

7. CHANGES IN HEART RATE DURING JUDO PRACTICE

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Anyone interested in Judo would also take an interest regarding the degree of intensity of exercise involved in Judo. By "intensity of exercise" is meant the magnitude of the load on the body. The present study was undertaken in order to elucidate the problem of the intensity of exercise involved in Judo. One of the methods of investigating this problem is the measurement of energy exchange. Sugimoto and associates¹ compared the intensity of exercise involved in various Judo techniques by measuring the energy exchange rate during performance of various techniques. However, there are certain difficulties involved in this method of investigation. For instance, it is not suitable for measurements during a protracted performance, and also, the mask and the tube hinder free movement, and the performance cannot be termed "free exercise".

Thereupon, in the present investigation, a study of the heart rate of Judoists performing freely was made by telemetry (wireless recording), and the intensity of the load which the techniques impose on the body was studied along this parameter.

The telemetric method has already been used by Oka and associates² in studying the ECG and respiration curves during swimming and running. Takagi³, Matsui⁴, and Nomura⁵ made early investigations into the technical aspects of telemetry and contributed much to its development. Recently, telemetric studies on the heart rate were made by Yokobori⁶ (hockey), Shirai⁷ (cycling), Matsui⁸ (track and field), and Tsukakoshi⁹ (basket ball). Ishiko¹⁰ made studies on the strength applied to the oar during boating by telemetry. Also, many studies on the changes in heart rate made by telemetry have been reported from abroad: A.J. Kozac's¹¹ and V. Skubic's¹² comparative studies on the intensity of exercise of various sports, J. Faulkner's¹³ studies on the heart rate during physical education exercises, and E.H. Christensen's¹⁴ studies on the heart rate during skiing.

In the present investigation, the telemetric method was applied to the study of Judo for the first time.

METHOD OF INVESTIGATION

The apparatuses used were an N.E.C. heart rate meter (type 101) and a recorder (electrocardiograph). This arrangement is the simplest form of a telemeter and was devised in order to measure heart rate only. After applying an ample amount of electric paste to two flat disc electrodes (1 cm. in diameter), one was placed on the sternal region of the experimental subject and the other on the left submammary region between the 5th and the 6th ribs, and the two electrodes were fixed in place by adhesive plaster. The transmitter was attached to the abdomen of the experimental subject by means of a belt, and the transmitter and the clasp of the belt were wrapped in a towel. Instead of the original rod type antenna, a vinyl cord was used and was wrapped around the waist of the experimental subject. In this manner the Judoists were able to practice freely, wearing their Judo costumes. The receiver after catching and amplifying the impulses sent by the transmitter, not only led the current to the recording circuit, but also to an earphone through which pulsating sounds corresponding to the heart beats could be heard. Consequently, the heart rate may be studied by reading the meter or by listening to the sound in the earphone. However, in the present study, in

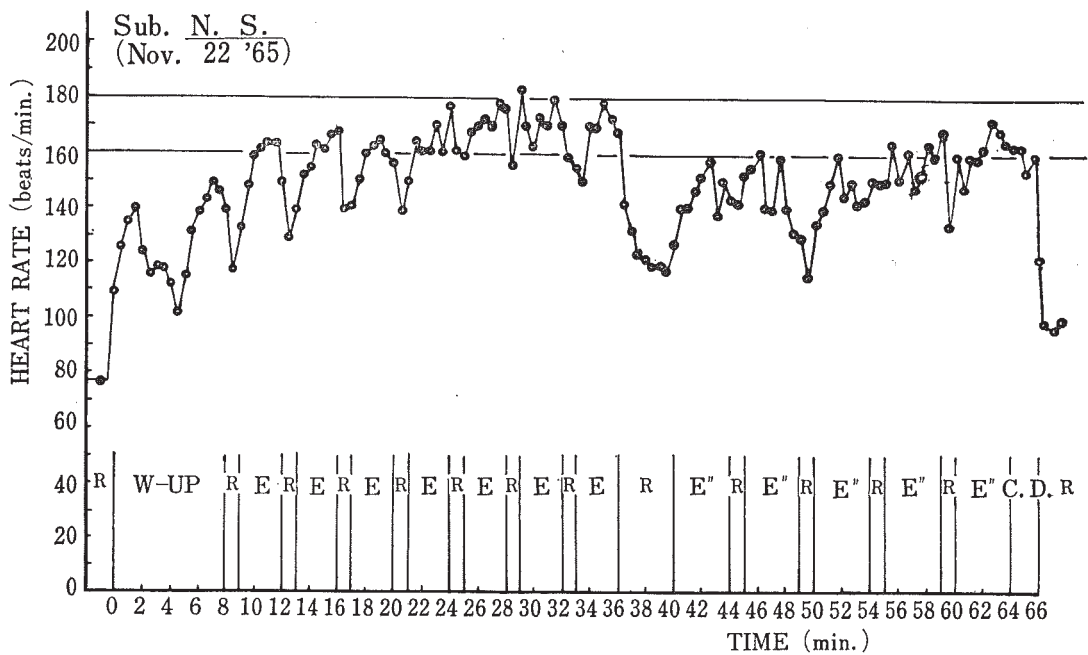


Fig. 1 Changes in heart rate during practice
E: Tachi-waza Randori E'': Ne-waza Randori R: Rest

order to ensure reliability, the pulse in the earphone was recorded by an electrocardiograph. The record thus obtained was not an actual electrocardiogram, however, the pulse corresponding to the R wave could be recorded with certainty.

RESULTS AND DISCUSSION

In Figs. 1-5 the heart rate during Judo practice recorded by the aforementioned wireless method is plotted against time. The axis of ordinates indicates the heart rate (beats per minute) and the transverse axis the time elapsed during the Judo practice. Details of the Judo practice are indicated by symbols on the transverse axis, thus: E for Tachi-waza (technique performed from a standing position) Randori (free exercise), E'' for Ne-waza (technique performed from a lying or semi-reclining position) Randori, and R for rest in standing position.

Case 1 (Fig. 1). This experimental subject (N.S.) was a heavy weight Judoist and had participated in the All Japan Judo Contest. Two peaks (140/min. and 150/min.) were observed during the preliminary exercise. The first peak corresponds to the running and the defensive position, the interval between the peaks to the exercise period, and the second peak to the Kakari-geiko (endurance practice).

As the number of Tachi-waza Randori increased, the heart rate also began to increase, and after the fourth Randori the average heart rate was 170/min., and occasionally registered as high as 180-184/min.. Also, as the number of Randori increased the degree of reduction in heart rate during the rest interval diminished, and after the fourth Randori, the heart rate during the rest interval did not lower beyond the 160/min. level. Heart rate dropped to 120/min. during the 3 minute rest period following the Tachi-waza Randori, however, it rose again during the next Ne-waza Randori, although it did not reach the high level attained by the Tachi-waza Randori.

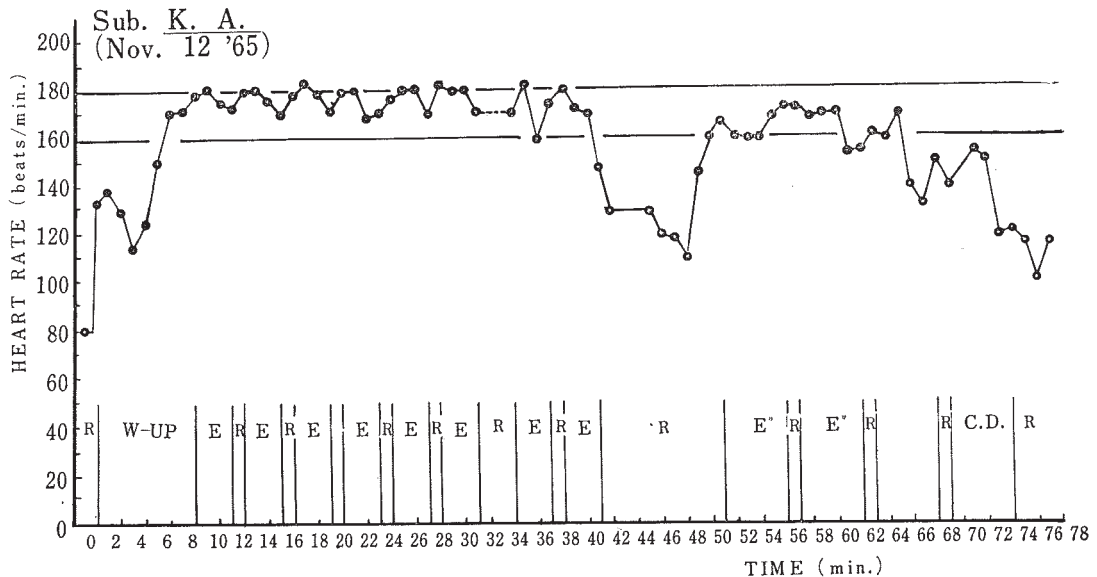


Fig. 2 Changes in heart rate during practice.
E: Tachi-waza Randori E': Ne-waza Randori R: Rest.

Case 2 (Fig. 2). In this experimental subject (K.A.), the heart rate already reached 180/min. in the first Randori and in every one of the following Randori the same high level was also noted, and even during the one minute rest intervals, his heart rate did not lower beyond the 170/min. level. From these findings, it is inferred that the performances imposed considerable load on his heart. His heart rate during the Ne-waza Randori was also higher than that of N.S.

Case 3 (Fig. 3). This experimental subject (T.S.) was a light weight Judoist and had participated in the All Japan Judo Contest. His heart rate reached 180/min. in the first Randori, and from the second Randori reached as high a level as 190/min.. His highest recorded heart rate was 194/min., and even during the rest intervals his heart rate remained in the 170/min. level. During the Ne-waza Randori the electrode became detached from his body, resulting in defective recording in certain places. However, in the latter stage his heart rate registered 180/min., and from this it may be surmised that the heart rate during the earlier stage was around 170–180/min.. The movements of this Judoist was very active and aggressive, and attacked his opponent incessantly. This intensive activity, most probably, accounts for his high heart rate.

Case 4 (Fig. 4). In this experiment, Judoist K.A. performed seven Tachi-waza Randori in succession with one minute rest intervals in between. After the seventh Randori a rest period of 3 minutes was allowed, after which seven consecutive Tachi-waza Randori were performed without any rest interval in between. In the successive Randori with the rest intervals, the heart rate of the experimental subject increased by degrees and reached a maximum of 180/min. in the latter half. However, this high level was not maintained for any length of time, but usually fluctuated between 160–180/min. showing an interval practice pattern. On the other hand, in the seven consecutive Randori without any rest interval, his heart rate remained in the 180/min. level, at least until the sixth Randori. In other words, an almost maximum load was imposed on the heart for 15–17 minutes. After a rest period of 3 minutes following the seven consecutive Tachi-waza Randori a series of Ne-waza Randori

was performed, during which his heart rate registered comparatively high levels also.

Case 5 (Fig. 5). As in Case 4, consecutive Randori without any rest interval was also performed in this case (experimental subject T.M.). The experimental subject's heart rate reached the 190–200/min. level, already in the first Randori. In this increased heart rate pattern there is an impression of a deviation from the general increasing trend, and it may probably be due to the fact that the Judoist began to perform the extremely strenuous exercise before his body became completely accustomed to it. However, his heart rate during the rest intervals between the Randori dropped considerably indicating that he had ample reserve strength. As soon as he started the five consecutive Randori without the rest intervals, his heart rate reached 180/min. and remained so or even exceeded this level during the rest of the performance. In other words, a very heavy load was imposed on his heart for more than 10 minutes. Even during the Ne-waza Randori, his heart rate often registered the 180/min. level, and it is thought that this was due to the fatigue resulting from the previous consecutive Randori.

Other cases. Measurements were made in 4 other cases. In some cases, recording was defective in certain parts, however, excluding one case in which heart rate was below the 170/min. level, in all the others heart rate registered 180/min. or more in the latter half of the Randori.

One of the noteworthy points in the aforementioned results of the experiments is that the heart rate, in most of the Judoists under observation reached frequently the high level of 180/min. or more.

Two of the experimental subjects, N.S. and T.S., have had the opportunity to run on a treadmill until all-out in 5 minutes in another experiment (Physical Education Laboratory, University, of Tokyo 1965). In this experiment, when their heart rates registered the maximum levels reached during the Judo experiment (180/min. in N.S. and 190/min. in T.S.) they also reached their respective all-out points (within 1 minute after reaching the 180/min. and 190/min. levels, respectively). In other words, a heart rate of 180–190/min. indicates that a considerably heavy load is imposed on the heart. It may be said that the load on the heart was of maximum intensity, especially, in K.A. and T.M. whose heart rate registered 180–185/min. for as long as 15–20 minutes during the consecutive Randori. If they were made to perform the endurance run they would also be all out within a few minutes after reaching a heart rate level of 180/min. Then, why is it that in Judo they were able to continue physical exertion for such a long time with a heart rate of 180/min. or more? The following explanation may be given: In a treadmill run, muscular activity is enforced at a fixed pace, and when the energy supply fails, even slightly, to meet this pace, the execution of further exercise at the same speed becomes impossible. However, in Judo, the pace of the movements of the arms and legs may be regulated and while replenishing energy by involuntarily decreasing the amount of exercise before all-out is reached, the Judoist is able to continue practice with an intensity nearing the limit of physical exertion. The decrease in the amount of exercise and the time duration in which the decrease is made are very slight so that no significant drop in the heart rate is observed, and as a result a high level of heart rate is maintained for a considerable length of time. However that may be, there is no doubt that the consecutive Randori without rest intervals is a very strenuous exercise requiring much stamina. Whether it is advisable to cultivate stamina by enforced strenuous exercise lasting for a protracted length of time is another question, however, at least, it helps to cultivate endurance. According to Reinder¹¹ who advocated interval training it is advisable for the heart rate level which had been elevated to 180/min. during the exercise period to be lowered to 120–130/min. during the rest interval before going into the next exercise period. By so doing, it is believed, that an adequate stimulus is produced in order to increase heart output. According to this theory the one minute rest intervals allowed during Judo practice is insufficient and due consideration must be given to extending the duration of the rest intervals. It is the view of the present authors that a reduction in heart rate to at least 140/min. is necessary. If the cultivation of speedy techniques is the prime object, it is necessary to allow ample rest intervals.

The method of practice used in the present experiment is only a trial method, however, it is

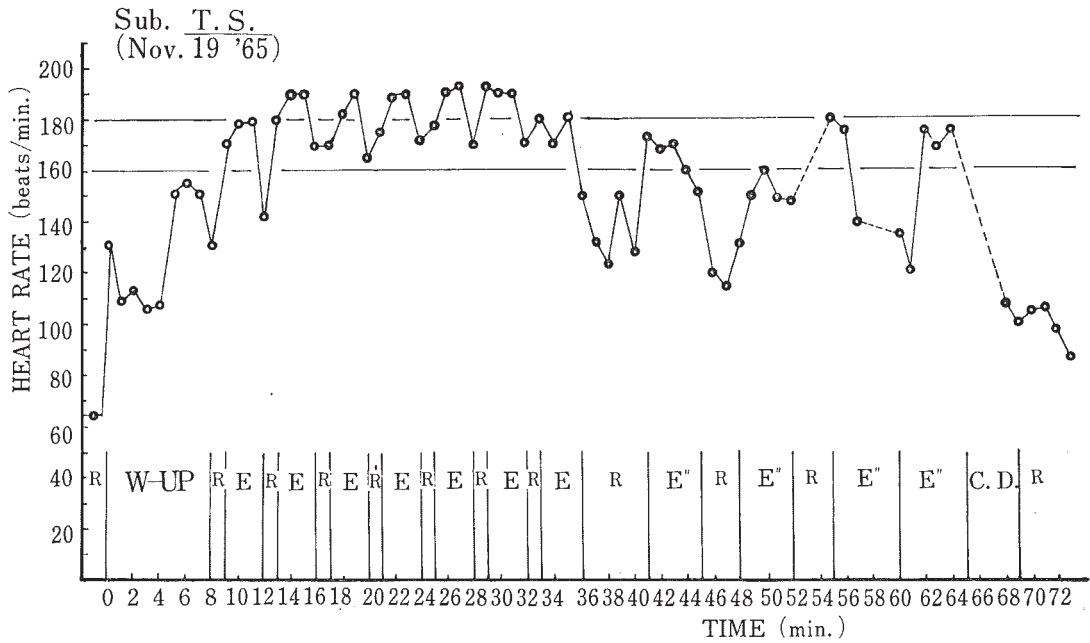


Fig. 3 Changes in heart rate during practice.
E: Tachi-waza Randori E' Ne-waza Randori R: Rest.

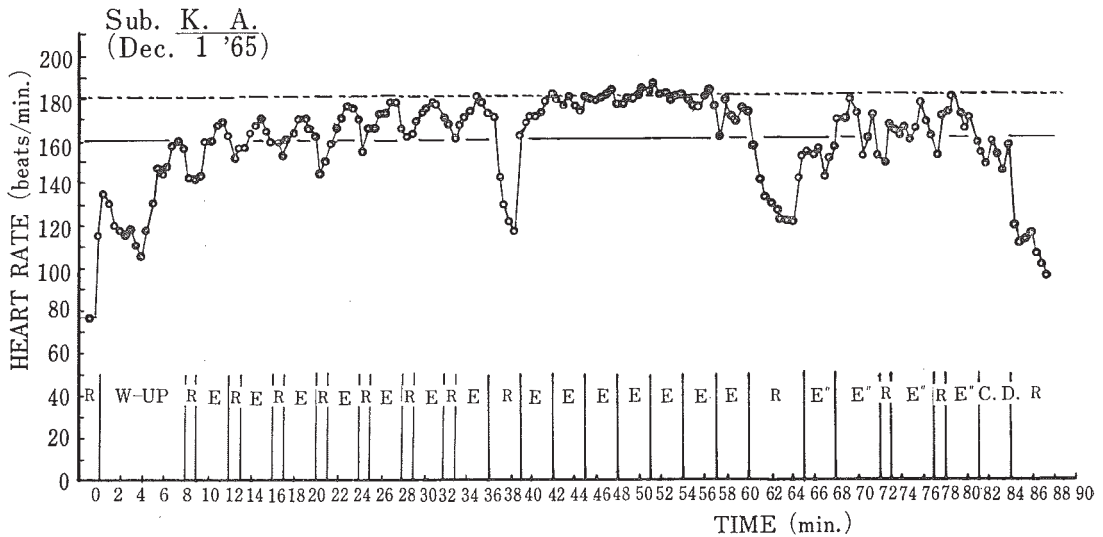


Fig. 4 Changes in heart rate during practice.
(continuous exercise from 39 min. to 60 min.)

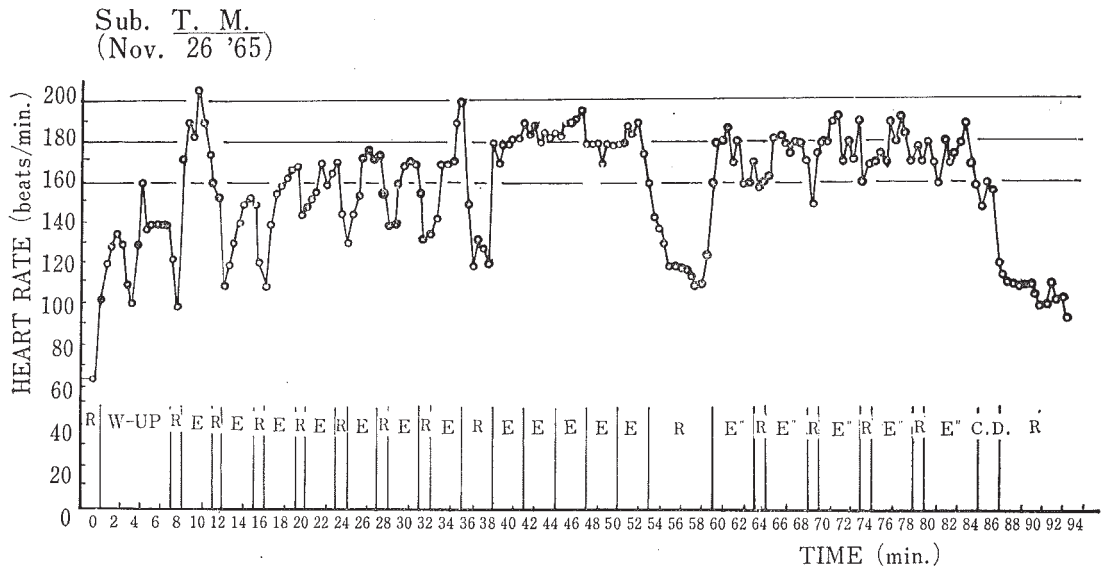


Fig. 5 Changes in heart rate during practice.
(continuous exercise from 38 min. to 53 min.)

hoped that data obtained in this study will serve as a reference in considering methods of practice.

CONCLUSION

The heart rate of Judoists during a Judo practice was recorded by means of a telemeter (wireless remote measurement) and the following results were obtained:

- 1) The heart rate during the preliminary exercise was 150–160/min.
- 2) As the number of Randori increased, the heart rate also increased and reached a maximum level of 180/min. in most cases.
- 3) The heart rate during the 1 minute intervals between each Randori also gradually increased as the number of Randori increased, and in most cases reached 170/min.
- 4) In the consecutive Randori without rest intervals, a heart rate of 180/min. or more lasted for 15–20 minutes.

From the foregoing results it is inferred that Judo is a sport in which a very heavy load is imposed on the cardiac function.

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