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Biomechanics and Medicine in Swimming XI

Per-Ludvik Kjendlie, Robert Keig Stallman, Jan Cabri (eds)

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The Evolution of Swimming Science Research: Content analysis of the "Biomechanics and Medicine in Swimming" Proceedings Books from 1971 to 2006

Barbosa, T.M.[1,4], Pinto, E.[1], Cruz, A.M.[1,4], Marinho, D.A.[2,4], Silva, A.J.[3,4], Reis, V.M.[3,4], Costa, M.J.[1,4], Queirós ,T.M.[1]

[1] Polytechnic Institute of Bragança, Bragança, Portugal
[2] University of Beira Interior, Covilhã, Portugal
[3] University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
[4] Research Centre in Sports, Health and Human Development, Vila Real, Portugal

The aim of this study was to analyze the evolution of swimming science research based on the content analysis of the "Biomechanics and Medicine in Swimming" Proceedings book series from 1971 to 2006 (i.e., a total of 622 full papers). There was an increasing number of papers published within the period of time analyzed (ranging from 23 papers in 1971 to 145 manuscripts in 2006). Comparing the sub-categories related to "Aquatic activity" most research done was clearly on "competitive swimming". In the last decade there is a slight but increasing interest in "head-out aquatic exercises" Analyzing the main "scientific area" of study, "Biomechanics" was the most often assessed area, followed by "Physiology". Since 2003 an increasing trend in "interdisciplinary assessment" manuscripts was verified.

Key words: research, content analysis, aquatic activities, sport sciences,

INTRODUCTION

Swimming seems to be one of the most studied sports within the Sport Sciences research community. More than a decade ago, Clarys (1996) conducted an analysis about swimming research. The author analyzed the content of 685 papers related to swimming based on 12 knowledge areas. The scientific area with most papers was "Biomechanics" representing 20 % of total manuscripts, followed by "Physiology" representing 18 %, "Medicine/Clinics" representing 16 %, "Hydrodynamics" representing 9 % and "Electromyography" representing 8 %.

In these last 14 years there have been several developments in the aquatic activities domain. It was hypothesized that the Clarys (1996) report could be updated. New highlights and technologic evolutions were introduced in "swimming science". Major updates happened in the "state of the art" of swimming. In the past, "swimming research" was dedicated almost exclusively to competitive swimming. Nowadays there are several other aquatic activities being practiced in aquatic centres, such as head-out aquatic exercises, aquatic rehabilitation and infant swimming. Swimming research is also dedicated to analyze and understand all these aquatic activities. Moreover, characterizing the evolution of research in these different aquatic activities has never been attempted.

The "International Symposium on Biomechanics and Medicine in Swimming" (BMS) is a scientific meeting of aquatic activities researchers. The symposium happens every 4 years and is supported by UNESCO, among other organizations, gathering all main research groups dedicated to these sports. The first meeting was held in 1970 (Brussels, Belgium) and titled "1st International Symposium of Biomechanics in Swimming". In 1986 (Bielefeld, Germany) the definitive name of "International Symposium on Biomechanics and Medicine in Swimming" was adopted. All main conferences, oral communications and poster presentations are collected, reviewed and published in a proceeding book that nowadays is titled "Biomechanics and Medicine in Swimming". In this sense, BMS can be considered as representative of the work conducted by the main groups dedicated to aquatic activities research in a given historic time frame.

The aim of this study was to analyze the evolution of "swimming science" research in the last decades based on the BMS proceedings books.

METHODS

The content of all the 622 papers published in the proceedings books of the "International Symposium on Biomechanics and Medicine in Swimming" series edited from 1971 to 2006 were analyzed. An observation grid for the manuscript analysis was developed. This instrument was composed by observational categories previously defined by the researchers. Two main categories were defined: (i) the "aquatic activity" studied in each paper analyzed and; (ii) the main "scientific area" applied for the assessment.

The main category "aquatic activity" included the following subcategories: (i) Competitive swimming; (ii) Water Polo; (iii) Synchronized Swimming; (iv) Diving; (v) Hydrotherapy; (vi) Infant Swim; (vii) Head-out Aquatic Exercises; (viii) Fin Swimming and; (ix) others. The main "scientific area" included the following sub-categories (adapted from Clarys, 1996): (i) Biomechanics; (ii) Psychology; (ii) Sociology; (iii) Pedagogy/Teaching; (iv) Biochemistry; (v) Physiology; (vi) Thermoregulation; (vii) Hydrodynamics; (viii) Electromyography; (ix) Anthropometry; (x) Equipment/Methodology; (xi) Clinical Medicine/ Traumatology and; (xii) Interdisciplinary assessment.

For identification of each sub-category the following steps were used: a) read the abstract, identifying the aquatic activity studied, as well, the scientific area of assessment; b) whenever necessary or appropriate read the full paper; c) if the paper was not able to be inserted in any of the sub-categories defined for the main category "aquatic activity" it would be identified as "others" (e.g., life saving, recreational games, etc).

The absolute frequency for the number of papers in each edition of the proceeding s was registered. Relative frequency for each subcategory in a given edition and for full period of time between 1971 and 2006 was considered.

RESULTS

Figure 1 presents the number of papers published between 1971 and 2006. There was an increasing number of papers published within the period of time analyzed (ranging from 23 papers in 1971 to 145 manuscripts in 2006). The only exception to the increasing trend was the 1996 edition.

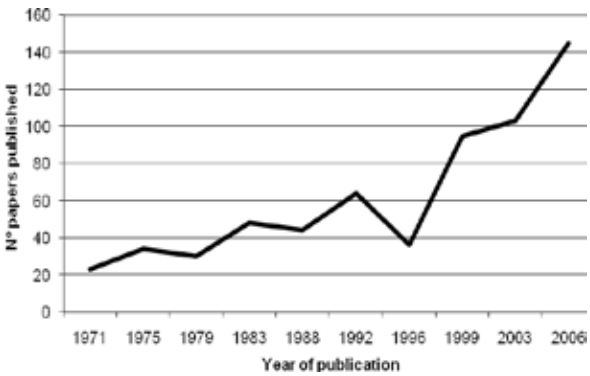

Figure 1. Evolution in the number of papers published between 1971 and 2006.

Figure 2 presents the partial contribution of each sub-category, for both main categories, in the period of time from 1971 to 2006 considering overall data. For the "scientific area", main interest was in "Biomechanics" (37.8 %), "Physiology" (17.20 %) and "Interdisciplinary assessment" (8.52 %). Related to the "aquatic activity", the sport with the greatest number of papers, by far, was "Competitive swimming" (87.46 %), followed by "Water polo" (3.22 %) and "Head-out aquatic activities (2.57 %).

Figure 3 presents the evolution in the relative frequency of each sub-category within the 1971-2006 time frame. About the "scientific area" it is possible to verify that at any given moment there is a major interest about one or a couple of specific issues, besides "Biomechanics" and "Physiology". For example, in 1983 there were several papers published about "Hydrodynamics", in 1988 "Biochemistry", in 1992 "Anthropometry" and in 2006 "Interdisciplinary assessment". For the "aquatic activity" "Competitive swimming" was always on top. However, starting in 1999 there was an increasing interest for "Head-out aquatic exercises" and "Fin swimming".

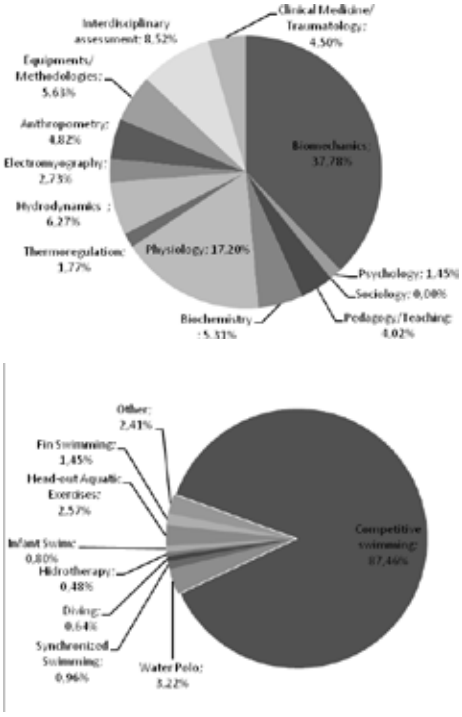

Figure 2. Partial contribution of each sub-category for "swimming science" in the period of time from 1971 to 2006.

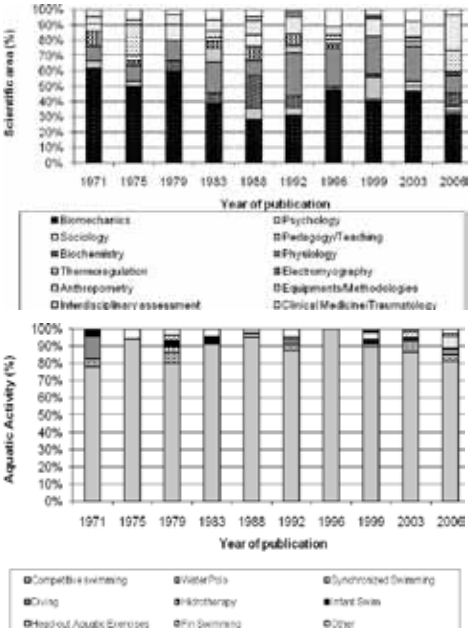

Figure 3. Evolution of sub-categories in each proceeding book edition between 1971 and 2006.

DISCUSSION

There was an increasing number of papers published within the period of time analyzed (ranging from 23 papers in 1971 to 145 manuscripts in 2006). So, "swimming science" seems to be increasing since 1971, as the number of research groups focused in this sport is increasing, as well as, the number of research projects developed by each group. The 1996 book was the only one that did not present a greater number of papers in comparison to the previous edition. From the 80 studies presented at the VIIth Symposium in Biomechanics and Medicine in Swimming, only 36 were selected to be published. This means that from the 1992 edition (with 64 papers published/presented) to the 1996 edition there was actually an increase in the number of studies presented.

Comparing the sub-categories related to "Aquatic activity" the one with most research conducted was clearly "Competitive swimming" (ranging from 78.8 % in 1971 to 100 % in 1996). In the last decade there is a slight but increasing interest in "Head-out aquatic exercises" (e.g., the second most studied aquatic activity in 2006 with 6.9 %). Aquatic activity was for a long time synonymous with swimming. Added to this, "Water polo" was also specially under the BMS scope, as is verified by the name of the 1971 proceeding book: "First International Symposium on Biomechanics in Swimming, Water Polo and Diving". Nowadays "Head-out aquatic exercises" are gathering a large part of the persons practicing physical activity in aquatic centres. Indeed, these facilities provide services that are complementary to "traditional" competitive sports, such as "Head-out aquatic activities". This is related to the increasing importance of aquatic activity for health. Starting in 1999 there was also an increasing interest in "Fin swimming". "Fin swimming" now has a more consistent position among the aquatic competitive sports. "Fin swimming" has competitions at all levels, including international and media attention is increasing in some countries.

Analyzing the main "scientific area" of study, "Biomechanics" was the most common area (ranging from 27.3 % in 1988 to 60 % in 1979), followed by "Physiology". As "Biomechanics" and "Physiology" were within the origins of this scientific meeting, it is logical that they are the largest sub-categories. It is consensual that biomechanical and physiological profiles of a swimmer are determinant factors for his/her performance enhancement. Since 2003 an increasing trend in "Interdisciplinary assessment" manuscripts is verified. There is now a trend to understand not only how each scientific area determines performance, but also how they interplay. At certain periods of the history of BMS the major area of interest in addition to "Biomechanics" and "Physiology" (e.g., in 1983 the "Hydrodynamics", in 1988 the "Biochemistry", in 1992 the "Anthropometry" and in 2006 the "Interdisciplinary assessment"). It seems there are some topics that are deeply explored in a given moment by several research groups.

CONCLUSION

As a conclusion, there is a significant increase in scientific production regarding aquatic activities throughout the 1971-2006 period. Concerning the scientific area the main interests are related to "Biomechanics" and "Physiology". Recently there is a trend in "Interdisciplinary assessment". "Competitive swimming" is the main aquatic activity studied. In the last proceedings, the tendency for a higher interest in "Head-out aquatic activities" was verified.

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