REVIEW

Research on the physical training model of human body based on HQ

Liu Junjie[1,2]
[1]School of Physical Education, Central China Normal University, Wuhan, Hubei, China
[2]Department of Physical Education, Wuhan University of Science and Technology, Wuhan, Hubei, China

Abstract: Health quotient (HQ) is the newest health culture and concept in the 21st century, and the analysis of the human body sports model is not enough mature at present, what's more, the purpose of this paper is to study the integration of the two subjects the health quotient and the sport model. This paper draws the conclusion that physical training and education in colleges and universities can improve the health quotient, and it will make students possess a more healthy body and mind. Then through a new rigid body model of sports to simulate the human physical exercise. After that this paper has an in-depth study on the dynamic model of the human body movement on the basis of establishing the matrix and equation. The simulation results of the human body bicycle riding and pole throwing show that the human body joint movement simulation can be realized and it has a certain operability as well. By means of such simulated calculation, we can come to a conclusion that the movement of the ankle joint, knee joint and hip joint's motion law and real motion are basically the same. So it further verify the accuracy of the motion model, which lay the foundation of other research movement model, also, the study of the movement model is an important method in the study of human health in the future.

Keywords: Health quotient; human physical exercise model; simulation; dynamic model; matrix and equation.

INTRODUCTION

Health quotient as the latest health culture and brand new health concept in the 21st century, which was firstly proposed and applied by the international well-known health experts Xie Huazhen, who is a M.D in Harvard University. The so-called HQ is the abbreviation of Health Quotient, which was used to measure a person's health awareness, health knowledge and health ability. Meanwhile, HQ reflects a person's health intelligence and represents a person's health level as well as the fire-new attitude towards health. Health quotient philosophy can help people build up health consciousness, cultivate good behavior and life style, what's more, it can eliminate or reduce the risk factors which may influence the individual's health and it also can prevent diseases, promote the health level and enhance the quality of life. Health quotient education refers to mobilize the whole society and all kinds of people to participate in education activities through planned means of information dissemination and education, which can make people own the desire, knowledge and skills to maintain health. Health quotient is an effective evaluation index to the individual health condition (Wan *et al.*, 2012). If one's Health quotient index is high, it indicate that the individual reserve a rich health knowledge in life and they have known which factors will affect their own health, or their life style and skills are developing towards a health direction (Zimmerman *et al.*, 2012). The health quotient not only defines health without diseases, but broadly refers to individual's good condition.

There have been few scholars adopt the HQ concept (Poplin *et al.*, 2012) to study the mode of human physical exercise of university students, at the same time, physical exercise is one of the most active and important factor to promote health. Is there a link between the college students' health and the quotient level? Whether physical exercise can effectively improve the health quotient? This study explores the internal relationship between college Students' physique and health quotient, physical exercise and health quotient, and this research was based on the analysis of college students' health quotient level (Garcíaortiz *et al.*, 2012). The purpose is to provide reference basis and theoretical support for the health education and physical exercise in Colleges and Universities.

The present situation and reasons of the lack of health quotient of college students in China

In recent years, the Ministry of education increasingly focused on the College Students' health situation, meanwhile, the research on the health quotient of the students in our country has already begun to put forward after the concept of the HQ was put forward. The research on the lack of health quotient of college students mainly focuses on the following aspects: mental health, lifestyle, health knowledge, health quotient differences and gender differences, etc. In the investigation of mental health in college students, it was found that the symptoms of

**Corresponding author:* e-mail: 1422769538@qq.com

psychological problems of college students often manifest as paranoia, interpersonal relationship, depression, anxiety, hostility, obsessive compulsive etc. and the physiological diseases caused by physical and mental interaction are increasing. According to the results of the survey, about 76.1% of the College students' life style is unhealthy (Franklin *et al.*, 2012), it is because that many of the College students have a unhealthy living habit, such as drinking, smoking, lack of physical exercise and unreasonable diet etc. In addition, many college students remain a serious lack of basic medical knowledge and health knowledge, they cannot make a correct evaluation to their own health condition and very few of the students insist on exercise. Some of the college students believe that the higher health quotient index is the lower self-esteem, depression, anxiety, guilt, anxiety and other emotions will be, it means that the total index of health quotient has a connection to a variety of emotions. There are researchers made a Health Quotient questionnaire test to 10 college's students, according to the results of the survey (Fajclkova *et al.*, 2012): the amount of exercise and physical strength of the college students is obviously insufficient and the rate of obesity has increased a lot, meanwhile, there is an increase but no decrease of the unhealthy lifestyle such as drinking and smoking. The following health care data is the results of the health survey data analysis from mass of students:

We can see from table 1, health quotient factors in 6 to 8 segment accounted for the largest proportion in the sample, almost a percentage above 50% (the percentage is coming from this: insult a health quotient factor as an object of analysis, the survey of all health providers factor scores of 0 to 3~5,6~8, 9~10 four scores, and then calculate the percentage share according to the number of the insults a score in all scores), 3 to 5 accounts for a large proportion, according to health table, we can know, students for 6 to 8 score, their health quotient scores show that they have good health practices and for 3 to 5 score of the students indicates that their health in a way that might go wrong. It shows that the majority of students are in middle level of HQ, minority students are in high health quotient, so the same as they are in extremely low levels (Huang *et al.*, 2012). The majority of students have improved their needs and potential space of health quotient. This gives us schooling vast battlefield.

For data table 1, draw the following line chart 1, we can see above results from the fig. 1, it is obvious that health quotient of the factor scores in 6~8, 3 ~5 is more, the number of 0~2, 9 ~10 accounts for percent relatively small. Draw line fig. 1 for table 1 as follows:

As can be seen from the investigation and study, researchers have put health quotient as college students' health assessment method and applied it to the college's health education to service the students. From the perspective of the researchers, the relevant college professional teachers will be the main force of the health quotient research. The introduction of the health quotient to the higher education, which is the effective means to evaluate the implementation of the health education in colleges and universities, also, it was provided with scientific nature, rationality and operability. Even though we all know that the health education has a significant impact to the college students, but it is not so easy to put the theory into practice (Khan *et al.*, 2012). There are many reasons lead to this situation, such as the management neglect, lack of teachers, the health education policy objectives are not clear and lack of operability, etc. the all factors will bring obstacle to the implementation.

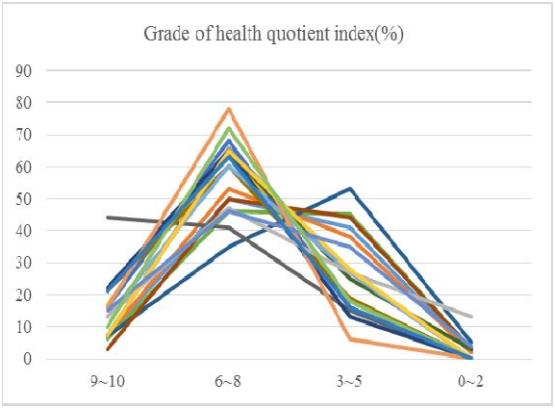

Fig. 1: The percentage of the health quotient factor score of the line chart.

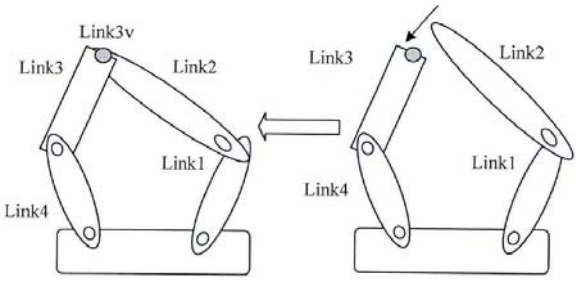

Fig. 2: The hinge (joint) connects the rigid body.

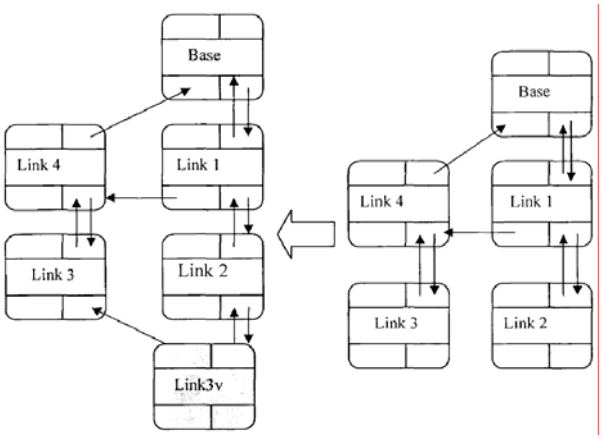

Fig. 3: Link description before and after connection.

The performance and reasons of college students' lack of health quotient

(1) The poor life style was short of health knowledge and awareness of self-health. A lot of research shows that smoking, drinking, sleep deprivation, irregularities in the diet, excessive intake greasy spicy, high oil and high fat food etc. such bad life style will lead to a series of diseases. At the same time, bad learning habits, such as staying up late for a long time and sitting too long to study without any exercises also will cause the students' sub health. Due to college students are in the period of full of vigorousness, so many of them lack of self-health care consciousness, what's more, many of them lack of the enthusiasm to participate in kinds of physical activities. As a result, it will inevitably lead to their body in a state of sub-health, because they ignore the overdraft physical ailment and seldom do the routine physical examination.

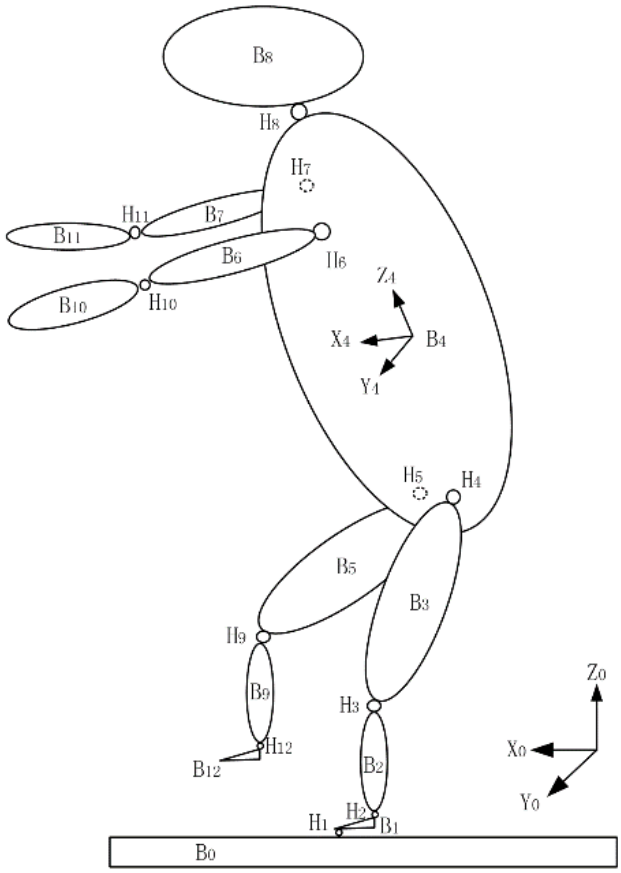

Fig. 4: System model of multi rigid body.

(2) Heavy life and ideological pressure, First of all, many of the college students have the financial difficulty, because most of the college students rely on the support of their parents to complete their studies, those students who come from the rural area or mountainous area face a heavy economic pressure, their tuition fees and living expenses are a great burden to the families, so it caused the students' psychological burden. Secondly, the employment pressure would be difficult to the college students, because most of them are lacking of experience, some of them feel depressed to the uncertain future. The stress will influence the students' behavior which has a bad impact to their mental health, then the physiological condition will change, which will lead to illness as well. Finally, it may produce kinds of emotions and trust crisis. Many college students have the belief crisis, which is related to their escape from difficulties in life (Smith *et al.*, 2012). The depression in the life makes them feel empty, and the pressure makes them fell confused and then appear the problem of belief crisis.

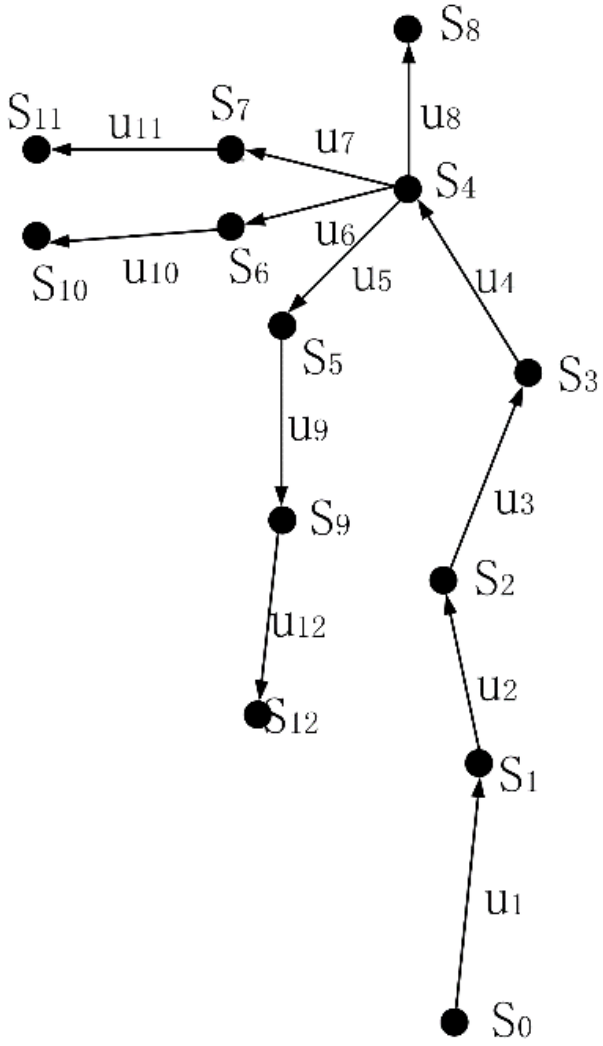

Fig. 5: System diagram of human body directed.

(3) Part of the university administrators do not attach importance to health education. To begin with, the equipment of health teachers in many colleges is insufficient, due to inadequate attention to the college health education teachers, the health education teachers' responsibility was undertook by the sports teachers or doctors in many colleges and there are no full-time teachers in health education, so, the teaching methods are

not suitable and the teaching forms are too simple, as a result, the educational achievement is not obvious. Secondly, there exists misunderstanding in the college health education. Part of the university administrators interprets health education as the impartment of the health knowledge, and there is no doubt that it will lack of unified management organization during the teaching process. Thirdly, the evaluation of the health education effect in colleges and universities is unrealistic. At present, the exam is the only standard to the evaluation of the health education effect, so the college students just study for the exams, in this condition, the education lack of comprehensive evaluation of students' health awareness, behavior and knowledge.

Attach importance to the cultivation of health quotient

The meaning of cultivating the health quotient

Health quotient is a kind of self - health care, which is built up on the new health knowledge; in addition, this is a healthy cultural concept of a healthy lifestyle and a systematic health care method. Health quotient is not only the theory but also need the personally practice, which emphasis to get the best results by maintaining the physical and mental health, so as to achieve the best condition of the body. The purpose of health quotient is to let people control their own health condition. "Health Quotient" as a new concept of human health, it shows a strong vitality. In recent years, the pace of life and the social competition is becoming more and more intense, as a result, more and more people begin to pay attention to the health quotient. An important feature of modern education is to connect the education and personal development together. The formation of health, personality and the formation of intellectual ability has become the ultimate goal of the modern education, and the essential attribute of education to improve the quality of life. College Physical exercise has put the "health first" as the dominant ideology in recent years, to achieve this goal, we must first cultivate and improve the health quotient of college students. And physical exercise in colleges and universities have the exceptional advantages in cultivating the students' sports consciousness and ability, especially in the cultivation and improvement of health quotient, which cannot be replaced by the other disciplines in the health education. Under the new situation, to cultivate and improve the "Health Quotient" have many benefits, it not only can improve the health level of college students, but also can conducive to the sustainable development of talents and improve the social competitiveness.

Attach importance to the "Health Quotient" is conducive to the formation of Lifelong Physical Education

The health of body and mind is the symbol of life force and health, and it is the foundation and source to health, happiness, family harmony and success. HQ has become one of the important goals of modern education, so it has been proved that the ultimate value orientation of physical exercise is to promote students' physical and mental health. How to correctly grasp the connotation of "health first" and truly implement the thought of "health first" in the teaching process has become an urgent and important issue nowadays. The cultivation and formation of "Health Quotient" concept, which has great significance to further grasp the guiding ideology of "health first", and it also can promote the education reform in colleges and universities. The best way to implement the "health first" is to improve the students "Health Quotient" in the process of physical exercise. "Health Quotient" is the promotion of health awareness and skills, which was accumulated in the influence of the education and the environment, what's more, it is able to develop students' good living habit and health concept. Therefore, pay high attention to health quotient education is beneficial for the formation of lifelong sports consciousness and lifelong sports ability.

Health Quotient" training is conducive to promoting the reform of physical exercise in Colleges and Universities

"Health Quotient" is a kind of performance of human health intelligence, by paying attention to cultivate and improve the students "Health Quotient" can lay a solid foundation for the realization of lifelong physical exercise. To improve the "Health Quotient" can be the high enrichment and generalization of the way to realize the lifelong physical exercise. Therefore, as long as we can attach great importance to the cultivation and improvement of the health quotient, and enhance the "Health Quotient" from the whole idea of the sports teaching and from the specific practicing process, in addition, we should try the best to design, operate and control etc. in this way to get rid of the previous exercise stereotype. Only from the perspective of "Health Quotient" to analyze, explain and practice, which can improve the drawbacks of pure technology teaching, in this way can truly achieve the purpose of physical and health education (Fouhey *et al.*, 2012). Practice shows that in order to improve the health quotient, it must enable college students to understand the profound meaning of physical exercise and health on the basis of paying attention to their health and future needs, it means that the students display great initiative in the scientific training and form a good learning motivation, so as to promote the reform of physical exercise in colleges and universities.

Research on the mode of human physical exercise

There are two major kinetic models exist in human sports (Kasabova *et al.*, 2012): (1) Body can be partitioned into a finite body system of particles; (2) There is a muscle force between the bodies of the human body, which can change the movement state between the two adjacent points. Multi rigid body dynamics method is based on the two main kinetic features of bodies, the human body is divided into several independent rigid bodies on the basis of the principles of anatomy and each rigid body has the physical characteristics of mass, mass center and moment

of inertia. Meanwhile, the hinge (joint) connect the adjacent rigid body together (see fig. 2), and applied spring damper at the connection point, in this way to simulate the function of the soft tissue (muscle, ligament, etc.), in addition, it can make us get to know some restrictions on the relative movement between the adjacent rigid bodies, so that the human body is simplified into a multi rigid body system with a limited degree of freedom (see fig. 3). There exist external forces and internal forces in the process of movement, which will have an intergrade effect on people, such as the ground friction, equipment or ground support force, the gravity, the muscle force between the joints etc (Hwang *et al.*, 2012). In general, we only need to consider the part of the force, the key point of the rigid multi-body dynamics is to calculate a set of binding force (or torque), so that the movement of the object can conform to the given constraints. The human body model, which is based on the multi rigid body dynamics, which is mainly including the Hanavan (Delingette *et al.*, 2012) rigid body model and R.L. Huston (Fouhey *et al.*, 2012) rigid body. Now we will analyze the human body motion model in accordance with the bike riding and javelin throwing process.

Research on bicycle mode of physical exercise

China is a bicycle kingdom, riding a bicycle is commonplace and you can see it everywhere in the country, but how to get good results in athletics is still worth studying. Therefore, it is important to study the human dynamics of riding a bicycle. Without considering the influence of muscle deformation on the body mass distribution, the human body can be simplified as a multi rigid body system (Linkenauger *et al.*, 2012). For different research direction, researchers put forward different body models: different models should correspond to different motion, four rigid body models to analyze the diving movement was firstly established by Miller; ten rigid body mechanical model for the simulation of space motion is established by the Passerello & Huston; Hanavan and Hatze are proposed to be applied to the seventeen body model of the rigid body, which can be applied to the fifteen body model and the long jump.

On the basis of the Hanavan model, the model of the 12 multi rigid body system is built on the basis of the human body system. Rigid body B0, B1, B2, ……, B12 respectively represent the zero rigid body and human's left foot, left leg, left thigh, body, right thigh, left arm, right arm, head ,neck, right leg, left forearm, hand, right forearm and foot; Hinge H1, H2..., H12 are respectively represented by the corresponding joint. The connection between B0 and B1 is reduced to 4 degrees of freedom which are relative to the movement of the rigid body (see fig. 4). in addition, the connection between the rest of the rigid body is simplified as a pure rotating ball joint. The Using graph theory represents the human body model of the system diagram (see fig. 5). This system has a root system with a complete constraint hinge and each rigid body is represented by a vertex, meanwhile, the hinge is represented by a directed arc (Lindsay *et al.*, 2012). This system has a root system which has a complete restraint hinge, each rigid body is represented by a vertex S_i (i=1,…12) and Hinge is represented by directed arc U_a (a=1,2…12).

Mathematical expression of the structure of the rigid body in the human body

(1) Correlation matrix and path matrix

From fig. 4 we can summarize the human body model S and human body model correlation matrix T. The correlation matrix S is used to represent the constraint state of a rigid body and a hinge in a model, the incidence matrix S element S_{ia} is defined as:

$S_{ia} = 1$, when arc U_a is related to S_i and depart from S_i; $S_{ia} = -1$, when arc U_a is related to S_i and point to S_i; $S_{ia} = 0$, other Situation。

Whereby, $i = 1,2\ldots,12; a = 1,2\ldots,12;$ path matrix T is described by the state of the path between the rigid body and the zero rigid body in the system. In the incidence matrixc T, T_{ai} is defined as:

$T_{ai} = 1$, when arc U_a is between S_0 to S_1 and depart from S_1 :

$T_{ai} = -1$, when arc U_a is between S_0 to S_1 and point to S_1 :

$T_{ai} = 0$ other Situation Thereby, $a = 1,2\ldots,12;$

According to the definition can be obtained S, T in order to guarantee the consistency of the description, the spherical joint is generalized by Carle, at this moment, $P_{al}k_{al}$ are respectively represented by a unit vector of the hinge axis, and it is the direction of the slip axis.

(2) Hinge position vector matrix and path vector matrix, the hinge vector matrix and the path vector matrix is the vector expression of the parameters in the rigid body model.

The distribution of the rigid body hinge C is represented by a hinge position vector, the elements of the hinge position vector matrix are defined as $C_{ia} = S_{ia}c_{ia}$, $(i,a=1,2,\ldots12)$, Path vector matrix is defined C as: $D=CT$。

$$S=\begin{bmatrix}
-1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\
0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\
0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\
0 & 0 & 0 & -1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0\\
0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 & 0 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 1\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1
\end{bmatrix}$$

$$T=\begin{bmatrix}
-1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1\\
0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1\\
0 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1\\
0 & 0 & 0 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1\\
0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & 0 & -1\\
0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & -1\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0\\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1
\end{bmatrix}$$

(3) Generalized force array with holonomic constraints hinge system.

Except there is a translational force element between B_0 and B_1 in the system, the rest just add a rotation force element and then generalized the force array system.

$$Q = (\alpha^T S + \beta^T \times P) \cdot X - PY \tag{1}$$

$^{pi+}(a)a$, $^{pi-}(a)a$ is the position of the connecting points between two rigid bodies and force elements. X, Y respectively represent the internal force and internal force of rigid body which come from the force:

$$\begin{cases} \alpha = (PT \times CT - kT)^T \\ \beta = -(PT)^T \\ k_{al} = \dfrac{\partial C_{i^+(a)a}}{\partial q_{al}} \end{cases} \quad (a, l = 1, 2, 3 \cdots 12) \tag{2}$$

$$P_{ia} = S_{ia} \rho_{ia} (i, a = 1, 2 \cdots 12) \tag{3}$$

Dynamic equations of multi body system of human body

The cycling status of human motion model can be simplified to rooted tree- shaped multi rigid body system, they are constrained by the complete constraint (Dinos *et al.*, 2012) can be known by multi system dynamics and the kinetic equation is:

$$A^* \overset{\circ\circ}{q} = B^* \tag{4}$$

q is the generalized coordinates of the multi rigid body system.

$$A^* = (PT) \cdot K (PT)^T - \left[PT \times C \cdot (TmT) k^T \right] - \left[PT \times C \cdot (TmT) k^T \right]^T + k (TmT) k^T \tag{5}$$

$$B^* = (PT) \cdot \begin{bmatrix} K \cdot V + G - L + (CT) \times \\ (F + mT^T h - m \ddot{r}_{01} l_{12}) \end{bmatrix} - (kT) \cdot \left[F + mT^T (g + h) - m (CT)^T \times V - m \ddot{r}_{01} l_{12} \right] + Q \tag{6}$$

m_i is the rigid body's quality of B_i; $m = diag(m_1, m_2 \ldots m_{12})$; A^* is the Generalized mass matrix; F, L is the active role in the system of the rigid body and in the principal vector, the principal moment of the array is 12×1, which is the acceleration of the mass center of pure rotational hinge system. J_i is the inertia tensor of the rigid body to the center of mass. $J = diag(J_1, J_2 \ldots \leq J_{12})$. According to the definition of augmented body centroid can be obtained:

$$\sum_{j=1}^{12} b_{ij} m_j = 0, (i = 1, 2, \cdots 12) \tag{7}$$

The relationship between the path vector d_{ij} and augmented body vector b_{ij}.

$$d_{ij} = d_{i0} - b_{ij}, (i, j = 1, 2, \cdots 12) \tag{8}$$

Matrix K is augmented matrix element of the tensor to the inertia hinge and it point to zero body, its elements are showed in the following matrix:

$$K_{ij} = \begin{cases} J_i + \sum_{k=1}^{12} m_k (d_{ik}^2 E - d_{ik} d_{ik}), (s_i = s_j) \\ M (b_{j0} \cdot d_{ij} E - b_{j0} d_{ij}), (s_i < s_j) \\ M (d_{ij} \cdot b_{j0} E - d_{ij} b_{j0}), (s_i > s_j) \\ 0, (other \quad conditions) \end{cases} \tag{9}$$

$i, j = 1, 2, \cdots 12$

k and P respectively represented the transformation matrix and slip matrix

$$\begin{cases} V = -T^T (\varpi + \varpi^*) + \dot{\varpi} l_{12} \\ \varpi = \beta q + \dot{\varpi}_0 l_{12} \\ \varpi^* = \varpi_{i^-(a)} \times \Omega_a \\ \Omega_a = \sum_{l=1}^{3} p_{al} q_{al} \end{cases} \tag{10}$$

$\varpi + \varpi^*$ is generalized coordinates and a function of the first derivative of time.

h has the following elements of the array:

$$\begin{cases} h_a = s_a + 2 \omega_{i^+(a)} \times c_{i^+(a)} \\ c_{i^+} = k^T q \\ s_a = \sum_{l=1}^{3} \sum_{r=1}^{3} \dfrac{\partial C_{i^+(a)a}}{\partial q_{al} q_{ar}} \dot{q}_{al} \dot{q}_{ar} \end{cases} \tag{11}$$

Thereby, a=1,2,…12, G has the following elements of the array:

$$G_i = M \begin{Bmatrix} \sum_{j=i} d_{ij} \times \left[\omega_j \times \omega_j \times b_{j0} \right] + \\ b_{i0} \times \sum_{j=i} \omega_j \times \omega_j \times d_{ij} \end{Bmatrix} + \omega_i \times K_{ii} \tag{12}$$

The model calculation results truly reflect the human riding bicycle, namely human riding bicycle is the first four animation key frames as shown in action cycle. As shown in fig. 6, hip joint, the height of knee joint and ankle joint in human cycling process changes with the human body movement and change, which is consistent with the actual situation

As to the individuals, after measured the height and weight, calculating the relative data by means of the

binary regression equation coefficient table and the given regression equation, then calculate the human dynamics equation by means of substituting the above equation.

Table 1: Analysis of the 20 factors of the health quotient of the percentage of the score of each score

	9~10(%)	6~8(%)	3~5(%)	0~2(%)
The way to get physical and mental health	7	50	41	2
Treatment of disease and discomfort	7	53	38	2
Awareness of physical and emotional state	7	66	27	0
Positive personality	17	65	18	0
Health knowledge	16	68	16	0
Knowledge of physical health care system	6	46	45	3
Knowledge of maintaining health	7	35	53	5
Health monitoring and health monitoring	3	50	44	3
Specific knowledge				
Smoking, drinking, drug abuse	44	41	15	0
Diet, juice, and eating habits	21	60	19	0
Exercise and fitness	22	65	13	0
Daily life	2	65	20	3
Mental and psychological state	8	60	22	0
Emotional state	16	78	6	0
Personal belief	13	47	27	13
pressure	13	57	30	0
Flat life skills	7	65	28	0
Environment and learning	15	46	35	4
Social concern, support and behavior	10	72	18	0
Interpersonal relationship	21	63	16	0

Research on benchmarking mode of physical exercise

The human body is a very complicated system, in the condition of ignoring the impact which the muscle deformation act on the physical quality, each member can be abstracted as a rigid body, the joints of the limbs can be simplified as a spherical hinge, so the human body can be regarded as a multi rigid body system, which is composed of a finite number of rigid body with a spherical hinge joint. This paper adopts the famous Hanavan15 model (fig. 7), it resolves the human body to 15 sections, it constitute with the following parts: Pretext (including neck), Upper and lower trunk, left and right arm, left and right arm, left and right hand, left and right thigh, left and right leg, left foot. The trunk it set to the main part to the human body, and it's mark number is 1, the rest of the other sections were labeled in fig. 1. Each segment of the rigid body is recorded as B_i, the corresponding centroid is recorded as C_i, the *i* paragraph's quality is marked as m_i and the centroid is recorded as m_i, the inertia is recorded as J_{ic} the total quality of human body is recorded as M, H_a is recorded as hinge joint.

Then set up a coordinate system as shown in fig. 7, the Ground fixed coordinate system is $X_0Y_0Z_0$, the upper & lower trunk and head coordinates have the same direction with the fixed coordinate system, the Z_4 axis of the upper arm coordinate system is located on the ligature of the shoulder and elbow, which pointed from the shoulder to the elbow, when the arm have a standard natural falling, X_4 axis points to the back of the human body, meanwhile, the Y_4 axis points to the left; when the human body have a the standard posture, the rest of the arms, legs, hands and feet's coordinates share the same direction of the upper arm coordinate system.

Dynamic equations of multi body system of human body.

During the javelin movement process, the human body has vacated action. In order to make the model can describe the whole process of the javelin movement; by means of systematically descript the human body in accordance with the rootless multi rigid body system, the ground fixed coordinate system is a zero rigid body, which is connected with a free 6 of the human body.

Mathematical description of the structure of multi rigid body system

According to the rules of the multi rigid body system, the directed graph of the multi rigid body system is made, as shown in fig. 8. $X_4Y_4Z_4$ represents the vertex of a zero rigid body in the graph. S_i(i=1,2…,15) Represents the Vertex of a rigid body to B_i, arc U_a shows the label of hinge to U_a(a=1,2…,15). The inner hinge U_a connects to the two adjacent rigid bodies of the system are $B_{i*(a)}$ and $B_{i-(a)}$. The former is called the latter as the front rigid body. From fig. 8 we can see that the human body of the incidence matrix of rigid body system S and path matrix T. The related matrix S describes the connection state between the rigid body and the hinge in the system, and

the path matrix T describes the path state between the rigid body and the zero rigid body system.

Movement of each section of the human body

In order to guarantee the consistency of the description, the spherical joint is generalized by Carle's angle. By this moment, *Pal*(*l*=1,2,3) are represented by the unit vector of the real axis along the three continuous rotations, φ_{al}(*l*=1,2,3) is generalized coordinates, from document 4 and 5 we can get to know the rigid body $B_{i-(a)}$ and the relative angle velocity's speed of the relative pre-rigid body $B_{i*(a)}$:

$$\Omega_a = \sum_{l=1}^{3} P_{al}\, \overset{\circ}{\varphi}_{al} \quad (a = 1,2,\cdots,15). \tag{13}$$

Angular velocity of rigid body B_i:

$$\omega_i = -\sum_{a=1}^{15} T_{al}\Omega_a + \omega_0 \quad (i = 1,2,\cdots,15). \tag{14}$$

Merge the formula (14) to matrix form:

$$\omega = -T^T\Omega + \omega_0 I_{\ n} = -(PT)^T\varphi + \omega_0 I_{\ n} \tag{15}$$

The centroid acceleration of the rigid body B_i is:

$$r_i = -\sum_{j=1}^{15} \omega_j \times d_{ji} + r_0 \tag{16}$$

In this formula, the vector of the pathway is indicated:

$$d_{ji} = \sum_{j=1}^{15} T_{ai} S_{ja} c_{ja} \tag{17}$$

The formula (16) is merged into a matrix form:

$$r = (CT)^T \times \omega + r_0 I_n \tag{18}$$

C is a weighted vector matrix, $C_{ia}=S_{ja}c_{ja}$ indicates that the B_0 to the B_i pathway is connected with each piece.

Dynamic equations of multi body system of human body

This paper simplify the final stage of the javelin throwing motion model, and make it to a multi rigid body system with a pure rolling hinge. From the literature 4 we can make the conclusion that the matrix form of the kinetic equation is:

$$A^* \ddot{q} = B^* \tag{19}$$

Here the system generalized coordinates of the multi rigid body is expressed by *q*

$$A^* = (PT)K^*(PT)^T$$

$$B^* = (PT)\left[K^* v + G^* - L + B \times F\right]$$

Q is a generalized force and generalized coordinates of the corresponding array

F_i, L_i is the principal vector and principal moment of the active force system acting on a rigid body:

$$v = -T^T(\omega + \omega^*) + \omega \overset{\circ}{I}_n \tag{20}$$

An element of the matrix X is:

$$\omega^* = \omega_{i(a)}^{-} \times \Omega_a \ (a = 1,2,\cdots,15) \tag{21}$$

The elements of the matrix *K** in the formula：

$$K_{ij}^* = j_{ic} + \sum m_k (b_{ik}^2 E - b_{ik} b_{ik}) \ (i = j) \tag{22}$$

$$K_{ij}^* = -M(b_{ik} b_{ik} E - b_{ji} b_{ji}) \ (i \neq j) \tag{23}$$

G^* is a matrix with the following elements：

$$G_j^* = -M \sum_{\substack{j=1 \\ j\neq i}}^{15} b_{ji} \times \left[\omega_j \times b_{ji}\right] + \omega_i \times k_{ii}^* \cdot \omega_i \tag{24}$$

As to augmented vector b_{ij}, it has the following provisions: when $i=j$, b_{ij} is a vector to the rigid body of the augmented constitution, when $i \neq j$, b_{ij} is the first augmented body centroid vector of the hinge point.

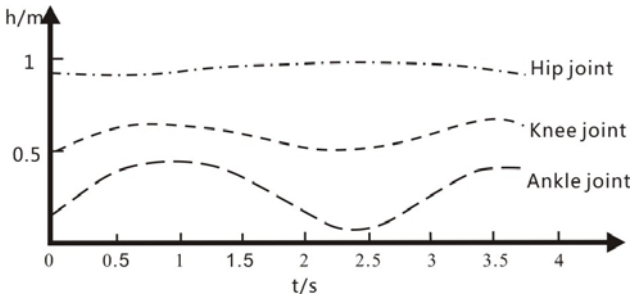

Fig. 6: Height change of support leg

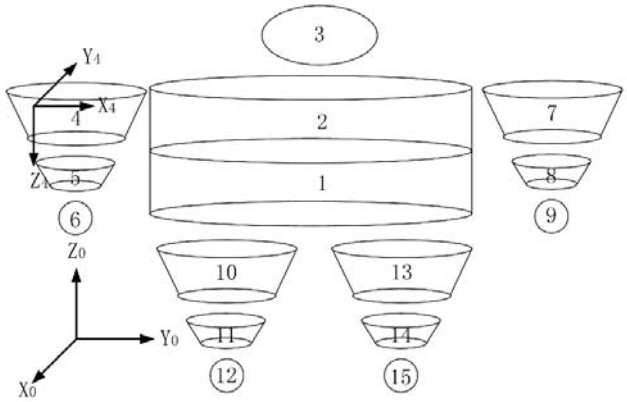

Fig. 7: System model of multi rigid body

The model calculation results truly reflect the human pole throwing, namely human pole throwing is the first four animation key frames as shown in action cycle. As shown in fig. 9, hip joint, the height of knee joint and ankle joint in human cycling process changes with the human body movement and change, which is consistent with the actual situation.

As for a specific sports player, it can be directly measured his or her height and weight, then according to the table of reference, it provides the inertia parameters of the human body in China. The mass, centroid and the steps of inertia of the 15 segments are calculated by the regression

equation given in the regression equation. According to the human rigid body oriented graph system which was given before, we can gradually calculate the augmented vector, angular velocity, the speed of rigid and kinetic equation of each coefficient matrix. Then calculate the human dynamics equation of last effort of throwing javelin eventually.

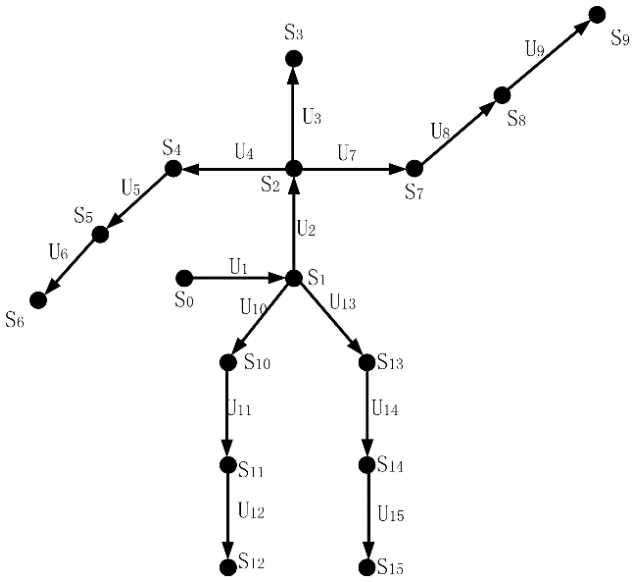

Fig. 8: system diagram of human body directed

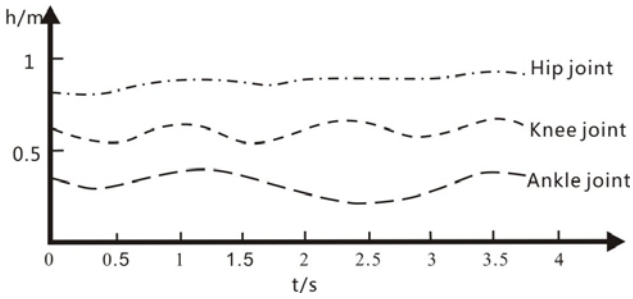

Fig. 9: Height change of support leg

CONCLUSION

Then discusses the body exercise mode on the basis of the health quotient theory, which can truly reflect the dynamics model of human body. Take riding a bicycle and javelin as an example, we did body exercise mode research on the human gait simulation and collision simulation etc. The modeling of human body movement is a difficult and complex work, it is very difficult to accurately reproduce the real situation of human movement. At present, the multi rigid body dynamics method has been simplified to different degrees and the simulation results are still unsatisfactory, the main reason is: (1) Simplified model of human body deformation are not considered enough; (2) The experimental measurement need muscle strength and muscle torque as the boundary conditions or constraint condition; (3) In the process of solving the differential equation, the singular points is not eliminated. On the contrary, the skeletal muscle modeling method takes into account the deformable body (such as muscle and ligaments), it is necessary that we should know how to control the muscle strength. Therefore, it is undoubtedly a new research direction of human movement pattern to combine the multi rigid body dynamics modeling method and the bone muscle modeling method together.

ACKNOWLEDMENT

The work presented in this paper is supported by two research project. One is Hubei province higher education research project, its subject name: Study on the Present Situation and Development Countermeasures of Special Physical Education in Colleges and Universities, its research number: 2012221, the other is Humanities and social sciences research project of Hubei Provincial Department of Education, its subject name: Study on the Current Situation, Problems and Countermeasures of the Construction of the Public Service System of the youth Sports in Hubei Province, its research number: 2013Q024.

REFERENCES

Delingette H and Ayache N (2015). Building patient-specific physical and physiological computational models from medical images. Handbook of Biomedical Imaging. Springer US. pp.169-182.

Dinos ME, Borke JL and Swiec GD *et al* (2015). *In vitro* study of the adverse effect of nicotine and physical strain on human gingival fibroblasts as a model of the healing of wounds commonly found in the military. *Mil. Med.,* **180**(3S): 86-91.

Fajclkova K, Cveckova V and Stewart A *et al* (2014). Health risk estimates for groundwater and soil contamination in the Slovak Republic: A convenient tool for identification and mapping of risk areas. *Environ. Geochem. Hlth.,* **36**(5): 973-986.

Fouhey DF, Delaitre V and Gupta A *et al* (2012). People watching: Human actions as a cue for single view geometry. *Int. J. Comput. Vision,* **110**(3): 259-274.

Fouhey DF, Delaitre V and Gupta A *et al* (2014). People watching: Human actions as a cue for single view geometry. *Int. J. Comput. Vision,* **110**(3): 259-274.

Franklin S (2014). Analogic return: The reproductive life of conceptuality. *Theory Cul. Soc.,* **31**(2-3): 243-261.

Garcíaortiz L, Reciorodríguez JI and Martíncantera C *et al* (2010). Physical exercise, fitness and dietary pattern and their relationship with circadian blood pressure pattern, augmentation index and endothelial dysfunction biological markers: EVIDENT study protocol. *Bmc. Public Health,* **10**(10): 1158-1158.

Huang X, Betha R and Tan LY *et al* (2015). Risk assessment of bioaccessible trace elements in smoke

haze aerosols versus urban aerosols using simulated lung fluids. *Atmos. Environ.,* **125**(B): 505-511.

Hwang JH, Kang TW and Park SO *et al* (2015). Empirical channel model for human body communication. *IEEE Antenn. Wirel. Pr.,* **14**: 694-697.

Kasabova BE and Holliday TW (2015). New model for estimating the relationship between surface area and volume in the human body using skeletal remains. *Am. J. Phys. Anthropol.,* **156**(4): 614-624.

Khan S, Reid B J and Li G *et al* (2014). Application of biochar to soil reduces cancer risk via rice consumption: A case study in Miaoqian village, Longyan, China. *Environ. Int.,* **68**: 154-161.

Lindsay AR, Hongu N and Spears K *et al* (2014). Field assessments for obesity prevention in children and adults: Physical activity, fitness and body composition. *J. Nutr. Educ. Behav.,* **46**(1): 43-53.

Linkenauger SA, Wong HY and Geuss M *et al* (2015). The perceptual homunculus: The perception of the relative proportions of the human body. *J. Exp. Psychol. Gen,* **144**(1): 103-113.

Poplin GS, Pollack KM and Griffin S *et al* (2015). Establishing a proactive safety and health risk management system in the fire service. *Bmc. Public Health,* **15**(1): 1-12.

Smith S E, Vargas G and Cucchiara AJ *et al* (2015). Hemiparesis and epilepsy are associated with worse reported health status following unilateral stroke in children. *Pediatr. Neurol.,* **52**(4): 428-434.

Wan S X, Li H L and Wang W *et al* (2016). Psychometric properties of the postpartum women health quotient scale among Chinese post partum women. *Midwifery,* **39**: 63-70.

Zimmerman L, Patel AA and Stempinski K *et al* (2015). Utilization of the family planning quotient in three cohorts of women. *Obstet. Gynecol.,* **125**(s1): 81S.