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The Concept of Taiiku in Academic Disciplines: Its Creation and Transition from an Assembly of General Reviews in the Japan Journal of Physical Education, Health and Sport Sciences*

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This review attempts to clarify the essence and perspective of Taiiku through the analysis of review articles published in the Japan Journal of Physical Education, Health and Sport Sciences. The review comprises five parts: (1) Introduction, (2) Discourse on methodology, (3) Review articles in the Journal from a humanities perspective, (4) Analysis from a perspective of social science, and (5) Examination from a medical-natural sciences perspective, followed by concluding remarks. The analysis suggests that Taiiku designates all bodily movement contributing to the corporeal and social basis of human well-being, providing a foundation for more enlightened discussion on the essence and conceptual expansion of Taiiku and well-being.

Key words: competitive sport, health, bodily movement, happiness, human being

I. Toward problem formulation: What does it mean to question “Taiiku”?

When people in and outside the field of the Science of PE, Health and Sport Sciences regarding the meaning of Taiiku (体育), it is almost always unconditionally assumed that Taiiku is equal to Physical Education (PE), and it continues to be examined under that meaning. PE (体育) as it is used today emerged as a shorthand of Shintai Kyoiku (身体教育: PE), and the historical transition of the debate over the meaning has been discussed by researchers in the field of principles and philosophy of PE (e.g., Higuchi, 2005; Sasaki, 2015; Sato, 1993; Tomozoe, 2009; Maekawa, 1981). The Japan Society of Physical Education, Health and Sport Sciences (2006) published a society-wide view on this matter (Note 1). In addition, according to Ohtsuki (2010), the view that Taiiku is equivalent to PE is demonstrated by the English name of Taiiku-Gaku Kenkyu: the Japan Journal of Physical Education, Health and Sport Sciences (Jpn. J. Phys. Educ. Health Sport Sci.; Note 2). The view that Taiiku is equivalent to PE is the basis of discussion in the study of Taiiku. However, many scholars have noted that Taiiku does not necessarily mean PE in the current Science of PE, Health and Sport Sciences (Taiiku-gaku: 体育学) (Kinpara, 1998; Mitsui, 1989). In other words, the present Science of PE, Health and Sport Sciences, that is Taiiku-gaku in Japanese, includes research publications that are abstracted from and do not include educational implications of the concept of Taiiku as PE, though the discipline must contain without fail the concept of Physical Education (PE) from the viewpoint of Japanese. Shigematsu et al. (2018), who examined frailty prevention for successful aging, and Akashi et al. (2019) and Saito (2019), who investigated adapted sport sciences, are no longer within the scope of PE research. As these examples suggest, the essence of the concept of Taiiku (体育) of Taiku-gaku (体育学) expanded, becoming obscure. As the translation for English of 体育 in the present English name of 体育学研究 as *Physical Education*, *Health and Sport Sciences* shows that Taiiku (体育) of Taiiku-Gaku (体育学) as an academic discipline can no longer be translated as simply PE (Note 3). Thus, Sato (1999) and Hayashi (2015) suggested a

change in perspective and a new way of questioning 体育 as PE by transcribing the Japanese term 体育 as Taiiku (Note 4). This study reviewed how researchers in Science of PE, Health and Sport Sciences have viewed the concept of Taiiku in academic disciplines, and differentiated Taiiku from PE. That means that this study reviewed the concept of Taiiku (体育), which is distinct from that of PE (体育, though it is also within the concept of Taiiku), and shed light on future research on the concept of Taiiku (Note 5). The formulation of the problem in this study is, however, certain to arouse many questions, doubts, and criticisms. Although the use of Taiiku in the Jpn. J. Phys. Educ. Health Sport Sci. can be confirmed, research discussing the concept of Taiiku itself or its history is lacking. Therefore, it may be inappropriate to consider this study a review paper, which is fundamentally a review of literature and research history on a specific research domain. However, as will be discussed in the next section, the essence of Taiiku has been revealed by various researchers in Science of PE, Health and Sport Sciences, and this study reviewed the concept of Taiiku based on their findings. After summarizing the understanding of the concept of Taiiku among researchers in academic disciplines, the current status of the concept of Taiiku in academic disciplines is revealed and future research on this concept is discussed. As the essence of Taiiku is clear, the implications of this review are discussed in the following section.

II. Taiiku-Gaku-Gairon (TGG) as an analytical perspective

Many studies in this discipline present the concept of Taiiku as the conception of the researchers of Science of PE, health and sport Sciences, who are the authors of these books, and the contents are discussed individually after listing the various fields that are considered to be included in the essence of the concept. Ohtani and Tsuzuki (1931) published one such example in the prewar period; however, even the major literature since the establishment of the Japan Society of Physical Education, Health and Sport Sciences in the postwar period includes many studies attempting to clarify or introduce the content and substance of various studies in Science of PE, health and Sport Sciences (e.g., Aikawa, 1981; Japan Society of Physical Education, Health and Sport Sciences, 1966; Kato and Shigeta, 1957; Kawamura, 1968; Maekawa, 1950, 1982; Ohashi, 2012; Takabe, 1971; Terasawa and Ikegami, 1967; Hoken Taiiku Kagaku kenkyu kai, 1998; Daigaku Hoken Taiiku kenkyu kai, 1998; Daigaku Taiiku kenkyu circle, 1966).

In other words, even if no strict definition is given of the concept of Taiiku, there have been many attempts to list the various disciplines included in study of Taiiku and explain their research results by comprehensively grasping their essence. Therefore, considering the ways in which the Science of PE, health and Sport Sciences were understood in various papers, this study highlighted the essence of Taiiku by referring to the results of various disciplines that have been considered to be included in Taiiku. More specifically, the following perspectives were adopted.

In current Science of PE, Health and Sport Sciences, various aspects of human physical activity and health, as well as issues related to competitive sports and school PE, are discussed based on the trichotomy of humanities, social sciences, and natural sciences, which is widely referred to as the general classification system of academic fields. If we consider the Science of PE, Health and Sport Sciences, that is Taiku-gaku in Japanese, the concept of Taiiku may be captured based on the perspective of the Science of PE, Health and Sport Sciences as a comprehensive science (Fukashiro, 2010; Note 6), which comprises a trichotomy of humanities, social sciences, and medical-natural sciences (medical-natural sciences is a term used by Kagaya et al. [2015] to refer to natural sciences of Taiiku). This trichotomy provides a clue for unveiling the essence of Taiiku. If we regard study of Taiiku as a comprehensive science following Fukashiro (2010), we may consider it a method of discussion to reveal the essence of Taiiku by examining each of the above three categories and synthesizing the results. This analytical perspective may be referred to as Taiiku-Gaku-Gairon (TGG) (Note 7). Using this perspective, this study clarified how the concept of Taiiku has been constructed and perceived by researchers in study of Taiiku.

However, this perspective cannot be used as an argument to determine the essence of Taiiku, as, even if we were to collect and analyze an endless number of studies that have been circulated under the current names of PE, Sport Sciences, and physical activity sciences, that is, studies that contribute to health, sport pedagogy, competitive sports, and welfare by examining physical activity, questions and criticisms regarding the collection criteria, academic standards of the

literature, and appropriateness of the number of studies could arise. In other words, when collecting studies related to PE and sports or dealing with the significance and methods of physical activity for the promotion of health and welfare, it is virtually impossible to gain unanimous consent from an unspecified number of people regarding the quantitative and qualitative level and range of the collection. Therefore, TGG functions as nothing more than a reflection of the author's subjective selection of various articles and cannot escape criticism that objectivity, which is a basic and prerequisite condition for academic research, cannot be guaranteed. Therefore, if the criticism that materials are included and excluded to justify an argument based on the arbitrary view of the collector is valid, one may question what criteria can be used to promote discussion that reveals the essence and prospect of Taiiku. To answer this question, it is plausible to proceed with the discussion that review articles published in the Jpn. J. Phys. Educ. Health Sport Sci. reveal the essence of Taiiku.

Studies published in the Jpn. J. Phys. Educ. Health Sport Sci. are, as the name of the journal suggests, are related to the study of Taiiku. In other words, papers published in the Jpn. J. Phys. Educ. Health Sport Sci. fall within the conceptual extension of the Taiiku and can be assumed to satisfy the necessary conditions to be recognized as expressing the Taiiku concept.

Science of PE, Health and Sport Sciences are the study of or on Taiiku, and research papers published in the Jpn. J. Phys. Educ. Health Sport Sci. can be regarded as Taiiku studies. Assuming this is true, studies published in the Jpn. J. Phys. Educ. Health Sport Sci. can be regarded as constituting a substantial part of Taiiku. Therefore, based on TGG as a perspective to question the essence of Taiiku, three categories were formed: area of humanities, area of social science, and area of medical-natural sciences. The essence of Taiiku was examined using the articles published in the Jpn. J. Phys. Educ. Health Sport Sci.

This study used review articles and special lectures as sources for elucidating the concept of Taiiku, as review articles are summaries of academic papers written on a certain research theme and demonstrate the achievements at the time of writing. In other words, review articles provide a comprehensive review of a certain theme in study of Taiiku that reveals how the theme has been discussed and debated over time. Therefore, in determining the essence of Taiiku, it is useful as a concrete indication of the contribution of a certain research theme in study of Taiiku. In addition, special lectures are reports of general findings on research problems that study of Taiiku seeks to solve and are closely related to the clarification of problems pursued by study of Taiiku. In other words, special lectures explain and summarize specific problems on a certain theme from a broad perspective and have the character of oral review papers that present the results of the study of Taiiku. Therefore, this study considered special lectures review papers in a broad sense and used them as materials to reveal the essence of the concept of Taiiku.

III. Taiiku in the area of humanities

Among the current specialized fields of the study of Taiiku, research in the area of humanities, which includes the philosophy of PE, the history of PE, and the anthropology of sport, has been conducted based on three features: (1) debates on the nature of study of Taiiku, whose main research interest is to understand the structure and uniqueness of study of Taiiku, (2) studies aiming to reveal the essence of major concepts related to all fields of study of Taiiku, (3) and proposals of research perspectives that attempt to provide new insights into the present and future of the problem by discussing past events. These features are clearly distinct from those of other studies in the area of social science and medical-natural science, and the differences have remained unchanged from 1950, the year of the establishment of Japan Society of PE, Health and Sport Sciences, to the present. The object of research in the area of humanities, as that of social sciences and medical-natural science, remains physical activity.

However, it is also clear that this area of research does not aim to provide achievements in real human life, such as victory in competitions or recovery and maintenance of health (discussed in more detail below).

First, one of the research themes discussed in the field of principles and philosophy of PE concerns the debate on the structure and uniqueness of study of Taiiku as an academic discipline, which arises in connection with its examination. This debate, which adopts differentiation and synthesis as a framework for examining these issues, has been studied with a different attitude toward the problem than the acquisition of knowledge that contributes to the improvement of and usefulness in people's real lives.

Mizuno (1973) envisioned the structure of the study of Taiiku by summarizing and organizing the interrelationships among the various disciplines in the study of Taiiku and questioned the structure using specific cases of the body, such as the flatness of the tibia.

Kataoka (1997) reviewed the research history of differentiation and synthesis in the study of Taiiku and questioned the very framework of differentiation and synthesis. As such, there is the argument that questions the very validity of the traditional approach to the question of how to understand the discipline, that is, the study of Taiiku. To elaborate, the argument indicates the character of examining the state of study of Taiiku and its research objects. The same attitude was present in the arguments of Kawamura (1974), Sato (1999), and Hayashi (2015), who examined the structure of research and issues to be solved within the scope of research in study of Taiiku, to which they belong.

These examples indicate that discussions that question the structure and uniqueness of study of Taiiku have been historically conducted in the reviews of the principles and philosophy of PE.

Incidentally, the character of research in the area of humanities that is not directly concerned with victory and improvement of real life, as exemplified by the area of principles and philosophy of PE, can also be seen in the field of the history of PE. Kishino (1974) observed the problematic relationship between Sport sciences and history of sports and discussed the significance and prospects of the basic theories in the field of sports history for the development of Sport sciences to clarify the structure of study of Taiiku as a discipline from different perspective from that of the field of principles and philosophy of PE. Kishino's (1974) argument questioned the identity of study of Taiiku as a discipline by explaining its system, which has consistently had a hybrid structure since its inception. In other words, like Mizuno (1973) and Kataoka (1997), Kishino (1974) questioned the academic foundation and research scope of study of Taiiku by revealing its structure, the research subjects, and the attempts to clarify research questions.

Kishino (1974) believed that, to clarify the structure and uniqueness of PE, the debate over the status of study of Taiiku can be regarded as one of the main research subjects in the area of humanities of Taiiku.

Studies in the area of humanities of Taiiku have questioned the essence of the main concepts related to any specialized field of study of Taiiku, such as the concepts of body and sport. In other words, they are attempts to question the extension and intension of the basic concepts dealt with in study of Taiiku, that is, to demarcate these concepts. For instance, Yamamoto (1998) proposed to reconsider the key concepts common to study of Taiiku, such as body, health, and exercise. Taketani (2002) demonstrated the rise of ethnic sports that developed in a context different from that of modern sports or disciplines adopted for the Olympic Games and encouraged readers to reconsider the concept of sports. Kozu (2010) discussed the issue of popular sports from a similar perspective. Furthermore, Endo (1999) in the field of cultural anthropology, examined dance, which is categorized as art, regarded as sport, teaching material for school PE, or being as play, and reviewed the expansion of its discussion and problems in Japan and abroad. This study contained an argument that encouraged readers to reconsider the essence of the concept of dance after providing an overview of the research history of dance anthropology in the world. These achievements not only clarified the scope of research in study of Taiiku by questioning the essence of the main concepts dealt with in this academic discipline but also provided a foundation for concepts related to various issues of sports culture, such as PE, sports, and the body.

In addition, the third feature of the area of humanities is that it provides a new perspective on the present and future of the research issues by finding novelty in certain events of the past, which is particularly evident in the reviews in the field of the history of PE. Research in the areas of social sciences and medical-natural sciences is mainly concerned with finding generally valid laws or equivalent findings from field practice or current situation in the time axis and seeking the significance of such findings in solving future issues. On the other hand, research in the area of humanities is concerned with drawing out and presenting findings that contribute to the future from the discussion of past events. For instance, Okubo (2009) investigated PE in Japan and the influence of an instruction book named *Instruction* for French military on the formation of modern school PE in Japan, specifically, the formation of army military exercises and drills in Japan. Otagiri (2010) examined the American Association for the Advancement of Physical Education to reveal the birth of the PE professions and its historical and social development. Furthermore, Shimizu (2001), who adopted the perspective of history of ideas, claimed that his argument "raises a

problem for modern Japanese study of Taiiku" (p. 228) and that "summarizing the past of study of Taiiku from the perspective of history of ideas provides a perspective for sorting out problems, if not a quick fix" (p. 228). Shimizu noted that research in the area of humanities of Taiiku illuminates the present and future of problems through the exploration of events that occurred in the past and "provides some basic perspective on the status of study of Taiiku" (p. 236). Yuasa (1987) used this perspective for a commemorative lecture from the field of philosophy, while Takahashi (2011) used it to examine women's sports in the ancient Greek world.

The analysis of past events for the clarification of the present and future is not conducted only in the form of an empirical literature review, as in the above studies. Riordan (1996) shed light on the progress of female athletes in China, including their background and challenges by analyzing athletes who have rapidly gained strength in various sports from a historical or cultural perspective and determined the reasons for their rapid progress and the government's intentions. Specifically, Riordan explained the breakthrough of Chinese female athletes in light of the historical fact, such as the relationship between the history of the influence of drug use in the former communist bloc and the progress of Chinese female athletes, the role of sports in Chinese society, the political system that prioritizes the convenience of China as a nation over women as individuals, and the tradition of women's sports in China and the influence of Confucius. In other words, Riordan focused on the past success of Chinese female athletes in the early 1990s from historical, social, and religious perspectives to illuminate their present and future.

Meshizuka (1975) summarized the basic characteristics of research in the area of humanities of Taiiku, including the interrelationship and transition of the main concepts of study of Taiiku. According to Meshizuka, "The subject of PE used to be gymnastics but came to include sport, dance, martial arts, and even health education" (p. 142). Furthermore, MeshiFzuka stated that "PE is the act of maintaining and strengthening the health of the human body and mind through physical activity" (p. 143) and that the "Science of PE, Health and Sport Sciences, whether it is for school education of young people or for the health and well-being of the general public, are the basic field of application" (pp. 143-144). Moreover, Meshizuka defined study of Taiiku as "the science of the effects of physical activity on the body and mind" (p. 143) or "a reliable science for practitioners on PE" (p. 144). Finally, Meshizuka argued that "PE and Science of PE, Health and Sport Sciences are important fields of science that should be effectively utilized throughout one's life and contribute to the fulfillment of life. They differ from medicine in that they should accompany all people in their lives as a direct life science from beginning to end" (p. 145).

Since these findings are all derived from the past research results of study of Taiiku, they clarify the present position of study of Taiiku and the path it should take in the future based on the research achievements accumulated in the past.

Research in the area of humanities of Taiiku not only discusses the definition and character of study of Taiiku as an academic discipline but also investigates how to grasp the essence of the major concepts. The results of these studies are based on past research results in study of Taiiku and provide guidelines for the future direction of study of Taiiku as an academic discipline. Therefore, research in the area of humanities of Taiiku is based on various studies that aim to clarify and define the structure, uniqueness, and essence of study of Taiiku, examine and reinterpret the essence of major concepts dealt with in this discipline, and determine the present and future prospects of the discipline based on past research results.

IV. Taiiku in the area of social science

As the study of education, or pedagogy, research on PE and sports is sometimes categorized as a social science. In the Jpn. J. Phys. Educ. Health Sport Sci., Ejiri (1975) discussed the problem of administration of PE in relation to society from a meta-perspective, while Ikeda (1998) stated that "in the age of internationalization or borderless society, we are increasingly required to work on sports policy from a global perspective" (p. 226). In addition, Sugawara (1977) explained the history of sport sociology from referring on the support of UNESCO, while Flath (1987) gave a lecture comparing the differences in the climate of PE in Japan and the United States in terms of facilities, evaluation systems, and opportunities to participate in sport. The arguments made by these scholars demonstrated that PE and sports are social products generated in society, which arise from their spatiotemporal fields.

In examining the review articles in the area of

social science, this study focused first on Maekawa (1974), as it highlighted the issue of pedagogics of PE as scientific research and the maturity of current pedagogics of PE as a discipline. "The field research in physical education in Japan tends to be 'ad hoc' and 'spur-of-the-moment'" (Maekawa, 1974, p. 157). By presenting the problem in this way, Maekawa sought a theoretical basis to break away from the situation where pedagogy as PE did not go beyond accumulation of knowledge through experience and transform it into the pedagogics of PE as a science of PE, a discipline with a scientific foundation. Maekawa stated that "there is an urgent need for a change from methods of physical education to the pedagogics of physical education and its research by cultivating competent instructors" (p. 161). This raises the question of whether the "quantification of physical education" that Maekawa described has been realized today. Kobayashi (1998) investigated the difficulty that exists in sport pedagogy as pointed out by Maekawa (1974), that is, the criticism made by assumed opponents that sport pedagogy is "too complex and based on empirical things to be called science" (p. 160), and added as follows: "Classroom analysis is a research method that accurately grasps events in the classroom and elucidates the causes that gave rise to such events. By accumulating such research, the rules and principles for creating good classes are determined and systematized, leading to the establishment of subject pedagogy" (Kobayashi, 1998, p. 71). In other words, Kobayashi's statement reflects his intention to accumulate case studies, and clarify the rules and principles governing the phenomena based on them, and conceive a scientific system of sport pedagogy. However, in the conclusion of the discussion, Kobayashi states that what is essential for the development of excellent PE classes is "sensitivity" on the part of teachers (p. 77) or "having a humble heart to sympathize with and learn from the practices of excellent practitioners" (p. 77), which can be interpreted as expecting personal mastery by excellent teachers rather than scientific principles. This argument falls short of providing the foundation of the natural science method, in sport pedagogy.

Takahashi (2000) promoted an approach that relies on the methods of natural sciences in PE and argued that the discussion focuses on the problem of methodology, originating from the question of the academic nature of sport pedagogy. Takahashi summarized the approach to class research using the methods of natural science based on "the process-product research method" (p. 148), he explored the possibility of sport pedagogy as scientific research.

However, in light of the basic conditions of scientific research, which is to reveal "the 'universal structure' of natural phenomena" (Kobayashi, 2009, p. 37), whether the quantification of sport pedagogy, which is influenced by almost unlimited variables related to the target students, including weather, can be completed should be investigated further.

The debate over sport pedagogy is not only about the quantification of this field. According to Kagawa (2006), a comprehensive perspective on learning materials is an important issue. Specifically, this review explores the future prospects and issues by presenting research and practical reports on the use of computers, which were introduced in the school education setting in response to the notification by the Ministry of Education in December 1999. As mentioned, the research conducted by Kagawa (2006) can be described as an attempt to identify measures to deal with educational issues that have arisen in response to changes in social trends, mainly from the perspective of learning materials. In addition, there are several studies in the review of sport pedagogy that were inspired by overseas trends. This indicates the efforts of sport pedagogy to deal with various problems related to PE that have arisen in the changing social conditions. Beran (1984) examined the curriculum and educational trends of PE in the United States based on the concept of "politico-economic-socio milieu" (p. 269). Itani (2001) conducted a comparative study of PE and fitness programs in the United States, while Takenaka (2001) focused on children in the United States and looked at health education and public health. These studies give an overview of the research trends from the perspective of international comparisons, illuminate sport pedagogy in Japan, and extrapolate on the current state and future of study of Taiiku. This is evidenced by the approach of Itani, who clearly states the research target and its current status, including statements such as "the state of development of new fitness education programs" (p. 326), "a study on the ideological aspects of new fitness education programs" (p. 329), and "a comprehensive examination of the transformation of fitness education programs" (p. 332). This research was based on the situation of fitness education programs in the United States, which are changing due to curriculum revisions and changes in social conditions.

In addition, Takenaka (2001), in his cross-disciplinary approach to the problems in education and public health, explained the health insurance system in Japan and discussed children in the United States by posing the following question: "Aside from the curriculum that focuses only on the methods of teaching PE, what can be done in PE classes to focus on the amount of physical activity itself, increase the amount of physical activity in daily life other than PE, and create lifelong habits of physical activity and exercise?" (p. 508). In addition, Yamazaki (2003) noted that attention to foreign countries can be observed in the field of health education. "The reality was that American youth were facing public health, educational, and social challenges that they had never experienced before" (Yamazaki, 2003, p. 512). Furthermore, Yamazaki examined the School Health Policies and Program Study (SHPPS), the study of school health in the USA carried out in 1994 and 2000, in the United States and introduced the trends of public health and health education in the United States. "The development of SHPPS in the United States may provide valuable suggestions for considering and taking measures for the health of youth in Japan, and for analyzing the current state of school health and health education and envisioning future prospects" (Yamazaki, 2003, p. 513). Yamazaki emphasizes the significance that SHPPS advances its research on the basis of "evidence-based medicine" (p. 520). In other words, "we cannot deny that such scientific procedures and the treatment of evidence based on them are not only necessary in the medical field but are also essential requirements in the field of school health and health education" (Yamazaki, 2003, p. 521). This reveals the intention to establish the idea of prevailing the methodology of evidence-based medicine as exemplified by SHPPS. Therefore, at least two trends can be identified in sport pedagogy based on the review articles. The first trend is the promotion of quantification in the field of sport pedagogy and the examination of its pros and cons and discussion of the current status and future prospects of the development of learning materials in accordance with the current trends. The second trend is trying to show the future direction of PE and health education in Japan through examining the current status of the discipline based on the trends in the United States (Note 8).

Imashuku et al. (2019) mainly focuses on issues related to PE in Japan and abroad and summarized the research on athletic club activities while paying attention to the perspective of history. However, apart from the interest in issues related to PE in Japan and abroad, some review articles in the area of social science focus on the so-called sports industry and regional sports. Recent studies include Yamaguchi et al. (2019) and studies of sports activities in local communities by Chogahara (2003) and Toyoda and Nakagome (2000). These discussions reveal the current situation where sports industry and regional sports are regarded and studied as important issues in study of Taiiku. In other words, these two papers characteristically show the nature of research in the area of social science and examine the state of sports in society and in their idea of developing discussions from a broad perspective.

Chogahara (2003) reviewed studies "on the promotion of physical exercise for the middle-aged and elderly and the results of various studies related to the participation of the middle-aged and elderly in physical activity and scientific and practical issues for the future promotion of lifelong sports". This research was driven by the concern regarding how Japanese people can utilize sports in an automobile society and, in particular, how to find ways to contribute to sports to help people live happily by capturing the connection between lifelong (life-worthy) sports (Chogahara, 2003, p. 246) and the elderly. Using the basic guideline of "community-level physical activity promotion for middle-aged and elderly people," three perspectives were examined based on previous studies (Chogahara, 2003, p. 247). More specifically, Chogahara summarized the issues in sports research on the welfare of elderly people in terms of the following three perspectives: Project studies: What kind of programs can improve the conditions for exercise and sports activities? (project→factor), Determinant studies: What are the conditions that lead people to do exercise and sports? (factor→behavior), and Benefit studies: What are the individual and social benefits of exercise and sports activities? (behavior→benefit) (Chogahara, 2003, p. 253). Chogahara argued that "further academic development and integration of knowledge in the areas of aging (gerontology), sport (physical activity science), and promotion (promotion science) are the building blocks for creating a new lifelong sport culture in the 21st century" (p. 260). What is common to the various studies discussed in Chogahara (2003) is the nature of research that seeks a way for individuals to maintain their physical functions in a sustainable and healthy manner in an aging

society and achieve fulfillment, or well-being, in their lives. In other words, research in the area of social science can be described as research that seeks the fulfillment of life from a physical perspective during one's lifetime or, more specifically, research that seeks contributions from both physical and social perspectives to achieve well-being. To put it differently, study of Taiiku address the question of what kind of physical activity is necessary for human well-being from physical and social aspects by examining appropriate physical activity and promotion to achieve it (Note 9).

On the other hand, Toyoda and Nakagome (2000), who were in the field of social science, examined athlete retirement and analyzed sporting events in society from a different perspective than the pursuit of athletic victory, prominent in research in the area of medical-natural science. Toyoda and Nakagome investigated problems associated with athletes' retirement based on theoretical and empirical research. Specifically, they demonstrated that theoretical research contains the attitude to examine the issue of athlete retirement in terms of life stage, as seen in sociogerontology, thanatology (science of life and death), and the study on the transition to adulthood, while empirical research addresses the issue of athlete retirement based on their roles and relationships as professionals and amateurs. Their research began by rethinking the positioning of competitive sports and athletes in society and examined the fulfillment of the lives of retired athletes and the starting point for reaching well-being as the final stage of their lives.

As such, research in the area of social science can be summed up as research that aims for well-being through sport and PE, as research in this area takes the society in which one lives as a given premise.

This research area is related to the area of humanities, as it deals with fundamental issues, such as what should be thought in PE (Nakamura, 2003). In addition, it is related to the area of medical-natural science, as seen in Toyota and Nakagome, indicating a particularly strong interdisciplinary character among other studies in study of Taiiku. It clarifies the problems that appear in the practice of PE and sports and suggests desirable prospects for the future, while exploring the path to well-being as the fulfillment of human life through PE and sports. Research in the area of social science deals with the analysis of the current status of PE and sports in the phase related to real life, including consideration of the health and welfare of people living in society, as well as various educational issues. These studies ultimately aim to realize a fulfilling life for humans, that is, human well-being.

V. Taiiku in the area of medical-natural science

The disciplines belonging to the area of medical-natural science have a basic character of having a goal of the achievement of victory or health and use mathematics and physics as the basis of their research methods.

Between 1965 to 1985, several studies attempted to clarify the academic nature of the area the authors specialized in through comprehensive reviews of disciplines belonging to this area of medical-natural science. Sasaki (1974), Takagi (1973), and Ogihara (1975) offered such discussions. Kawahata (1974) examined the essence of growth and development studies within the scope of study of Taiiku. In the same year, Asakawa (1974) discussed "scientific research on physical education methods and the current status of coaching, and the problems of planning and teaching methods for learning through physical activity" (p. 125). These discussions commonly dealt with the topics of extending one's specialty within study of Taiiku, its positioning as an academic discipline, and the implications of the discussion, suggesting the basic questions that need to be answered by each field and the direction of solutions. Takagi (1973) began with a discussion on the historical background of the development and inception of kinesiology research in Japan. Kawahata (1974) began with a definition of growth and development (p. 2) and identified the concept. Asakawa (1974) began the discussion with the delineation of "the field of coaching and training" (p. 126). Sasaki (1974) demonstrated the position of his field by reviewing the major topics, such as "evaluation of teaching materials in ball games" (p. 244), "game structure in ball games" (p. 245), "teaching of ball games" (p. 247), and "whole-part-whole method" (p. 250). Ogihara (1975) pioneered the current discussion on the relationship between brain science, neuroscience, and physical activity by starting with the problem of the nervous system and taking a broad view of the mechanisms of physical activity and their effects on PE. What these discussions have in common is the basic nature of research that tries to comprehensively grasp the structure and function of physical activity, pursue victory

in various sports, and realize and maintain good health. Although mathematical and physical methods were the basis of the discussion, these studies adopted a comprehensive view of the human being as a unity of body and mind. This is supported by Nakagawa's (1985) summary of strategy research on ball games, Muraki's (1999) review of coaching research, and Asaoka's (2011) discussion of concerning the "Contemporary issues in coaching science from the viewpoint of the developmental process in German linguistics" (p. 1), as he shows on the title of the paper.

Studies that used mathematics and physics to analyze physical activity to achieve victory in various competitions include Ito (2003), who examined sprinting in track and field, Asai (2006), who examined mechanical modeling for sports movements, and Fujiwara et al. (2017), who examined the speed and measurement method of vaulting in gymnastics. Ishikawa (1973), who focused on physiological phenomena during warm-up, can also be regarded as providing useful knowledge for victory in various sports. In addition, a recent review by Naito and Hayashi (2018) discussed the methods of body cooling, mainly divided into external and internal, to address problems with thermoregulation among people with spinal cord injury (SCI). Naito and Hayashi did not merely focus on the physiology of people with SCI but also considered the so-called athletic performance or conflict with the rules of competition, differing in research scope from medical sciences, which focus primarily on disease prevention and recovery. Furthermore, major achievements in the methodology based on mathematics include Fukunaga (1998), Miyamura (1999), Yamaji (1985), Fukashiro (2000), and Tanaka (2000).

Fukunaga (1998) presented how to calculate the joint torque as one example, "multiplication of the muscle exertion tension and the moment arm (vertical distance from the rotation center of the joint to the line of action of muscle tension)" (p. 338). Higuchi (1999) discussed "research and practical issues in nutrition related to health management and athletic performance improvement of athletes" from the standpoint of evidence-based medicine (EBM), which is a scientific approach to establish results through mathematical arguments (p. 2).

However, to address expected criticism in advance, research in the field of medical-natural science used mathematics on examining the human body as a substance. Rather than abandoning the exploration of the area that corresponds to the human mind, research in the field of medical-natural science maintained focus on the limitations of numbers, that is, areas that are difficult to quantify, and developed studies based on the spiritual aspect of human beings as a unity of body and mind (Note 10). This was demonstrated by Hoshino (1997) and Tanaka (2014) in the field of psychology of PE. Hoshino (1997) examined sport motor behavior to "explore the effectiveness of movement methods in PE and sports, which require solving the dual problems of appropriate self-control of one's psychological state and rational and purposeful self-control of one's body according to each discipline during play" (p. 205). Hoshino suggested that "there are no statistically abstract human beings" (p. 211) and concluded that "clinical research needs to be conducted more vigorously from the viewpoint of 'what to do' to improve in order to assist the efforts of 'one' real athlete who is striving to improve beyond the current level" (p. 211). While Hoshino conducted research based on methods of natural sciences, such as mathematics, he does not absolutize such research. Hoshino described the basic position of sport psychology in approaching the study of voluntary movements, stating, "We need an approach that considers the way the self acts to manipulate the strengthened body, or 'how to move the body', as in itself a psychological phenomenon" (p. 212). Thus, although methods based on mathematics and physics are important and essential for the understanding of various aspects of physical activity, Hoshino saw that they are not panaceas (Note 11).

The basic character of research in this area of medical-natural science is not to pursue victory in competitions but to elucidate the structure and function of the body and question the validity of evaluation indices, which are not necessarily directly aimed at achieving victory in competitions, with the aim of contributing to the application of sports sciences to the maintenance and promotion of health and welfare (Note 12). Demura and Sato (2006) and Demura (2007) discussed the transition and evaluation methods in quality of life (QOL) research with the elderly as well as research related to the maintenance and promotion of lifelong health on the topic of fatigue. as According to Demura (2007), health research on fatigue has been a traditional topic of study since the first volume of the Jpn. J. Phys. Educ. Health Sport Sci. In addition, Satake (2006) stated regarding issues of growth and development to be studied in relation to health, "Science of PE, Health and Sport Sciences

examines changes in aging over a human lifetime" (p. 254). In other words, studies of growth and development in study of Taiiku examine the measures and methods necessary to achieve healthy development and outcomes.

Wada et al. (2006a) discussed the reevaluation of lactic acid in the field of physiology, including the current understanding of lactic acid as a fatigue-inducing substance, traced the research history from its discovery, and concluded that "we are approaching a time when we need to radically change our thinking about the role of lactic acid in the body" (p. 237). This discussion marks a paradigm shift in kinetic physiology that originated in the reconsideration of fatigue-inducing substances and can be related to health management in various aspects of sports and victory, as well as the realization of appropriate exercise and other cases (Note 13). Takenaka and Uechi (2002) argued that the purpose of physical activity in daily life "has shifted from the traditional goal of increasing physical fitness to promoting health" (p. 210). In response to this research background, the study distinguished between outcome efficacy and efficacy expectation and used the latter as the frame of reference to develop discussion. Both Takenaka and Uechi identified problems related to (1) the level and intensity, (2) the content and number of items, and (3) the reliability and validity of each of the SE (Self-Efficacy) scales that have been used in physical activity and exercise related research. In other words, this study examined the evaluation scales for the realization of health and can be considered a numerical study of the essence of health. In addition, Takenaka (1990) examined the "Electromyographic (EMG) biofeedback" (p. 2) and identified the current status of objective indicators of the function of the autonomic nervous system, focusing on muscle activity, as well as the challenges for and objectives to the application of these indicators to sports. Three challenges and objectives were identified: 1) rehabilitation of athletic injuries, 2) stress management, and 3) training athletic postures and movements" (Takenaka, 1990, p. 11), which clarified how the problem should be formulated for future sports exercise and how to apply the above EMG, as well as expectation for it. In sum, Takenaka (1990) presented indices for the maintenance and improvement of physical functions and their applications.

Research on health promotion and the examination of evaluation indices involving analyses of the structure and function of the body, as described above, is not secondary to the pursuit of victory but constitutes the two major subjects in the area of medical-natural science along with the pursuit of victory. This paper labeled research based on the methods of natural science in the study of Taiiku as the area of medical-natural science (医科学象限) not only because Kagaya et al. (2015) demonstrated examples of its use. Rather, as the Chinese character for medicine (医) indicates, the results of research in this area reflect the nature of research aimed at the fulfillment of life based on the realization of human health, that is, human well-being.

This is evident in Hattori (2006), Takenaka (1992), Kitagawa (1998), Matsuda (2006), Kagaya (2001), Saito (1997), and Wada et al. (2001).

Takenaka (1992) began the discussion with the difficulty of defining stress. After observing the differences in the results of studies on the effects of aerobic exercise as a stress reduction method and work ability, Takenaka discussed the effects of aerobic exercise on stress by comparing various items. Hattori (2006) discussed body composition, starting with an analysis of the current status and problems of the BMI index, and engaged in defining the standard BMI value and resolving the problem of obesity tendency in children. In other words, Hattori discussed the problems of BMI as a measure of obesity tendency, as a risk factor, with the goal of achieving health. Kitagawa (1998) discussed the measures of body indices individually, followed by a discussion of the obesity tendency and countermeasures in the context of the changes in body composition of Japanese people due to aging. Kitagawa stated, "I feel that the interest of society in this field in general has increased remarkably" (p. 1). He explained, "The central keyword in this change is obesity, and the body fat percentage is the criterion for determining obesity" (p. 1). In other words, the study examined the index of obesity, which is an impediment to the realization of health, and aimed to achieve the goal of overcoming obesity as a lifestyle problem, that is, the realization of health.

The basic nature of health-oriented research is also found in Kagaya (2001), Wada et al. (2001), Saito (1997), and Matsuda (2006). These studies include statements such as "to determine the conditions that regulate muscle blood flow during exercise in terms of exercise characteristics" (Kagaya, 2001, p. 430), and "it is important to determine the various responses of the sympathetic nervous system to exercise in consid-

ering health and physical fitness from the basic standpoint of living" (Saito, 1997, p. 59), and "to provide an overview of the effect of aerobic exercise on the decrease in arterial stretch with aging and its mechanism" (Matsuda, 2006, p. 422). A reconsideration of the relationship between muscle fatigue and "sarcoplasmic reticulum (SR)" (Wada et al., 2001, p. 444) can be interpreted as aiming to contribute to the realization of appropriate physical exercise in daily life and fulfillment of life based on this. As "Exercise as a proof of being alive" (Saito, 1997, p. 59), the above studies tried to identify the problems hindering the realization of meaningful physical exercise through the elucidation of the mechanisms of the body and of individual health and well-being, provide solutions, and present issues to be solved.

Research in the area of medical-natural science is oriented toward realization or achievement of something as its outcome (Note 14). The basis of the goal is the realization of victory, the elucidation of the structure and function of the body, and the realization of health supported by the implementation of useful measures, which may be derivatively referred to as acquisition, recovery, and elucidation (investigation). Research in the area of medical-natural science can be summed up as the research for the achievement-oriented people. This includes victory in competitions, maintenance of health in daily life and physical activity, and suggestions for healthy living through the elucidation of body structures and functions that were previously unknown, contributing to the field of sports and welfare. In addition, the research results enrich the lives of sports practitioners and those in need of welfare and provide safety. On the other hand, by employing the research method of elucidating the mechanism of physical activity through mathematics and physics, and by mobilizing psychological research, the research in the area of medical-natural science also examines the aspect of the human mind. As such, the research reveals human functioning in physical and mental aspects and can progress with a practical, goal-oriented approach to achieving victory and health. However, in the course of research progress, there arises a distance between the research results and the practice of physical activity, expressed as the difficulty of "bridging the gap" (Watanabe, 2002, p. 310), concerning the return of the results. In other words, it is impossible to apply the research results directly to the field of practice. Watanabe (2002) sought the return of research results to the field of practice from the consideration of the extent to which and how the knowledge of biomechanics can be applied to the field of education. Thus, research in the field of medical-natural science strives to contribute to the field of practice by closing the gap between the research results and the field of practice.

Therefore, research in the area of medical-natural science aims at realization, or achievement; however, as in the case of social science, it aims at the fulfillment of the lives of people who enjoy physical activity, such as PE and sports.

VI. Results and conclusion

In the area of Humanities studies have been done for defining the essence of the main concepts in study of Taiiku, including PE, and study of Taiiku itself, as well as their relationships with other major concepts and their historical transition. Furthermore, this study investigated the structure of the study of Taiiku and its uniqueness as a discipline as well as the current status and future prospects of this discipline. This study revealed the meaning of the question of physical activity and laid the foundation for further discussions in the study of Taiiku. Research in the area of humanities also questions what should be analyzed and why as well as what type of system necessitates the study of Taiiku and why. Subsequently, research addresses physical activity. The field of social science had the character of ultimately pursuing well-being as the fulfillment of life, focusing on health policy and education based on the analysis of the current situation and problems of PE and sports. In the field of medical-natural science, while the goal is to achieve victory and health, useful knowledge for health is presented by elucidating the way to a victory in competitions of various targets and scales, and clarifying the structure and function of the body, and evaluation indices. In addition, this research aims to help the practitioner of physical activity who enjoys the research results to achieve the ultimate goal of their lives, that is, well-being. Although the research methods of these Taiiku studies differ, they are common in viewing human beings and their physical activity as the basis of their research subjects.

The study of Taiiku focuses on physical activity and aims to help the practitioners achieve well-being. In particular, as stated in a series of recommendations by the Subcommittee on Health and Human Science of the Science Council of Japan (2008, 2011, 2017),

appropriate physical activity, including sports, contributes to the development of human skeletal, muscular, respiratory, circulatory, cerebral, and neural functions in childhood and adulthood, the improvement of lifestyle-related diseases, and the building of psychological characteristics and overall vitality in children. In other words, Taiiku is a general term for physical activity that contributes to the creation of physical and social foundations for human well-being. Viewed from a different perspective, the study of Taiiku explores human well-being from the physical and social perspectives based on the empirically verified arguments and conclusions to the question of physical activity. The study of Taiiku is the discipline that collects wisdom that contributes to well-being through physical activity.

The issue to be discussed in the future is not merely the extension and intension of the concept of Taiiku as discussed in this paper. There is a new debate on the essence of well-being as the research goal in the areas of social and medical-natural science. Specifically, research will progress to the clarification of the essence of well-being as something that is "to be well" or "to live well," to express it in philosophical terms. If the study of Taiiku paves a way to the attainment of well-being, that is, toward a more satisfying well-being, then research will move further toward the elucidation of the essence of human well-being through research of study of Taiiku.

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Appendix

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Notes

*1 Many other scholars have tried to position Shintai Kyoiku (身体教育: PE) as PE. For instance, Maru (1957), Takabe (1959), Fujimoto (1969), Miyashita (1984), Kawamura (1985), and Hirai (1995), who were researchers of Science of PE, Health and Sport Sciences in the past, also regard Taiiku as an activity related to education.

*2 According to Ohtsuki (2010, p. 125), the word Taiiku (体育) in Taiiku-gaku Kenkyu (体育学研究) (Jpn. J. Phys. Educ. Health Sport Sci.) in Japanese, the official journal of Japan Society of Physical Education, Health and Sport Sciences, was translated into English as "Physical Education" from the first volume to the 45th volume, while from the 46th volume to the present, it has been translated as "Physical Education, Health and Sport Sciences" in consideration of the research subject.

*3 The fact that Taiiku in the study of Taiiku never means PE can be further supported by reviewing the research results of the first issue of Jpn. J. Phys. Educ. Health Sport Sci, which contains abstracts of research presentations made at the first meeting of Japan Society of Physical Education, Health and Sport Sciences, with the table of contents showing the subject matter and research results that differ from those of PE conducted in school. Moriwaki (1951), Tamano (1951), and Watanabe (1951) are examples of research on sports and dance that are not intended to be applied to school PE. Kaneko and Shiotani (1951) examined the fatigue mechanism. Kawase (1951) analyzed health consciousness among youth. As these examples show, the concept of Taiiku has been inherited without clarity since the early days of postwar PE. Suetoshi (1977) revealed the number of presentations made in each field of research in the Japan Society of Physical Education, Health and Sport Sciences over the past 25 years and the percentage of the total in each field. According to the report of the papers published in the field of sports teaching and coaching, the papers that were intended to bring a return to education, which were classified under the gymnastics educational category, accounted for only 3% of the total. Research on Olympic issues and athletes, ball games, such as basketball, volleyball, soccer, and baseball, swimming, martial arts, and dance, which were not necessarily intended to contribute to PE, were dealt with in the area of coaching and training in Science of PE, Health and Sport Sciences. Suetoshi described research in Science of PE, health and Sport Sciences as "recent research on physical activity in Japan" (p. 305). This suggests that most research on Taiiku coaching and training was viewed as research on physical activity or competitive sports, while research on Taiiku as education only accounted for a part of it. In addition, research on the definition of Science of PE, health and Sport Sciences, attempted to explain the system of the discipline in a consistent manner (e.g., Abe, 1971; Abe and Nakafusa, 2009; Hatano, 1976; Nagai, 1971; Takahashi, 1994), as research on Taiiku that separated it from PE was recognized and included in Taiiku research. This historical background shows that the concept of Taiiku goes beyond the

framework of education, that is, Taiiku as PE occupies only a part of the concept.

*4 Even in recent years, Takahashi (2015) referred to Taiiku as "a higher-level concept that encompasses competitive sports, plays, recreation, and Taiiku in a narrow sense" (p. 218), suggesting the need to discuss the essence of Taiiku as a concept denoted by the English name of Nippon Taiiku Gakkai (Japan Society of Physical Education, Health and Sport Sciences), that is, as a concept that can comprehensively capture the Physical Education, Health and Sport Sciences.

*5 Asami (2010) discussed the name change of the Japan Society of Physical Education, Health and Sport Sciences and its journal. Asami considered sport pedagogy a part of the study of Taiiku, but not the whole of it, and reported that some researchers in the study of Taiiku hold a view that Taiiku cannot be called PE. The Japanese word Taiiku is used not only in the sense of PE but also in a broader sense that includes sports, as in expressions such as "Nippon Taiiku Kyokai" (Japan Sport Association) and "Taiiku no Hi" (Health and Sports Day), and many society members felt nostalgia for and a certain attachment to the word Taiiku (体育). Therefore, there was no move to change the name of the society when it was incorporated, and the name remains Taiiku to this day. On the other hand, the change of the English names of the society and journal was rejected at one time. However, as PE was understood to cover only the range of sport pedagogy and not accurately represent the research range and subjects of the society, the proposal to change the name of the society to Japan Society of Physical Education, Health and Sport Sciences and the journal name Taiiku-gaku Kenkyu to Japan Journal of Physical Education, Health and Sport Sciences was readily approved at the 51st general conference in October 2000. This English name was used from Vol. 46, No. 1 of the journal published in the following year (p. 29).

*6 "I think one of the characteristics of the Japan Society of Physical Education, Health and Sport Sciences is that it is a comprehensive science, and another is that it is an applied science. (...) The paper itself cannot be something that can be published by people in the engineering department, medical department, or science department, which are the parent disciplines of natural sciences, but it must be such that it can be published only by those in PE, Health and Sport Sciences" (Fukashiro, 2010, p. 41). As a clue for producing unique papers by those in PE, Health and Sport Sciences, Fukashiro stated, "Since Japan Society of Physical Education, Health and Sport Sciences is a society of scholars majoring in an applied science, one of the main characteristics is to apply the research results to sports competition, health, and education" (p. 41). There is a further question that arises as to the specific target to which the research results in the study of Taiiku are to be applied, that is, what the results can be applied to. There is room for a separate discussion on this question.

*7 A form of research that comprehensively explains an entire field from a comprehensive perspective is often called "gairon" in Japanese. Omodaka (2016), Sugioka (2014), and Tanabe (1963) are examples of this.

*8 However, apart from these trends, Takenaka (1989) explained the significance of education through sports to solve the problem of drug use by athletes in the United States. Takenaka identified this in terms of "psychological and psycho-social tendencies" (p. 2). He proceeds with the discussion in terms of stress in athletic and life situations on the one hand, and related issues that should be associated with them on the other, concluding that "drug education" (p. 8), drug testing, and psychological stress management are the three effective pillars of anti-doping. Takenaka extracted the issues and problems from the social environment surrounding athletes to identify solutions and tackle the problem of drug use by athletes.

*9 These trends can also be confirmed from leisure behavior research (e.g., Ninomiya et al., 2002). Ninomiya et al. (2002) defined leisure behavior research as "a discipline that attempts to elucidate various events that occur in the process of people voluntarily using their free time to participate in leisure activities according to the paradigm of social science" (p. 319) and discussed the research trend accompanying the "specialization of recreation" (p. 321). Ninomiya et al. can be described as research on leisure activities that provide the basis of well-being as the fulfillment of leisure time. Ninomiya et al. included leisure activities such as fishing, canoeing, hiking, playing cards, hunting, and yachting, which are physical and social activities that are separate from daily work and have fulfillment in life, or well-being, as the ultimate goal.

*10 In this regard, we can also refer to Morishita (1999), who examined the movement trajectory of infants' mechanisms of physical activity. While using the methods of natural science, Morishita focused on attachment as a psychological emotion and revealed the mechanism of infant behavior by capturing a mental state that cannot be reduced to mathematics, that is, cannot be fully described by mathematical tools.

*11 A similar position can be seen in the discussion provided by Tanaka (2014). Tanaka analyzed factors that inhibit motor performance of golf putting and identifies three types of research: (1) research that explains the decline in putting performance under pressure in terms of attentional focus and attentional capacity, (2) research that reports psychological, physiological, and behavioral symptoms of putting under pressure, and (3) research that demonstrates coping strategies to prevent putting errors under pressure, and reviews "the experimental research on golf putting under pressure" (pp. 2-3). In each of the three categories of research, the theories used assumed the disclosure of results based on mathematics; however, the human being as a unity of body and mind is a research object which cannot be elucidated only using mathematical calculations on which the three categories of research above have tackled.

*12 However, as one of its examples, Wada et al. (2006a) demonstrated that it is not possible to clearly distinguish between scientific research to pursue victory in competitions, research to elucidate body functions or structures, and research to maintain and improve health, as the range covered by the results of sports science research is extensive, going beyond the mere pursuit of victory and including suggestions for everyday activities. The distinction between the pursuit of victory, the elucidation of body functions and structures, and research on the maintenance and promotion of health on this paper is a strategic one. Ohtsuki (1998) is one example of cross-sectional research in Sport sciences. Ohtsuki analyzed athletic movements from various perspectives, including prediction, timing and location, load intensity and muscle exertion, visual reaction time, eye movement, feinting, and switching time of motor commands. Ohtsuki included not only cases of sports but also tooth brushing in daily life, suggesting that sports science research can contribute to the acquisition of movements in daily life.

*13 In addition, Wada et al. (2006b), while focusing on muscle fatigue and high-intensity exercise as the main areas of inter-

est, described inorganic phosphate, glycogen, and reactive oxygen species as the "causes of muscle fatigue that replace lactic acid" (p. 400) and summarized the effects of these substances on muscle contractile function.

*14 Arima's (1984) account of his ascent of the Himalayas deserves to be called a report of achievement in a sense different from that of victory in an athletic competition, indicating overcoming a difficult natural environment to reach the summit; although, in a metaphorical sense, it may be appropriate to call this a victory.

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