CHAPTER III

METHODOLOGY

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.

A methodology does not set out to provide solutions - it is, therefore, not the same as a method. Instead, a methodology offers the theoretical underpinning for understanding which method, set of methods, or so-called "best practices" can be applied to specific case, for example, to calculating a specific result. Research methodology involves a systematic procedure by which the researcher starts from the initial identification of the problem to its final conclusion. The role of methodology is to carry out the research work in a scientific and valid manner. The purpose of the study was to find out the effect of tabata interval methods of various durations on selected physiological and athletic performance variables of school students. In this chapter, selection of subjects, selection of variables, experimental design, selection of tests, instruments reliability, reliability of data, orientation to the subjects, pilot study, training programme, test administration, collection of data and statistical technique adapted to analyse the data are presented.

3.1. SELECTION OF SUBJECTS

The purpose of the study was to investigate the effect of tabata interval methods of various durations on selected physiological and athletic performance variables among school students.

For the present study, forty five school students were selected randomly from Navbharath Matric. Hr. Sec. School, Ponnaiyah Ramajayam Public Hr. Sec. School and St. Antony's Hr. Sec. School, Thanjavur, Tamil Nadu, India. The age of the subjects ranged between 15 and 17 years. The selected subjects were divided into two experimental groups: Group I (TTG1) - Tabata Interval Training group (1: 1 (active period : rest period)), Group II (TTG2) - Tabata Interval Training group (1: 0.5 (active period : rest period)) and control group (CG) with fifteen subjects (n=15) each.

All subjects were informed about the nature of the study and their written consent was obtained to co-operate till the end of the experiment. For the pilot study and final study experimental groups (namely TTG1 and TTG2) were trained-up for six weeks using tabata interval method (1:1 ratio) and tabata interval method (1:0.5 ratio) respectively. The subjects were free to withdraw their consent, incase they felt any discomfort during the period of their participation. But there were no dropouts. A qualified physician examined the subjects medically and declared them fit for the study.

3.2. SELECTION OF VARIABLES
3.2.1. Dependent Variables

Tabata training is the fastest way to fitness and fat loss. Tabata interval training is the single most effective type of high intensity interval training, it's also the most intense by far, and surprisingly it's the shortest in duration, it only last for four minutes... but those four minutes produce remarkable effects. Lose Fat, Get Fit in four minutes (**http://www.intervaltraining.net/tabata.html**). Tabata and a variety of short HIIT formats are highly popular intense forms of interval training.

Research shows that Tabata and short HIIT workouts can be used to increase both aerobic and anaerobic fitness, promote fat loss, and even improve blood pressure, insulin sensitivity, and glucose regulation in a relatively short time (**Olson,2014**).

Body weight and composition should not be the sole criterion for participation in sports. Optimal body fat levels depend upon the sex, age, and heredity of the athlete, and may be sport-specific (**Rodriguez, Di Marco and Langley, 2009**). Body composition and sports performance body fat percentage of athletes varies depending on the sex of the athlete and the sport. The estimated minimal level of body fat compatible with health is 5% for men and 12% for women (**Heymsfield, et al., 2005**); however, optimal body fat percentages for an individual athlete may be much higher than these minimums and should be determined on an individual basis **(Marfell-Jones, et al., 2006).** Body composition analysis should not be used as a criterion for selection of athletes for athletic teams. Weight management interventions should be thoughtfully designed to avoid detrimental outcomes with specific regard for performance, as well as body composition (i.e., loss of lean body mass). Body fat assessment techniques have inherent variability and limitations. Preferably, weight loss (fat loss) should take place during the off-season or begin before the competitive season and involve a qualified sports dietitian. Body weight is basically how much does one weigh; body composition is what that weight is composed of (muscle, bone, fat, etc). Body weight can influence athlete's speed, endurance, and power, whereas body composition can affect athlete's strength, agility, and appearance. Those with greater muscle to fat ratio are often at an advantage where speed is involved. More muscle equals more speed (**Rodriguez, Di Marco and Langley, 2009**).

Many sports such as football, basketball and cycling require energy from both the anaerobic and aerobic systems (**Wilmore and Costill, 2005)**. Speed and endurance are critical for training and competition in these events. It is critical to make efficient use of time for coaches and sports scientists especially when limited time for training is available. The maximal oxygen uptake (VO_2max) is generally considered the best indicator of cardiorespiratory endurance and aerobic fitness (**Carey and Richardson, 2003**). Of course, in elite athletes VO_2max is not a good predictor of performance. While a high VO_2max may be a prerequisite for performance in endurance events at the highest level, other markers such as anaerobic threshold are more predictive of performance [**Wilmore and Costill, 2005**]. Anaerobic power is also considered important in athletic performance especially in the evaluation of peak power (**Craig and Norton, 2001**).

Hence, the following dependent variables were selected for this study.

1. Body fat

2. VO_2max

3. Resting heart Rate

4. Speed

5. Speed Endurance

6. Agility

7. Abdominal muscular endurance, and

8. Arm strength

3.2.2. Independent Variables

Tabata training programme compared highly effective interval workout with a protocol using 4-5 repetitions of a 30-second workout at 200% of VO_2max and 2-minute rest intervals. Tabata looked at both the accumulated oxygen deficits of the two protocols and the peak oxygen uptakes during the last 10 seconds of each interval. It was clear that the 20:10 seconds work : rest ratio taxed the anaerobic and aerobic systems maximally. The advantage of 20:10 Tabata intervals is that they are very effective and do not take a long time at all. The disadvantage is that they are very hard work and it takes a highly motivated athlete to work at the high levels of intensity required (**http://www.intervaltraining.net/tabata.html**). Other studies have looked at different interval work : rest ratios and also how their subjects coped with the workloads. One study compared a work : rest ratio of 1:1.5 during 40 minutes of treadmill running with the work intervals being either 6, 12 or 18 seconds. The work rate was at 120% of VO_2max (easier than the Tabatas at 170%) and the rest was passive. The 12 and 18-second work intervals were more effective than the 6 seconds at inducing physiological strain measured by respiratory exchange and mean exercise intensity (**http://www.intervaltraining.net/ tabata.html**). However, when beginning interval training, it may be better to use slightly shorter work intervals, and progress by increasing the work time. A recent study in Japan looked at running at 100% of VO_2max and then working at 50% of VO_2max during the recovery period. Work to rest intervals (in seconds) of 15:15, 30:15 and 60:15 were measured. Only five of the 12 subjects were able to complete the 60-second work trial, which produced blood lactate levels of 12.5mmol (high!). When measuring the percentage of VO_2max that was used during the trial, the 15:15 protocol elicited significantly less than the other two, and the researchers concluded

that a 2:1 work to rest ratio could be a good way to start (**http://www.intervaltraining.net/tabata.html**). As previously noted, the intensity of HIIT is well above moderate at approximately 90% of VO_2max or higher. ''Supra'' intense (supramaximal) formats include not only the original Tabata format but also the formats developed and studied by **Burgomaster, et al., (2008)** and **Zong, et al., (2013)**. Because supramaximal protocols are done with a full-on anaerobic effort, the actual volume of exercise is almost shockingly low VO_{2max} between approximately 4 and 12 minutes. In sport training and conditioning, athletes who must perform repeated bursts with an all-out effort can benefit from these supramaximal HIIT protocols such as Tabata because they match the athletes' more extreme performance needs and improve both aerobic and all-important anaerobic fitness. For instance, exercise physiologists **Little, et al., (2010)** and **Hood et al. (2011)** adapted the pure anaerobic format by **Burgomaster, et al., (2008)** by reducing the intensity and increasing the length of the effort intervals from 30 seconds to 60 seconds. **Olson** used body weight squat jumps with the Tabata 20-second effort and 10-second rest format. All three of these modified formats (**Ingle, 2014, Little, at al., 2010 and Olson, 2013**), although not supramaximal, are not ''soft,'' though, on intensity. The aerobic HIIT formats also can prove more ''user-friendly'' and suitable for the general fitness setting while still being quite economical on time requiring no more than minutes to complete. One can do Tabata exercise with sprints, but it is far more adaptable than other forms of interval training. One can use exercises such as the front squat or push press if one are in the gym. Kettle bells work exceptionally well. Basically anything that one can put a large load on one's biggest muscle groups. Be sure to use one's large muscle groups

otherwise one will get very little of the benefit (**http://www.intervaltraining.net /tabata.html**). The most important part of a successful exercise program is to have a program designed with gradual progressions, and with an individual's very own specific needs in mind. Much of the time when beginners are motivated to start an exercise program and hear of a fat burning method of exercise that works, their tendency is to attempt to fit themselves into the workout, rather than adapting the type of workout to their own special individual needs. In the excitement of making that commitment to a healthier lifestyle, the most important part of the program is overlooked – modifying to one's own needs to avoid injury and set back as one begin a healthier lifestyle (**http://www.askthetrainer.com/low-impact-high-intensity-interval-training**).

To achieve the purpose of the present investigation, the following variables were selected as independent variables.

1. Tabata interval training (1:1 ratio) method and

2. Tabata interval training (1:0.5 ratio) method and

3. Control group

3.3. EXPERIMENTAL DESIGN

The experimental design used for this study was similar to a random group design involving forty five subjects, who were divided at random into three groups of fifteen each. This study consisted of two experimental groups: Group I – Tabata interval training group (1:1 ratio) (TTG1) and Group II – Tabata interval training group (1:0.5 ratio) (TTG2) and a control group (CG). All the subjects were tested prior to and after the experimentation on selected dependent variables

3.4. SELECTION OF TESTS

The following standardized tests were used to collect the relevant data on selected dependent variables and they are presented in Table I.

TABLE I

SELECTION OF TESTS AND UNITS OF MEASUREMENT

Variables	Tests	Units of Measurement
Body fat	Bio-Electrical Impedance Analyser (Karada Scan)	In Percentage
VO$_2$max	Bleep test	In ml/Kg/min
Resting Heart Rate	Radial pulse	In beats per minute
Speed	50 yards run	In Seconds
Speed Endurance	120 mts run	In Seconds
Agility	30 feet shuttle run	In Seconds
Abdominal Muscular Endurance	Bent knee sit-ups	In Numbers
Arm Strength	Push-ups	In Numbers

3.5. INSTRUMENTS RELIABILITY

Instruments like measuring tape, stopwatches, bio-electrical impedance analyser, MP3 player, and Bleep test music in the laboratory of Department of Physical Education, Navbharath Matric. Hr. Sec. School, Thanjavur were all reliable and manufactured by standard companies. Instrument reliability was also established by test-retest method.

3.6. RELIABILITY OF THE DATA

Three months before the commencement of the pilot study, the reliability of the data was established by using 12 subjects at random. To ensure reliability, test and re-test method was executed. In between the test and retest one-day rest was given to all the subjects. The researcher using the same equipments under identical conditions tested for all the selected variables twice on the same subjects. The raw data are presented in appendices A, B, C, D, E, F, G and H. The intra class co-efficient of correlation was used to find out the reliability of the data and the results are given in table II.

TABLE II

INTRA CLASS CO-EFFICIENT OF CORRELATION ON SELECTED VARIABLES

S.No.	Variables	'R' value
1	Body fat	0.82*
2	VO$_2$max	0.83*
3	Resting heart rate	0.89*
4	Speed	0.84*
5	Speed endurance	0.83*
6	Agility	0.81*
7	Abdominal muscular endurance	0.93*
8	Arm strength	0.91*

*Significant at 0.05 level. (Table value required for significance at 0.05 level of confidence is 0.576)

Since the obtained 'R' values are much higher than the required value, the data are accepted as reliable in terms of instrument, tester and the subjects.

3.7. ORIENTATION TO THE SUBJECTS

The investigator explained the purpose of the training programme and also the involvement of the subjects. Before the commencement of the training programme, the tabata interval method (1:1 ratio) techniques were taught to group I (TTG1) and the tabata interval method (1:0.5 ratio) were taught to group II (TTG2). Three one-hour sessions were spent on alternate days (Mondays, Wednesdays and Fridays) to practice the tabata interval training exercises for the experimental groups. This helped them to understand the tabata interval training method and perform the training exercises perfectly.

3.8. PILOT STUDY

A pilot study was conducted with 12 school students. The subjects were selected at random and divided into two groups of six each, in which group I underwent tabata interval training with 1:1 ratio, group II underwent tabata interval training with 1:0.5 ratio under the supervision of the researcher. However, the individual differences were considered. While constructing the training programmes, the basic principles of sports training namely progression, of load and specificity were followed.

3.9. TRAINING PROGRAMME

The subjects underwent their respective training programme under precise supervision. The group I (TTG1) underwent tabata interval training with 1:1 ratio, group II (TTG2) underwent tabata interval training with 1:0.5 ratio but group III (CG) did not participate any training programme during the training period. They treated as control group. The duration of training period was restricted to six weeks and the number of sessions per week was confined to three. Initially, each subject

performed a 1 RM test and also to assess the maximal heart rate. Each individual's training load and intensity were fixed according to the training principles. Prior to every training session, subjects underwent 5 minutes of warm-up exercise, which included stretching, jogging, striding, parallel squats, arms rotation and jump and toe touch. All the subjects involved in training programme were questioned about their stature throughout the training period. None of them reported any injuries. However, muscle soreness was reported in the early weeks, but it subsided later. Based on the response of the subjects in the pilot study, the training schedules were constructed and presented in the following tables.

TABLE III

TRAINING SCHEDULE - TABATA INTERVAL TRAINING GROUP-I (RATIO:

DAY	EXERCISE	DURATION OF EXERCISE		NO. OF REPETITION	REST BETWEEN EXERCISE	IN	
		ACTIVE	REST			1-2 WEEKS	W
MONDAY	Skipping	20 Secs	20 Secs	8	10-12 mins	80%	
	Back squat	20 Secs	20 Secs	8		80%	
	Lunges	20 Secs	20 Secs	8		80%	
	Sit-ups	20 Secs	20 Secs	8		80%	
WEDNESDAY	Skipping	20 Secs	20 Secs	8	10-12 mins	80%	
	Push-ups	20 Secs	20 Secs	8		80%	
	Dead lift	20 Secs	20 Secs	8		80%	
	Burpee	20 Secs	20 Secs	8		80%	
FRIDAY	Skipping	20 Secs	20 Secs	8	10-12 mins	80%	
	Hang cleans	20 Secs	20 Secs	8		80%	
	HBA Step-ups	20 Secs	20 Secs	8		80%	
	Sit-ups	20 Secs	20 Secs	8		80%	

TABLE IV

TRAINING SCHEDULE - TABATA INTERVAL TRAINING GROUP-II (RATIO:

DAY	EXERCISE	DURATION OF EXERCISE		NO. OF REPETITION	REST BETWEEN EXERCISE	INT	
		ACTIVE	REST			1-2 WEEKS	3 WE
TUESDAY	Skipping	20 Secs	10Secs	8	10-12 mins	80%	8
	Back squat	20 Secs	10Secs	8		80%	8
	Lunges	20 Secs	10Secs	8		80%	8
	Sit-ups	20 Secs	10Secs	8		80%	8
THURSDAY	Skipping	20 Secs	10Secs	8	10-12 mins	80%	8
	Push-ups	20 Secs	10Secs	8		80%	8
	Dead lift	20 Secs	10Secs	8		80%	8
	Burpee	20 Secs	10Secs	8		80%	8
SATURDAY	Skipping	20 Secs	10Secs	8	10-12 mins	80%	8
	Hang cleans	20 Secs	10Secs	8		80%	8
	HBA Step-ups	20 Secs	10Secs	8		80%	8
	Sit-ups	20 Secs	10Secs	8		80%	8

3.10. TEST ADMINISTRATION

3.10.1. Body fat

Objective

To measure body fat of each subject.

Equipment

Bioelectric Impedance Analyzer.

Procedure

First, feed the data regarding gender, athletic or non-athletic, age and height of the subject in the bioelectric impedance analyser and the subject was asked to stand on the instrument.

Scoring

After the subject stands on the instrument, it displays the subject's weight, body fat percentage, body water level, calories required and bone mass. The required body fat percentage score was recorded.

3.10.2. VO$_2$max

Objective

To assess the VO$_2$max.

Equipments

Flat, non-slip surface, marking cones, 20m measuring tape, CD player, recording sheets.

Procedure

This test involves continuous running between two lines 20m apart in time to recorded beeps. The subjects stood behind one of the lines facing the second line, and begin running when instructed by the recording. The speed at the start is quite slow. The subject continues running between the two lines, turning when signaled by the recorded

beeps. After about one minute, a sound indicates an increase in speed, and the beeps will be closer together. This continues each minute (level). If the line is reached before the beep sounds, the subject must wait until the beep sounds before continuing. If the line is not reached before the beep sounds, the subject is given a warning and must continue to run to the line, then turn and try to catch up with the pace within two more 'beeps'. The test is stopped if the subject fails to reach the line (within 2 meters) for two consecutive ends after a warning.

Scoring

The athlete's score is the level and number of shuttles (20m) reached before they were unable to keep up with the recording. Record the last level completed (not necessarily the level stopped at). This level score can be converted to a VO_2max equivalent score and it was recorded as attest score. (**http://www.topendsports.com/testing/tests/BI.htm**)

3.10.3. Resting heart rate
Objective

To assess the resting heart rate.

Equipments

A stopwatch 1/10 of a second was used.

Procedure

The pulse rate of all the subjects was recorded in the sitting position and in the evening between 3.30 and 4.30pm. Before taking the pulse rate the subjects were asked to relax for about 30minutes. To record the pulse rate the fingertips were placed on the radial artery at the wrist in such a manner that palpitation was clear (**Clarke, 1976**).

Scoring

The number of palpitation was counted for one full minute and it was recorded as the test score.

3.10.4. 50 Yards Run test

Objective

To assess the speed

Equipment and Materials

Measuring tape, starting clapper and stopwatch Marking Two lines (starting and finish) were drawn 50 yards apart in the straight portion of the 400 meters track.

Procedure

Students were advised to use standing start method. The subject stood behind the starting line with the command 'ready' and on 'clap' they ran through the 50 yards distance. A stopwatch measured the elapsed time from the starting signal to the runner crossing the finish line. Since the timing was operated by hand, the time was recorded to one hundredth of a second.

Scoring

Each subject was given two trials with sufficient rest in between and the best out of the two trials was recorded. (**Baumgartner and Jackson, 1991**)

3.10.5. 120 meter run

Objective

To asses the subject's speed endurance.

Equipments

Stop watch, Assistant, score sheet and pencil.

Procedure

This test requires the subject to run as fast as possible over 120 meters. The subject makes the warm up for 10 minutes. The assistant marks with cones a 120 m section on the 400 m track, then the athlete sprints as fast as possible from a standing stationary position at the start line to the 120 meter finish line. The assistant stands at the finishing line and starts the stopwatch from the subject's first foot strike and stops the stopwatch when the subject's torso crosses the finishing line.

Scoring

The score is the amount of time between the starter's signal and the instant the subject crosses the finish line. Record in seconds to the nearest tenth of a second.

3.10.6. 30 feet shuttle run

Objective

To measure the agility of an individual.

Equipments

Two blocks of wood, 2 inches x 2 inches x 4 inches, and stop watch. Pupils should wear sneakers or run barefooted.

Procedure

Two parallel lines are marked on the floor 30 feet apart. The width of regulation volleyball serves as a suitable area. Place the blocks of wood behind one of the lines.

The subjects starts from behind the other line. On the signal "Ready? Go" the pupil runs to the blocks, picks one up, run to the starting line, and places the block behind the line, subjects then runs back and picks up the second block, which subjects carries back across the starting line. If the scorer has two stop watches or one with split – second timer, it is preferable to have two subjects running at the same time. To eliminate

the necessity of returning the blocks after each race, start the races alternately, first from behind one line and then from behind the other.

Scoring

The time of the better of the two trials to the nearest tenth of a second is recorded (**Hendry Allan Lipman, 2009**).

3.10.7. Bent Knee Sit – Ups

Objective

To measure the abdominal muscular endurance of an individual.

Equipments

Gymnastic Mats and stop watch.

Procedure

Subject supine on the mat, heels not more than 12 inches from buttocks, angle of knees less than 90 degrees. Subjects places hands behind of neck with fingers clasped and elbows squarely on mat. The subject's curls to a sitting position touching elbows to knees. This completes one sit – ups.

Scoring

The number of correctly executed sit – ups performed in a 60 second period shall constitute his score. (**Hendry Allan Lipman, 2009**).

3.10.8. Push - Ups

Objective

To measure the Arm strength of an individual.

Equipments

Floor, Score Sheet, Pencil.

Procedure

The tester takes a front leaning rest position with tester supported on hands and balls of feet. The arms are straight and at right angles of the body. Subject then dip or lower the body, so that the chest touches or nearly touches the floor, then pushes back to the starting position by straightening the arms, and repeats the procedure as many times as possible.

In performing the floor push - ups, only the chest should touch the floor, the arms must be straight with each push – up, and the body must be held straight throughout.

Scoring

Scoring consist of the number of correct push – ups and the unit of measurement in number. (**Clarke & Clarke, 1987**).

3.11. COLLECTION OF DATA

The data on selected dependent variables for pre and post tests were collected three days before and after the training programme respectively. Resting heart rate, speed endurance and agility were tested on the first day. On the second day, arm strength and VO₂max were tested, and, body fat, abdominal muscular endurance and speed were tested on the third day.

3.12. STATISTICAL TECHNIQUE

The data was collected from the three groups before and after the experimental period. The collected data were statistically examined for significant different by dependent 't' test. No attempt was made to equate the groups in any manner. Hence, to make adjustments for difference in the initial means and test the adjusted posttest means for significant differences, the analysis of covariance (ANCOVA) was

used. Whenever the 'F' ratio was found to be significant, Scheffe's test was used as post-hoc test to determine which of the paired means differed significantly. In all cases, the criterion for statistical significance was set at 0.05 level of confidence (P<0.05).

3.12.1. Assumptions for ANCOVA

A preliminary analysis was conducted to determine whether the prerequisite assumptions of one-way univariate **ANCOVA** were met before preceding the univariate analysis. Thus, the assumption of equality of variance (homogeneity), was examined and presented below.

Levene's Test of equality of error variances on selected variables were calculated and presented in table V.

TABLE V

LEVENE'S TEST OF EQUALITY OF ERROR VARIANCES ON SELECTED VARIABLES OF TTG1, TTG2 AND CONTROL GROUPS

Variables	F Ratio	df1	df2
Body fat	0.132	2	42
VO$_2$max	0.111	2	42
Resting heart rate	0.440	2	42
Speed	0.413	2	42
Speed endurance	0.732	2	42
Agility	0.097	2	42
Abdominal muscular endurance	0.182	2	42
Arm Strength	0.147	2	42

* significant at 0.05 level

(The table value required for 0.05 level of significance with df 2, 42 is 3.22)

The results from the Levene's Test for homogeneity of variance of comparing the three groups regardless of the ability level for each of the dependent variables indicates that homogeneity of variance has been met for all the dependent

variables. The 'F' ratio values for all dependent variables are less than the table value of 3.22 against with df 2 and 42 at 0.05 level of confidence. Hence, it is concluded that the assumption of homogeneity of variance has been met.