Scopus (1681 hits). Removal of duplicate hits yielded 2247 unique references. Records belonging to the fields of chemistry, geography, human therapies, and animals other than horses were put aside. A list of 1788 potentially relevant references were scrutinized from the abstracts and/or the full papers, refining the search results to include only papers in English and disregarding papers on other subjects, for example, exercise physiology. During this process 'reproductive research, cell-specific pathology, cadaver/in vitro studies (where unsupported by live data), maxillofacial kinematics, and rider kinematics (only)' were excluded, as was done in [4]. Conference proceedings and books were also excluded (<20). Furthermore, we omitted clinical case reports or case series if they did not have a major biomechanical focus, as well as studies with only subjective evaluation. These were included in the comparison study [4], but comprised only 0.6% each of their final outtake. Our criteria for deeming studies as biomechanical were that they measured the response of the (equine) body to forces or displacements (general biomechanics, biomechanical methods), or that equine biomechanics were modeled (from live data) or reviewed. Using these criteria, we assigned included papers to one of four categories; general equine biomechanics, equine biomechanical methods, equine biomechanical models, and reviews. This work was done by the principal author (AE), in collaboration with the second author (AB).

We cross-matched our list of included papers to those found in the comparison study [4], based on the paper titles. This was done semi-automatically, using the knnsearch function in MATLAB version 2019b, ignoring case and allowing five differing characters in order to account for differences in spelling. The results of the automatic search comparing the two sets of data were then reviewed manually, but it remains possible that the automatic search failed to match some of the items.

3. Results

A total of 902 papers, published between 1978 to 2018, were selected for inclusion from the 1788 scrutinized references. They were distributed in the four categories as follows; general equine

biomechanics (n = 733), equine biomechanical methods (n = 90), equine biomechanical models (n = 43), and reviews (n = 36). A complete list of included items is found in supplementary material item 1.

In total 412 references matched between our list of included papers and the comparison study [4] in the automatic search. With regard to the non-matched titles, both lists included unique papers that matched the inclusion and exclusion criteria. This means that neither of the two searches can be considered complete.

4. Discussion

The Joanna Briggs Institute has compiled guidelines on how to perform state-of-the art scoping reviews [5]. These guidelines, also cited by the authors of the comparison study [4], indicate that: 'Scoping reviews undertaken with the objective of providing a map of the range of the available evidence, can be undertaken as a preliminary exercise prior to the conduct of a systematic review'.

'In a scoping review the goal is to determine what kind of evidence (quantitative and/or qualitative) is available on the topic and to represent this evidence by mapping or charting the data'. '[An] important distinction between scoping reviews and systematic reviews is that, unlike systematic reviews, scoping reviews provide an overview of the existing evidence, regardless of quality'. From this we interpret that completeness is important when performing a scoping review. We found 902 papers, which exceeds the 510 papers found in the comparison study [4] by 77%. This illustrates that the relative completeness of a review will be heavily influenced by the search strategy chosen. Not limiting the search to papers including 'Equine OR Horse*' [4] in the title was perceived to be the major reason why we found more papers.

Mapping the existing literature within a subject over an extended time period, in this case 40 years, comes with both advantages and challenges. For example, the evolution of different measurement technologies in equine biomechanics is nicely illustrated in [4]. However, the time perspective was not considered when reviewing the distribution of different topics stated to require further research. We believe that this context is important, as suggestions made in papers published centuries ago will be outdated by now, as they were based on the research available at that point in time. The same is to some extent also applicable to the thematic analysis of study limitations. At the same time, we clearly agree with several of the overall and specific points raised in [4], that we believe would hold if a larger share of equine biomechanics papers had been included. The low number of study subjects in many studies is undeniable, though perhaps understandable in the early studies that required an enormous time commitment to analyze each subject. We also support the conclusion that confidence intervals would have advantages over p-values.

In the comparison study [4] the most frequent study design was reported to be the observational study (43%). This is an epidemiological term used for studies where no interventions are made by the researchers [6]. The three main observational study designs are cohort, case-control and cross-sectional studies. All of these are often used to analyze risk/protective factors relative to some state (e.g., health status), defining the population into cases and controls. The epidemiological term observational study is seldom used for purely descriptive studies, as was done by the authors of the comparison study [4]. In the field of equine biomechanics this term is used infrequently. The authors of the comparison study [4] did not elaborate on how they distinguished between experimental and observational studies. However, we acknowledge that

biomechanical studies are often difficult to assign to conventional study design categories.

We conclude that neither of the outtakes were complete, given the incomplete match between the results of the two searches. We found considerably more papers compared to [4]^{1,2}, even so our research strategy would have needed further refinement to achieve complete coverage of the intended subject area. During processing of the search results, we identified that additional references may be found had we included the key words 'pace', 'jumping' and 'hoof', for example. In systematic literature research it is common to include relevant papers that are already known to the authors as well as papers found in reference lists of other papers [7], but this approach was not used by the authors of the comparison study [4] or in the present outtake. The approach and result illustrate that when performing a scoping review within a diverse field, it is necessary, but difficult, to formulate a search strategy that is broad enough to not miss too much, yet still narrow enough to make the task of scrutiny feasible. Further, it is key to define the subject as unambiguously as possible, referring to generally accepted definitions whenever possible. In the process, we noted difficulties in delineating among the different categories chosen. Also, when performing a scoping review of such a broad field, deciding between inclusion vs. exclusion of borderline items is not easy. To accomplish this task more optimally we suggest that it is necessary to include a librarian or an information specialist, and at least one experienced researcher with a very broad knowledge of the relevant literature throughout the time period that is being searched, and to do the search iteratively to optimize the search strategy with regard to completeness.

- (1) The authors were awarded the Peter Rosedale EVJ Open award 2019, which is awarded to 'the paper that best achieves the EVJ's mission to publish articles that influence and improve

clinical practice and/or add significantly to the scientific knowledge supporting equine veterinary medicine' [8].

- (2) As of November 30, 2021 the comparison study [4] has been cited in 15 articles in scientific journals, according to the database Scopus.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.jevs.2022.103920](https://doi.org/10.1016/j.jevs.2022.103920).

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