Original Article

The Cloud FIBER-FIT Model for Physical Fitness Check-Up

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Abstract

Background: Physical fitness refers to the ability of the body to perform tasks or do one of the physical activities well without being tired quickly. The objective of this research is to develop a physical fitness instrument for measuring oneself heart rate, grip strength, and reaction time that could develop a model for a self-check-up on physical fitness which helps to plan the improvement for health which is called the "FIBER-FIT" model. **Methods:** The physical fitness measuring instrument is composed of three modules; (1) heart rate meter module using a green light emitting diode and a photosensor, (2) grip strength meter module using a load cell transducer, and (3) reaction time meter module using a computer graphical function. All modules are controlled by computer programming, LabVIEW. The program could measure the physical fitness parameters in real-time and display the results in graphs, values on a computer monitor. The data could be recorded on cloud storage and could be retrieved for viewing and analyzing from anywhere via the internet. **Results:** Getting the "FIBER-FIT" model, a physical fitness measuring instrument to evaluate and analyze the results in real time. Overall performance test results were comparable to the standard commonly used instruments. The satisfaction survey scores from the participants were 33.33% and 66.67% for the highest level and the high level, respectively. **Conclusions:** The Cloud "FIBER-FIT" model is recommended for physical fitness applications for health improvement.

Keywords: *Cloud storage, grip strength, heart rate, physical fitness, reaction time*

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Introduction

Those who have good physical fitness also usually have good physical and mental health, can be considered as healthy people, be able to perform tasks or work effectively. Physical fitness can be divided into physical fitness relating to health and physical fitness relating to skills.[1-3] Heart rate is a variable that shows the functioning of the cardiovascular system, as well as an important parameter that can indicate the fitness of the body. In general, it is used as an index to tell the intensity of exercise, or the rate of energy consumption of the body, together with an evaluation of exercise or training. Healthy people generally have a heart rate while resting about 60–80 times per minute. Furthermore, it was found that people who are physically healthy or athletes will have a lower heart rate than those who do not exercise and can work longer than those who do not exercise.[4] Muscle strength represents the physical fitness that is related to health. It refers to the ability of tetanus or work of the muscles at a maximum each time, such as the ability to lift heavy objects or able to exert oneself to push strong weight things to move. We generally use grip strength to evaluate the muscle strength, especially the upper muscles by using a grip strength measuring instrument, Jamar Hydraulic Hand Dynamometer.[5] The work that is coordinated between the nervous system and the muscles is a representation of physical fitness that is related to skills. In general, it takes time to respond to decisions, which means the period since the stimulus appeared until the response. It is an assessment of the co-ordination of nerve impulses from the receptor through a few neurons into the brain, then translates the results and sends them to the muscles to respond by using a digital reaction time meter.[6-7] Regarding the literature review found that the heart rate, grip strength, and reaction time to the decision[8-9] are widely used to evaluate physical fitness both in healthy people, patients, or athletes, because it takes a little time and no complicated methods. However, the instruments that are commonly used today can measure and

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show heart rate values, grip strength, and reaction time to the decision by numeric value, but they cannot keep the information of the test person recorded. The data from these measurements in different periods or days are important. It can be used to evaluate their physical fitness oneself from exercising or doing various physical activities by using these values to assess whether the body has improved physical fitness or not and in what manner.

It may be used in assessments to modify programs or activities from practice to achieve individual objectives. From the current situation assessment, the progress of computer technology has improved dramatically and plays an important role to meet human needs. Especially, the application of computers for many tasks such as business, industry, medical, education, etc. The feature of the application of the computer is mostly on data storage, data searching, data processing, job description design, as well as the use of various machinery equipment controls. If we apply these technologies to make practical use, it will enable the development of basic health care equipment for the public. Physical fitness or physical competence means a complete physical condition, ready to perform the mission with vigor, not fatigue. Those with good physical fitness will be able to return to normal quickly is the ability of the body to operate or do the one activity without being tired soon.[1,2,4] People with good physical fitness often have a perfect body, strong, endure the work, are active, have high immunity, always have a cheerful mind, able to work efficiently. Therefore, the overall meaning of physical fitness is the ability of the body to perform tasks or do one of the physical activities as well without being tired soon. Physical fitness is an important part of human physical development. The physical fitness of individuals can arise from body movement or exercise regularly. When there is a break or less physical activity, physical fitness will decrease.[2]

We are interested in developing a physical fitness measuring instrument for heart rate, grip strength, and reaction time. These parameters would be developed as a model for a self-check-up on physical fitness, which is called the FIBER-FIT model. Personal data could be recorded and retrieved on cloud storage for a continuous physical fitness improvement plan anywhere. The benefit is to help people be aware of health care and find the ways to prevent and reduce risks that may occur to their own bodies, to reduce the incidence of disease, reduce time and expenses that are lost in medical treatment as well as reduce economic crisis. In addition, it can be applied to give advice and take care of the physical health of others for the better quality of life of people in society and the community.

Methodology

Developing a physical fitness measuring instrument for heart rate, grip strength rate, and reaction time parameters. The instrument is composed of three modules: (1) Heart rate meter module, (2) grip strength meter module, and (3) reaction time meter module. All modules are controlled by using the LabVIEW computer program. The data could be recorded on cloud storage and could be retrieved for viewing and analysis from anywhere through the Internet [Figure 1]. The details of each module are described below.

Heart rate meter module

Designing the subsystem for measuring the heartbeat pulse by using 5 Vdc operating. It composes of an light emitting diode (LED) for emitting the light source and a photosensor for detecting the response signal. The LED light emits onto the blood vessels that are close to the skin surface. The blood cells absorbed some light and reflect back some part of the remains to the photodetector. The variation of blood cells density during the heart beating cause the variation of light reflection that could be detected via a photodetector unit that shows pulse related to the heartbeat.[10] There was a study on the effectiveness of using the LED light source for red, green, and blue colors by observing the signal-to-noise ratio. The green LED gave the most effective for this application because light penetration reaches the dermis skin layer, which is the area of papillary capillaries, dermal plexus when the red color was too deep and the blue color was too short.[11] Then, the analog output voltage is amplified and digitized by a 14-bit-digitizer. Both analog output and power supply have been controlled and operated by an interface kit NI USB-6009 multifunction I/O unit and LabVIEW software from National Instrument Instrument (11500 N Mopac Expy, Austin, TX 78759, USA), a computer program to show the measured signal obtained from the heart rate monitor tool to a numeric value, and a hard beat pulse on the computer screen [Figure 2]. It can measure both heart rate while resting, heart rate before or after exercise, heart rate while recovering, including variability of heart rate.

Grip strength meter module

Designing a subsystem for grip strength measuring instrument consisting of a load cell. The load cell transducer could transform the mechanical force from the grip strength to the

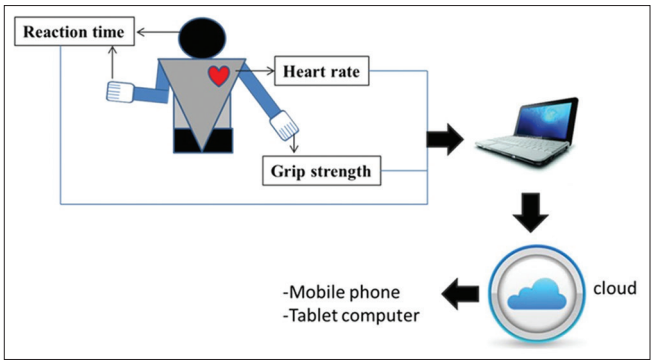

Figure 1: The conceptual framework of the model. If can record and analyze the results immediately with a computer program, as well as record and store data on cloud central data storage that is accessible through online computer networks internet systems around the world to show the results to users on the personal computer and portable devices, such as a mobile phone or tablet

electrical signal. The load cell consists of four strain gauges that are put in a Wheatstone bridge circuit. The applied force would induce the strain gauge deformation (stress) as a result of the changing in voltage of the bridge output [Figure 3a]. The output voltage is proportional to the applied force, so the force could be measurable in the electrical signal.[12] The measured output voltage is amplified and digitized by a 14-bit-digitizer from the NI-USB-6009 multifunction I/O unit. The subsystem requires a 5 Vdc power supply to operate and it uses a power source from this multifunction I/O kit [Figure 3b]. LabVIEW program is used for reading the electrical signal of the force and displaying it on the computer screen [Figure 3c and d].

Reaction time meter module

Designing the measurement of reaction time that responds to the choice reaction time by creating a test program by using LabVIEW graphical function. When the testing software shows a random color on a test window (red, green, or blue), the subject must click an answer button that corresponds to the test color suddenly. The accuracy and reaction time interval would be recorded until finish the test. The result would be reported the accuracy and the reaction time interval. The statistical report of reaction time interval composes of maximin, minimum, average, standard deviation, and variance [Figure 4].

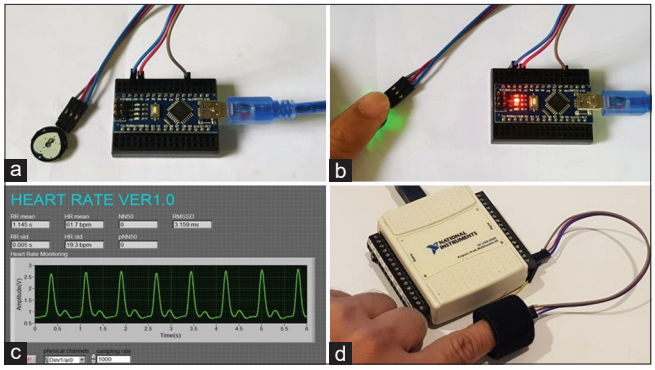

Figure 2: The Heart Rate Meter (a-b) and the measurement of heart rate signaling (c-d). Designing the circuit consisting of a green light emitting diode and a receiver to obtain the signal to detect the blood density at the tip of the finger that is related to the heart rate change. The waveform graph of changed heart rate and variability of heart rate showed on the computer screen

Results

A physical fitness instrument has been developed to measure the "FIBER-FIT" model parameters [Figure 5] by a computer program which composes of three sub-programs; (1) Heart rate measurement sub-program (heart rate meter module), (2) grip strength meter module sub-program (grip meter module), and (3) reaction time meter module sub-program. The details of each sub-programs are as the following.

Heart rate meter module sub-program

1. It can measure heart rate from fingers and display the heart rate values on the computer screen as scale and numeric values
2. Showing the wave of the change of heart rate on the computer screen (Hear rate pulse) at the measurement and continuously show the results for 1 min by appearing in heart rate monitoring
3. Record the image of the heart rate, which can name the desired data file into the computer storage
4. Bring the image of changes wave of heart rate recorded on the computer to analyze by using the toolbar to analyze the heart rate by number in times/minutes.

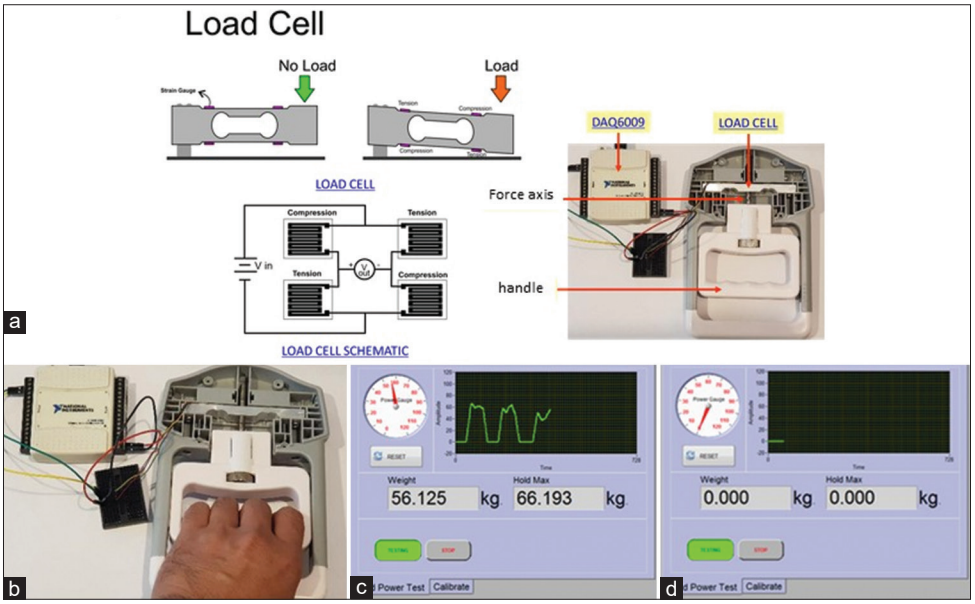

Figure 3: The Grip Meter (a) and the measurement of handgrip strength (b-d). Designing the grip strength measuring instrument consisting of a load cell. The load call will change the mechanical signal from the grip strength to the electrical signal into the voltage, send signals to NI USB-6009 multifunction I/O unit and Labview Software to the display on the computer screen

Characteristics of the wave shape of heart rate in 1 min of the test person can be expanded at any position, both in the X-axis and the Y-axis of the graph of interest. In addition, it can compare the distance of heart rate by each time into units of time.

Grip strength meter module sub-programs

1. Measure the force from the stranglehold. Display the grip strength on the computer screen by scales and numbers, which shows the grip strength value while testing, and the maximum value measured in kilograms
2. Showing changes in force squeezing hands in the column of Hand Grip Graph on the computer screen while doing the measurement and showing continuous results while testing the hand force up and down with the rhythm of squeezing
3. Record the grip strength and display a graph that can name the desired data file into the computer's storage
4. It can bring the graph showing the grip strength measurement record into the computer and perform a retrospective analysis by using the analysis toolbar. The grip strength value is in kilograms. It can compare values while measuring and the maximum value measured, then compare the time to squeeze hands each time for how long it can be squeezed once.

Reaction time meter module sub-program

Measuring the reaction time of decision making with the choice reaction time programming, by using the color window displayed in various colors, such as red, green, blue, etc., which has changed according to the time set. Then let the test person click on the correct color display bar as seen, to observe the reaction time responding to visible colors and the accuracy of the decision. Time values of reactions to the decision-making and accuracy in color selection can interpret the results by using the LabVIEW program.

The study subjects were thirty healthy male volunteers, aged between 20 and 30 years old as shown in Table 1. All of them do not have abnormalities about their nervous, bone, muscular systems, acute illness, or accident. They have been controlled continuously exercised three times a week for 20 min each time for at least 6 months. Then, the participants were tested for their physical fitness performance by using the FIBER-FIT measurement program.

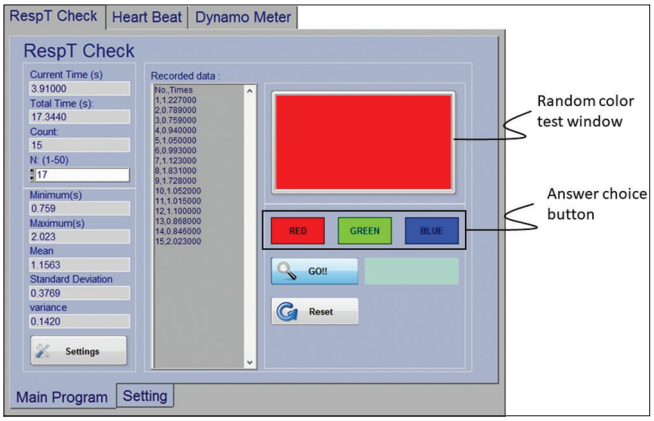

Figure 4: The Reaction time meter module sub-program window

Heart rate meter

The performance test of heart rate meter compared with a heart rate monitor that displays standard numbers called HEART RATE MONITOR CASIO SPORT (CHR-100-1VDR model) of CASIO COMPUTER CO., LTD, Japan.). It can measure metabolism/energy consumption and record the results with a digital time display. The record time is at 100 h timer, resolution 1/1000 s. The accuracy of timekeeping is plus or minus 30 s per month. Timing accuracy is at 99.9988%. Performance test results of the prototype heart rate meter compared with the standard heart rate monitor showing in 30 healthy male volunteers. We process to measure while taking a rest by recording the heart rate at the end of the 5th min, and after exercising continuously for 5 min that is heavy enough to make the heartbeat at least 120 times per minute, recording the heart rate immediately after the end of the 5th min as well. The heart rate values obtained from both instruments show in Table 2 and Figure 6. That is, while resting, there is an average difference in the use of the instrument to measure the heart rate at 2.47 times per minute with an average difference of 3.03%. However, during the exercise, the average difference in the use of the

Table 1: Characteristic of subjects (mean±standard deviation)

Personal information	Male healthy subject (*n*=30)
Age (years)	25±5
Height (cm)	158.8±8.1
Weight (kg)	60.1±7.9

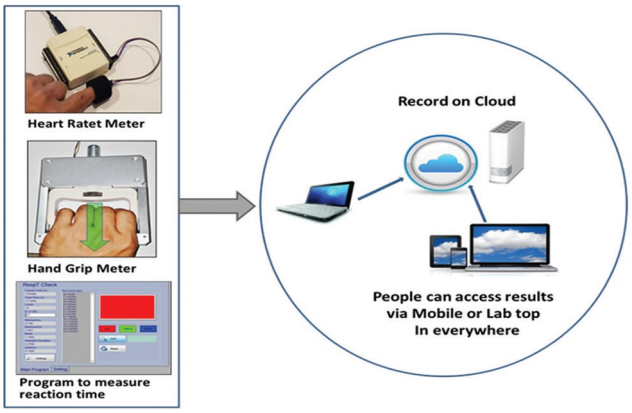

Figure 5: The FIBER-FIT Model with a computer program, capable to record and display results via an online network. It can be divided the work into three parts: Heart Rate Meter module, Hand Grip Meter module, and Reaction time module

heart rate measuring instrument is 3.77 times per minute with an average difference of 3.02%, which is close to the results of the performance test of the heart rate measuring instrument. However, it's not unlike the research in 2007 that he has created an automatic heart rate measuring instrument, reported that the heart rate of the samples measured by an automatic heart rate measuring instrument has a difference between the heart rate measured by the continuous heart rate measuring instrument about 2.43%.[13] Recently, heart rates detected by the heart rate meter were approximately 1%–2% different from those detected by the wireless electrocardiography[14] and heartbeat detector.[15,16]

Grip strength meter

The performance test of grip strength meter compared with the grip strength measuring instrument that shows standard numbers, Digital handgrip dynamometer (Takei Hand Grip Dynamometer Digital 5401 model of Cartwright Fitness. co.uk, England.), which is a tool with accuracy ± 2.0 kgf, showing in healthy male volunteers aged 20–30 years. In Table 2 and Figure 7, there is an average difference of using the instrument to measure the grip strength at 0.02 kg per body weight which accounted for 3.07% of the average difference. The prototype grip strength measuring instrument is used to record the force of the handgrip, showing waveforms of change of the grip strength per time on the computer screen while measuring. It can name in the data file to save data in the computer's storage and then use the data to analyze the grip strength per time. It can basically analyze the fatigue of the hand muscles from the waveform of the change in the grip strength when done many times at different times with continual process by calculating the reduced grip strength compared to the maximum grip strength value.

Reaction time meter

The participants were then tested for their reaction times by turning on the reaction time measurement program. The program measured and recorded reaction times and percentage of decision-making accuracy in selecting the right colors from the screens. It was found that the average reaction time in 30 healthy male volunteers aged 20–30 years [Table 2 and Figure 8], which is similar to the average reaction time value compared to the reaction time detected by the digital reaction time meter (the screen shows the time value of 0.001 s, Electronic timer model 83009 of Neighbor Sport, Thailand). The average difference reaction time is 0.02 and 1.94% of the average difference. The results of our study agree with previous studies that reported the average reaction time in people of various ages.[7] It can be said that the reaction time rate of the volunteers after the test is in the criteria of average response. In addition, there were about 27.03% of color selection errors. However, the previous studies found that when the body had to work continuously for a long time, it may cause fatigue and stress onto the body, the ability

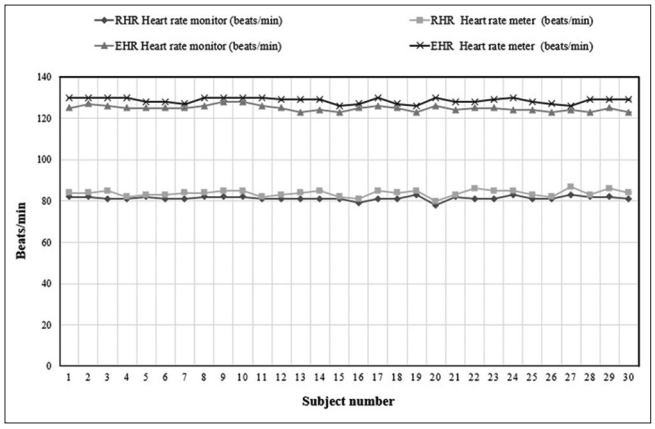

Figure 6: The performance test of the heart rate meter compared with the standard heart rate monitor for resting heart rate at rest and exercise heart rate after exercise

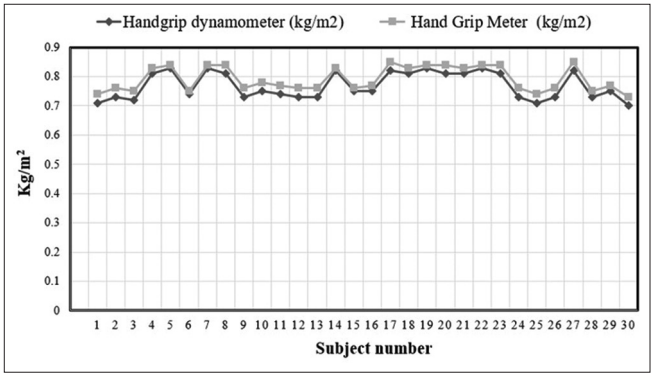

Figure 7: The performance test of the Hand Grip meter compared with the standard Handgrip dynamometer

Table 2: Performance test for the physical performance parameters of the FIBER-FIT model by comparing the general standard meter with the prototype meter in 30 healthy male aged 20-30 years

Parameters	General standard meter	Prototype meter	Difference value	Percent difference
	Heart rate monitor	Heart rate meter		
Resting heart rate (beats/min)	81.33±1.00	83.80±1.52	2.47±1.14	3.03±1.4
Exercise heart rate (beats/min)	124.87±1.35	128.63±1.34	3.77±1.25	3.02±1.02
Parameters	**Handgrip dynamometer**	**Handgrip meter**	**Difference value**	**Percent difference**
Grip strength (kg/m^2)	0.77±0.04	0.79±0.04	0.02±0.01	3.07±1.15
Parameters	**Digital reaction time meter**	**Reaction time Meter**	**Difference value**	**Percent difference**
Reaction time (s)	1.05±0.09	1.07±0.09	0.02±0.01	1.94±1.03

to see and make decisions decreases, and may result in reduced performance and quality. If fatigue or the risk of fatigue continues without a break, it may adversely affect both physical and mental health.[17,18]

Overall performance test results of every part of the instrument are similar, compared to standard commonly used measuring instruments. With reference to the satisfaction results in Table 3, it is summarized that 33.33% of the participants were satisfied at the highest level and 66.67% were at a high level. Regarding the comparison between the general standard meter and the "FIBER-FIT" meter, it is shown in Table 4. The FIBER-FIT" meter has functions that are not complicated, easy to use. Users can choose to use the only desired measurement program or can measure all three parts to assess overall physical fitness, including heart rate, grip strength, reaction time to the decision, and accuracy in color selection.

Discussion

The Cloud FIBER-FIT Model for Physical Fitness Check-Up can measure heart rate, grip strength, reaction time by oneself instrument. Heart rate is one of the vital signs that refer to the number of times the heart beats or squeezes in 1 min. It is used to evaluate the function of all organs in the body, especially the heart, lungs, and brain. In addition, it is useful both for evaluating and diagnosing basic health and be used to monitor and evaluate treatment results. The normal value of the heart rate while resting of men is 60–70 times per minute, as for women is 72–80 times per minute. The values in each person are not the same depending on the age and activity in the movement, especially exertion or exercise. When abnormalities or diseases occur, the value will be changed. There are many types of research to support the idea that the fitness of the body can let people work for a long time or be more resistant to fatigue. It can be found that a person with a healthy body or athlete has a heart rate while resting lower than a person who does not exercise, as well as they can work longer than those who do not exercise. The fitness of the body is the result of training and exercising correctly and regularly. Heart rate is used as an indicator of the functioning of the cardiovascular system during exercise. For example, it can tell the intensity of the exercise or the energy consumption rate of the body. In addition, evaluation of exercise or training can identify the level of physical fitness. If the body is healthy, the heart is effective in squeezing to bring nutrients to the various parts of the body effect reduced heart rate while resting. In addition, it is an important parameter that shows the ability of the cardiovascular system and indicates the fitness of the body.[2] In general, there are many popular methods to measure the heart rate, such as use the stethoscope to measure the heart rate directly from the heart, use hands to touch the blood vessels around the wrist, or neck veins, and count the number of times that the pulse beats, or use a heart rate watch, etc.

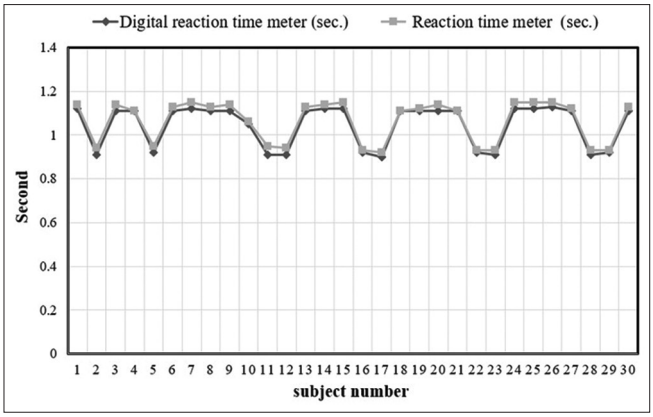

Figure 8: The performance test of the reaction time meter compared with the standard digital reaction time meter

Grip strength is the value that tells the strength of the hand muscles. It refers to the ability of the muscle groups to respond with full contraction once to withstand the resistance or weight given. In the previous study, the report found that the grip strength assessment is often used to evaluate the work of the hand or the strength of the muscles by stay contracting because it is conveniently done and can be used to evaluate and plan for further treatment by using Jamar Hydraulic Hand Dynamometer.[9] The instrument is a widely used and accurate tool that is generally accepted. It can adjust the handle size at 5 levels to be suitable for each participant in the experiment. The value obtained from the tool is shown as a numeric value, can read both pounds and kilograms. There are many prior types of research conducted to study grip strength. In addition, it was also found that the grip strength will decrease as age increases, and males have stronger grip strength than females. Furthermore, research in 2014[8] studied the posture and position of the elbow on the force of the hand. Found that the standing position with a fully stretched elbow resulting in the most powerful grip strength. It can be explained that standing posture affects

Table 3: The satisfaction percentage with the "FIBER-FIT" model

Question	Number of volunteers, *n* (%)		
	Moderate	Much	Most
Using the program of the "FIBER-FIT" is convenient or not	5 (16.67)	15 (49.99)	10 (33.33)
To carry or move the "FIBER-FIT" is easy or not	5 (16.67)	20 (66.67)	5 (16.67)
The "FIBER-FIT" is safe or not	-	-	100
Overall satisfaction	-	20 (66.67)	10 (33.33)

Table 4: The comparison between the general standard meter and the "FIBER-FIT" model

Topic	General standard meter	FIBER-FIT model
Ease of use and safety	✓	✓
Comfortable of portability and mobility	✓	✓
The data can be record and retrieve to display the result	✓	✓
Apply online and internet system on a daily lifestyle	✓	✓

the stimulation of the perception of the joints. It caused the mobilization of muscle function units to increase. In addition, the straight elbow position causes the actin and myosin fibers to be in an overlap position, which has the most effect on increasing muscle power. For this reason, it is used as a standing posture that is used to measure the grip strength that is commonly used.[5] However, there are still many factors that may affect grip strength. As there is research reporting on factors that affect grip strength. That is, the grip strength has a significant positive relationship with the height, weight, and hands size of both males and females. The body mass index is positively correlated with grip strength in males and females. Furthermore, it was found that the body proportions, hand proportions, grip range, and strength of the hand force of the sample group have a significant difference. Therefore, if need to test the grip strength to get the correct and true value, it must control individual factors such as the size of the hand, durability, aptitude, age, sex, motivation, or extra force of the person being tested to have similar, or equal values.[19]

Reaction time is a collaboration of the eye and hand muscles. This skill is one of the factors of reaction response time. It refers to the time that is in the range from the stimuli appear until the response begins. The response time is the time that includes reaction time and movement time. It was a total period from the beginning of the stimulation, or the stimulus began to appear until the body has a complete movement. The speed of the time value, the reaction to the decision is the result of the stimulation of the sensory organs. Hearing stimulation will have the fastest reaction time to decide, followed by stimulation of seeing, pain, taste, smell, and touch respectively. The human ability to respond to various stimuli depends on the speed of the reaction time to the decision. Moreover, we can practice better by doing activities that have the characteristics of the movement. Repeated use of skills over a period can result in the development of reaction time to decisions.[20-21] The reaction time to an individual's decision will have many factors to determine. The factors of the tested person are gender, age, ability to respond, movement skill, left or right-handed, the mood of the tested person, stress, anxiety, fatigue, training, habituation, disease, and physical and mental disorders. As age increases, the time value of the reaction to the decision will gradually decrease. Gender differences are related to reaction time responses to decisions. Men will have a faster reaction time to decisions than women. Fatigue that occurs in the accumulated muscle mass may result in a longer reaction time to the decision.[22]

Conclusions

For application with an online network "FIBER-FIT" model, it can analyze or evaluate the physical fitness in real time, and it can record the personal information of the test person. It is convenient to carry and move for use in various locations, with safety because the instrument is designed to not directly contact the test person, the device is used through a USB computer. In addition, there are insulators in all parts of the measuring device, making it safe from high voltage. It can display data, analyze as well as record and store on Cloud central data storage media. It can call the display on personal computers and portable devices such as mobile phones or tablet computers through an online computer network, internet system. This research can also further develop the prototype instrument both hardware and software, which means to develop the application to measure in real-time on smartphones, to be ready for use with the public for various activities in everyday life, such as work or exercise. In addition, it may be developed further to provide suggestions for improving an individual's physical fitness, such as appearing a sentence to read or an alarm, etc. Furthermore, it can be cooperated with the medical team to develop an analysis program and can continue to be used as research work in a large group of people.

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Conflicts of interest

There are no conflicts of interest.

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