松 山 大 学 論 集
第 20 巻 第 2 号 抜 刷
2008 年 6 月 発 行

# Evidence Based Training : a Data Format for Sports Training Support Systems

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## Introduction

To practice effective training, continuous enforcement using scientific data is important. This research proposes an effective method of information control when performing machine training using a Personal Digital Assistant. The paper begins by addressing the importance of today's sport training and then addresses problems with raising the effects of training. With this information as a background, information management systems using cellular phones are examined from past research. The research review clearly reveals problems in collection of data and the method of management. The collection/record method of training data is analyzed, and a new data format is proposed. The training method using scientific data is defined as EBT, Evidence Based Training.

Sport training is more than instruction on how to perform exercises and use machinery. In sport training, it is important to train in a range which does not produce harmful strain. This range requires menus, or programs, compatible with the individual's purpose and health condition. However, creating a training menu demands skills that even an athlete may lack. For example, when people go to a training gym, they get advice from a trainer about an individual training menu. Generally, individual guidance of a trainer in an exercise room is a limited resource. Thus, the management of training data is an important key for goal achievement.

Unfortunately, training data, in many training centers, is given low priority on a list of other important needs. Trainers concentrate more on the actual physical processes than entering data into personal computers or jotting down statistics with a pencil and pad. Record keeping skills are secondary to concentrating on training. From this perspective, the need for a efficient, safe method for recording and referencing training information is apparent. This need leads to Evidence Based Training.

For the realization of EBT, a cellular phone can be a very effective apparatus. Cellular phones permeate society widely regardless of age or gender, and have become ubiquitous information processing devices. Although it is easy to propose data collection and processing via the ubiquitous cellular phone, various issues occur in EBT. One of the issues is the problem of how to collect the training histories. Usually, various kinds of training machines are not equipped with the interface which outputs the use result to an electronic device. Even when they are, they require a maker's original data format and a personal computer USB for interface. Such an inconvenient situation is a serious obstacle in the realization of EBT, except for special cases.

In this research, the systems development which led to the two-dimensional code which is a noncontact interface is performed. Building a standard data format aims at creating a high convenience system that can be used with various kinds of equipment. If this standard data format is realized, trainers and trainees can manage data unified by a fixed form, regardless of the kinds and makers of machines used.

## Exercise and Sport Training

The result of this research can be effective in the dissolution of today's important social problem of metabolic syndrome. Metabolic syndrome is a

combination of medical disorders that increase the risk of developing cardiovascular disease and diabetes. The cause of metabolic syndrome is mainly lack of exercise and poor eating habits. Diet simultaneously reduces muscle and fat, reducing basal metabolism. Thus, even moderate exercise is important to reduce the body fat ratio and to prevent what is known as rebound fat or rebound weight gain.

Today, exercise machines are widely accepted, by people of all ages and genders, as alternatives and supplements to other forms of exercise, and they have contributed significantly to the goal of increased physical activity in our society. Joggers, hikers, bicyclers, and swimmers, as well as those who play tennis or practice yoga and taichichuan perform various movements. However, especially middle aged and elderly people begin to perform these forms of exercise suddenly, resulting in failure and even injury in many cases. Therefore, machine training, not only for athletes but for the general public as well, has become an important exercise element. Machine training is a kind of weight training performed using a training machine, which can vary the weight load and strengthen muscles. It is has adjustable features (e. g., the height of a seat) creating a custom fit to one's body and making movement efficient and free using the right form. Various kinds of machines have been developed to strengthen various muscles. Along with these weight training devices, aerobics should be used. There are many aerobic training machines : aero motorbikes, treadmills, Stairmasters, etc. With some of these machines, weight load on pedals can be adjusted or programmed to change over time. Another feature is pulse measurement, such as found on the aero motorbike. Although the training machines used for weight training differ from the aerobics machines, they are altogether called training machines in this paper.

Training on how to use these machines is, of course, necessary, but forming a plan for what kind of and how many muscles are trained using training machines is also important, and feedback on progress is a vital motivating factor. Because

advice is usually obtained from a trainer as for formulating such a plan, there are no big problems to begin with. However, there is the problem of how to continue training. To deal with this problem, it is important to improve performance and to raise "motivation." To measure performance development, it is important to measure results based on data. This is just EBT. Modest results are common in many machine training programs which involve modest body movement, unlike various kinds of games. Nevertheless, even without results appearing immediately, there is the effect of improving game performance or health maintenance, later. Yet, just the recognition of movement being healthy and useful is insufficient. In the motivation of movement, expectation of results and expectation of effects are indispensable viewpoints.[1] The former is prediction of what kind of outcome exercise produces and the latter becomes prediction of how well the exercise has worked.

## Training Support System

Results and effects require a system designed to show a quantitative measurement of each. This chapter shows the outline of the system used until now. It is possible to build a program for weight training by using parameters of weight, movement, and/or number of lifts and sets. And it is possible to adjust the intensity and quantity of movement, speed, and time according to age, physical strength, the degree of health, and the individual's purpose for exercising (e. g., weight loss, strength building, or rehabilitation). Based on individuality, a plan is devised, and its effectiveness determines its longevity. These plans require support systems to facilitate record keeping.

One kind of support system is the proposal system-a support system for the sports training using a cellular phone as ubiquitous computing. One of the advantages of this system is its portability. A cellular phone can be used easily and

safely, but a notebook PC used in a training room is inconvenient and dangerous. Cellular phones can record changes of a practice schedule which can be checked quickly. It uses its own training data through bidirectional processing. This system was used in this research, and effective training support was attained.

In this study, using the cellular phone, training machine information and management of an individual training schedule were developed for every training item : training menu, fitness lesson, standard of load, muscles corresponding to each training machine, and maximum load analysis of data for each student. With this system, the two dimension code could be used, and the data on the Internet could be referred to at any time.

It is important to evaluate goal achievement based on health conditions and life situations. For that purpose, individual tests of physical strength and fitness are used to diagnosis an individual's needs, and a training scheme is implemented. Based on a scientific understanding, the specific part of the body suitable for training is matched to each machine. However, good effect cannot be expected without a plan, applying load blindly. Therefore, to guide the load and the training target suitable, always considering health conditions and life situations, the features of each machine (Fig. 1) are used to map exercise menus. An example of mapping with the part of the body in butterfly & reverse and muscles, and a training item is shown in Table 1.

**Table 1 : The outline of Butterfly & Reverse machine**

| Training item | Butterfly & Reverse |
|---|---|
| Part | Back / Shoulder |
| Muscles | Deltoid muscle<br>Latissimus Dorsi Muscle<br>Trapezius Muscle |
| Repetition Maximum | 100Kg |

For example, in the butterfly reverse which is one of the training items of the upper half of the body, three muscles are related to two parts of the body in Table 1. In order to carry out machine training, it is necessary to decide targets for each muscle and to show how to utilize this machine, or it is necessary to obtain suitable advice from a leader (trainer). From the advice, the individual maximum may rise and weight will be measured. The number of repetitions, the number of sets, and an interval (a break and cooling-down period) will be decided. Moreover, each person's progress is planned and monitored. A leader needs to grasp an individual training history and perform effective machine training or improvement will not be attained..

**Fig 1. Training machine**

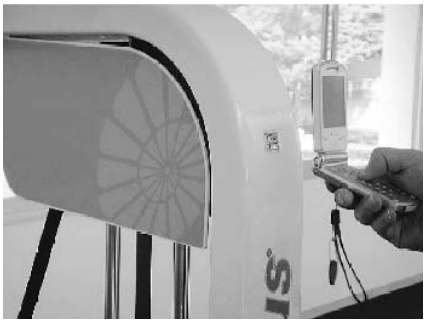

**Fig 2. Reading of a two-dimensional code by a cellular phone**

The item (i. e., the machine to be used) is decided by the body part and muscles to be trained. In order to perform well-balanced training, various kinds of machines must be combined, and the menu according to the condition of the day must be created. That is, the individual maximum 40%, 60%, or 80% of load is calculated by the condition of the day. If these processes are carried out one by one while training, the rhythm of the training is disturbed. Furthermore, depending on the manufacturer of the machine, the difference in kilogram or pound display can hinder positive training. A personal computer is not used especially here, but

utilizing the cellular phone is easy and effective in a training room. First, a user can read machine information as shown in Table 1 in two dimension code (Fig 2), and can check the body part and muscles which will be trained. This information can be provided at any time, and the help of a leader with the notes and instruction on solving problems is always available. Each weight decision is made from a whole plan. On a Web site, the basic information for every machine is displayed along with displays of 40%, 60%, or 80% of personal Repetition Maximum (RM). Thereby, a user can begin planning scientifically and intentionally. Such support is effective to help attain the target from a long-term viewpoint. Moreover, from the leader's point of view, the user follows the exercise time schedule and inputs data, freeing him or her to be a more productive trainer.

## Data Format for EBT Systems

This chapter describes the problems which became clear while using the above mentioned training system. In response to these problems, the standard data format which can perform required general-purpose data collection by training activities is proposed. This proposal format is useful in data collection from the varied apparatus. People can save data on their own Personal Digital Assistants if needed. Such a practical method is desirable from individual privacy and security concerns, as well. Furthermore, in order to secure continuity, data collection which is not influenced by the model or the contents of training of the machine is required to ensure uninterrupted movement and exercise efficiency.

With data input using a cellular phone, a two-dimensional code is possible as the preceding chapter showed. The two-dimensional code allows for taking in data peculiar to a machine : the body part and the muscles to which load is applied. It also allows for focus on training. The user of machine training here needs to record his training information. In the experiment system, it was decided to choose an

item by Web access from a cellular phone. Here, in machine training, what is considered as an item which records a training result is shown in Table 2.

In Table 2, nine items show the value of a machine use situation. The contents of each item are as follows.

1. Record date

   Time data is actually recorded. The time when beginning to use a machine is the time machine use information was entered. The time

**Table 2: Data format for EBT system**

| No. | Item | Data type | Digit number |
|---|---|---|---|
| 1 | Record date | Date | 15 |
| 2 | Machine code | Char | 30 |
| 3 | Weight | Number | 5(1) |
| 4 | Number of times | Number | 2 |
| 5 | Set count | Number | 2 |
| 6 | Time | Number | 2 |
| 7 | Break | Number | 4 |
| 8 | Course | Number | 300 |
| 9 | Reserve | Char | 20 |

**Table 3: Special course format**

| | Item | Data type | Digit number |
|---|---|---|---|
| 1 | Course | Char | 3 |
| 2 | Step | Number | 2 |
| 3 | Load | Number | 3(1) |
| 4 | Time | Number | 4 |
| 5 | Pulse (maximum) | Number | 3 |
| 6 | Pulse (average) | Number | 3 |
| 7 | Pulse (minimum) | Number | 3 |
| 8 | Rotations (max) | Number | 3 |
| 9 | Rotations (avg) | Number | 3 |
| 10 | Rotations (min) | Number | 3 |

ranking for every used machine should be known.

2. Machine code

   The product code of a training machine. A management code also may be sufficient.

3. Weight

   Weight used. Distinction of kilo or a pound is put into the single figure of the beginning.

4. Number of times

   The number of repetitions.

5. Set count

   When carrying out a set using two or more machines, how many times is one set repeated ?

6. Time

   A machine hour of use. When a trainer is not available, the measured value in a pretest is used.

7. Break

   The recess at the time of repeating (a minute and second). Here, the value decided in advance is used. Refer to Table 3 for the contents.

8. Course

   When apparatus other than machine training, such as an aero bike and a fat measuring instrument, is used, it records on this domain as another course.

9. Reserve

   Reserve.

In many cases, a training machine is not equipped with a function which outputs and inputs data. Therefore, use of this data format is performed by another means. The best method considered is a two-dimensional code. The information

for every machine can be offered by a two dimensional code as shown in a former chapter, but the pattern sheet for data input is prepared. A user chooses the pattern corresponding to his training and should just enter it with a cellular phone. There are fortunately few items which are needed by machine training, and it is not difficult to prepare this pattern sheet for every machine. Moreover, also when a set requires two or more machines, the combination and the number of times are decided to some extent by the muscles being trained. The advantage of this data format is in the flexibility. The item in Table 3 corresponds to the aero bike used often in addition to a training machine. There are two features of data processing in an aero bike. One is measuring a pulse and another is the point that program changes load. The contents of each item in Table 3 are as follows.

1. Course

   The course name chosen by aero motorbike, etc. Although this differs in expression depending on the model, inputs are alphabetic characters or a numbers.

2. Step

   The number for every step which changed the load.

3. Load

   The value of the load. Single of triple figures is a decimal point.

4. Time

   Minutes and seconds.

5. Pulse（maximum）

   The maximum of the pulse rate in an applicable step.

6. Pulse（average）

   The average of the pulse rate in an applicable step.

7. Pulse（minimum）

   The minimum of the pulse rate in an applicable step.

8. Rotations (maximum)
   Number of pedal rotations (maximum)
9. Rotations (average)
   Number of rotations (average)
10. Rotations (minimum)
    Number of pedal rotations (minimum)

In many cases, with the aero motorbike or the body fat measuring instrument, the function which outputs a result to an attached small printer, or is displayed with a liquid crystal display is attached. Then, it is possible to add to the output function of each instrument, using the data format proposed here as standard format. If the print-out and the liquid crystal display are already equipped, the function of a two-dimensional code output will be possible by easy correction of software. Therefore, it seems that adding this function does not require cost in almost all apparatus. The above method enables collection of training data with a cellular phone in a certain form. The data collected as two-dimensional data can be sent to the server of a training system by e-mail. In the server side, taking advantage of the strong point of a standard data format, data is analyzed and it becomes possible to add new data to a user's directory as a database. An aero bike and its screen are shown in Figs. 3-6. Moreover, the screen of a body fat measuring instrument is shown in Fig. 7. If it is a two-dimensional code with few amounts of data, the degree of minuteness will be unnecessary, and a display functional addition will be possible. The capacity of the data format proposed by this research is only hundreds of bytes, but is satisfactory to the memory and output (resolution) to these apparatus.

**Fig 3. Aero bike**

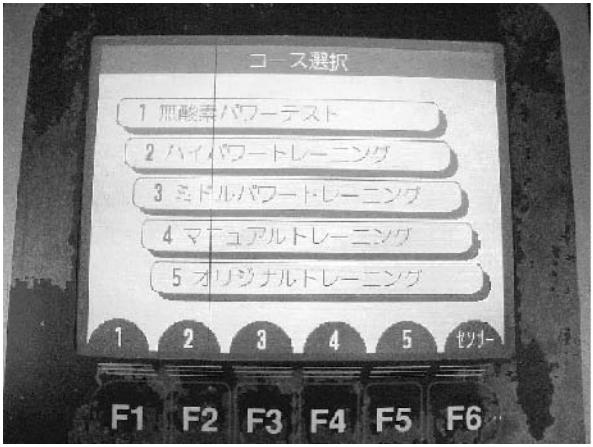


**Fig 4. The example of a screen of an aero bike**


**Fig 5. The example of a screen of an aero bike**


**Fig 6. The example of a screen of an aero bike**

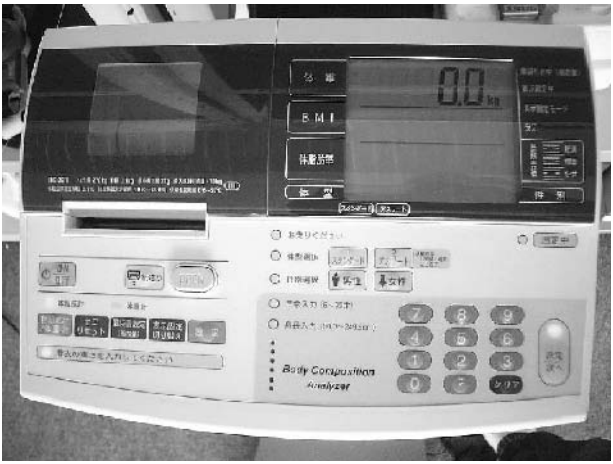


**Fig 7. The example of a screen of a body fat measuring instrument**

## Conclusion

According to the result of the user questionnaire in a certain public gymnastics institution, many of elderly people want to train in response to advice of a trainer.[2] Then, each user's history needs to be well-known to the trainer, who is a counselor, by referring to the person's training history data. Depending on the memory of a user or a trainer, there is a danger that a user will miss important data. Therefore, in machine training, instruction with a trainer has its merits. The principle in training is overload. This is performing above the level of normal exercise intensity. Although the optimum strength changes also with individual difference, Beginners are running by load higher than regulation in fact.[3] This suggests that feelings and actual physiological exercise intensity are out of balance. Although this is an issue which should be taken into consideration, it is thought that this research takes an important position.

Maintenance of a motor function is mentioned as one of the factors of Successful Aging[4] which Rowe and Khan advocated.[5] Humans walk erect against gravity, and in order to live everyday life, maintenance of muscular power is needed. When elderly people perform mild training of about 20 RM, it is supposed that there is no increase in muscular power.[4] This suggests that continued training is required to gain muscular power.

This paper showed an example of information processing using a cellular phone which is expected to be effective in sport training. It is important to establish a custom of movement. With support using a cellular phone being effective in respect of the motivation of forming a plan and continuing it, positive utilization[1] is expected. Moreover, it is thought that ubiquitous information processing[2] addresses the issue of the tendency to delay physical action in elderly people by showing positive motivational influences. A nearly full-scale support system is due providing better analysis in the future.

In the case of training machines, use of a standardization data format can be realized by using the tables prepared beforehand. Although it is possible to use this table system also with an aero motorbike or a body fat measuring device, in order to promote more positive use, it is important to add the output function as a two-dimensional code. Moreover, probably, the input function with a two-dimensional code is also needed. About this point, because of cost concerns, it appears difficult. However, a completely different system using cheap IC chips etc. may reduce costs to a manageable level. A compatible format requires standardization. It is necessary to move research forward, especially with the input-and-output methods, irrespective of the kinds of machines general-purpose or hardware from now on.

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