A Study on the Causal Relationship between “the Flow of a Game” and Its Outcome in Basketball: Focusing on the Interdependence Relations of Four Periods*

Haruki Uchiyama¹, Eiji Ikeda², Kenji Yoshida¹, Yosuke Machida³, Tomoo Amino⁴ and Hidenori Kashiwakura¹

¹Faculty of Health and Sport Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8574
E-mail: uchiyama.haruki.fp@u.tsukuba.ac.jp
²Faculty of Education, Art and Science, Yamagata University, 1-4-12 Kojirakawa-machi, Yamagata, Yamagata 990-8560
³Sapporo University, 7-3-1 Nishioka3jou, Toyohiraku, Sapporo, Hokkaido 062-8520
⁴Faculty of Education, Hakuoh University, 1117 Daigyoji, Oyama, Tochigi 323-8585

*Original article published in Japan J. Phys. Educ. Hlth. Sport Sci. 63: 605-622, 2018 (in Japanese)
[Received December 3, 2020; Accepted February 11, 2021; Published online March 5, 2021]

The purpose of this study was to clarify the causal relationship between the “flow of a game” that can be defined “the situation on which 4 periods which consist of division time as 10 minutes are advancing gradually while having an influence each other” and its outcome, focusing on the interdependence relations of four periods in basketball. In order to accomplish this purpose in this study, a hypothesis was set in that, the “flow of a game,” in which “factors causing changes in conditions” cannot be overlooked in basketball, consists of four periods, with each first generating functions as opportunity, in the end affecting the outcome. In order to test this hypothesis, an analysis was performed over 1044 periods in 261 games in Japan’s strongest university league, Kanto Men’s First Division League, based on the following three analysis perspectives: (1) the importance of each period; (2) the mutual dependency between periods; and (3) the relationship between the difference in cumulative scoring and outcome. Results observed using logistic regression analysis and structural equation modeling of the obtained data clarified the following three points: (1) periods that exerted influence on the outcome were the first, third and fourth, with their importance ranked as “third > first > fourth > second”; (2) as for mutual dependency for each period, the point difference in the preceding period in the sequence, “first → second (cumulative),” “second (cumulative) → third (cumulative),” “third (cumulative) → fourth” creates an opportunity for the following period; and (3) if there is the cumulative score difference within eight points by the end of the third period, there is a high possibility (potential) for coming back to win. These findings will be able to apply to coaching in various games under the official rules of FIBA as new practical guidelines for closely analyzing the causal relationships between the unique “flow of a game” and outcomes in basketball that take place over four periods.

Keywords: problem of partial or whole, moment, factors affecting the outcome of a game, logistic regression analysis, structural equation modeling
1. Introduction

1.1. Locating the problem

The general essence of competitive sports, irrespective of place and time, lies in “determining the result through a comparison of strengths” (Uchiyama, 2009b, p.173). “It is only when there is a constitutive rule clarifying the competitive purpose, tasks, and format of the (said) competition, that it is possible to determine the result, and emphasize the unique physicality” (Uchiyama, 2012, p. 29; parentheses in original). Based on this premise, through a “mechanism of athletic development” in which the athlete repeatedly “adapts to the specificities of their body” and “breaks free from the status quo to achieve a higher level of sophistication” by mediating their various inherent physical abilities (Uchiyama, 2009, p.175), the athlete trains every day to achieve “excellence of strength” (Uchiyama, 2009b, p.172) which is expressed in measurement, scoring, or points, and aims for victory by maximizing that excellence in the game.

The work invested in order to acquire and demonstrate this “excellence of strength” that is one of the most important characteristics for many disciplines, is considerably difficult, even for team sports—especially with a sport like basketball, where “individuals, groups, and teams compete for points on the same court attempting to shoot at a horizontal plane above their heads” (Uchiyama, 2009a, p.38). This is because it is visible in the form of constantly changing developments of an “acyclic motion” (Meinel, 1960) brought about primarily by “open skill” (Poulton, 1952), and invisible “complex characteristics are more intensely imprinted than in most sporting events or various other ball games” (Neumann, 1990).

However, although it is difficult to achieve and demonstrate “excellence of strength” in basketball, coaching, defined as “leading athletes to victory” (Uchiyama, 2013, p.683), indisputably plays an important role as well. However, the “compelling power” necessary for a coach to lead an athlete or a team must not be based on experiences that stay in their personal frame of reference. If we cannot overcome the bottleneck of the spontaneous order of the temporal particularity of the “results of analysis based on a coach’s subjective criteria” (Miyazoe et al., 2007, p.33), the non-evidentiary nature of explaining team performance from images relying on “sense data”— “what is known directly by the senses” (Russel, 2005, p.15)—and the theory of “autopoiesis,” characterized by “the freedom to transform while continuing to operate for its own sake” (Kawamoto, 1995, p.337), not only does the coach’s “compelling power” become meaningless, the daily training also becomes a waste of effort. Therefore, in order to achieve “excellence of strength” and win, there must be guidelines with a certain objective validity in the coach’s “compelling power.” In other words, “we need practical guidelines based on scientific and applied understanding of team processes to ensure optimum team functioning” (West, 2012). In basketball, with constantly changing developments, if the “compelling power” a coach employs on an athlete or a team does not include “practical guidelines” that examine the “effects of situational variables” (Gómez et al., 2013, p.1579) appropriate for achieving and demonstrating “excellence of strength,” it is impossible to “use objectively tested theories to provide a rational explanation of events, or to use ‘theoretical knowledge’ with the predictability of the future” (Sato, 2011), and consequently, it is not possible to guarantee an understanding of the team’s playstyle among the team members, which is the basis of the team’s process. As a result, the team cannot function at its best.

If the practical guidelines inherent to the game of basketball, essential for achieving and demonstrating “excellence of strength,” are not based on the coach’s subjective judgment and instincts, then the guidelines to lead a team to victory must naturally be based on “a legal understanding of developments, based on quantification on a common scale that is not influenced by subjectivity” (Sato, 1993). “As in many other sports, basic statistics in basketball can never completely explain the outcome of any one game” (Britton and Yerger, 2015, p.683). This is because “a recognition of what are considered norms constitutes the basis upon which the coach can accurately judge individual and team performance from a statistical viewpoint” (Knight and Newell, 1986, p.21). Therefore, if the “practical guidelines” that verify the “influence of factors that change the situation” can be clarified through a “legal understanding of events based on a common scale,” then the coach’s “compelling power” will be far more effective, the quality of daily training will improve and bring the team closer to achieving their goal of victory.
1.2. Review of previous research and issues in this study

Given this situation, how can we find “practical guidelines” for basketball, a game in which “the factors that influence the result are intricately intertwined?” (Miyazoe et al., 2007, p.33) “Regardless of how systematic the analysis of a basketball game is, the interactions among players are unique and cannot be replicated, and cannot be reproduced either, because environmental conditions and players’ actions change from moment to moment” (Remmert, 2003, p.5). Accordingly, is it possible to construct a practical guide?

To this end, since “Coaches and analysts in today’s basketball tournaments use winning and losing statistics to analyze the performance of athletes and teams in complex and diverse games,” (Hughes and Franks, 2004) a “practical guide” that takes into account the “influence of factors that change the circumstances” is closely linked to the factors affecting the outcome of a game, which identifies the causal relationship between developments that are considered causes or effects of the result. (Britton and Yerger, 2015, p.683; Oliver, 2004, p.63; Sampaio, 2010a, p.391). Based on (statistical) data obtained, if we infer the causal relationship between the causes and effects of developments, and if such a relationship exists at all, it will enable “a lawful understanding of the developments based on quantification by a common scale uninfluenced by the subjectivity” of questions such as the extent to which the causal relationship influences the result, whether it can be ignored or must be accounted for, how useful it is, etc.

From this perspective, the number of studies that have been conducted on the factors affecting the outcome of a game, including those that do not include it in the title, is enormous. However, the main issue, as is typical of the assertion “a coach can afford him the opportunity of winning the majority of his games if he achieves predetermined shooting average.” (Newell and Benington, 1962, p.27), is that we can get “a shift of focus on... how to effectively and probabilistically take a shot, which is the game’s iconic form of movement, and from a defensive standpoint, how to prevent shots” (Uchiyama, 2012, p.30). This is evidenced by the fact that the mechanism of shooting itself is still being studied for over 100 years after its creation, albeit under controlled conditions. (Knudson, 1993; Lam et al., 2009; Lindeman et al., 2004; Okazaki and Rodacki, 2012). Further, with the emphasis on the fact that “an important topic studied in basketball is the players’ performance analysis during games and competitions” (Gómez et al., 2009, p.278), the methods of “game analysis” or “notational game performance analysis” have been used to intensively analyze the types of shots, number of attempts, and the success rate of shots that actually occurred during the games (Gómez et al., 2009). The factors determining the result are not limited to just the quality of shooting, but also include the complex mixture of circumstances that led up to it (Yoshii, 1969), such as the number of missed plays, blocks, and turnovers, as well as the prowess in acquiring the rebound ball, which is related to the increase or decrease in the number of attacks that lead to taking shots, and performance analysis of individual players such as their offensive and defensive patterns and dribbling and passing paths (Cleabaut, 1998; Krause, 1994; Ibañez et al., 2008; Oliver, 2004).

However, if persuasive individual “performance indicators” (Gómez et al., 2013, p.1579) are provided as information, independent of the analyst’s or observer’s ability, team performance will not necessarily improve and win games, but the existence of such a wide variety of factors affecting the outcome of a game will confuse the field. As the statement “interactions between offensive and defensive players are poorly regarded by basketball game analyses” (Remmert, 2003, P.5) suggests, each part of the cause of the result can be understood and described independently at the level of explanation, and although such descriptions have some effect in explaining the whole, it is not possible to explain or understand the whole by describing individual facts of the parts. This is because, “Although there is interest in identifying and describing these performance indicators and their effects... research is still very scarce when all these dimensions are addressed simultaneously” (Gómez et al., 2013, p.1579).

Under these circumstances, although team victory is achieved through coordination and continuity of the performances of individual players, as “it is impossible to overcome the complexities and diverse game situations through individual player performances alone” (Uchiyama, 2004), and the “individual ability to perform in a group, that is, a team, can only be demonstrated with teams” (Stiehler et al., 1988), studies have reported on the factors affecting the outcome of a game as well as the thresholds that differentiate between results in terms of team performance. (Knight
and Newell, 1986; Miyazoe et al., 2007; Newell and Benington, 1962; Oga, 2014). On the other hand, as noted in the beginning of this article, the competitive issues that directly determine the result of a basketball game change each time the constitutive rules are changed, so studies have also analyzed the new “influence of factors that change the situation” through the performance of the entire team. Especially after the 1980s, when the world governing body for basketball FIBA (International Basketball Federation) promoted “rules that compelled offensive play” (Morino, 1984) like the 24-second rule and the 8-second rule, as well as the 1999 change in playing time to “four 10-minute quarters,” the examination of the “effect of factors that influence the circumstances” emerged. Even before that, when the 40-minute playtime was divided into two halves, studies attempted to explain the final result based on the results at halftime (Cooper et al., 1992) or to analyze the relationship between team performance in the first and second halves from a bird’s-eye view (Moreno et al., 2013). However, the change to “four quarters of 10 minutes each” emphasized the fact that the “temporal dependence of the result of a basketball game is high” (Martinez, 2014, p.763), which has made the importance of play during every quarter all the more important.

For example, Oga (2014) analyzed the standard deviation of shots scored in 20 2-minute intervals and found that the reason for the Japan Women’s National Team’s defeat in the 2012 London Olympics Preliminary round was the way they played early on in the game, in the first two minutes of the first and second quarters. Sampaio et al. (2010a) studied 126 games of the Spanish Men’s Professional Basketball Teams, and Moreno et al. (2013) studied 364 games in the same Spanish Women’s Professional League. Both focused on the point differentials in the 5 minutes in the beginning and end of each quarter, measured their impact on the results of the game, and derived valuable findings—that for men, the difference in scoring in the first quarter can have an impact on the final result of the game, and for women, the difference in scores in the first quarter affected only the score in the second quarter. Gómez et al. (2013) analyzed the importance of the rate of ball control in each quarter from 40 Professional League games for both men and women in Spain and reported that for men, the first five minutes of the first quarter and the five minutes before the end of the fourth quarter, and for women, the last five minutes of the game affected the winner of the game. On the other hand, Ikeda et al. (2015) used logistic regression analysis of 122 International Women’s Wheelchair Games to examine the relationship between the point difference and game result, using the point difference in the first five minutes of each quarter and at the end of the game as independent variables and the result of the game as a dependent variable and reported that the first, third, and fourth quarters affect the result, and order of importance was “third > first > fourth.”

On the other hand, these findings demonstrate that “the game period (quarter) is also a situational variable of interest in basketball” (Gómez et al., 2013, p.1579) that influences the game result. The results are broadly divided into two types—first, that the final part of the game is most important (the last five minutes of the fourth quarter) (Bar-Eli and Tractinsky, 2000; Kozar et al., 1993; Mechikoff et al., 1990) and second, that the beginning of each quarter (the first five minutes) is the most important (Sampaio et al., 2010a; Sampaio et al., 2010b). As regards the former, it is unclear whether the relationship between each quarter is related to the final result of the game. Although the latter demonstrates the interesting finding that “the point difference between whether recovery is possible or not is 8-point cut-off” (Sampaio et al., 2010a, p.394), considering that it is possible to win by “just” 1 point over the opponent (at the end of the fourth quarter), and the method of multiple regression analysis is used with the dependent variable as a quantitative measure rather than a nominal scale (win/lose), the credibility of the results is also questionable. The importance of quarters on winning or losing the final game has been established in Ikeda et al. (2015). The targets were wheelchair-bound. Although it was at a high level and was limited to girls, it did not mention the relationship among the four quarters.

It is clear from the previous studies that the quarter-by-quarter playstyle is important, and particular quarters or specific times have a great effect on the result of the game. On the other hand, as the game is often interrupted by 10 to 15 minutes break between the first and second and halves and two-minute breaks between the first and second, and the third and fourth quarters, the 40 minutes of the game duration is often considered a simple mechanical combination of 10-minute quarters chained together, or as a simple ordering of specific quarters or times. These findings lack the perspective of individual quarters and their relationship with each other as part of the game time.
as a whole, and as a result, even if a particular quarter or time affects the result of the game, it can lead to a simplistic understanding that problems in the game as a whole are solved when the problems of the individual parts have been solved, or it can lead to a reductionist view as the whole is formed of constituent parts, of taking individual quarters as they were themselves whole, or even fall into the trap of infinite retrogression, where the order can be subdivided to any extent, causing further confusion in the field.

To overcome this confusion, it is obvious that a new analytical framework must be established to investigate the relationship between the parts and the whole, and the relationship among the parts. To this end, the following two statements provide useful perspectives for a solution to this issue. First, on the relationship between the whole and the parts, Cassirer (1982) said that parts are in a collection and generate interactions with each other; if we take the aggregate of the interrelationships of such parts to be the whole, then the parts act only as a “function” for the whole in its role of controlling diverse objects under a certain logical mechanism for the whole, and it is an assertion that each part does not mean something independent of itself, but that the “parts have meaning only in the whole.” The other is Husserl’s (1979) development of an analytical method that rationally considers the problem of relationships among the parts in various contexts, dividing them into two concepts based on whether they are relatively independent parts “fragments ‘Stücke’” or relatively dependent parts “moments ‘Moment’” of the whole. However, if we consider the establishment of a suitable analytical framework for investigating the part, the whole, or the relationship between them based on these assertions, it is sensible and appropriate to adopt Husserl’s position of “seeing the parts as a moment of the whole,” which is an extension of Cassirer. This is because the characteristic of “fragments” is that when the whole is divided, the parts remain independent and discrete, even though there is nothing common between the parts, and the synthesis of the whole is a mere collection, whereas a “moment” is defined as “an impetus that causes a certain event” (Kojien dictionary) and just like the relationship between the individual sound, sound quality, and melody, they cannot exist independently of each other. Unlike volleyball competitions in which the game wins or losses are determined by the sum of the number of sets acquired, basketball games are closer to the latter, where victory or defeat is determined by the accumulation of points per quarter. The validity of this position is supported by the study (Sampaio et al., 2010b) which found that the cumulative score of each quarter affects the subsequent psychological aspect of the competitors. By adopting this position, we can see that the uniform segments of 10 minutes starting in the first quarter and ending in the fourth are “chronologically transitive” (Oga and Sasaki, 2005, p.263; Oga, 2014, p.1). In other words, these 4 quarters have a progressive nature. The 40 minutes of game time comprising four 10-minute quarters do not exist as mere parts, but rather as interdependencies between quarters, which means that each quarter is understood to be interacting with others.

Based on these considerations, we can use the term “flow of a game” to describe the interaction and progression in the four quarters of 10 minutes each (Cooper et al., 1992; Oliver, 2004, p.2; Uchiyama et al., 2001)*7, and the “flow of the game” can be taken as the analytical framework for investigating the parts of the game, the whole, and the relationship between them. Based on this framework, we can clarify the causal relationship between the four quarters, factors affecting the situation, and the game result. The abovementioned statement, that is, that the four quarters of 10 minutes each is one of the factors that change the situation, is subsumed into an analytical device of the abovementioned “game flow” and the relationship among the four quarters becomes even more important as a factor affecting the outcome of a game.

This study aims to test this hypothesis, that is, to overcome the problem of how the “flow of the game” generated by each of the four quarters as the “situation-changing factors” of a basketball game, derived through the function of moments affect game results, to understand the relationship between the “flow of the game” as a factor affecting the outcome of a game, and to find practical guidelines to acquire and demonstrate “excellence of strength” based on a scientific and practical understanding of the factors that change the situation.

1.3. Purpose of this study

This study aims to investigate whether the causal relationship between the “flow of the game,” namely the four quarters of 10-minute segments progressively interacting with each other affects game results. Once
accomplished, the result will contribute toward team victories as a new guideline by introducing a higher degree of objective validity and effectiveness through the “compelling power” of the coach and overwriting previous factors affecting game results, which overemphasized the parts rather than the whole.

2. Methodology

2.1. Analytical perspectives

To test the hypothesis of the “flow of the game,” we establish three analytical perspectives: (1) the importance of each quarter, (2) the interdependence between quarters, and (3) the relationship between cumulative points and the game result. In analyzing these three perspectives, this study adopts the position that the “flow of the game” expressed by point difference and the result can be understood through three causal models (Figure 1).

The first model assumes that in a basketball game with rest between quarters, each quarter exists independently of the other, and is a 10-minute mini-game within a 40-minute game, and their “parts” are “aggregated.” Research (Gómez et al., 2013; Ikeda et al., 2015; Moreno et al., 2013; Sampaio et al., 2010a) investigated not just the point difference for each quarter, but also subdivided the quarters further (into 5-minute segments) for study. To ensure a certain degree of comparison with the results of these studies, plus the fact that although basketball games comprise four 10-minute quarters, there is a relatively longer rest time (roughly 10-15 minutes, though it is left to the organizers’ discretion) between two halves (between the second and third quarter) rather than the 2-minute durations between the quarters (first and second, third and fourth). After the second quarter half-time breaks up the continuity of the game—which may change the mental attitudes of the players and coaches—I added the variables “point difference five minutes into the first quarter” and “point difference five minutes into the third quarter.” Here, we assume a causal relationship in which each point difference (six variables) independently affects the final result of the game.

The second model adds unidirectional arrows (causal paths) to the first one, which assumes a causal relationship between the quarters, and removes the point difference at five minutes after the first and third quarters. In the above two models, the point difference is not cumulative, but in each case, the point difference of the chronologically preceding variable (five variables: five minutes after the start of the first and third quarters, and first, second, and third quarters) based on the start of the quarter was not added with the start of the quarter as the base (0).

The final model (Model 3) considers the chronologically preceding quarter to be the “situation-changing factor” of the subsequent quarter, and was developed with reference to the suggestions in previous studies regarding the importance of the first and fourth quarters, and the point difference up to the third quarter as given by Miyazoe et al. (2007) and Sampaio et al. (2010a). This model assumes that the subsequent quarter depends on the point difference of the preceding quarter. Given that the result (final point difference) is a cumulative product from the first quarter, it is reasonable that the first quarter holds a strong significance in explaining it, and similarly, in explaining the point difference at the end of the second and third quarters. However, assuming that each quarter is independent if the cumulative point difference is used as a variable, the point difference can be treated as a variable only up to the end of the third quarter; it fails to take into account the position in research findings (Bar-Eli and Tractinsky, 2000; Kozar et al., 1993; Mechikoff et al., 1990) that the final phase of the game is important. Therefore, Model 3 takes as variables the cumulative point difference up to the third quarter and the non-cumulative goal difference of the fourth quarter, the final phase of the game, which is particularly important in close games. Cumulative point differences are used for the second and third quarters. The point difference with the start of the quarter as the base (0) is used for the first and fourth quarters.

2.2. Target

To investigate the causal relationship among the four quarters based on the three analytical perspectives mentioned above, this study examined 261 games of the 87th, 88th, and 89th league games in the Kanto College Basketball League-I, one of the top-level league games in Japan from 2011 to 2013. As many as 8 games that went into overtime and 1 that was a forfeit were excluded from a total of 270. This was because it was thought that (1) the data obtained about league matches was between teams of competitive strengths and the sample had high reliability and validity, and
the results of the analysis had high versatility and potential for application as the matches were conducted under FIBA rules, which are used not only in high-level international competitions like the Olympics and World Championships, but also in high school-level and higher competitions in Japan.

In this league, each team played one match against all the others (first round), which was repeated, with all 10 teams playing 2 matches each with every other team (two round-robbins). Therefore, after selecting data on point differences in the first five minutes of the first quarter, at the end of the first quarter, the end of the second quarter, the first five minutes of the third quarter, the end of the third quarter, the end of the fourth quarter, and team results, adjustments were made to the point difference between the first and second rounds of games, and to the criteria for selecting winners and losers to avoid bias toward any one team (for example, in a match between Teams A and B, point differences and results were selected based on Team A in the first round, and on Team B in the second round). The point difference at the end of each

Figure 1  Conceptual models for the three analytical perspectives (from the top, Models 1, 2, and 3)
quarter was calculated from the records published by the Kanto College Basketball Federation (http://www.kbbbf.jp). The point differences at five minutes into the first and third quarters were recorded and calculated by the authors based on video footage of the games.

2.3. Statistical analysis

2.3.1. Verification of the importance of each quarter using logistic regression analysis

To clarify the quarters that are important for the final victory or defeat in the games, Model 1 was used to calculate the odds ratio of the variables affecting game results using a logistic regression analysis with point differences in the first five minutes of the first quarter, at the end of the first quarter, the end of the second quarter, the first five minutes of the third quarter, the end of the third quarter, and the end of the fourth quarter as independent variables, and team results as the dependent variable. The point difference here was not cumulative—the point difference in goals scored in the chronologically preceding quarter was not added, taking the start of the quarter as the base (0). Probability for stepwise method (forward selection method) was set at 5% for adding and 10% for removal. Following previous studies (Gómez et al., 2008; Gómez et al., 2014; Ikeda at al., 2015; Moreno et al., 2013; Sampaio et al., 2010a), the 261 matches were classified into several clusters using the \( k \)-means method for the final point difference. The final point difference is the absolute value of the accumulated point difference (final score) of the sampling teams for logistic regression analysis.

2.3.2. Verification of interdependencies between quarters using structural equation modeling

To clarify the relationship between each quarter (how the preceding one relates to the next chronologically, i.e., first to second, first and second to third, and so on) the causal relationship model was examined through a structural equation modeling using the first, second, third, and fourth quarter point differences and the result. Maximum-likelihood estimation was used for estimating the parameters of a probability distribution, and each path from the error variable to the observed variable was constrained to 1 in order to ensure the identifiability of the model. For the overall evaluation of the model, the Comparative Fit Index (CFI), Non-Normal Fit Index (NNFI), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Standardized Root Mean Residual (SRMR), Roots Mean Square Error of Application (RMSEA) were used as indicators. The standards of adopting the fit indices were \( \geq 0.9 \) for CFI and NNFI (Browne and Cudeck, 1993; Joarreskog and Soabom, 1996; Short et al., 2005), \( \geq 0.95 \) for GFI and AGFI (Bentler and Bonnet, 1980; Hu and Bentler, 1999; Toyoda, 2007), and \( \leq 0.08 \) and \( \leq 0.06 \) for RMSEA and SRMR, respectively (Hu and Bentler, 1999). The model displayed goodness of fit while meeting the above criteria. Akaike’s Information Facility (AIC) was used to compare the models.

Based on these two models, we examined the above analytical perspectives for (1) the importance of each quarter and (2) the interdependence between the quarters. First, using the data prepared for logistic regression analysis, the causal model of point differences was calculated under the assumption that each quarter is independent (Models 1, 2, and 3). Second, assuming that the quarters have an interdependency among them, to verify that the first can be a moment leading up to the second, the second to the third, and the third to the fourth, as well as to provide “practical guidelines,” we classified the game based on the cumulative point difference specifically at the end of the third quarter, and tested whether the causal model varied based on the situational factors for the point difference at the start of the fourth quarter (Model 3). In the multiple-group analysis of structural equation modeling based on Model 3, the games were classified into two: “point difference \( \geq 9 \)” and “point difference \( \leq 8 \),” based on Miyazoe et al. (2007), who found that the point difference up to the third quarter was important, and that “the final point difference between whether a game is recoverable or not is 8 points” (Sampaio et al., 2010a, p.394). The cumulative point difference up to the third quarter was used as a basis as we believe that there is a strong relationship between chronologically adjacent variables and variables like game score changes. All statistical analyses were performed using SPSS Statistics version 21.0 (IBM), Amos version 19.0 (IBM), with a statistical significance level at 5%.

3. Results and considerations

3.1. Importance per quarter

Cluster analysis using the \( k \)-means method revealed that the matches under study can be classified into two groups. Group 1 (69.0%) comprised games with a
The Causal Relationship between “the Flow of a Game” and Its Outcome in Basketball

The flow of a game and its outcome in basketball were analyzed. Logistic regression analysis was performed on 261 matches. The point differences at the end of the first quarter (OR = 1.352, 95% CI = 1.233 – 1.483, p = .000), at the end of the third quarter (OR = 1.473, 95% CI = 1.309 – 1.658, p = .000), and at the end of the fourth quarter (OR = 1.349, 95% CI = 1.224 – 1.486, p = .000) were significant factors affecting the game result. The model χ² value in the omnibus tests of model coefficients was p = .000, guaranteeing the significance of the model (p < .05). The Hosmer-Lemeshow test also guaranteed the predictive accuracy of the model (p = .906, p > .05) and the predictive value of discrimination was 90.4%.

Logistic regression analysis for groups classified using cluster analysis revealed that in “balanced games,” the point differences at the end of the first quarter (OR = 1.329, 95% CI = 1.211 – 1.459, p = .000), at the end of the third quarter (OR = 1.440, 95% CI = 1.278 – 1.623, p = .000), and at the end of the fourth quarter (OR = 1.317, 95% CI = 1.192 – 1.454, p = .000) were significant factors affecting the game result. The model χ² value in the omnibus tests of model coefficients was p = .000, guaranteeing the significance of the model (p < .05). The Hosmer-Lemeshow test also guaranteed the predictive accuracy of the model (p = .825, p > .05), and the predictive value of discrimination was 86.1%. In “unbalanced games,” only the point difference at the end of the first quarter (OR = 1.382, 95% CI = 1.204 – 1.586, p = .000) was a significant factor affecting the results of the game. The model χ² value in the omnibus tests of model coefficients was p = .000, which guaranteed the significance of the model (p < .05). The Hosmer-Lemeshow test also guaranteed the predictive accuracy of the model (p = .414, p > .05), and the predictive value of discrimination was 87.7%.

In the analysis of all 261 games, the first, third, and fourth quarters were found to affect the result, and their relative importance was found to be “third > first > second.” This was also true for “Balanced Games.” In both cases, the second quarter was not a significant predictor of the result. However, if we add the second quarter in the relationship between the importance of the quarters above, it is reasonable to express the results as “third > first > fourth > second.” This result is thought to be related to the player’s “playing time.” According to Sampaio et al. (2010b), important and less important players in terms of their roles in the team have a difference in their influence of turnover—an important statistic for game results—and the number of successful 2-point shots. Naturally, the former has been identified to have a positive impact. As is well known, the game of basketball has sped up since the rules were revised, abolished, and supplemented, and the up-tempo nature of the game and the athletic intensity required is so high that makes it difficult for 5 players alone to fight through 40 minutes in a single game. Inevitably there are times in the game when important players need to be rested. They are often the ones playing at the highly important points in the beginning of the first quarter of the game. They usually rest in the second quarter. It is reasonable to assume that this affects the fact that the second quarter is not a significant predictor of the result. The performance of the important players determines the outcome of the match, and the duration when they have reduced playing time is not important to the result of the game. In unbalanced games, only the goal difference in the first quarter affected the result, and the results of the analysis for each cluster showed that it was the first quarter that had the greatest influence on the result. This suggests the possibility that different quarters affect the results of the games depending on whether they have a relatively small or large point difference. The finding that the situational factors differed based on the difference in the game conditions (final point difference) supports past research (Ikeda et al., 2015; Moreno et al., 2013; Sampaio et al., 2010a).

3.2. Interdependencies between quarters

The aforementioned causal model of logistic regression analysis (Model 1) was tested through a structural equation modeling to shed light on the interdependence between each quarter. The fit indices were χ²(6) = 25.18, p < .001, CFI = .94, NNFI = .90, GFI = .96, AGFI = .90, SRMR = .06, RMSEA = .11 (90% CI = .068 – 1.57), AIC = 43.185, and though the criteria were met for all but one of the indices, the values of RMSEA were poor (Figure 2).

Focusing on the value of the path coefficients in Figure 2, the results confirm the importance of the
path coefficients for the results as suggested by the odds ratio of “third > first > fourth” in the logistic regression analysis. It was found to be poorly-validated. This result demonstrated that the “flow of the game” in basketball cannot be understood using a simple addition schema where each game is considered to comprise four independent quarters, and each player plays four 10-minute mini-games.

Next, the causal model of Model 2, in which the one-way arrows “first → second,” “first → third,” “first → fourth,” “second → third,” “second → fourth,” and “third → fourth” were added to Model 1, was validated by a structural equation modeling. The findings were that the paths (causality) at “first → second, fourth” and “second, third → fourth” were not significant, and the final model derived from removing those paths is shown in Figure 2. The fit indices in Figure 2 were $\chi^2(4) = 7.50$, $p = .112$, CFI = .99, NNFI = .99, GFI = .99, AGFI = .96, SRMR = .06, RMSEA = .06 (90% CI = .000 – .122), AIC = 29.50. The fit indices fulfilled criteria and usefulness of the model was observed. Comparing Models 1 and 2, we can see that paths were added between “first → third” and “second → third.” This means that the point difference in the first and second quarters significantly predict the point difference in the third.
The Causal Relationship between “the Flow of a Game” and Its Outcome in Basketball

quarter, suggesting, for example, that teams that outscored their opponents in the first and second quarters are more likely to play the game dominantly in the third quarter as well. The results of all standardized direct and indirect effects up to the third quarter (direct: first → result "41," second → result "32," third → result "41"; indirect: first → third → result "07," second → third → result "07") indicate that the result of most games can be taken to be explainable by the point difference up to the third quarter, suggesting that how the game unfolds until the third quarter is important to the “flow of the game.”

The analysis was repeated for Model 3 as well, removing non-significant paths, and the final model was derived. The results showed that the fit indices were $\chi^2(5) = 4.85, \ p = .435$, CFI = 1.00, NNFI = 1.00, GFI = .99, AGFI = .98, SRMR = .01, RMSEA = .00 (90% CI = .000 – .085), AIC = 24.85. The value of all indices were very good (Figure 4). Compared to the result of the fit indices in Model 2 (Figure 3), although there was not much difference in the absolute criteria (CFI, GFI, etc.), Model 3 is a slightly better fit looking at the relative criteria of $\chi^2$ and AIC. Thus, “flow of the game,” an understanding of the result, is represented somewhat more clearly by a model using the cumulative point difference at the end of each quarter until the third quarter and the point difference at the beginning of the fourth quarter as variables rather than a model that uses point differences between the start and end of each quarter. Both values of the path coefficient in Figure 4 are significant, suggesting that the point difference in the quarters leading chronologically from the “first → second (cumulative),” “second (cumulative) → third (cumulative),” and “third (cumulative) → fourth” are “moments” for the next quarter. Further, “third (cumulative) → result” and “fourth → result” were also observed as significant paths.

3.3. Relationship between the cumulative point difference and the result

To test whether we could observe a variance in the causal model based on the point difference at the start of the fourth quarter, we performed a multiple-group analysis using the structural equation modeling based on Model 3. The cumulative point difference in the third quarter was classified into two groups (cumulative point difference up to the third quarter ≤ 8 points: $n = 91$, cumulative point difference up to the third quarter ≥ 9 points: $n = 170$) for comparison and verification with reference to previous studies.

The model’s fit indices were $\chi^2(10) = 5.27, \ p = .872$, CFI = 1.00, NNFI = 1.00, GFI = .99, AGFI = .98, SRMR = .03, RMSEA = .00 (90% CI = .000 – .034), AIC = 45.27, all of which met the criteria and the construct validity was recognized (Figure 5). The results showed that the “first → second (cumulative)” and “second (cumulative) → third (cumulative)” paths were significant. For the “third (cumulative) → fourth” path, although there was a significant path (causality) in games with a cumulative point difference of 9 or more points up to the third quarter, the path coefficient was not significant for games with a

---

**Figure 4** Results of the examination of Model 3 using structural equation modeling (standardized estimates)
cumulative point difference of 8 points or less. Although significant paths (causal relationships) were observed in both the groups for “third (cumulative) → result,” they were not for the “fourth → result” in games with point differences of 9 or more points in the third quarter. While testing with pairwise comparison the critical ratios for differences between parameters, we observed that all path coefficients except for the “third (cumulative) → result” were significantly different ($p < .05$).

We observed that the path coefficients between the quarters (first (cumulative) → second (cumulative), second (cumulative) → third (cumulative), third (cumulative) → fourth (cumulative)) were all higher in games with a cumulative point difference of 9 or more until the third quarter than in games with a point differential of 8 or lower. This suggests that the games with a point differential of 9 or more are more dependent on the point differential from the chronologically preceding quarter. In other words, the point difference that manifested in the first quarter either remains unchanged or increases. Conversely, such a game shows that there was already a difference in ability before the game began and it was not influenced by the “flow of the game,” which would be intentionally generated by tactics like member substitutions and timeouts that the coach could take in the game. In contrast, if you look at the path coefficients in “third (cumulative) → fourth” and “fourth → result” in a game within a cumulative point difference of 8 or less, it cannot explain the development of the fourth quarter through the cumulative gain and loss difference up to the third quarter. The possibility remains that the game could be won or lost based on how the last 10 minutes are played. In other words, this suggests that if the cumulative point difference until the end of the third quarter is 8 or less, there is still a high probability that it can be reversed even if the team is losing by 8 points.

4. Conclusion

This study aimed to investigate the causal relationship between the flow of the game—which focuses on the interdependence of the four quarters of a basketball game and their progressive interaction—and the result.

We studied 1044 quarters of 261 games in the Kanto College Basketball League-I, one of the strongest collegiate leagues in Japan, based on the following three analytical perspectives: (1) the importance of each quarter, (2) the interdependence among the quarters, and (3) the relationship between cumulative point differences and the results. We also clarified which quarter is most important for the final result of a game. We analyzed using a logistic regression analysis with stepwise method, with the point differences in the first five minutes of the first quarter, at the end of the first quarter, the end of the second quarter, the first five minutes of the third quarter, the end of the third quarter, and the end of the fourth quarter as independent variables, and team wins and losses as the dependent variable. The causal relationship between the models used for logistic regression analysis (Model 1) and the cumulative point variation mixing models.
The Causal Relationship between “the Flow of a Game” and Its Outcome in Basketball

(Models 2 and 3) based on the findings of previous studies was verified by a structural equation modeling.

The results of the analysis and discussion in this study are summarized as follows:

1. The first, third, and fourth quarters affect the results of games, whether the final point difference is \( \leq 19 \) points or \( \geq 20 \) points, and the importance in order of each quarter, including the second, is “third > first > fourth > second.” In the case of unbalanced games where the score difference is \( \geq 20 \) points, the point difference in the first quarter is a factor that affects the result. These results show that the quarters that affect the final result are different based on whether the game is one where the final point difference is close, or the difference is quite high.

2. The interdependence of each quarter is “first \( \rightarrow \) second (cumulative),” “second (cumulative) \( \rightarrow \) third (cumulative),” and “third (cumulative) \( \rightarrow \) fourth,” and the point difference with the chronologically preceding quarter acts as a “moment” for the next. The “third (cumulative) \( \rightarrow \) result” and “fourth \( \rightarrow \) result” paths have a strong causal link and a significant impact on the result of the game.

3. Based on the interdependence of the “third (cumulative) \( \rightarrow \) result” and “fourth \( \rightarrow \) result,” if the cumulative point difference at the end of the third quarter is 8 points or less, the game will be decided on how the fourth quarter is played. This suggests that if the cumulative score difference until the end of the third quarter is within 8 points, there is a greater chance of upset than if the cumulative point difference is 9 or more.

These findings verify the hypothesis that in a basketball match, the “flow of the game,” that is, the four 10-minute quarters of a basketball game progressively interacting with each other, affect the game result, and for teams that play on FIBA rules, it is a scientific and practical guideline that is suitable to acquire and demonstrate “excellence of strength.” However, these findings have been derived only for universities, although they are at a superior level. Thus, it is necessary to verify the findings by examining games in various categories of matches above high school in the future.

Notes

*1 “Compelling power” refers to the ability inherent in a coach to extrinsically compel athletes to “physically change their body” toward the goal of victory using an intellectual ability comprising “reasoning” and “production” processes based on theoretical knowledge. It is the ability to constantly free the athletes from the constraints of a “dead weight.” However, it is essentially the exact opposite of the Machiavellian “management education” that is associated with similar terms. It does not “seek to control in order to conform to some specific condition or prevent deviation from a predetermined arrangement,” but can rather be understood as being “exercised in an attempt to break away from the constraints of a specific condition” (Uchiyama, 2013, p. 631).

*2 “Sense data” is “private to each individual” (Russell, 2005, p. 26), and “pictures” also “cannot render unique rules” (Wittgenstein, 1958).

*3 According to Kawamoto, “If one player makes a move, whether intentional or by chance, other players will initiate moves to continue it. When the team continues to operate in such a way that moves continue, it has reached the stage of auto-poiesis.” However, this “freedom to transform while continuing to operate” is actually an ideal. Generally, no matter what the level of the team is, such freedom does not generate team performance. This is because, as Kawamoto (1995, p.335) said, it takes a large amount of time for “repetitive practice” to allow for “full mastering of the rules of formation, to internalize them so that the rules themselves disappear” and “from the spectators’ perspective, it seems that the players are creating new formations one after another, or performing versions of known formations at will” (Kawamoto, 1995, p.336; emphasis in original) because they are only momentary events (developments) in various game situations.

*4 The “knowledge” and “experience” that comes from “stories of personal experience that are merely episodes sport specific to that person and event” (Lyle, 2002) and “the ‘internal interpretations’ of the subjective phenomena of experience” (Nishi, 2002) are unique to the individual, and “experience” is nothing more than the “disparate sensory knowledge of individual events” (Ide, 1968). Experiences are more than words and can only take shape when given form, and if there is no attempt to express them, they will never become clear. However, it is naturally a “challenge to the unknown” to transform athletic culture into a new form by repeatedly “adjusting to the particulars” and “breaking free from the status quo to achieve a higher level of sophistication” with the aim of victory. Therefore, it is impossible in principle to lead an athlete to a never-before-attained level only by relying on known experiences and familiarity. The knowledge and information floating around in today’s globalized world can never guarantee a definitive answer to a coach’s choice of action. In contrast, it is also a source of confusion. This is why we must not impose arbitrary and dogmatic ideas on people, but rather be acquainted with the intrinsic logic that drives the surface phenomena at the deeper levels. This logic comprises a cycle of reflection on a single experience, the accumulation of lawful knowledge and conceptual/academic knowledge characterized by generality and necessity, the sublimation of this knowledge into critical evidence, and the verification of this knowledge in practice. The role of theoretical knowledge is to predict the hidden connections between seemingly unrelated events and to verify these predictions.

*5 This “notational game performance analysis” is a key factor in quantifying game outcomes, and a valid and coherent objective method for recording and providing feedback on performance (Nevill et al., 2008).
*6 Some studies have mentioned gender differences. For example, defensive rebounding and field-goal success rates are strongly related to game outcomes for men (Ibañez et al., 2003; Sampaio and Janeira, 2003) and three-point shot success rate and the number of assists mark the difference for women (Gómez et al., 2006; Gómez et al., 2009). Oliver (2004) also identified four factors that are most important in evaluating offensive performance: field success rate, the number of offensive rebounds, the number of errors on ball possession, and the relationship between free throws and the number of attempted field throws. Some studies have suggested a strong correlation between rebounding and height, although not a baseline, and that one rebound is equivalent to 0.6 to 0.7 points in terms of points scored (Oga, 2014, p. 4).

*7 The reason for defining the “flow of a game” this way is that none of the previous studies that discussed it have provided a clear and establishing explanation of the phenomenon or the situation that was defined as the “flow of a game.” Some studies have referred to terms or definitions similar to the “flow of a game” based on a succession of points scored: “pace of a game” (Mexas et al., 2005; Mikes, 1987; Moreno et al., 2013), or “momentum” (Britton and Yerger, 2015), or “the chronological development of play expressed through tempo or pace” (Oga and Sasaki, 2005, p.263; Oga, 2014, p.1). However, although we see commonalities such as “they have a constantly varying ratio relative to the opponent’s power” (Oga and Sasaki, 2005, p.270), as described above, we do not find a convincing explanation for the source of the term or a definition of its semantic content. As the relative change because of consecutive goals scored is not inevitable in any quarter of any game, an element of coincidence enters, and in the case of Oga et al., we are only discussing “play.” In contrast, the four quarters are permanent by constitutive rules and cannot be affected by chance. Thus, the concept of “flow of a game” is a suitable target for extracting and identifying the semantic content of the concept.

*8 The one-way arrow “→” connecting the variables in the structural equation modeling (path diagram) is called a “path.” The variable to the left of the arrow represents the cause and the one to the right represents the effect. Thus, a causal relationship is established. The “path coefficient” is a numerical value of the strength of the relationship.

References

Bar-Eli, M. and Tractinsky, N. (2000). Criticality of game situations and decision making in basketball: an application of performance crisis perspective. Psychol. Sport Exerc., 1: 27-39.

Bentler, P. M. and Bonnet, D. C. (1980). Significance tests and goodness of fit in the analysis of covariance structures. Psychol. Bull., 88: 588-606.

Britton, P. and Yerger, C. R. (2015). A boxing-like round by round assessing model fit. In: Bollen, K. A. and Long, J. S. (eds.), Testing Structural Equation Models (pp. 213-226). California: Sage Publication.

Cassirer, E. (1982). 実体概念と間接概念. 第3刷 (Y. Yamamoto Trans.). (p.119). Tokyo: Misuzu Shobo. (Original work “Substanzbegriff und Funktionsbegriff” published 1910)

Cleabaut, D. (1998). The NBA analyst: a revolutionary method for evaluating NBA players and teams. Texas: Taylor Publishing.

Cooper, H., DeNeve, K. M., and Mosteller, F. (1992). Predicting professions sports game outcomes from intermediate game scores. Chance, 5: 18-22.

Husserl, E. (1979). 論理学研究 3 (H. Tatematsu and Y. Matsu Trans.). (pp.11-84) Misuzu Shobo, Tokyo: Misuzu Shobo. (Original work “Logische Untersuchungen 3” published 1901)

Gómez, M. A., Lorenzo, A., Sampaio, J., and Ibañez, S. J. (2006). Differences between women’s basketball winning and losing teams performance in game related statistics. J. Hum. Mov. Stud., 51: 357-369.

Gómez, M. A., Lorenzo, A., Sampaio, J., Ibañez, S. J., and Ortega, E. (2008). Game-related statistics that discriminating winning and losing teams from the Spanish Men’s Professional Basketball Teams. Coll. Antropol., 32: 451-456.

Gómez, M. A., Lorenzo, A., Ortega, E., Sampaio, J., and Ibañez, S. J. (2009). Game related statistics between basketball starters and nonstarters players in Women’s National Basketball Association League (WNBA). J. Sports Sci. Med., 8: 278-283.

Gómez, M. A., Loernzo, A., Ibañez, S. J., and Sampaio, J. (2013). Ball possession effectiveness in men’s and women’s elite basketball according to situational variables in different game periods. J. Sports Sci., 31: 1578-1587.

Gómez, M. A., Pérez, J., Molik, B., Szyman, R. J., and Sampaio, J. (2014). Performance analysis of elite men’s and women’s wheelchair basketball teams. J. Sports Sci., 32: 1066-1075.

Hughes, M. and Franks, I. M. (2004). Notational analysis of sport. Systems for better coaching and performance in sport. Routledge.

Hu, L. and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct. Equ. Modeling, 6: 1-55.

Ibañez, S. J., Sampaio, J., Saenz-Lopez, P., Gimenez, J., and Janeira, M. A. (2003). Game statistics discriminating the final outcome of Junior World Basketball Championship matches (Portugal 1999). J. Hum. Mov. Stud., 45: 1-19.

Ibañez, S. J., Sampaio, J., Feu, S., Lorenzo, A., Gómez, M. A., and Ortega, E. (2008). Basketball game related statistics that discriminate between team’s season-long success. Euro. J. Sport Sci., 8: 369-372.

Ide, T. (1968). [Translator’s note. Corpus Aristotelic, Volume 12, Metaphysics] (p.515). Tokyo: Iwanami Shoten. (in Japanese)

Ikedo, E., Tachibana, K., Uchiyama, H., Iwai, K., Hotta, K., Mutuzaki, H., and Wadano, Y. (2015). Relationship between “flow” and victory or defeat in wheelchair basketball: Focusing on time and goal difference. Jpn. J. Coach. Stud., 28: 225-229. (in Japanese)

Joareshog, K. and Soiurbom, D. (1996). LISREL 8.14: Structural equation modeling with the SIMPLIS common language. Illinois: Scientific Software International.

Kawamoto, H. (1995). [Autopoiiasis 3rd generation system]. Tokyo: Seidosha. (in Japanese)

Knight, B. and Newell, P. (eds.) (1986). Basketball Volume 1. Indiana: Graessle-Mercer Company.

Knudson, D. (1993). Biomechanics of the basketball jump shot-six key teaching points. J. Phys. Educ. Rec. Dance, 63: 67-73.

Kozar, B., Whitefield, K. E., Lord, R. H., and Mechikoff, R. A. (1993). Timeouts before free-throws: do the statistics support the strategy? Percept. Mot. Ski., 76: 47-50.

Lam, W. K., Maxwell, J. P., and Masters, R. S. W. (2009). Analysis versus explicit learning of a modified basketball shooting task: performance and kinematic outcomes. J. Sports Sci., 27: 179-190.

Lindeman, B., Libkuman, T., King, D., and Kruse, B. (2000). Development of an instrument to assess jump-shooting form in
The Causal Relationship between “the Flow of a Game” and Its Outcome in Basketball

basketball. J. Sport Behav., 23: 335-348.

Lyle, J. (2002). Sport coaching concepts: a framework for coaches’ behavior (p.31). London: Routledge.

Martinez, J. A. (2014). The influence of the first quarter on the final result in basketball. Revista internacional de Medicina y ciencias de la Actividad Fisica y el Deporte, 14: 755-769.

Mexas, K., Tiskaris, G., Kyriakou, D., and Garefis, A. (2005). Comparison of effectiveness of organized offences between two different championships in high level basketball. Int. J. Per. Anal. Sport, 5: 72-82.

Mikes, J. (1987). Computer breakdown of percentage basketball. Scholastic Coach, 57: 52-54.

Moreno, E., Gómez, M. A., Casais, L., and Sampaio, J. (2013). Effects of starting quarter score, game location and quality of opposition in quarter score in elite women’s basketball. Kinesiology, 4: 48-54.

Meinel, K. (1960). Bewegungslehre (S.149-154). Berlin: Volk und Wissen Volkseigener.

Miyazoe, S., Uchiyama, H., Yoshida, K., Sasaki, N., and Gotoh, M. (2007). Statistical analysis of the factors affecting the outcome and standard value in basketball game. Bull. Inst. Health Sport Sci., Univ. Tsukuba, 30: 31-46. (in Japanese)

Morino, S. (1984). [Sociology of sports and rules] (p.179). Aichi: University of Nagoya Press. (in Japanese)

Neumann, H. (1990). Basketball training (S. 8). Aachen: Meyer & Meyer.

Nevill, A., Atkinson, G., and Hughes, M. (2008). Twenty-five years of sport performance research in the Journal of Sports Sciences. J. Sports Sci., 26: 413-426.

Newell, P. and Benington, J. (1962). Basketball methods (p.27). New York: Ronald Press Company.

Nishibe, S. (2002). [Structure of intelligence] (p.213). Tokyo: Haruki Bunko. (in Japanese)

Oga, K. and Sasaki, K. (2005). An Analysis of the Basketball Games on the Changing Ratio of the Player in Offense and Defense with the Progress of Scores-An Attempt to Analysis of Tempo (Nagare). Bull. Yamagata Univ. Educ. Sci., 13: 263-272. (in Japanese)

Oga, K. (2014). An Analysis of the Basketball Games on the Tempo of Women’s Team Japan: 2012 FIBA London Olympic Qualifying Tournament. Bull. Yamagata Univ. Educ. Sci., 16: 1-15. (in Japanese)

Okazaki, V. H. A. and Rodacki, A. L. F. (2012). Increased distance of shooting on basketball jump shot. J. Sports Sci. Med., 11: 231-237.

Oliver, D. (2004). Basketball on paper: rules and tools for performance analysis. Nebraska: Potomac Books.

Poulton, E. C. (1952). On prediction in skilled movements. Psychol. Bull., 54(6), p.474.

Remmert, H. (2003). Analysis of group-tactical offensive behavior in elite basketball on the basis of a process orientated model. Euro. J. Sport Sci., 3: 1-12.

Russell, B. (2005). 哲学入門 (N. Takamura Trans.). Tokyo: Chikuma Shobo. (Original work “The Problems of Philosophy” published 1912)

Sampaio, J. and Janeira, M. (2003). Statistical analyses of basketball team performance: understanding teams’ wins and losses according to a different index of ball possessions. Int. J. Per. Anal. Sport, 1: 40-49.

Sampaio, J., Lago, C., Casais, L., and Leite, N. (2010a). Effects of starting score-line, game location and quality of opposition in basketball quarter score. Euro. J. Sport Sci., 10: 391-396.

Sampaio, J., Drinkwater, E. J., and Leite, N. (2010b). Effects of season period, team quality, and playing time on basketball player’s game-related statistics. Euro. J. Sport Sci., 10: 141-149.

Sato, T. (1993). [Philosophy of physical education-physical education philosophy-]. Tokyo: Kitaki Publishing. (in Japanese)

Sato, T. (2011). [Philosophy of coaching] (p.62). 2011 Philosophical Exploration of Sport and Dance.

Short, S. E., Sullivan, P., and Feltz, D. L. (2005). Development and preliminary validation of the collective efficacy questionnaire for sports. Meas. Phys. Educ. Exerc. Sci., 9: 181-202.

Stiehler, G., Konzag, I., und Döbler, H. (1988). Sportspiele (S.67). Berlin: Sportverlag.

Toyoda, H. (2007). [Covariance Structure Analysis Amos ed: Structural Equation Modeling]. Tokyo: Tokyo tosho. (in Japanese)

Uchiyama, H., Takei, M., Oga, N., and Hidaka, T. (2001). A study on the collective tactics action in world class basketball teams: based on game analysis of the 18th Asian women’s basketball championship. Jpn. J. Sport Method., 14: 104. (in Japanese)

Uchiyama, H. (2004). Structural analysis of team tactics in basketball. Jpn. J. Sport Method., 17: 26. (in Japanese)

Uchiyama, H. (2009a). An analysis of the gaming characteristics of basketball: Differential discussion-style approach with attention to moving forms. Jpn. J. Phys. Educ. Health Sport Sci., 54: 29-41. (in Japanese)

Uchiyama, H. (2009b). An approach for grasping the concept of athletic capability. Jpn. J. Phys. Educ. Health Sport Sci., 54: 161-181. (in Japanese)

Uchiyama, H. (2012). Ontological structure of rules in basketball: From a range as intellectual opportunities that constitute athletic capability. Bull. Inst. Health Sport Sci., Univ. Tsukuba, 35: 27-49. (in Japanese)

Uchiyama, H. (2013). The essential role of coches. Jpn. J. Phys. Educ. Health Sport Sci., 58: 677-697. (in Japanese)

West, M. A. (2012). Effective teamwork: practical lessons from organizational research(3rd ed.) (p.337). New Jersey: BPS Blackwell.

Wittgenstein, L. (1958). Philosophical investigations (p. 54). London: Macmillan.

Yoshii, Y. (1969). Factors that determine the outcome of basketball. Phys. Educ. Sci., 19: 354-358. (in Japanese)
Name:
Haruki Uchiyama

Affiliation:
Faculty of Health and Sport Sciences, University of Tsukuba

Address:
1-1-1 Tennodai, Tsukuba, Ibaraki 305-8574, Japan

Brief Biographical History:
2011-present Professor, Faculty of Health and Sport Sciences, University of Tsukuba
2016-2018 Chair of the Master’s Program in Health and Sport Sciences, University of Tsukuba
2016-present President of the Japan Society for Basketball Studies
2018-present Dean of the Graduate School of Comprehensive Human Sciences, University of Tsukuba

Main Works:
• Uchiyama, H. (2019). Exploring the guiding principle of collaborative in team sports. Jpn. J. Phys. Educ. Health Sport Sci., 64: 731-747. (In Japanese)
• Uchiyama, H., Ikeda, E., Yoshida, K., Machida, Y., Amino, T., and Kashiwakura, H. (2018). A study on the causal relationship between the “flow of a game” and its outcome in basketball, focusing on the interdependence relationship of the 4 periods. Jpn. J. Phys. Educ. Health Sport Sci., 63: 605-622. (In Japanese)
• Uchiyama, H. (2015). Examination of the prerequisites for the creation of team performances: preliminary considerations for investigating “kansei in team.” J. Phil. Sport Phys. Educ., 37(2): 115-131. (In Japanese)
• Uchiyama, H. (2014). A study of the norm for supporting play by athletes in team sports: focusing on Michael Jordan’s “authority.” Jpn. J. Phys. Educ. Health Sport Sci., 59: 591-608. (In Japanese)
• Uchiyama, H. (2013). The essential role of coaches. Jpn. J. Phys. Educ. Health Sport Sci., 58: 677-697. (In Japanese)

Membership in Learned Societies:
• Japan Society of Physical Education, Health and Sport Sciences
• Japan society for the Philosophy of Sport and Physical Education
• The Japan society of Coaching studies
• Japanese Society of Sport Education
• The Japan Society for Basketball Studies