Research of Computer Sensor Technology in the Examination of Energy Metabolism of Preschool Children with Muscle Inactivity

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Abstract. At present, the accelerometer has gradually become a general-purpose instrument that can objectively measure human movement, and has been gradually applied to the research on the human movement of preschool children. Among them, the accelerometer is used to measure the human movement of preschool children. methodological research. It mainly includes: determination of exercise intensity threshold, estimation of exercise energy consumption, estimation of exercise energy consumption, etc. This article compares the parameters, functional characteristics and evaluation indicators of the three most common accelerometers used for physical activity measurement in preschool children. The purpose is to provide some methodological references for relevant researchers in the field of children's physical activity.

Keywords: Computer, Sensors, Preschool Children, Muscle Activity, Energy Metabolism.

1. Introduction

Body movement refers to a kind of body movement that occurs with energy consumption due to muscle contraction, and is usually translated as body movement in China. Studies have shown that physical exercise has a positive impact on physical and mental health. Moderate physical exercise can not only improve children's growth and development, but also maintain their energy metabolism balance and help their mental health. In the early stages of life development, the most important thing at present is the physical exercise of children aged 0-5, especially in the preschool age, that is, children aged 3-5. During this period, children can carry out appropriate physical exercise, This is very helpful for children to develop good physical exercise and prevent overweight and obesity, high blood pressure and cardiovascular disease. A precise and efficient method of physical exercise is important [1]. Although conventional physical exercise assessments represented by self-assessment and questionnaires are simple and low-cost, there are large subjective biases, which make the accuracy of the assessment results low. The two methods, namely "direct observation" and "double-labeled water", are both the "gold standard" for the determination of human exercise intensity and energy consumption, but both have problems such as cumbersome operation and testing environment restrictions, and cannot be used for large sample populations health monitoring. In recent years, with the advancement of sensor technology, acceleration sensors are gradually being widely used in the objective detection of human motion. The instrument can be worn 24 hours a day, and can give the total amount, intensity, frequency, duration and energy consumption of human activities. Because it is light in weight, easy to carry, and will not interfere with the daily activities of the respondents, the test data is very accurate and suitable for use in epidemiological studies of the population.

Intensity and energy required are the two main indicators of physical activity. Using the accelerometer method as an objective measurement method, it can accurately judge the intensity of various sports and estimate the energy consumption required for sports. In recent years, scholars at home and abroad have conducted a lot of discussions on the intensity threshold and energy consumption of preschool children's physical exercise. Accelerometers can not only provide a methodological reference for the objectivity index of physical exercise, but also can be used to measure conventional testing methods such as questionnaires [2]. When evaluating the physical exercise of preschool children, questionnaires are often used to understand the daily physical exercise

status of children. The objective value of physical exercise time obtained by the established objective methodology standard was compared with the objective value of physical exercise time obtained by the questionnaire survey method, so as to test the reliability and validity of the questionnaire.

Lack of physical exercise is one of the main factors affecting the health of Chinese teenagers. Countries around the world have issued different levels of guidelines for physical exercise, clarifying the recommended amount of physical exercise per day, that is, the intensity and duration of physical exercise. The National Physical Education Association of the United States, the Australian Department of Health, and the Canadian Society of Sports Psychology all recommend that preschool children should have no less than 3 hours of total physical activity (TPA) per day, and the total amount of physical exercise at a higher level should not be less than 1 hour Hour. At present, the use of a gravimeter to measure the relationship between the daily physical activity of young children and the recommended values has become the focus of research, and this method can also be used to determine the influencing factors of young children's physical activity [3]. However, in stark contrast to this, domestic research on physical exercise mostly focuses on young children, with little interest in young children. This paper introduces the functional characteristics of the three most commonly used accelerometers for preschool children's body movement research, and sorts out and summarizes their application research status, which provides some reference for the development of children's body movement research.

2. A common acceleration device for physical exercise of preschool children

The accelerometer is essentially a sensor that converts the acceleration generated by the movement of the measured object into an electrical signal. After processing, the acceleration count can be obtained, which can represent the acceleration per unit time. The count itself does not have any biological meaning. It is used to determine the cut-off value and energy calculation formula of various physical activity intensities, so as to obtain results such as the amount of time of physical activity with different intensity levels and the energy consumption value of the activity. In this paper, we selected three different accelerometers: Actigraph, Actical and ActivPAL. Among the three accelerometers, Actigraph and Actical are the two most frequently used, and ActivPAL is currently the most accurate accelerometer for human body posture recognition.

2.1. Actigraph type

Among them, GT3X is the most used one among the fourth-generation machines, and it uses the acceleration counter of three coordinate systems. The most recent one is the GT9X, which uses a nine-dimensional accelerometer, which is not yet widely available. Actigraph is currently the most widely used acceleration sensor in the world. It can not only identify different stages of human motion, but also can be worn on the wrist to effectively estimate the energy required for human motion during motion. Some scholars have verified the ability of GT3X to judge physical activity intensity by direct observation, and the Spearman coefficients of all physical activity intensity results range from 0.69 to 0.91. Another study testing its ability to predict energy consumption confirmed that Actigraph is highly accurate in predicting energy consumption values per physical activity intensity for children aged 3 to 5 years, with a correlation coefficient of 0.82.

2.2. Actual type

Actical is second only to Actigraph in frequency of use in the field of preschool children's physical activity research. This is a three-axis accelerometer, which is most sensitive to the acceleration of the longitudinal axis. It has good waterproof performance and can be worn continuously for 30 minutes at 1 meter in the water. Has good reliability and validity [4]. Pfeiffer et al. at the University of South Carolina evaluated the reliability and validity of exercise monitoring and found that the correlation between the energy consumption of exercise monitoring and the gold standard reached 0.89, which

is extremely high. The cutoff between moderate and heavy exercise was 0.73 and 0.85, respectively. Figure 1 shows the working principle of the Actical type acceleration sensor.

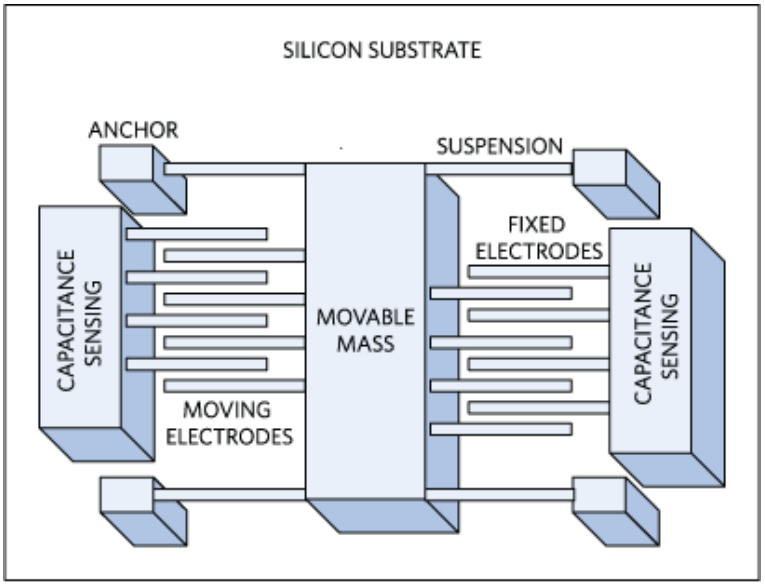


Fig. 1 Working principle of the Actical type accelerometer

2.3. ActivPAL type

ActivPAL is currently the most accurate body posture recognition, which can recognize sitting, lying and standing postures. It is a shape similar to a Band-Aid, which can be in direct contact with the skin and cling to the legs, and according to the inclination angle of the legs to determine the movement direction of the legs, and then determine the movement posture of the human body. Since the existing acceleration sensor cannot identify the type of human motion, dynamic PAL can identify the posture of human motion, thus solving this problem in a sense. Figure 2 shows how a dynamic PAL-type accelerometer works (picture referenced in A Printed Organic Circuit System for Wearable Amperometric Electrochemical Sensors).

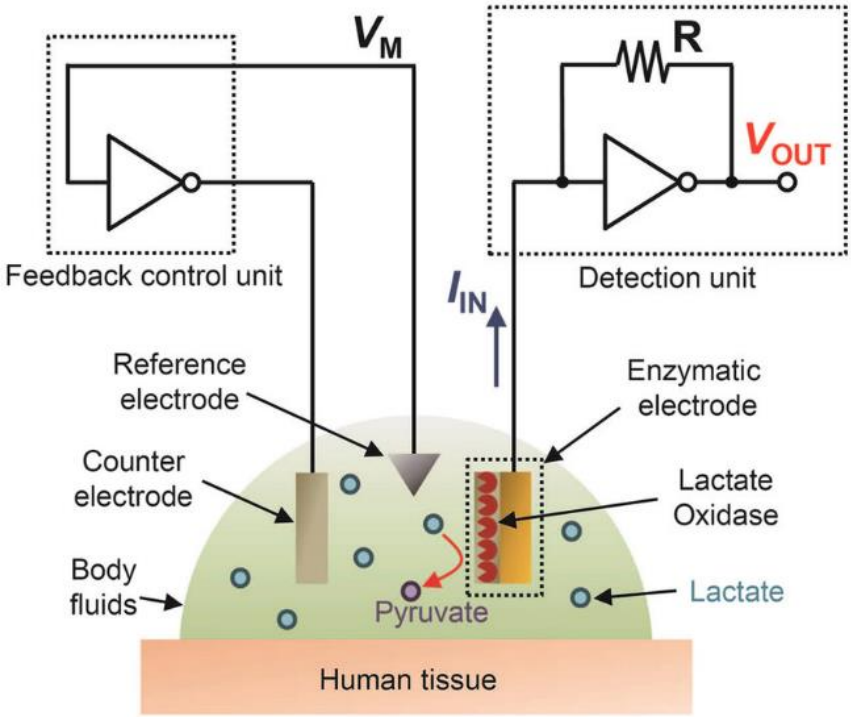


Fig. 2 Working mechanism of dynamic PAL type accelerometer

3. Some key parameters about the acceleration sensor

Before the application, the sampling interval should be set on the dedicated software, and then the position and time of wearing should be decided, so that it can play a better role [5]. After the equipment is recovered, the data should be downloaded to the computer, the data should be screened, and an appropriate threshold point or energy calculation formula should be selected to calculate the physical activity time or energy consumption value of various intensities. Because there are many types of acceleration sensors, there is no general specification for parameter setting.

3.1. Sampling spacing

The accelerometer will accelerate once at a certain period of time. This period of time is called the sampling period, generally from 1 second to several minutes. After setting a short time interval to acquire data, you can combine it with a long time interval, for example, set the sampling interval to 1 second, then after the collected data, you can use 15 seconds, 30 Second and 60 second data files are synthesized for comparison. Children's physical exercise is characterized by suddenness, frequent changes in intensity, and short duration [6]. They often perform high-intensity physical exercise in a short period of time, and there are also low-intensity physical exercises at different times. Therefore, shortening the class time can better evaluate the degree of physical exercise of students. When investigating the physical exercise of preschool children, most of the sampling time is set at about 15 seconds. Some scholars used Actigraph to set different sample intervals (1 second, 15 seconds, 30 seconds, 60 seconds) to monitor the physical activities of 31 children aged 3 to 5 in one day. In terms of output, in the judgment of (MVPA), the results of 15 seconds, 30 seconds and 60 seconds are very different. Therefore, it is suggested that when using shorter time intervals to measure physical activity, researchers should take into account the possibility of re-combining to evaluate MVPA results with longer sampling intervals to bring about differences.

3.2. Assembly position

It is generally worn on the wrist, hip and waist, and can also be worn on the legs. The selection of the wearing part is very important. Different wearing parts of the same instrument will have different wearing effects. In this survey, more than half of the people chose the hip as an accessory. Since the buttocks are the backbone of the human body and are closer to the center of the human body, they can more accurately reflect the state of motion of the human body. Worn on the right hip, there is almost no interference with body movements. In terms of comfort, the subjects are easy to accept. A recent study showed that children between the ages of 3 and 6 have an accelerometer (AG) on the wrist and hip, and the relationship between the two is only 0.78 and 0.80. The correlation coefficient of the model data after combining the wrist and the hip is 0.82, suggesting that the wrist and the hip are worn at the same time, and the measurement effect is better.

4. Practical application

4.1. Experimental design

In this experiment, 20 preschool children were selected as the subjects. The daily body movement status of the test subjects was measured by the ActiGraphGT3X+ in three coordinate systems, which was strapped to the right maxilla for 7 days. Because the subjects are very young, before the test, the staff will give a detailed explanation to the parents of the subjects, teach them how to put on and take off these sensors, and tell them that there is nothing to do except bathing, swimming and sleeping [7]. They should be put on at any time, and all sensors should be put on and taken off during the test with the help of their parents. After the 7-day trial (Day 8), the staff recovered the tools. The observation time was divided into 12 groups from 2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 15, 29, 30, 59, 60 seconds or longer. Among them: from 2 to 9 s, no allowable error is allowed, and only activities within 9 s that meet the MVPA requirements are recorded as one MVPA that lasted 9 s. The time of 10-14 seconds is set as

an allowable error of at most one sampling interval. For example, within 12 seconds, 11 seconds meet the MVPA standard, and 1 second is not reached, it will be regarded as a continuous 12 seconds. MVPA. The three categories with longer durations of 15 to 29 seconds, 30 to 59 seconds and more than 60 seconds are set as the allowable error of the maximum two sampling intervals.

4.2. Conclusion of the test

Table 1 lists the average frequencies of the subjects during different intensities and different durations of body movements. Except for the 2 s and 3 s MPA frequency, there are obvious differences between men and women, and there is no significant difference between men and women in the frequency of other exercises with the same intensity and the same duration. In addition, it can be seen from Table 1 that at the same intensity, the frequency of body movement will be significantly reduced.

Table 1. Number of daily physical exercises of the subjects with different intensities and durations

duration/s	LPA/(time·d-1)		MPA/(time·d-1)	
	male	female	male	female
2	2189.79±367.37	2032.32±298	641.16±165	583.16±117.37
3	922.21±194	856.53±157.16	216.53±77.29	197.16±58.53
4	456.74±120.84	422.95±98.84	92.63±44.84	85.68±36.53
5	251.58±82.53	233.26±68	47.89±29.16	45.05±24.84
6	149.47±58.74	138.95±49.37	28.11±20.11	26.84±18.42
7	93.89±44.11	88±37.37	17.89±14.42	17.58±13.79
8	61.79±33.79	58.53±28.95	12±10.63	12±10.74
9	42.42±26.53	40.95±22.74	8.42±8.21	8.63±8.53
10~14	69.68±31.37	63.89±27.37	13.37±10.84	13.16±10
15~29	31.68±17.37	28.53±15.37	6.63±6.11	6.74±6.11
30~59	2.63±3.58	3.05±3.47	0.74±1.05	0.74±1.47
≥60	0.21±0.63	0.32±0.53	0.04±0.14	0.04±0.16
Duration/s	VPA/(time·d-1)		MVPA/(time·d-1)	
	male	female	male	female
2	691.89±235.26	627.16±232.11	1753.05±447.79	1581.68±390.84
3	312.95±118.84	287.89±122.11	907.16±255.58	815.68±226.11
4	160.95±67.16	150.32±71.79	533.79±163.16	478.95±146.74
5	93.05±42.11	88.84±46.84	345.05±113.47	310.32±103.16
6	58±28.32	56.11±32.21	236.74±83.58	212.74±76.32
7	38.63±20.21	37.89±23.26	169.16±64.11	152.53±58.95
8	26.74±14.95	26.63±17.58	125.37±50.53	113.58±46.53
9	19.26±11.47	19.58±13.68	95.58±40.53	87.47±37.58
10~14	23.79±13.26	21.47±12.42	106.63±39.89	94.74±36.21
15~29	10.53±6.21	10.32±7.05	53.89±21.68	48.11±20.11
30~59	1.26±1.26	1.37±1.37	5.26±3.89	4.95±3.37
≥60	0.11±0.32	0.21±0.21	1.37±1.37	1.47±1.26

5. Conclusion

At present, the use of accelerometers is increasing in the physical exercise of young children. The accelerometer is currently the most objective, accurate and effective means of motion detection, which can effectively monitor the motion of preschool children. When vigorously promoting the application of acceleration sensors, we should also pay attention to the application of acceleration sensors. However, for different types of acceleration sensors, there is no unified application specification so far, and it is necessary to comprehensively consider research needs, population

characteristics, parameter settings and other considerations. Especially considering the suddenness and high frequency of preschool children's physical activities, it is urgent to study and formulate a set of application specifications for acceleration sensors that meet Chinese national conditions. At the same time, to address the critical public health problem of severe physical inactivity among preschoolers, more research is needed in the future to increase levels and awareness of physical activity among caregivers, improve the teaching environment in kindergartens, and develop physical activity Curriculum and other methods to increase the time of physical activity of preschool children, so as to improve their lack of physical activity.

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