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Analysis of Technology of Basic Actions for Aerobics Based on Biomechanics

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Abstract: As one of people's favorite sports, with the urgent enhancement of demand of spiritual civilization, the number of aerobics lovers is increasing. To provide better scientific methods, this study analyzes its basic arm actions, basic trunk actions and basic lower limbs actions, proposes a method in biomechanics. Finally, it extracts the biomechanical parameters for basic actions and analyzes the significances and validities of varied parameters. The technical analysis and study method provide theoretical bases for studies and trainings of aerobics.

Key words: Mechanical parameter, action intersection angle, space coordinates, aerobics technology

INTRODUCTION

Aerobics is a popular sport item which integrates gymnastics, dance, music, fitness and amusement. "Health, power, beauty" demonstrates its artistry. It is the body's peak. However, aerobics contains all. It has strong rhythms which can bring fitness through music (Ma, 2010). During its learning and training, it is essential to analyze its basic actions. Only when you hold those minimal actions finely, you can reach the effect of "Health, power, beauty". This study analyzes its basic arm actions, basic trunk actions and basic lower limbs actions. Then this study proposes a biomechanical method to provide theoretical bases for aerobics (Li, 2010).

Lots of scholars have been studying methods for aerobics and physical training. Their conceptions and methods contribute to the development of aerobics. For example, through Ma Xiaocong sports literature, expert interview and statistical analysis method, compare the rules for competitive aerobics contests during 2005~2008, 2009~2012, study the requirement alternations for 09th rule and explore the difficult actions based on rule. Its purpose is to provide advice for development of our difficult actions for competitive aerobics and training (Zhang, 2013). Zhang (2009) studies the trends of aerobics and factors of aerobics performances and provides some references for its teaching and training (Cui, 2013); Ling Xingguan combines training theories of aerobics and study methods for biomechanics, according to characters of difficult actions (Ling, 2008), conduct analysis in biomechanics from perspective of theory and science and get the biomechanical principles, so as to provide theoretical bases for training (Yang, 2013).

Based on previous studies, this study analyzes its basic arm actions, basic trunk actions and basic lower limbs actions, through space forms of technical features. Directing at varied basic actions, through conducting biomechanical analysis, provide some valid advice for aerobics lovers.

ANALYSIS OF TECHNICAL ACTIONS

Basic technical actions are fundamental which is the base for varied combined actions. Therefore, clear understanding of basic technical actions is helpful for mastering action specification correctly and fostering correct conceptions. Then by analyzing technical actions from three parts of body, the external demonstrations of actions provide space bases for biomechanics (Wang and Yang, 2013).

Analysis of arm actions: Arm action focuses on arm and hand. Arm actions include raise, bicep curls, thrust, swing, lifting, dropping down, chest pressing, punch, shoulder pressing, swing, circle and cross. The hand actions include five fingers together, split, ballet, fist, standing palm and Cachucha. Figure 1 shows the basic situation of arm actions.

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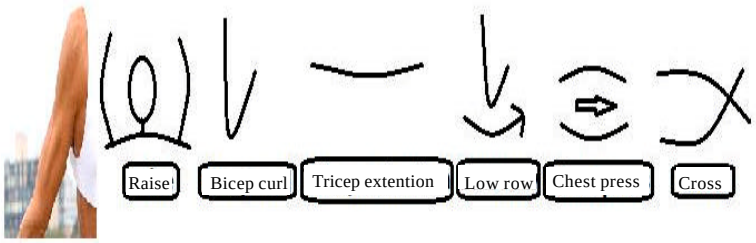

Fig. 1: Basic arm actions

Fig. 2: Basic hand actions

Figure 1 shows six basic actions such as raise, bicep curl, triceps extension, low row, chest press and cross. Raise refers to raising elbow joint higher than shoulder until the intersection angle between forearm and upper arm approaching 180°.Athlete should control his velocity according to requirements and rhythms. Besides the intersection angles between forearm and upper arm can be studied; bicep curl refers to drawing close to upper arm which also can be studied though that intersection angle; triceps extension is to make forearm to draw close upper arm to some degree, or in the process, upper arm swings around shoulder joint; chest press means upper arm taking forearm to the front and we can study the changes of intersection angle between upper arm and arms; cross is common, mainly refers to coinciding, we can study the position of coinciding point and its intersection angle (Liu, 2013).

There are many kinds of hand actions which are developed from jazziness, ballet, cachucha, disco, martial art, etc. Their alternations improve the vitality, shown as Fig. 2. (1) Demonstrates five fingers together, (2) Demonstrates split, (3) Demonstrates ballet, (4) Demonstrates fist, (5) Demonstrates standing palm and (6) Demonstrates cachucha.

Analysis of basic trunk actions: Trunk functions as continuing, protecting and fixing. Its exercise is for developing and balancing muscle planes. In the middle of trunk, only the muscle and soft tissue around spine and waist abdomen connect and support the body. In daily life, many people have some injuries or bad shapes due to imbalanced development and not enough strength. Therefore in the training or practice, these muscles should be developed and balanced. Some specific rules have been published. The actions against natural directions are banned. And list some bad actions as violation. Figure 3 shows the basic trunk actions.

Figure 3 shows five basic trunk actions such as fade-away, hypsokinesis, erect, procaine and anthemion. Fade-away is, considering waist as a supporting point and spine as a node, to fade upper trunk away and procaine the down trunk to reach the demands; hypsokinesis is

weak with small magnitude; procaine is, considering waist as a supporting point and spine as a node, to procaine upper trunk and fade the down trunk away to reach the demands; likely, anthemion is weak with small magnitude. Such actions can be indicated in two angles and a scale value, shown as Fig. 4.

In Figure 4, L is the length of spine and k is the percentage of parts above node. Shown as Figure 4, the variables are time-varying which demonstrates the trunk actions.

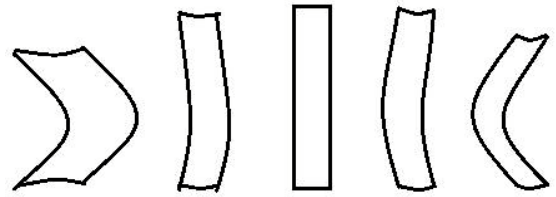

Fig. 3: Basic trunk actions

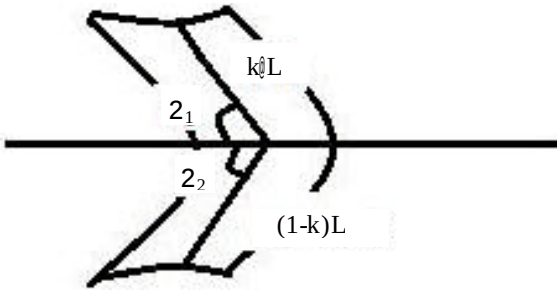

Fig. 4: Scale value of trunk actions

Analysis of lower limbs actions: It mainly studies basic paces. According to the action types, it can be classified into alternation, step, touch step, leg raise and double legs. The basic actions for alternation include: March, walk, easy walk, V step, roam and run; the basic actions for step includes: Step touch, step tap, step knee, step curl and Grapevine; the basic actions for leg raise include knee lift, swinging kick, kick, play kicked and leg curl; the basic actions for double legs include: step jump, split jump, jumping jack, leap ups, lunge and toe raise.

Figure 5 shows eight basic actions such as March, easy walk, V step, step touch, step tap, step curl, grapevine and touch gap.

Shown as Fig. 5, the action description and techniques of basic step methods can be summarized as Table 1.

BIOMECHANICAL ANALYSIS OF AEROBICS ACTIONS

Biomechanical analysis of arm actions: It mainly refers to upper arm actions. If the length of arm is fixing, the action can be described by angle which is time-varying. Build a 3-dimensional coordinate based on trunk plane and the straight line which is perpendicular to trunk plane and through shoulder joint (Tan, 2013). The arm includes upper arm and forearm. Analyze the intersection angle between projecting of upper arm onto trunk plane and axis and the intersection angle between upper arm and forearm, shown as Fig. 6.

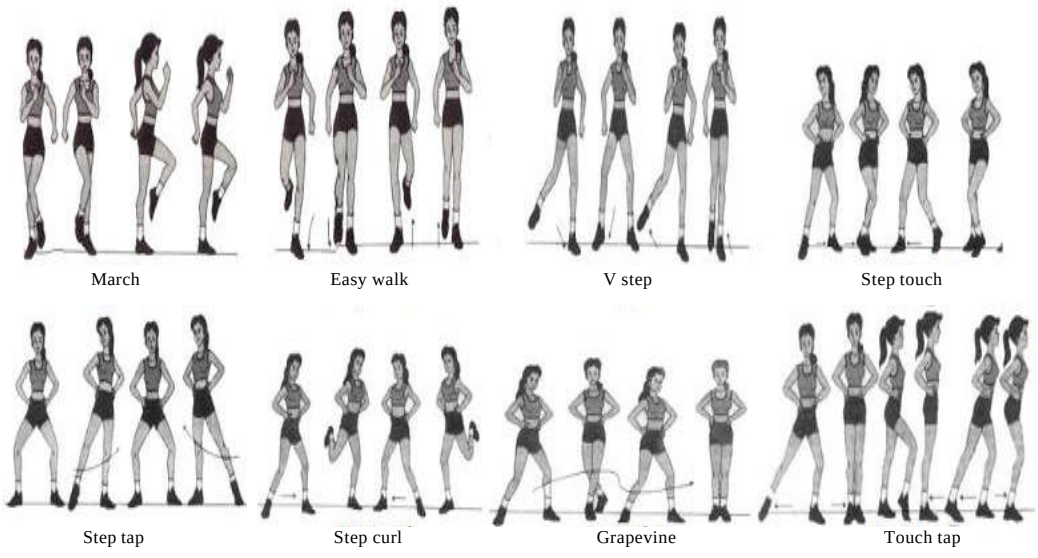

Fig. 5: Basic lower limbs actions

Table 1: Action description and techniques of basic step methods

Name	Description	Tips
March	Two legs raise and turn to the ground in turn	Ankle, knee and hip joints fall down with elastic cushion
Easy walk	A foot step forward and the other steps then reset in turn	While stepping forward, the heel touches ground first, then transiting to the whole feet, fall-away should exist in the whole process and elastic cushion should be kept
V step	A foot step forward and the other foot step to another direction, opening two feet, bend his knees, then return to the original place in turn	Two knees and ankle joints should keep elastic, keep leg apart and half squatting after dividing and control the gravity line between two legs
Step touch	A foot step, the put the feet together, bend knees and tap and move in the opposite direction	Keep two knees elastic, action amplitude and power can be adaptive
Step tap	A foot step aside, move gravity center by bending knees, the other leg touch the ground in toes or heels in the front or aside	Two knees bend or stretch at the same time, the trace of gravity center is arc, no twisting exist in upper body
Step curl	A foot step forward, the other leg bend back, then step to the opposite direction	After bending knees, half squatting, bending knees of supporting legs, the heel of leg bending back next to hip
Grapevine	A foot step aside, the other foot grapevines behind. Then step aside again, keep two feet together, bend knees and tap	In the first step, the heel touches ground first, the gravity center moves with the steps rapidly. Keep knees, ankle joints elastic
Touch tap	A leg bends knee slightly and stands. The other leg stretches. Tap side and return to the step posture	Keep support legs bending

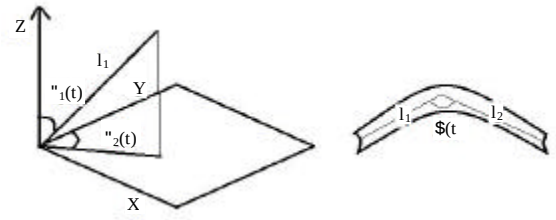

Fig. 6: Angle of arm actions

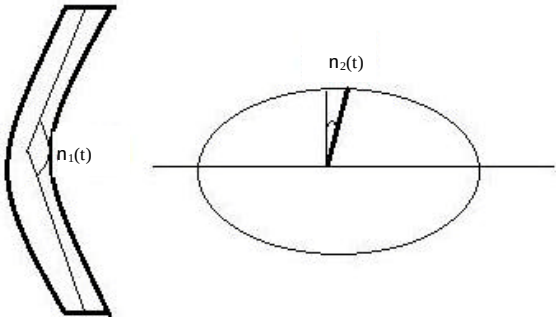

Fig. 7: Trunk rotation

In Fig. 6, l_1, l_2 indicates the lengths of upper arm and forearm, respectively. The upper arm action in 3-dimensional coordinates meets Eq. 1:

$$l_1 \sin\alpha_1(t) = l \quad (1)$$

In Eq. 1, l indicates the project of upper arm onto trunk plane. If $\alpha_1(t)$ is time-varying, l will be bigger. The derivative of $\alpha_1(t)$ is a component of swing angle rate of upper arm. $\alpha_1(t)$ indicates that the forearm tends to approaching shoulder line. $\beta(t)$ indicates the intersection angle between forearm and upper arm. The variables above can summary the characters of arm actions.

Biomechanical analysis of trunk actions: There are two directions to rotate for trunk. One is the plane containing gravity center line, vertical to trunk plane and the other is the plane vertical to gravity center line. The rotation can be described as the time-varying angle, shown as Fig. 7.

In Fig. 7, $\varphi_1(t)$ and $\varphi_2(t)$ reflect the trunk action. At certain time, $\varphi_1(t)$ is the intersection angle between upper trunk and lower trunk and $\varphi_2(t)$ is the rotation angle. If k is fix, the alternations of $\varphi_1(t)$ and $\varphi_2(t)$ can be understood and the rate reflects the bending and rotation angle rate. The power can also be reflected by angle accelerator from data collected.

Biomechanical analysis of lower limbs actions: Lower limbs actions are very important, including not only correction but also the rage of rhythm. Only coordinate actions can demonstrate the beauty of aerobics.

Lower limbs actions include leg and feet actions. The description starts from gravity measurement, velocity alteration and angle alteration. This study, starting from angle, indicates the mechanical characters through time-varying angle. Generally speaking, force generates accelerator. Non-zero accelerator changes velocity. Lower limbes actions include swing, bending and rotation. Due to knee ankles, the relative movement between thigh and shank can be studied in a plane at any time. Therefore, this study gradually analyzes swing of thigh, the alternations of intersection angle between thigh and shank, the alternations of intersection angle between shank and ankle and the relative position between feet and ground. The space structure is shown as Fig. 8.

In Fig. 8, γ_1 is the intersection angle between thigh centralized line and gravity center line which indicates the deviation of thigh from gravity center line; γ_2 indicates the projecting of thigh centralized line onto horizontal plane which indicates the deviation of thigh from sides; γ_3 indicates the intersection angle between thigh centralized

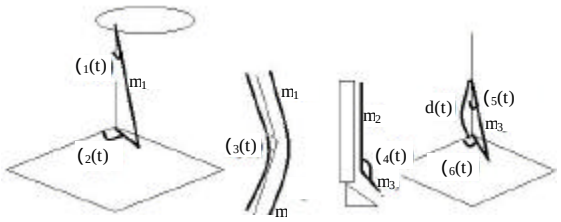

Fig. 8: Lower limbs actions

line and shank gravity center line, of which the range is [0°, 180°]; γ_4 indicates the intersection angle between shank centralized line and feet centralized line, of which the range is [0°, 180°]; γ_5 indicates the intersection angle between feet central line and body gravity center line. The situation in Fig. 8 is pirouette, no discussion on the heel on the ground. The angle indicates the close degree between feet central line and gravity center line. The smaller, the harder; γ_6 indicates the intersection angle between projecting of feet central line onto horizontal plane and right ahead which indicates deviation of feet central line from right ahead; d indicates the vertical distance between heel and tiptoe; m_1, m_2, m_3 indicates length of thigh, shank and feet central line, respectively. The variables above can explore the biomechanical characters of lower limbs actions.

CONCLUSION

Sport biomechanics is applied to analyze competitive physical education technology widely which has unique effects on improving athletes' levels and training capabilities. Moreover, it can be applied to research on human health which has prosperous prospect. Besides, it is relevant to mathematics, mechanics, computer, biomechanics and medicine etc. It is the margin of modern science. Therefore its study methods are updating continuously and it has broad developing space. As a branch of biomechanics, firstly, sport biomechanics studies mechanical features of human internal organ actions and external actions. Secondly, it explores the mechanical relation between internal organs actions and external actions, so as to construct the essential understanding of biomechanical principles of human sports. Different sports have different sport biomechanical characters. To aerobics, the key to jumping is studying the height of jumping. It should consider factors such as force, functioning time and angle, etc. The technical character of rotation actions is to control gesture, reduce rotation radius to reduce rotation inertia and increase angle rate. All in all, all the technical features are based on corresponding mechanical principles which have certain regulations. Conclusion: sport biomechanics can be applied widely to analyze competitive physical education which has important effects on improving athletes' levels and training capabilities.

This study firstly introduces the action situations of arm, trunk and lower limbs. Secondly, analyze and summary the technical points of varied parts; besides, it explores the biomechanical variables for actions by shape analysis of basic action technology. Moreover, this study specifically discusses the basic actions based on biomechanical characters and lists fine research methods.

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