EFFECT OF COMPREHENSIVE STRENGTH TRAINING INTERVENTION ON MIDDLE-AGED AND ELDERLY MCI PATIENTS OF MIAO NATIONALITY AND ITS MECHANISM

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ABSTRACT

Objective: *To explore the intervention effect of comprehensive strength training on middle-aged and elderly MCI patients of Miao nationality and its possible mechanism of action.*

Methods: *Forty middle-aged and elderly MCI patients (56±4 years old, 65±3 years old) were selected from Miao ethnic group, who were randomly divided into control group and intervention group. The control group received routine health education. The intervention group received exercise intervention of comprehensive strength training for 6 months. The subjects' changes in indicators like cognitive function, biochemistry, strength were tested.*

Results: *After 6 months' exercise intervention, compared with the control group, the intervention group had increased MoCA score, showing a significant increase in T6 period ($P<0.05$). Compared with the control group, the intervention group had increased HDL-C content, but decreased TG, TC, and LDL-C contents. TG content showed a significant decrease at T6 period ($P<0.05$). Compared with the control group, the intervention group had significantly increased average electromyogram amplitude in rectus abdominis at T6 period ($P<0.05$), but latissimus dorsi showed an increasing trend without statistical difference ($P>0.05$).*

Conclusion: *6 months' comprehensive strength training can effectively improve cognitive function of middle-aged and elderly MCI patients of Miao nationality; improve blood lipid levels, especially in the middle-aged group; help improve core muscle strength to some extent. In particular, rectus abdominis had the most obviously increased average electromyogram amplitude, which was especially true in the middle-aged group.*

Keywords: *Strength training, Miao nationality, MCI.*

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Introduction

Senile dementia is a common chronic degenerative disease of the central nervous system in the elderly, of which, Alzheimer's disease (AD) is the most common. Mild Cognitive Impairment (MCI) is in the transition phase between normal aging and AD. Based on some works, patients with MCI evolve into AD at a rate of 10-15% per year, which is 10 times that of normal elderly, so such patients are high-risk group of senile dementia[1]. Other studies,Adopting scientific and reasonable methods and means to control the transition of MCI to AD has become a key link in preventing and controlling AD and lowering its prevalence[2-9]. This study takes exercise intervention of MCI as a starting point, and uses strength training commonly used in the field of exercise intervention of aging in the world. The difference is that previous studies only select Han and elderly people as research subjects, but this study selects middle-aged and elderly MCI patients of Miao nationality as test subjects.

In the 6-month comprehensive strength training intervention, subjects' changes in indicators like cognitive function, biochemistry, strength were tested at different stages before, during and after exercise intervention to comprehensively analyze and investigate the intervention effect of strength training on middle-aged and elderly MCI patients of Miao nationality with different ages and physical conditions and explore its possible mechanism of action. The study aims to help middle-aged and elderly

MCI patients of different nationalities choose and implement suitable exercise intervention ways and promote them. It will also provide some help and reference for patients with chronic diseases from different nationalities in China to better adhere to physical exercise, control the development of chronic diseases, promote health and improve quality of life.

Research subjects and grouping

Miao males of 50-69 years old were selected from Guiyang Community Health Service Center in Guizhou Province for cognitive function screening to screen out MCI patients in line with the research criteria.

Subject inclusion criteria:

- The MCI diagnostic guidelines of National Institute of Aging (NIA) and Alzheimer's Disease Society (AA) and the Chinese expert consensus on the prevention and treatment of cognitive dysfunction.

Other works proved that when the daily mobility is normal, the overall cognitive function is normal. The Montreal scale (MoCA) test score is in the range of 15-24 points. Those with cardiovascular and cerebrovascular diseases, mental illness and dementia were excluded. All subjects volunteered to participate in the trial and signed informed consent[4].

Forty middle-aged and forty elderly MCI male patients who met the inclusion criteria were selected and randomly divided into 50-59-year-old group (middle-aged group, 56±4 years old) and 60-69-year-old group (elderly group, 65±3 years old). The experiment set middle-aged control group (C1) and intervention group (S1), elderly control group (C2) and intervention group (S2), 20 people in each group. From the start to the end of the experiment, two people in each of the C1, C2 and S2 groups withdrew due to transfer to another hospital, diseases and other reasons. The total subjects who finally completed the experimental intervention numbered 74.

Materials and methods

Experimental method

All subjects received routine medical and health services and MCI-related health education in the corresponding community health service centers. S1 and S2 groups received corresponding strength training interventions as planned. C1 and C2 groups were arranged for free sports activities of the same duration. According to the previous literature research, the previous research results of the research group and the pre-experimental results, a set of resistance strength training programs was designed for upper limbs, lower limbs, lumbar and abdominal muscle groups of middle-aged and elderly MCI patients. Some works proved that exercise intensity was 40% -45% of 1RM for every subject, which was adjusted according to the subject's condition[11, 12].

Each effective resistance strength training lasted 40-50min, three times a week on alternate days, with Sunday for rest. As the intervention time prolonged, the training time was appropriately extended to increase the training intensity. The specific training contents are shown in Table 1.

Training item	Training content	Training time and number of groups
Warm-up	Walking, static stretch	5-10min
Quiet squatting against the wall	With back against the wall, thighs parallel to the ground, and calves perpendicular to the ground. A 90-degree angle should be maintained.	Gradual extension from 30s to 2min, with 10-12 times/group. There are 2-4 groups, with 1 min break between the groups.
Standing trunk rotation with elastic band	The feet open naturally, and the knees are slightly bent. Hold elastic band tightly with both hands, straighten arms before the chest. Straighten the back, tighten the abdomen, shrink and press the scapula. Turn trunk leftward and pull hands leftward when you exhale. Slowly return to the starting position when you inhale, alternating between left and right positions.	10-12 times/groups, 2-4 groups, with 1 min break between the groups.
Arm flexion with elastic band	The elastic band is fixed under the foot, the body is kept upright, the elbow joint is fixed, the arms are clamped on both sides of the body, the back is straight. Perform flexion until the forearm is parallel to the ground.	8-10 times/groups, 3-5groups, with 1 min break between the groups.
Heel raising exercise	Hold yoga dumbbells and raise the heel	10-12 times/groups, 3-5 groups, with 1 min break between the groups
Plank	Keep the body upright and keep the body still via force of the two elbows and toes.	Gradual extension from 30s to 2min, 3-5 groups, with 1 min break between the groups
Cooling-down	Stretch and relax upper and lower limb muscles	5-10min

Table 1: Resistance strength training program.

Test indicators and methods

All subjects were tested three times for corresponding indicators before the experiment (T0), after 3 months (T3) and after 6 months (T6). The specific test indicators and methods are as follows:

Cognitive function indicator

Montreal Scale (MoCA), an internationally recognized rapid screening assessment tool specially developed for mild cognitive impairment[13].

Biochemical indicators

Total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C).

The automatic biochemical analyzer of Beckman, USA was used for detection. All kits were purchased from Nanjing Jiancheng Biological Co., Ltd.

Strength indicator

Electromyography was used to analyze the core muscle strength, including the rectus abdominis and latissimus dorsi, and strength assessment was made. The electromyography in NeuroExam M 800 model had a sampling frequency of 2048 Hz.

One collection point with relatively strong signal was selected for each muscle. Each collection point was sampled 3 times and the average value was taken as the final result.

Mathematical statistics

All data were statistically analyzed and plotted using SPSS 19.0 software. Data are expressed as mean ± standard deviation (X±S). For data obeying normal distribution, independent sample t test was used to compare inter-group differences before and after intervention, while paired t test was used to compare intra-group differences before and after intervention. For data not obeying normal distribution, independent sample nonparametric Mann-Whitney U rank sum test was used to compare inter-group differences before and after intervention, and related sample nonparametric Wilcoxon rank sum test was used to compare intra-group differences before and after intervention. P<0.05 indicates significant difference, and P<0.01 indicates very significant difference.

Results and discussion

Changes in cognitive function indicators

As shown in Table 2, MoCA scores are not significantly different between the groups in T0 period (P>0.05); as the intervention time prolongs, scores of each group are improved in T3 and T6 periods compared with T0 period, with more significant increase in S1 and S2 groups, but no significant difference is shown (P>0.05). Compared with C1 and C2 groups, S1 and S2 groups have significantly increased score in T6 period (P<0.05).

Group	T_0	T_3	T_6
S_1	20.53±4.25	21.36±3.28	24.68±9.51$^{\triangle}$
C_1	20.24±5.15	20.34±4.54	20.46±6.43
S_2	20.50±5.26	21.22±3.56	24.78±4.21$^{\triangle}$
C_2	19.59±2.90	19.68±6.35	19.89±3.73

Table 2: Changes in cognitive function indicators (MoCA score).

Note: $^{\triangle}$indicates P<0.05 when compared with the control group.

Changes in biochemical indicators

As shown in Table 3, seen from the change of TG, TC, LDL-C and HDL-C contents, in the T0 period, the middle-aged group has slightly lower content than the elderly group, but there is no significant difference (P>0.05). As the intervention time prolongs, compared with T0 period, TG, TC, LDL-C and HDL-C contents in C1 and C2 groups are basically unchanged. TG content in S1 and S2 groups shows a downward trend in T3 and T6 periods, both showing significant differences in T6 period (P< 0.05).

TC and LDL-C contents demonstrate a downward trend, while HDL-C content is on the rise, but there is no significant difference (P>0.05). Compared with C1 and C2, S1 and S2 groups have decreased TG content in T3 and T6 periods, both showing a significant difference in T6 period (P<0.05). TC and LDL-C contents show a downward trend, while HDL-C content shows an upward trend, but no significant difference is shown (P> 0.05).

Item/group	T_0	T_3	T_6
TC			
S_1	4.68±1.23	4.58±1.21	4.52±1.17
C_1	4.65±1.34	4.65±1.26	4.66±1.36
S_2	4.86±1.15	4.80±1.18	4.73±1.56
C_2	4.89±0.54	4.88±1.56	4.88±1.12
TG			
S_1	1.35±0.23	0.94±0.18	0.75±0.20$^{\#\triangle}$
C_1	1.36±0.16	1.35±0.15	1.35±0.18
S_2	1.60±0.13	1.02±0.24	0.82±0.13$^{\#\triangle}$
C_2	1.61±0.12	1.60±0.22	1.60±0.23
HDL-C			
S_1	1.25±0.13	1.27±0.20	1.31±0.14
C_1	1.25±0.14	1.25±0.12	1.25±0.15
S_2	1.20±0.21	1.25±0.12	1.28±0.16
C_2	1.20±0.22	1.21±0.14	1.21±0.17
LDL-C			
S_1	2.87±0.23	2.81±0.32	2.76±0.26
C_1	2.88±0.35	2.87±0.43	2.87±0.31
S_2	2.92±0.37	2.87±0.21	2.85±0.28
C_2	2.92±0.26	2.92±0.25	2.92±0.27

Table 3: Changes in biochemical indicators (unit: mmol/L).

Note: $^{\#}$means P<0.05 when compared with T0 period, and $^{\triangle}$represents P<0.05 when compared with the control group.

Changes in strength indicators

As shown in Table 4, seen from changes in average electromyogram amplitude of the muscle in each part, in T0 period, the middle-aged group has slightly higher amplitude than the elderly group on the whole, but there is no significant difference (P>0.05). As the intervention time prolongs, compared to T0 period, C1 and C2 groups have basically unchanged average electromyogram amplitude in each part, S1 and S2 groups have sustainably increased average electromyogram amplitude of rectus abdominis in T3 and T6 periods, both showing significant difference in T6 period (P<0.05). The same trend is shown in latissimus dorsi, but with no significant difference (P>0.05).

Compared with C1 and C2, S1 and S2 groups have sustainably increased average electromyogram amplitude of rectus abdominis in T3 and T6 periods, both showing significant difference in T6 period (P<0.05). The same trend is shown in latissimus dorsi, but with no significant difference (P>0.05).

Average electromyogram amplitude/group	T_0	T_3	T_6
Rectus abdominis			
S_1	537.1±16.1	568.5±17.3	618.3±12.4$^{\#\triangle}$
C_1	531.4±12.3	532.2±13.1	537.3±11.1
S_2	517.3±11.5	548.4±18.3	595.0±12.2$^{\#\triangle}$
C_2	516.9±12.3	519.3±16.6	517.2±15.3
Latissimus dorsi			
S_1	534.2±9.5	557.2±15.2	571.4±13.1
C_1	536.3±14.3	537.2±12.6	538.1±10.8
S_2	514.1±15.4	537.8±13.8	557.3±15.1
C_2	512.9±12.2	517.4±11.5	513.5±12.7

Table 4: Changes in strength indicators (unit: μV).
Note: $^{\#}$means P<0.05 when compared with T0 period, and $^{\triangle}$represents P<0.05 when compared with the control group.

Discussion and analysis

Analysis of changes in cognitive function indicators

Some research results indicate that long-time relaxation in muscle groups of the trunk and limbs will result in lowered compensatory function in the body. For the elderly with poor tolerance, it will cause a series of physiological stress reactions in the body, especially brain, which will easily increase the risk of brain cell damage in the elderly and may lead to cognitive dysfunction(3, 14).

In this study, Montreal Scale (MoCA) was used to evaluate and analyze cognitive function of middle-aged and elderly MCI patients of Miao nationality. Previous studies have found that physical exercise can have a positive effect on MoCA scores in MCI patients(15, 16). The results of this study showed that there was no significant difference in MoCA scores between the groups before the experiment (P> 0.05); as the intervention time prolonged, compared with T0 period, scores of S1 and S2 groups increased at T3 and T6 periods, but with no significant difference (P> 0.05). Compared with C1 and C2 groups, S1 and S2 groups had significantly increased score in T6 period (P<0.05), which increased by 4.22 and 4.89, respectively. The elderly group showed better result than the middle-aged group on the whole. Under the conditions of this experiment, comprehensive strength training plays a significant role in improving cognitive function of middle-aged and elderly MCI patients.

The possible reasons are as follows:

• Strength training can promote regeneration and vitality of brain neurons in a way that neurotransmitter releases growth factors which act on various systems of the body via the relevant cell signal pathways. At the same time, it improves antioxidant capacity of the cerebral vascular tissues, thereby improving the level of cognitive function;

• Exercise can improve the patient's psychological factors like self-esteem or emotion, then affecting patients' cognitive function;

• It may be related to the passive formation of the subject's learning behavior.

Analysis of changes in biochemical indicators

Abundant studies have confirmed that reasonable physical exercise can effectively improve the body's fat metabolism level, thereby helping improve blood lipids(17, 18). Increase in TG and LDL-C contents in blood lipids usually indicates that the body's inferior lipoprotein content increases. HDL-C, as a high-quality lipoprotein, plays an important role in increasing blood lipid metabolism capacity, so that blood vessels are cleaner. In this way, HDL-C serves as a powerful intravascular lipid scavenger(19).

This study found that before exercise intervention, there was no significant difference in TG, TC, LDL-C and HDL-C contents between each group (P>0.05), but middle-aged group tend to show slightly better result than the elderly group. After 6 months' exercise training intervention, compared with C1 and C2 groups, TG, TC, LDL-C, and HDL-C contents in S1 and S2 groups showed positive improvement. In particular, TG content had significant drop in T6 period (P<0.05), decreasing by 0.6 and 0.78mmol/L, respectively. It suggests that 6 months' comprehensive strength intervention has a positive effect on blood lipid levels in middle-aged and elderly MCI subjects of Miao nationality.

The possible reasons are as follows:

• Strength training can effectively stimulate the body and objectively increase the body's blood circulation, especially increasing blood supply of the skeletal muscle, so that HDL-C, a beneficial cholesterol which protects the elderly against cardiovascular and cerebrovascular diseases, starts to increase, while TG, TC, LDL-C, etc. which have a negative impact on blood vessels and blood circulation begin to decrease. In this way, vascular elasticity is effectively increased, with the body's blood lipid metabolism level improved.

• Although 6 months' strength training is not long, it may possibly activate the action channels and pathways of certain hormones or enzymes in the body, indirectly stimulate beneficial changes in some blood lipid indicators, thus improving blood lipid metabolism, but the specific mechanism and pathways demand further study.

Analysis of changes in strength indicators

Most studies have shown that proper strength training can increase strength level of the elderly, with varying increase amplitudes in muscle strength for different parts of the body[20, 21]. Therefore, this study proceeded from standardization, quantification and comprehensiveness of data, adopted a more intuitive electromyogram test for quantitative evaluation of the training effect. Strength of different muscle groups in the MCI patients was reflected by testing average amplitude of muscles in different parts of the body. The results of this study showed that in T0 period, the middle-aged group had slightly higher average electromyogram amplitude in muscle of each part than the elderly group, but without significant difference ($P > 0.05$). It suggests that without regular training, age becomes an important factor determining the strength. As intervention time prolongs, compared with C1 and C2 groups, they had significantly increased average electromyogram amplitude in rectus abdominis, increasing by $81\mu V$ and $77.8\mu V$, respectively, in T6 period; average electromyogram amplitude of latissimus dorsi showed an increasing trend, but without significant difference ($P > 0.05$). After 6 months of comprehensive strength intervention, MCI patients had significantly improved muscle strength.

The specific reasons may be as follows:

• The middle-aged group has more obviously increased muscle strength than the elderly group. It suggests that with the increase of age, muscle aging degree deepens, muscle contents have lowered quality, enzyme activity related to muscle contraction and strength decreases, and muscle is more trainable at a younger age.

• In terms of different parts of muscles, rectus abdominis has most obvious increase in muscle strength, which is probably because muscle strength training in the core area is consciously added in the strength training program of this study.

Therefore, obvious strength increase in rectus abdominis, one of the important muscles in the core muscle group, exactly illustrates feasibility and important practical significance of the strength training program in this study[18-26].

Conclusion

From the 6 months' exercise intervention of strength training on 80 middle-aged and elderly MCI patients, the following conclusions are drawn:

• Strength training can effectively improve cognitive function of middle-aged and elderly MCI patients in Miao nationality, with most significant effect in improving memory and delaying recall.

• Strength training can significantly improve TG content of middle-aged and elderly MCI patients of Miao nationality. TC, LDL-C and HDL-C contents show positive improvements, and the middle-aged group shows better result than the elderly group.

• Strength training can effectively improve the core muscle strength of middle-aged and elderly MCI patients in Miao nationality. Rectus abdominis and latissimus dorsi have increased average electromyogram amplitude to some extent. The former has particular increase, with the middle-aged group outperforming the elderly group.

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