Effects of Resistance Exercise on Glycemic Control and Physical Function in Older Adults with Type 2 Diabetes and Sarcopenia

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Abstract

Objective To investigate the effects of resistance exercise on glycemic control and physical mobility in elderly patients with type 2 diabetes mellitus and sarcopenia. Methods One hundred elderly patients with type 2 diabetes mellitus and sarcopenia admitted to our hospital from January 2021 to February 2022 were enrolled. Using a random number method, the patients were divided into a control group and an observation group, with 50 cases in each group. The control group received conventional exercise guidance, while the observation group additionally implemented elastic band resistance exercise intervention. Fasting plasma glucose (FPG), 2-hour postprandial blood glucose (PBG), glycated hemoglobin (HbAlc), Berg Balance Scale (BBS), and Timed Up and Go test (TUG) results were compared between the two groups before intervention and at 3 months and 6 months post-intervention. Results Before intervention, no statistically significant differences were observed in FPG, PBG, HbAlc, BBS, and TUG indices between the two groups ($P>0.05$). At 3 months and 6 months after intervention, FPG, PBG, HbAlc, and TUG indices in both groups decreased and were lower than pre-intervention levels, while BBS index levels increased and were higher than pre-intervention levels ($P<0.05$). At 3 months and 6 months after intervention, the observation group showed lower FPG, PBG, HbAlc, and TUG indices and higher BBS index levels compared with the control group, with statistically significant differences ($P<0.05$). Conclusion Resistance exercise contributes to glycemic control and improves daily activity ability in elderly patients with type 2 diabetes mellitus and sarcopenia, demonstrating satisfactory clinical intervention effects that warrant further promotion and application.

Full Text

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Abstract

Objective: To investigate the effects of resistance exercise on glycemic control and physical activity capacity in elderly patients with type 2 diabetes mellitus and sarcopenia. **Methods**: A total of 100 elderly patients with type 2 diabetes and sarcopenia admitted to our hospital between January 2021 and February 2022 were enrolled and randomly divided into a control group and an observation group, with 50 patients in each group. The control group received conventional exercise guidance, while the observation group additionally underwent elastic band resistance exercise intervention. Fasting plasma glucose (FPG), 2-hour postprandial blood glucose (PBG), glycated hemoglobin (HbA1c), Berg Balance Scale (BBS) scores, and Timed Up and Go (TUG) test results were compared between the two groups before intervention and at 3 and 6 months post-intervention. **Results**: Prior to intervention, no significant differences were observed between the two groups in FPG, PBG, HbA1c, BBS, or TUG scores ($P>0.05$). At 3 and 6 months post-intervention, both groups showed decreased FPG, PBG, HbA1c, and TUG values compared to baseline, while BBS scores increased ($P<0.05$). The observation group exhibited significantly lower FPG, PBG, HbA1c, and TUG values, and higher BBS scores compared to the control group at both time points ($P<0.05$). **Conclusion**: Resistance exercise effectively improves glycemic control and daily activity capacity in elderly patients with type 2 diabetes and sarcopenia, demonstrating satisfactory clinical intervention effects that warrant broader promotion and application.

Keywords: Resistance exercise; Elderly; Type 2 diabetes mellitus; Blood glucose control; Physical activity capacity

Introduction

Type 2 diabetes mellitus is a metabolic disease characterized by chronic hyperglycemia. In recent years, the incidence of type 2 diabetes among older adults has increased substantially in China, driven by changes in lifestyle and dietary habits alongside accelerated population aging [**?**]. Sarcopenia, also known as muscle wasting syndrome, is a common geriatric condition involving progressive age-related decline in skeletal muscle mass, strength, and physical function. Research indicates that the prevalence of sarcopenia among elderly patients with type 2 diabetes ranges from 15.9% to 39.9%, increasing with age and seriously compromising quality of life [**?**]. Consequently, improving physical activity capacity in this population represents an important clinical priority.

Resistance exercise has emerged as an effective therapeutic modality for type 2 diabetes patients with sarcopenia. Long-term resistance training can increase muscle mass and strength, thereby improving daily activity capacity [?]. This study investigated the impact of resistance exercise on glycemic control and physical activity capacity in elderly patients with type 2 diabetes and sarcopenia, aiming to provide evidence-based guidance for clinical practice.

Methods

Study Population

We enrolled 100 elderly patients with type 2 diabetes and sarcopenia admitted to our hospital between January 2021 and February 2022. Inclusion criteria were: (1) diagnosis of type 2 diabetes according to 1999 WHO criteria; (2) sarcopenia diagnosed per International Working Group on Sarcopenia guidelines; (3) age >60 years; (4) normal cognitive function and communication ability; (5) informed consent from patients and families; (6) ability to use smartphones and accept telephone follow-up. Exclusion criteria included: motor dysfunction, dementia, epilepsy, cancer, psychiatric disorders, severe cardiovascular/hepatic/renal complications, severe diabetic complications, or concurrent treatments that might influence study outcomes.

Using random number generation in Excel based on medical record numbers, patients were allocated to a control group (n=50) and an observation group (n=50). The control group comprised 30 males and 20 females, aged 61-79 years (mean 65.77$±5.18years)withdiabetesdurationof4 − 16years(mean7.22±2.71years).Theobservationgroupincluded28malesand22females,aged61− 80years(mean65.99±4.78years)withdiabetesdurationof3−16years(mean7.09±$2.56 years). No significant differences in baseline characteristics were observed between groups (P>0.05), confirming comparability.

Intervention

All patients received standard treatment according to the *Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes* [?]. The control group received conventional exercise guidance with telephone and WeChat follow-up after discharge. The observation group additionally underwent elastic band resistance exercise intervention as follows:

(1) Intervention Team Formation: The team consisted of eight diabetes specialist nurses, one endocrinologist, and one rehabilitation therapist. The physician assessed diabetes treatment efficacy and monitored safety, the rehabilitation therapist designed and adjusted exercise protocols and trained patients in elastic band exercises, and the specialist nurses implemented, supervised, and documented the intervention while managing adverse events. Weekly team meetings were conducted, and all eight nurses completed standardized training and passed competency assessments.

(2) Elastic Band Resistance Exercise Protocol: Each session lasted 30-40 minutes, performed 2-3 times weekly with at least 48 hours between sessions. Patients participated in group sessions led by specialist nurses, including 5 minutes of warm-up, 20-30 minutes of elastic band exercises, and 5 minutes of cool-down. The exercise routine comprised nine movements (e.g., bilateral band pull-downs, seated rows, unilateral knee extensions, and ankle plantarflexion), all performed seated. Each movement was completed in 3 sets of 10-15 repetitions with 2-3 minutes rest between sets. Training videos were provided via television and smartphone recordings to enhance technique mastery and compliance.

(3) Exercise Intensity: Elastic bands were color-coded (yellow, red, green, blue, black) with progressively increasing resistance. All participants started with yellow bands, progressing to higher resistance colors based on individual capacity.

(4) Safety Monitoring: Blood pressure and heart rate were monitored regularly during exercise. Training was immediately discontinued if patients experienced chest tightness, dizziness, or musculoskeletal pain.

(5) Discharge Planning: All patients received discharge education, with the observation group receiving additional elastic band training. Telephone and WeChat groups were established for weekly follow-up and compliance monitoring.

Outcome Measures

Glycemic Parameters: FPG and PBG were measured using fingerstick glucometry (Jiangsu Kangshang Medical), and HbA1c was assessed using an Aikang AC6601 analyzer at baseline, 3 months, and 6 months.

Berg Balance Scale (BBS): Assessed at baseline, 3 months, and 6 months, the BBS evaluates 14 tasks (e.g., sit-to-stand, unassisted standing, single-leg stance) scored 0-4 points each, with total scores ranging 0-56. Higher scores indicate better balance: 0-20 points indicates wheelchair dependence, 21-40 points indicates assisted ambulation, and 41-56 points indicates independent walking. Scores <40 suggest fall risk.

Timed Up and Go Test (TUG): Conducted at baseline, 3 months, and 6 months, patients were timed while rising from a chair, walking 3 meters, turning, returning, and sitting. The average of three trials was recorded: <10 seconds indicates normal mobility, \$ \$12 seconds indicates increased fall risk, <20 seconds indicates independent mobility, 20-29 seconds indicates unstable mobility, and >30 seconds indicates marked mobility impairment.

Statistical Analysis

Data were analyzed using SPSS 21.0 software. Continuous variables (FPG, PBG, HbA1c, BBS, TUG) were expressed as mean±standard deviation and compared using t-tests. Categorical data were presented as frequencies or percentages and analyzed using ^{2} tests. Statistical significance was defined as P<0.05.

Results

Glycemic Control Parameters

No significant between-group differences in FPG or PBG were observed at baseline (P>0.05). Both groups demonstrated significant reductions in FPG and PBG at 3 and 6 months compared to baseline (P<0.05). The observation group exhibited significantly lower FPG and PBG values than the control group at both time points (P<0.05) .

HbA1c Changes

Baseline HbA1c levels were comparable between groups (P>0.05). Both groups showed significant HbA1c reductions at 3 and 6 months (P<0.05), with the observation group achieving lower HbA1c values than the control group at both time points (P<0.05) .

Balance and Mobility Function

No significant baseline differences were found in BBS or TUG scores (P>0.05). At 3 and 6 months, both groups showed improved BBS scores and reduced TUG times (P<0.05). The observation group demonstrated significantly higher BBS scores and lower TUG times compared to the control group at both time points (P<0.05) .

Discussion

Elastic band resistance training is a flexible form of resistance exercise that engages most major muscle groups, addressing the limitation of traditional dumbbell and barbell training that typically isolates specific muscle groups. The progressive, linear, and predictable resistance provided by different colored bands, combined with its operational simplicity, low risk, and affordability, makes elastic band training particularly suitable for patients with type 2 diabetes. Multiple studies [**?**, **?**] have confirmed the importance of resistance exercise for improving glycemic control in diabetic patients with sarcopenia. Our findings demonstrate that while both groups exhibited gradual reductions in FPG, PBG, and HbA1c over 3 and 6 months, the observation group achieved significantly lower values at both time points, consistent with findings from Yao et al. [**?**]. These results suggest that resistance exercise enhances glycemic control in this population.

The mechanism likely involves improved glucose transporter-4 (GLUT-4) function. Overcoming insulin resistance is critical for glycemic control, and skeletal muscle accounts for more than 80% of glucose metabolism via GLUT-4 mediated glucose transport, uptake, and utilization. Sarcopenia reduces muscle mass and GLUT-4 content, impairing glucose uptake and promoting insulin resistance [?]. Resistance exercise improves muscle mass and volume, thereby increasing GLUT-4 content and enhancing glucose transport capacity [?].

Sarcopenia represents a significant risk factor for osteoporosis and coronary artery disease in older adults and is closely associated with insulin resistance. It causes difficulty standing, slow gait, and increased fall risk, severely compromising quality of life [?]. Muscle fiber atrophy is a primary contributor to muscle mass loss. Numerous studies have demonstrated that resistance exercise improves both muscle quality and strength, promotes muscle fiber contractile recovery, and enhances physical function and quality of life in diabetic patients with sarcopenia [?, ?]. The mechanisms may involve: (1) activation of Akt/mTOR and Akt/GSK3β/eIF2B signaling pathways that stimulate muscle protein synthesis and increase type I and II muscle fiber cross-sectional area [?]; and (2) improved mitochondrial function in skeletal muscle cells, which maintains normal signaling pathway regulation, reduces muscle fiber loss, and preserves muscle strength and physical activity capacity [?]. The BBS and TUG are reliable and valid measures for assessing mobility [?]. Wang et al. [?] reported that 12 weeks of supervised elastic band training significantly improved balance and walking ability in diabetic patients with sarcopenia. Our findings of higher BBS scores and lower TUG times in the observation group align with these results [?], demonstrating that elastic band resistance exercise provides superior improvements in physical activity capacity compared to conventional training.

Conclusion

Resistance exercise effectively improves glycemic control and daily activity capacity in elderly patients with type 2 diabetes and sarcopenia, yielding satisfactory clinical outcomes with significant potential for broader clinical implementation. Notably, despite its operational feasibility and efficacy, resistance exercise carries inherent risks. Given that many patients with type 2 diabetes have multiple comorbidities, exercise protocols must be individualized with comprehensive safety considerations to ensure both effectiveness and safety.

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Note: Figure translations are in progress. See original paper for figures.