Real-time water quality prediction model based on fine-grained image classification and home aerobic exercise rehabilitation for the elderly

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Abstract
This paper studies the real-time water quality prediction model based on fine-grained image classification and home aerobic exercise rehabilitation for the elderly. Fine-grained image classification refers to the classification of sub-categories under image classification. In the past, image classification mainly classified images into large categories. In contrast, the most important feature of fine-grained image classification is the large differences within the class and the small differences between the classes, which are very difficult. And because it has a wide range of application requirements, in human production and life, it has attracted a large number of scholars to conduct in-depth research on it. Based on the above research, the performance of the proposed model is analyzed and verified for specific water quality parameter prediction scenarios. The water quality model is an important part of the study of water environment simulation and water environment planning and management. Starting from the research review of water quality models, this paper introduces the development history of water quality models and several major non-mechanical water quality models and application research progress. It recognizes the objective facts of uncertainty in the water environment system and the limitations of organic water quality model in the application of water environment system in China. Finally, based on the above conclusions, elastic band resistance training combined with cardiac rehabilitation education improved the physical function of patients with coronary heart disease in the community, especially muscle health and cardiopulmonary rehabilitation training, as well as the quality of life of patients. The Heart Rehabilitation Training Program at Home can improve the awareness of cardiac rehabilitation of patients with coronary heart disease in the region, strengthen exercise compliance, popularize and apply to the home care of patients with coronary heart disease in the region, and also provide theoretical reference materials for regional medical personnel helping patients at home with training.

Keywords Fine-grained image classification · Real-time water quality prediction · Elderly rehabilitation · Home aerobic exercise

Introduction
With the advent of the information age, the amount of global data is growing rapidly (Ali 2016). It is very difficult to rely on humans to process such a large amount of data (Bai et al. 2020). The development of big data, cloud computing, and artificial intelligence has made it possible to process large amounts of data (Cuderman 1986). Some technologies have been successfully applied, bringing convenience to human production and life (Feng et al. 2018). People want to be able to classify images more finely, not only to recognize that the image belongs to a certain category, but also to further recognize that it belongs to a certain sub-category, that is, fine-grained image classification (Gao et al. 2017). The key point of this classification problem is that these sub-categories belong to a certain major category, which leads to small differences between each sub-category and large intra-category differences (Han 1994). When distinguishing images belonging to a certain sub-category, some subtle differences are often

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used for judgment. In addition, it will be affected by factors such as illumination, posture, occlusion, and background interference, making it more challenging (Hossain et al. 2000). Water quality management is an important part of the integrated management of the water environment, through the use of science and technology and administrative economic policies to effectively control and plan for pollutants to enter river waters (Huang et al. 2014). In order to solve its main technical problems, through the introduction of computational intelligence methods, it is hoped that the ability to cope with future water quality changes can be enhanced, thereby improving the scientific and rational decision-making of the water environment management department and forming a long-term mechanism for effectively preventing and controlling water pollution. The water quality remains in good condition (Huang et al. 2018). Satisfying human’s basic requirements for water quality in production and life is of great significance for ensuring people’s lives and production safety (Jaimes et al. 2012). At present, there are mainly two types of methods in the field of water quality prediction. One is the mechanism prediction method based on the physical model, and the other is the non-mechanical prediction method based on historical data. The former is a model that solves the water quality change process of the control equation, and the latter is a “black box” prediction model supported by mathematical methods (Khabirov 2016). In recent years, with the deepening of research on muscle strength training, muscle strength training has played a positive role in the cardiac rehabilitation exercise of patients with cardiovascular diseases (Kooper and Fairhurst 1971). Resistance training is also called resistance exercise or muscle strength training. It usually refers to the process by which the body overcomes resistance to achieve muscle growth and muscle strength improvement (Lanari and Fakhimi 2015). The benefit of resistance training in recent years is that resistance training increases the heart pressure load and improves the left ventricular dilatation pressure, thereby increasing the subendocardial blood perfusion, which means that it can reduce the heart rate, blood pressure, and myocardial oxygen consumption to reach the purpose of improving myocardial ischemia (Li et al. 1995). At the same time, muscle strength training can reduce the risk factors of various cardiovascular diseases, improve the peak oxygen uptake capacity of patients with cardiovascular diseases, and improve the function of peripheral blood vessels (Liu and Zhao 2008). Muscle strength training can improve muscle mass and increase the strength and endurance of skeletal muscles (Liu et al. 2018). Skeletal muscle plays an important role in preventing muscle atrophy in the elderly, improving physical function, and maintaining physical health (Ma and An 2008).

### Materials and methods

#### Data source and basic model design

This paper adopts the data collected from May to August of 2020 collected by the automatic water quality monitoring station, and the data is collected once a day. The accuracy and credibility of the data obtained through the sensors are different, usually containing noise and unstable, and the data at some moments will be lost.

Regarding missing data, linear interpolation is generally used. In other words, under the same conditions, adjacent data are obtained to meet the measured value. In other words

\[ x_{k+i} = x_k + \frac{i}{j} (x_{k+j} - x_k), 0 < i < j \]  

(1)

The error data is generally replaced by the mean smoothing method, that is, when the difference between the current and subsequent data is too large, the data is considered to be the error data, and the mean value of the data before and after it is used to replace the error data. There are also literatures using Laida detecting (3sigma criterion) to remove the noise value of the gross error value.

The above-mentioned missing data and error data processing methods are general adjustment methods. In practical applications, some methods are often used to simplify the data processing to reduce the complexity of the data and the difficulty of later modeling. The following briefly introduces the most used K-means clustering algorithm and principal component analysis method.

#### Fine-grained image classification model design

In the image branch, the image is input to the prototype network, the image is mapped to another space, the vector representation of the image is obtained, and the prototype center of each category is obtained in the prototype network; in the text branch, the GloVe algorithm is first used to the word vector W that is generated from the text information, and then the word vector is averaged with reference to the idea of fasttext. After conversion with parameters, the category prototype is adjusted by coefficients, so that the loss function of the text vector and the image feature vector of Rongzhou Zhiben model adopts the cross-moisture loss function. The specific definition can be shown in formula (2):

\[
I(\theta) = \frac{1}{N \times K} \left[ d(f(q_k), P_k) + \log \sum_k \exp \left( -d(q, P_k) \right) \right] \]  

(2)

In terms of image, the TADAM network is used as the basic network framework. The training data is extracted from the training set with an initial ratio of 0.9 as the co-training data. After that, the proportion is gradually reduced, and then
the co-training data and training set data are input into the network together; the category is calculated; the prototype is used as the task characterization information, updated by the TEN network; the vector representation of the image is obtained through calculation; and then the parameter \( a \) is introduced as the metric scaling factor to reduce the model's dependence on the selection of the distance metric function. In terms of text, the GloVe algorithm is used to generate word vectors and the average value is taken as the vector representation of the text. The fusion method of image feature vectors and text vectors adopts a cross-domain fusion mechanism and passes coefficients, adjusting the impact of images and text on the classification results.

The loss function used in this model refers to the public announcement (2), and the metric scaling factor is added to it to obtain the formula (3):

\[
J_k(\phi, a) = \sum_{x \in Q_k} \left[ a d(f_\phi(x), c_k) + \log \sum_{j} \exp(-a d(f_\phi(x), c_j)) \right]
\]  

(3)

**Improved seagull optimization algorithm design**

Due to the random factor \( B \), traditional SOA has weak development capabilities in the later stages. Therefore, this paper uses an improved change factor \( B \), as shown in the following formula:

\[
B = 2 \times A^2 \times rd^\ast(1-x/MaxIteration)
\]  

(4)

In order to solve the problem of weak algorithm development ability in the later stage, this paper adopts the chaos idea to increase the diversity of particles in the later stage and enhance its searchability. To introduce Logistic mapping, the basic formula is:

\[
Cx_k^{i+1} = \mu Cx_k^{i} \left(1-Cx_k^{i}\right)
\]  

(5)

The conversion between the chaotic variable and the original variable is as follows:

\[
Cx_k^{i} = \left( x_k^{i} - x_L \right) / (x_U - x_L)
\]

(6)

\[
y_k^{i} = Cx_k^{i} + Cx_k^{i} \left(1-Cx_k^{i}\right)
\]

(7)

The main idea of the improved SOA algorithm is to use the chaos after each iteration, to perform chaotic iterations on the seagull position with the best fitness to increase its diversity. Specifically, first, map the original variable to a chaotic variable by formula 6, then use formula 5 for transformation processing, and finally use formula 7 to return the original spatial position value. If the position after chaos is better than before chaos, save it, otherwise save the position before chaos.

**Research design of home aerobic exercise rehabilitation for the elderly**

Taking the health check of the regional health service center as an opportunity, from June 2019 to June 2020, 101 patients with stable coronary heart disease selected from the health records of the residents of the six regions of the health service center were the subjects of the survey. In order to avoid the experiment being affected, the two groups were separated according to their residence, but the six groups belong to the same medical service center and belonged to the same area both geographically and physically. From the perspective of construction and population composition, the communities are old communities of state-owned enterprises, and most of the residents are retired employees of state-owned enterprises. Therefore, by grouping the residences, it was possible to ensure the randomness and balance of the two groups of research subjects and avoid sample confusion.

After the researchers' own initial practice, literature review, expert consultation, team discussion, and pre-experiments, they finally formulated a home cardiac rehabilitation intervention plan for coronary heart disease patients. Intervention consists of two parts: collective cardiac rehabilitation education and individual resistance training guidance. The intervention lasted 3 months.

The control group promoted the knowledge of chronic diseases such as cardiovascular disease through regular health education lectures held in the region, asked patients about the latest situation through monthly telephone tracking, and received regular community care. In the process of rehabilitation training of patients, guidance is given to the problems encountered by patients.

**Results**

**Analysis of the prediction results of the basic model**

In this paper, the BP neural network adopts a three-layer structure. The prediction of ammonia nitrogen is of great significance to the accurate grasp of water quality, so the input parameters in this paper are water temperature and pH. The seagull population is 100, and the number of iterations is 100. Figure 1 shows the convergence comparison of the two model algorithms.

It can be seen from the figure that the convergence speed of the proposed SOA-BP model is faster, and it can converge faster. In terms of convergence accuracy, it is also iterated 100 times. The convergence value of the BP model is 4.536e-07, while the convergence value of the proposed SOA-BP model is 2.029e-8, and the convergence accuracy of the proposed model is higher. The simulation of 23 sets of verification data is shown in Figure 2.
It can be seen from Figure 2 that no matter in which set of sample data, it can be seen that the predicted value of the proposed optimized prediction model (the green curve in the figure) is compared with the predicted value of the traditional algorithm (the figure in the figure). The red curve is closer to the actual value (the blue curve in the figure). Therefore, it can be concluded that the proposed SOA-BP model has a more accurate prediction accuracy than the traditional BP model.

As shown in Figure 3, the curve of the model is smoother, the fluctuation is smaller, and the error value for the verification sample is smaller. The average error analysis of 23 sets of data shows that the average error of the SOA-BP model is 0.001243, while the average error of the BP model is 0.009366. The average error of the proposed model is lower and the prediction accuracy is higher.

For the traditional BP neural network that is easy to fall into the local optimal state and the low prediction accuracy is the goal, this section uses SOA to optimize the weights and thresholds of the BP neural network to obtain a more accurate prediction model. The simulation results show that the prediction accuracy of the proposed SOA optimization BP model is higher than the previous prediction models, and the effect is good.

Model optimization performance verification

In order to verify the optimization ability of the improved algorithm, several common benchmark functions are used to verify including 5 single-mode functions and 3 multi-mode functions. The optimization results of the improved algorithm on different functions are shown in Figures 4 to 5.

As can be seen from the figures, the SOA algorithm has better optimization effect than the PSO algorithm, and the convergence speed is faster. When most functions are optimized, the better results can be obtained when the number of iterations is about 100, and the convergence speed is higher than that of the traditional SOA algorithm. Faster, better results, better values than traditional algorithms can be obtained after 500 iterations. Refer to many literatures to combine PSO algorithm and neural network to obtain better prediction results. This article uses ISOA algorithm that is better than PSO optimization and combines neural network to obtain a new and improved neural network prediction model to obtain more accurate results. The next section is a detailed description of the improved model.

Analysis of optimization results of real-time water quality prediction model

In this section, BP, PSO-BP, SOA-BP, and ISOA-BP are compared to verify the improved seagull optimization algorithm to optimize the performance of BP neural network. The parameters of each algorithm are shown in Table 1.
The convergence comparison of various algorithms is shown in Figure 6.

It can be seen from the figure that the proposed ISOA-BP model converges faster, and it converges to the optimal value faster. In terms of convergence accuracy, it is also iterated 1000 times. The convergence value of the ISOA-BP model is lower than that of the SOA-BP, PSO-BP, and BP models, and the convergence accuracy of the proposed model is higher. The simulation results of the verification data of different models are shown in Figure 7.

It can be seen from Figure 7 that the curve of the proposed ISOA-BP prediction model is more similar to the actual value curve, and the predicted value is closer to the actual value, with more prediction accuracy.

Figure 8 is the error comparison diagram of the four models, and the value is the absolute value of the error. It can be seen from the figure that, among the four models, the error curve of the proposed ISOA-BP model fluctuates less, the error from the actual value of the verification sample is the smallest, the average error is the lowest, and the prediction accuracy is the highest.

It can be seen from the chart that compared with the traditional single neural network prediction model and PSO and SOA optimization models, the proposed improved optimization model, the ISOA optimized model, has higher prediction accuracy.

| Algorithm | Parameter | Value |
|-----------|-----------|-------|
| ISOA      | u         | 1     |
|           | v         | 0.1   |
|           | f_ε      | 2     |
| SOA       | u         | 1     |
|           | v         | 0.1   |
|           | f_ε      | 2     |
| PSO       | c1        | 1.49445 |
|           | c2        | 1.49445 |
|           | omega    | 0.5   |
accuracy, and its error RMSE is 0.046361, the lowest of all
models. And the NS value of the proposed ISOA-BP model
reaches 0.978851, which is the closest to 1 among the four
models. Therefore, it can be concluded that the prediction
accuracy of the improved model proposed can be higher.

In this section, aiming at the deficiencies of the SOA algo-
rithm itself, an improvement idea is proposed and applied to
the optimization of the BP neural network. The simulation
results show that the prediction accuracy of the proposed mod-
el is higher than the traditional BP neural network model, the
PSO optimized BP neural network model, and the SOA opti-
mized BP model proposed in "Results." The proposed ISOA
optimized BP model has the highest prediction accuracy ad
the best effect among the four models. It can be applied to
predict the value of water quality parameters in a more com-
plex water quality environment.

Analysis of the rehabilitation effect of home aerobic
exercise for the elderly

The Shapiro-Wilk normality assessment showed that the CM-
PPP scores of the two groups of patients at each time point
were inconsistent with the normal distribution. Using the gen-
eralized estimation equation, the trends of the CM-PPP scores
of the two groups of patients at different time points before
and after the intervention were analyzed, and the average and
standard deviation were used for statistical description. ①
Interaction effect: There is an interaction effect between the
inter-group factor and the time factor. In other words, the gap
between the two groups changes over time. ② Inter-group
effect: The difference in CM-PIT scores between the two
groups is statistically significant, and the CM-PIT score of
the intervention group is higher than that of the control group.
③ Effects within the group: From the point of view of each
time point, the difference in CM-PPP scores between the
groups of patients at different time points is statistically sig-
nificant. The specific results are shown in Table 2.

The 30-ACT times of the two groups met a normal distri-
bution at each time point. The 30-ACT times of the two
groups at different time points before and after the interven-
tion were repeatedly analyzed and compared through the una-
ry configuration. The results showed that there was no statis-
tically significant difference in the number of 30-ACTs at the
3 time points in the comparison group, but there was a statis-
tically significant difference in the number of 30-ACTs at the
3 time points in the intervention group (P < 0.001). Further
analysis using LSD-T showed that the gap between the inter-
vention group 1 month and 3 months after the intervention,
and before and after the intervention was statistically signifi-
cant (P<0.05).

Using 2 main reasons and 3 levels of repeated measure-
ment dispersion, the changes of 30-ACT frequency before and
after intervention were analyzed. For the test result, Morcle
The results of the general estimation equation analysis of the CM-PPT scores of the two groups of patients at each time point are shown in Table 2. The table includes the time point, the intervention group, the control group, the between-group effects, the within-group effect, and the interaction effect. The results showed that there was no statistical difference in the STS 10 between the two groups at each time point. At different time points before and after the intervention, the 6MWT values of the two groups were compared and analyzed through repeated analysis. The results showed that at three time points, there was no statistical difference in the average 6MWT level of the control group ($P > 0.05$), while at the three time points, there was a statistical difference in the average 6MWT level of the intervention group ($P < 0.05$). In addition, analysis was performed using the LSD-T method. Compared with the pre-intervention, the intervention group was statistically significant ($P < 0.05$).

Two factors and three levels of iterative measurement were used to analyze the changes of 6MWT before and after intervention. In all cases, sphericity was met, and the Greenhouse-Geisser correction was used. The results showed that at three time points, there was a statistically significant difference in the number of 30-ACT between the two groups after 1 month ($P < 0.05$), and there was a statistically significant difference in the number of 30-ACT between the two groups at different time points ($P < 0.05$). The difference in the number of 30-ACT between the two groups was statistically significant ($P < 0.05$). The time effect of 30-ACT frequency has an interactive effect with the effect between groups. Using the $t$ test of two independent samples, the difference between the two groups after 1 month of intervention and 3 months of intervention was compared. The results showed that there was no statistically significant difference in the number of 30-ACT between the two groups after 1 month ($P < 0.05$).

After the test, two sets of assumptions about the normality and dispersion uniformity of STS 10 h at each time point were established. Using repeated measurements of decentered analysis, the STS 10 h at each time point before and after the intervention of the two groups were compared. The results showed that there was no statistical difference in STS 10 at the 3 time points of the comparison group ($P > 0.05$). Further analysis using LSD-T showed that there was no statistically significant difference between the intervention group after one intervention and the intervention group before the intervention ($P > 0.05$), and there was a statistically significant difference between the subsequent and the intervention groups. In most cases, the “spherical symmetry” test is performed on STS 10 measurements at various time points, and the “spherical symmetry assumption” is discarded ($w = 0.629, P < 0.05$), showing that the Greenhouse-Geisser correction result is used. The results showed that the between-group effects of STS 10-h changes were statistically significant ($P < 0.001$). The interaction between time and grouping is statistically significant ($P < 0.001$). Using the $t$ test of two independent samples, the difference between the two groups after 1 month of intervention and 3 months of intervention was compared. The results showed that there was no statistical difference in the STS 10 between the two groups after 1 month, but the STS 10 between the two groups after 3 months was statistically significant ($P < 0.05$).

The 6MWT values of the two groups met the normal distribution at each time point. At different time points before and after the intervention, the 6MWT values of the two groups were compared and analyzed through repeated analysis. The results showed that at three time points, there was no statistical difference in the average 6MWT level of the control group ($P > 0.05$), while at the three time points, there was a statistical difference in the average 6MWT level of the intervention group ($P < 0.05$). In addition, analysis was performed using the LSD-T method. Compared with the pre-intervention, the difference between the 1-month and 3-month intervention groups was statistically significant ($P < 0.05$).

Two factors and three levels of iterative measurement were used to analyze the changes of 6MWT before and after intervention. In all cases, sphericity was met, and the Greenhouse-Geisser correction was used. The results showed that at three time points, there was a statistically significant difference in the number of 30-ACT between the two groups after 1 month ($P < 0.05$), and there was a statistically significant difference in the number of 30-ACT between the two groups at different time points ($P < 0.05$). The difference in the number of 30-ACT between the two groups was statistically significant ($P < 0.05$). The time effect of 30-ACT frequency has an interactive effect with the effect between groups. Using the $t$ test of two independent samples, the difference between the two groups after 1 month of intervention and 3 months of intervention was compared. The results showed that there was no statistical difference in the average 6MWT level of the control group ($P > 0.05$), while at the three time points, there was a statistical difference in the average 6MWT level of the intervention group ($P < 0.05$). In addition, analysis was performed using the LSD-T method. Compared with the pre-intervention, the difference between the 1-month and 3-month intervention groups was statistically significant ($P < 0.05$).

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30-ACT, STS 10, and 6MWT evaluation methods as the evaluation indicators for community home coronary heart disease, lower limb muscle rehabilitation, and cardiopulmonary rehabilitation (Majid et al. 2015). The assessment method is based on completing specific physical state tasks, such as speed (Passamaneck 1993). Researchers objectively evaluated their physical performance (Rao et al. 2014). These tests, in addition to the upper or lower extremity tests, may also include specific functional tests such as movable area, muscle strength, and walking speed (Rossmanith et al. 1996).

In this study, this measurement method does not require complicated equipment and cumbersome procedures and is suitable for regional publicity, so it was selected as a part of the physical function evaluation index (Sahil et al. 2017). On the other hand, many studies have shown that 30-ACT, STS 10, and 6MWT can reflect the muscle strength and cardiopulmonary function of the test subjects’ upper and lower limbs through high reliability and effectiveness (Sun et al. 2010). It is widely used in the process of medical evaluation. Through the implementation of the entire process of intervention in this study, no adverse events occurred in the collection of measurement indicators, and the effectiveness and safety of the measurement indicators have been confirmed. Some people suggest that it can be further popularized and applied to patients with coronary heart disease in the community in the future.

**Intervention helps to enhance the patient’s upper limb muscle strength**

Before the intervention, the 30-ACT frequency of the interventional group in this study was 20.04±2.35, which was slightly lower than the 30-ACT frequency of healthy elderly people in the region. This study showed that CHD patients in the region had upper limbs compared with healthy elderly people in the region. Muscle strength is weakening. In this study, 3 months later, elderly patients with coronary heart disease in the region were given elastic band strength training. The frequency of 30-ACT in the interventional group was 20.04±2.35 before intervention, which increased to 22.27±2.29. The frequency after intervention is significantly higher than that of the control group, and the difference is statistically significant. Lin et al. targeted elderly people over 65 years old in nursing homes for the elderly in Taiwan. After 16 weeks of elastic training intervention, the subject’s 30-ACT frequency was 20.3±3.6, which increased to 22.9±4.2. The increase of 30-ACT shows that elastic band resistance training can effectively improve the upper limb muscle strength of patients.

The reason for this study is that the first four movements of elastic band resistance muscle strength training are shoulder external rotation, shoulder lifting, arm push, and single-arm bending, which are expanded with the extension of shoulder external rotation and shoulder lifting. The target muscles are the deltoid tendons and the upper arm triceps, and the target muscles that are propelled by the extension of the straight arm and the one-arm bend are the back muscles and the back muscles. Exercising muscles through stretching exercises may increase the cross-sectional area of the muscles and the growth of the muscle bands. At the same time, in patients with cardiovascular disease, due to the reduction of myocardial contraction and insufficient blood irrigation, the oxidative capacity of the skeletal muscles decreases, and the skeletal muscle fibers change from type I to type II, causing a decrease in the amount of skeletal muscles and muscle atrophy. Muscle strength training can convert muscle fibers from type II to

### Table 3: Comparison of the 6-min walking distance between the two groups of patients

| Group       | Before intervention | Intervention for 1 month | Intervention for 3 months | Between-group effects | Time effect | Interaction effect |
|-------------|---------------------|--------------------------|---------------------------|-----------------------|-------------|-------------------|
| Intervention group | 584.45±47.17        | 607.65±48.35             | 653.99±31.71              | 14.694                | 32.761      | 9.237             |
| Control group   | 581.70±49.63        | 586.22±48.37             | 597.24±40.81              |                       |             |                   |
| Total          | 583.11±48.15        | 596.72±42.28             | 624.98±46.26              |                       |             |                   |

### Table 4: CQCC scores of the two groups of patients

| Project      | Group          | n  | Before intervention | Intervention for 1 month | Intervention for 3 months |
|--------------|----------------|----|---------------------|--------------------------|---------------------------|
| Total score  | Intervention group | 45 | 61.63±14.83         | 69.81±15.68              | 80.08±12.94               |
|              | Control group   | 47 | 58.65±14.63         | 62.86±12.55              | 62.97±11.36               |
| Physical condition | Intervention group | 45 | 19.28±7.13         | 25.34±14.33              | 31.06±12.62               |
|              | Control group   | 47 | 17.97±7.78         | 19.24±9.37               | 20.67±9.43                |
| Condition    | Intervention group | 45 | 13.94±3.02         | 15.07±2.93               | 16.34±2.99                |
|              | Control group   | 47 | 14.33±3.67         | 15.43±3.39               | 14.41±2.84                |
normal types, thereby improving muscle strength and the volume of skeletal tendons. Therefore, according to the scientific law of elastic band resistance movement, the muscles of the rotating tendon plate and other upper limb muscles can be improved.

**Intervention helps to improve the muscle strength of the patient’s lower limbs**

The results of this study show that STS 10 has statistical differences between the time effect, grouping effect, and interaction response between the two groups. After 12 weeks of intervention, the duration of STS 10 in the intervention group was significantly shorter than that in the control group. At various time points in the experiment, the duration of STS 10 in the intervention group was significantly shorter than that in the control group, and the reduction tendency was more meaningful in the middle and late stages of intervention. However, there was no statistically significant difference during STS 10 during the intervention period between the two groups in the first month. This is mainly because, on the one hand, compared with the STS 10 time of the intervention group at baseline than the control group (30.97 vs 30.63, \( P > 0.05 \)), the STS 10 time of the intervention group of 1 month was shortened, but it was still at the same level. The level of the control group was the same (30.28 vs 30.57, \( P > 0.05 \)); on the other hand, when the patients were just beginning to receive the intervention for 1 month, the overall intervention time became shorter. The exercise intensity of the resistance training in this study belongs to low-to-medium intensity, with a certain accumulation of physical function, but the degree of change is not obvious. There is no significant difference between the two groups of patients within 1 month. However, as the intervention time increases, the exercise intensity also increases appropriately, and the gap between the two groups gradually gets bigger, and the interaction effect gradually appears.

Yu Xin implemented 12 weeks of moderate and low-intensity muscle strength training interventions for maintenance hemodialysis patients. The results showed that after intervention, the STS 10 compliance rate of the intervention group was higher than that of the control group, but the improvement of the compliance rate of the intervention group before and after the comparison did not reach statistical validation. The authors found that this was mainly due to the high baseline level of STS 10 in the study subjects. Therefore, there is no room for further improvement. However, foreign intervention studies have shown that the STS 10 period of the intervention group is significantly shorter than before the intervention, and the difference is statistically significant and consistent with the results of this study. However, the time of STS 10 in foreign studies is mainly 2.5 to 6.0 s. Compared with the reduction of 2.68 s in this study, I am afraid it is for the safety of sports. The resistance training used in this study is low in intensity and low in frequency, so the reduction is more obvious, but it also shows that resistance training from moderate to low mild is possible to improve the muscle strength of the lower limbs of patients with coronary heart disease in the region.

**The impact of home aerobic exercise rehabilitation of the elderly on the quality of life**

**Quality of life of patients with coronary heart disease at home before intervention**

In addition to cardiopulmonary rehabilitation training and poor physical function in community patients with coronary heart disease, due to the lack of relatively complete resources in the community and the lack of heart-related knowledge of the patients, which leads to restlessness, powerlessness, and other harmful psychological and emotional rehabilitation training, have a serious impact on their quality of life. Many surveys and studies have also shown that the quality of life of patients with coronary heart disease in the community is at a medium-low level. With the increase of age, the quality of life of patients has a tendency to gradually decline.

In this study, the total score of quality of life of intervention patients was 61.62±14.82, which was slightly lower than the 64.90–66.86 reported in the literature, and was related to low income and education level. The monthly income of the test subjects in this study is almost less than 3,000 yuan. Most of the patients have an education level below middle school, and the income level of the patients is not high. Medical expenses are a great financial burden for them. In addition, the patient’s education level is not high, and the rehabilitation awareness and self-management ability are also very low, which has a certain impact on the patient’s quality of life. In addition to economic level and education level, the factors that affect the quality of life of CHD patients are also different. Many studies have concluded that age, the number of CHD patients, rehabilitation exercises, treatment methods, and the course of the disease are all factors that affect the quality of life of CHD patients. Although the influencing factors are different, these all indicate that improving the quality of life of patients with coronary heart disease in the community is an urgent problem that should be solved.

**The impact of intervention on the overall quality of life of patients with coronary heart disease at home**

After the intervention, the quality of life scores of the two groups of patients are reflected in the grouping effect. The time effect and the grouping effect are statistically significant. The quality of life scores before and after the intervention show that the effect of the intervention group has increased.
significantly, and the difference is compared with the control trial as time goes by. Compared with subjects, it is statistically significant, indicating that in order to effectively improve the quality of life, intervention and treatment of coronary heart disease patients in the community are needed.

The reasons are as follows: ① Analysis from the perspective of cardiac rehabilitation education: This study firstly consists of regional general doctors, cardiac rehabilitation doctors, and regional nurses jointly forming an interventional team. Generally speaking, most patients’ medical knowledge comes from doctors and nurses. Therefore, in order to increase people’s awareness of coronary heart disease, medical staff in the region rely on the development of cardiac rehabilitation education. Through exercise, cardiovascular disease risk factors, cardiovascular disease drug use, diet and nutrition, psychological and emotional adjustment, and other cardio rehabilitation exercises, we understand the knowledge of cardiac rehabilitation, in order to support patients’ self-management, comprehensive; in addition, it will be explained in detail to establish awareness of coronary heart disease and cardiac rehabilitation training. Studies have proved that by improving the self-management ability of CHD patients, the length of hospital stay can be shortened and the quality of life of patients can be improved. ② Analysis from the perspective of rehabilitation exercise: After that, the team guided each patient to implement elastic band resistance training, and regular follow-up ensured the patient’s exercise compliance. Many studies have shown that elastic band resistance training can effectively promote the recovery of cardiac and physical functions of patients with cardiovascular diseases, improve the physical functions of patients, and improve the quality of life.

Analysis of the rehabilitation effect of home aerobic exercise for the elderly

Implementability of the intervention plan

In the community included in this study, most CHD patients are elderly patients with low levels of knowledge and almost no knowledge about cardiac rehabilitation, and there is almost no possibility of being able to receive a systematic and comprehensive cardiac rehabilitation training program. At present, among the rehabilitation exercises that patients participate in everyday, aerobic exercises such as walking and cycling are the only exercises. CHD patients in most areas do not understand the role of muscle strength training in cardiac rehabilitation training. Therefore, according to the actual situation of rehabilitation training for patients in the community, this study has formulated a special program for cardiac rehabilitation education in order to systematically promote and educate patients about the knowledge of cardiac rehabilitation training. Compared with the universality of local group education, it becomes more detailed. In accordance with the characteristics of the patients at home in the community, an elastic band was selected as the resistance training device.

Compared with other resistance devices (dumbbells, etc.), the elastic band is a soft resistance exercise mode, which is not prone to risk. Most muscle groups in the body may participate, so the training effect is better, and it is most vulnerable to the elderly and chronic diseases. Of patients accept. Elastic bands of different colors show different resistance. The trainer can flexibly adjust the action and choose different colors according to the condition, difficulty, amplitude, frequency, and local of the elastic band. In this study, the 8 movements are very simple, and the patients at home can perform them anytime and anywhere, and the maneuverability is very strong. With the poster of muscle training, patients can remember, confirm, and correct their actions at any time. The 8 movements of elastic band muscle strength training even the strength of the patient’s upper limbs, lower limbs, and abdominal core muscles. According to this, the diversification of exercise is guaranteed, not only is it fun, but most of the muscle groups of the patient’s body are also involved in exercise, ensuring the exercise effect.

The spreadability of the intervention program

Compared with the previous daily care in the community, the home cardiac rehabilitation training program of this study is more focused. First of all, because the knowledge of cardiac rehabilitation training is explained in detail, patients can fully understand what the cardiac rehabilitation training is and what it contains, which can improve the patient’s awareness of cardiac rehabilitation training. Second, it provides patients with effective cardiac rehabilitation exercise methods and monthly follow-ups, investigates the actual application of patients, relies on health education to promote changes in patients’ actions, and also stimulates patients’ enthusiasm, and patients have a strong sense of participation.

In the implementation of the intervention plan, community nurses, from the perspective of medical staff, give full play to their own advantages to implement cardiac rehabilitation education for community coronary heart disease patients and cultivate awareness of cardiac rehabilitation. In addition, it is necessary to strengthen cooperation with sports medicine and rehabilitation medicine experts, establish interventional teams, and guide patients to implement cardiac rehabilitation exercises. After that, through regular follow-up, the guidance and supervision of cardiac rehabilitation for patients with coronary heart disease in the community were carried out. From the patient’s point of view, resistance training with elastic bands is not restricted by age, location, and season. Patients can train at home, and it is convenient to do exercises when going out. In addition, elastic belts are cheap and easy to get started. Elastic band resistance training is also a kind of soft muscle strength training. There is no tendency to take risks. Most
muscle groups in the body may participate. The training intensity can be flexibly adjusted according to the patient’s own situation, which is very suitable for use by patients with cardiovascular diseases in the community. Therefore, you can try to promote it in the community.

**Conclusion**

In this paper, by consulting data, real-time water quality prediction model based on fine-grained image classification, and home aerobic exercise rehabilitation for the elderly are studied, and it is found that most of the current fine-grained image classification algorithms are based on monomodality, that is, relying only on images. Data is classified, and there are a small number of algorithms to improve classification accuracy through multi-modality. Based on previous theories, this article conducts in-depth research on the cross-domain fusion mechanism to form a fine-grained image classification model for cross-domain fusion, which combines image and text information to more vividly imitate humans through visual and language information. The location understands the cognitive process of the thing. This paper studies the detailed image classification model based on cross-domain fusion from the perspective of small sample learning. Good experimental results are achieved through the CUB data set and the FLOWERS data set. Therefore, the effectiveness of the detailed image classification model based on cross-domain fusion of small samples can be verified. Through the above research, the following conclusions can be drawn: elastic band resistance training combined with cardiac rehabilitation education is simple and effective cardiovascular rehabilitation training program for coronary heart disease patients at home to restore physical function, especially to improve the level of muscle strength. Cardiopulmonary rehabilitation training improves the quality of life of patients. The resistance training program has raised the awareness of cardiovascular rehabilitation among patients with coronary heart disease in the community. This can be popularized and applied to the home care of patients with coronary heart disease in the community and provide a theoretical reference for regional medical staff to exercise guidance for patients at home in the community.

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**Declarations**

**Conflict of interest** The authors declare no competing interests.

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