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Pharmacological perspectives on integrating sports and medicine: Collaborative models for drug therapy optimization and health promotion

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Abstract: **Background**: The cross-disciplinary integration of sports and medicine has become an important trend. This integration not only creates conditions for optimizing disease treatment plans and enhancing the efficacy of drug therapy, but also provides a new path for promoting public health and improving the efficiency of health resources. **Objective**: The integration of sports and medicine offers opportunities to optimize drug therapies and improve health outcomes. **Method**: This study applies structural equation modeling to analyze the interplay between sports activity, pharmaceutical interventions and health promotion. By integrating quantitative and qualitative indicators-such as resource allocation, participation rates and drug utilization patterns-the research identifies pathways to enhance collaborative governance in sports-medicine fusion. **Results**: Strategic investment in sports and medicine can jointly enhance medication compliance, health outcomes, and resource utilization efficiency, and has clarified the key path for promoting the collaborative governance of sports and medicine integration. **Conclusion**: The research results provide a basis for formulating comprehensive policies that integrate physical exercise and drug intervention, which is conducive to promoting the deep integration of sports and medicine and achieving an improvement in the overall health level of the population.

Keywords: Collaborative; Drug adherence; Governance; Health promotion; Health outcomes; Optimization; Pharmacotherapy; Sports and medicine integration

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INTRODUCTION

The integration of sports and medicine is a health service model that utilizes sport and physical activity in conjunction with medical service programs to restore, maintain and promote health (Sullivan *et al*., 2021). However, the integration of sports and medicine fitness remains in the traditional developmental paradigm of "treating disease" (Green & Sauers, 2020). This model focuses on interventions that utilize physical resources rather than assessing and diagnosing physical activity, undermining the effectiveness of relying on the authority of the physician to promote physical activity until a healthy lifestyle is developed. The current integration of sports and medicine is an embedding and superimposition rather than a renewal of concepts and mechanisms (Nuzul *et al*., 2023, Doidge *et al*., 2020, Mollah *et al*., 2021). As a key link to promote healthy development and promote national health, sports and medical integration service is not only the internal requirement to improve the quality of national fitness service, but also the only way to build a healthy life for the whole people. Sports can supplement the drug treatment of chronic diseases such as diabetes or hypertension (Chaulagain *et al*., 2021).

While exercise and pharmacological interventions are individually effective for managing chronic diseases, their combined impact remains underexplored. This study investigates how collaborative governance can align sports participation with drug regimens to enhance adherence, reduce side effects and improve long-term outcomes. This study is based on structural equation modeling and the measurement model uses formative and reflective measures to express the relationship between observations and latent variables. Structural models are used to examine the relationships between latent variables in Sports and Medicine Fusion and can be constructed based on theory and experience. The latent variables are divided into endogenous and endogenous variables, according to which an effective analysis of the joint management path of Sports and Medicine Fusion can be realized and an in-depth study and understanding of this path can be achieved. The synergistic governance of Sports and Medicine Fusion is realized through four major development promotion mechanisms.

Related works

Life is about exercise, the body is the revolution and healthcare is an effective way to keep fit. Literature (McHenry *et al*., 2022) explores the challenges of interprofessional collaboration in providing comprehensive psychological support to athletes, particularly regarding the overlapping roles of mental performance counselors and mental health specialists. The importance of interprofessional collaboration was emphasized by describing the history, theoretical underpinnings and training pathways of each profession in order to avoid neglecting professional differences.

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Meanwhile, the World Health Organization Interprofessional Education and Collaboration Practices Framework was used to optimize the treatment of the collaborative model of sport psychology support teams. The aim is to provide athletes with more comprehensive and professional psychological support by clarifying responsibilities and facilitating communication, so as to enhance their sport performance and overall health. Literature (Zhang, 2023) reveals that athletes' success stems from the close integration of sports medicine, scientific training and physical training. Questionnaire data analyzed using SPSS-AMOS revealed that the synergy of the three had a significant effect on enhancing individual athletic performance within the Chinese sports complex and that athlete performance played a key mediating effect in this process. This finding provides an important basis for policy makers to develop more effective athlete enhancement strategies by optimizing and integrating the relevant elements, thus promoting the overall development of sports. Literature (Pavlikha & Tsymbaliuk, 2021) argues that Ukrainian sport and health services contribute to economic production as intangible assets. Demand for services grows but is affected by economic fluctuations. Positive future trends require strengthening state support, restoring infrastructure and promoting multi-party cooperation and expert participation to achieve development goals.

Literature (Wang & Ran, 2023) entangled relationship between network governance and collaborative governance, pointing out common and different themes and revealing four major points of entanglement. Literature (Kinder *et al*., 2021) explores how self-organizing ecosystems are led, finding that they are guided by a collective consciousness rather than a single subject and proposes a new framework to explain leadership in collaborative governance in ecosystems, which is important for the understanding of collaborative governance leadership in local service delivery. Literature (Henriksen *et al*., 2020) explores the mental health of athletes during the Olympic/Paralympic cycle and provides recommendations for sports organizations. Dividing the Olympic cycle into three phases - pre-competition, competition and post-competition - the conference discussed the key challenges of each phase, the impact of the sporting environment on mental health and collaboration between specialist teams. The need for mental health screening and support throughout the process was emphasized, with particular attention to the vulnerability of athletes in the post-competition phase. Recommendations included improving psychological safety, reducing stress, optimizing recovery, eliminating stigma and increasing access to help. Literature (Jayanthi *et al*., 2022).

Suggests that current sport development training models focus on adult and professional athletes, while youth athletes emphasize diverse participation to reduce injury risk. Despite opposition to specialization, many young athletes choose the professional pathway. Medical and sports experts recommend a gradual increase in training volume to accommodate high-level competition. There is no standardized risk assessment and return-to-play model for professional youth athletes. This study proposes a personalized training model that aims to prioritize athlete health and performance while flexibly responding to periods of growth vulnerability and injuries, providing scientific guidance for young professional athletes. Studies in the literature (Popovych *et al*., 2022) have shown that students in health technology programs such as Permaculture Sports and Exercise show positive changes in mental health, including elevated self-esteem, improved mood and increased life satisfaction, suggesting that these technologies can help improve the mental health of young students.

MATERIALS AND METHODS

All cases were randomly selected from the outpatient service of public hospitals from January to December 2023 from the database. There were 90 patients with chronic diseases (such as diabetes and cardiovascular disease), including 40 males and 50 females, with an average age of (41.25 ± 4.54) years, a course of 4-12 years and an average of 6.5 years. The patients were randomly divided into two groups. There was no significant difference in age, gender and course of disease between the two groups ($p>0.05$), which was comparable. The control group was treated with traditional prescription drugs and the treatment group was treated with exercise prescription adjuvant therapy on the basis of the control group. Both groups were treated for 30 days (Wang *et al*., 2022, Itoh *et al*., 2022).

Quantitative indicators

Drug adherence rates

It is designed on the basis of previous work experience, including 10 questions such as whether the patient knows the therapeutic purpose, usage and dosage, specifications, possible side effects, expiration date, storage conditions of the drugs he uses (Kramer *et al*., 2020, Burnouf *et al*., 2023). For each question, the correct answer is counted as 1 point, the wrong or uncertain answer is counted as 0 point and the total score is 10 points. ≥ 6 points are considered as good and<6 points are considered as poor. Morisky medication compliance scale was used, with a total of 8 items. Items 1-4 and 6-7 answered "yes" and "no" with 0 points and item 5 was scored in reverse. Item 8 was scored by using Likert's 5-level scoring method, with options including never, occasionally, often and all time, with 1, 0.75, 0.5, 0.25 and 0 respectively. The total score of the questionnaire was 8 points, 8 points for complete compliance, 6-7 points for partial compliance and<6 points for non-compliance. Full compliance and partial compliance were considered as good compliance and non-compliance was considered as poor compliance (Mochartini, 2022).

Drug efficacy

Before and after treatment, FPC (fasting blood glucose), HbAlc (glycosylated hemoglobin), BMI (body mass index) levels were detected and compared between the two groups and glucose oxidase method and immunoturbidimetric method were used to measure the levels (Khatami *et al*., 2022). The incidence of hypoglycemia and other adverse reactions in the two groups were observed and compared during the treatment. The criteria for hypoglycemia were that the blood glucose of patients was<3.9mmol/l or hypoglycemia symptoms occurred.

Qualitative indicators

The drug tolerance and general well-being of patients with combined exercise and drug therapy were evaluated by self-report. The contents are the feeling of drug side effects, the overall comfort of treatment and the subjective evaluation of treatment effect. There are 20 items in total in three aspects, with a full score of 80 points. The higher the score, the better the medical coping style.

Subgroup analysis

Stata l5.0 was used for statistical analysis and the standardized mean difference (SMD) and its 95% confidence interval (CI) were used to describe the intervention effect. When smd>0, it indicates that the intervention effect is biased towards the treatment group, when smd<0, it indicates that the intervention effect is biased towards the control group and when SMD=0, it indicates that there is no intervention effect. At the same time, the intervention effect can also be divided into small (SMD=0.2), medium (SMD=0.5) and large (SMD=0.8). At the same time, the meta-analysis results with heterogeneity were analyzed in subgroups, $p<0.05$ was statistically significant.

Governance models

After one month of intervention, a self-designed questionnaire was used to understand the unhealthy lifestyle of patients before and after the intervention, including BMI, living habits, diet, such as whether to eat seafood, viscera, Laohuo soup and hot pot and drink alcohol, sleep and exercise and the blood uric acid of patients before and after the intervention.

RESULTS

Impact on drug compliance

Table 1 shows the comparison of drug compliance between the two groups. There was no significant difference in the scores between the two groups before intervention ($p>0.5$), indicating that the data of the two groups were balanced and comparable. After the intervention, the treatment group was significantly higher than the control group ($p<0.01$). In this study, the score of the treatment group was significantly higher than that of the control group, from 50.81 ± 8.06 points to 85.17 ± 9.28 points, indicating that the combined intervention of exercise and drugs can significantly improve the drug compliance of patients with chronic diseases than drug therapy alone. The combination therapy of medicine and exercise strengthens the self-care measure of exercise and consolidates the effect of drug therapy.

Therapeutic synergy

The health conditions of the two groups before and after treatment are shown in table 2. There was no significant difference in FPC, HbAlc and BMI levels ($p>0.05$). After the intervention, FPG, HbA1c and BMI of the two groups were significantly reduced ($p<0.01$). The incidence of adverse reactions of the two groups was compared. During the treatment, hypoglycemia occurred in 6 cases (6.66%) in the control group and 1 case (1.11%) in the observation group. The incidence of hypoglycemia in the observation group was lower than that in the control group. It shows that exercise can significantly improve the curative effect of drugs, so that the health status of patients can be better controlled on the basis of drug treatment.

Comparison of patient reports

Table 3 shows the comparison of treatment experience between the two groups. Before intervention, there was no significant difference in the scores of drug side effects, overall comfort and treatment effect between the two groups ($p>0.05$). After the intervention, the scores of medical coping styles in the two groups were significantly different from those before the intervention in the same group ($p<0.05$). After the intervention, the coping score of the treatment group was significantly higher than that of the control group and the drug side effects, overall comfort and treatment effect of the treatment group were significantly higher than those of the control group ($p<0.05$). In a word, exercise intervention combined with traditional drug therapy has been affirmed by patients, reduced the side effects of drugs and improved the treatment effect of patients, which is worthy of clinical promotion and application.

Subgroup analysis results

In this paper, 7 patients in the treatment group were randomly selected and their therapeutic effects were analyzed. Fig. 1 shows the treatment effect of the treatment group. The results show that compared with the control group, the SMD scores of the treatment group are greater than 0 and the effect is better than that of the control group. In conclusion, exercise intervention combined with drug therapy can effectively improve the therapeutic effect.

Comparison of health management

The unhealthy lifestyle of the patients before and after the intervention is shown in table 4. It can be seen that the unhealthy lifestyle of the treatment group has been significantly improved and the difference is statistically significant ($p<0.01$).

Table 1: Comparison of drug compliance between the two groups

Groups	n	Before intervention	After intervention
Control group	45	33.15±7.25	80.22±9.14
Treatment group	45	50.81±8.06	85.17±9.28
t	-	0.625	0.003
P	-	0.586	0.003

Table 2: Health status of the two groups before and after treatment (n=45)

Groups	FPG(mmol/L)		HbAlc		BMI(kg/m^2)	
	Before	After	Before	After	Before	After
Control group	9.02±1.14	7.13±1.12*	8.15±0.47	6.92±0.14*	24.89±1.13	24.67±1.34
Treatment group	9.00±1.26	6.45±1.16*	8.66±0.54	6.17±0.09*	24.91±1.16	22.88±1.07*
t	0.445	1.501	1.008	6.587	0.132	2.885
P	0.686	0.045	0.287	0.000	0.787	0.000

Table 3: Comparison of treatment experience between the two groups of patients (n=45)

Groups		Side effects of medication	Overall comfort of treatment	Treatment effects
Before intervention	Control group	14.79±2.14	15.46±2.15	13.12±1.56
	Treatment group	16.54±2.98	16.89±2.32	13.44±1.61
	t	0.415	0.128	0.406
	P	>0.05	>0.05	>0.05
After intervention	Control group	17.79±3.24*	16.81±2.63*	19.73±2.08*
	Treatment group	19.64±2.14*	20.91±2.56*	19.85±2.04*
	t	3.442	5.163	6.814
	P	<0.05	<0.05	<0.05

Table 4: Unhealthy lifestyle of patients before and after intervention (n=40)

Items	Control group	Treatment group	P
BMI>24	50	11	<0.01
Seafood addiction	44	12	<0.01
Alcohol addiction	36	10	<0.01
Offal addiction	61	11	<0.01
Hot pot and traditional soup addiction	67	12	<0.01
Lack of exercise	81	2	<0.01

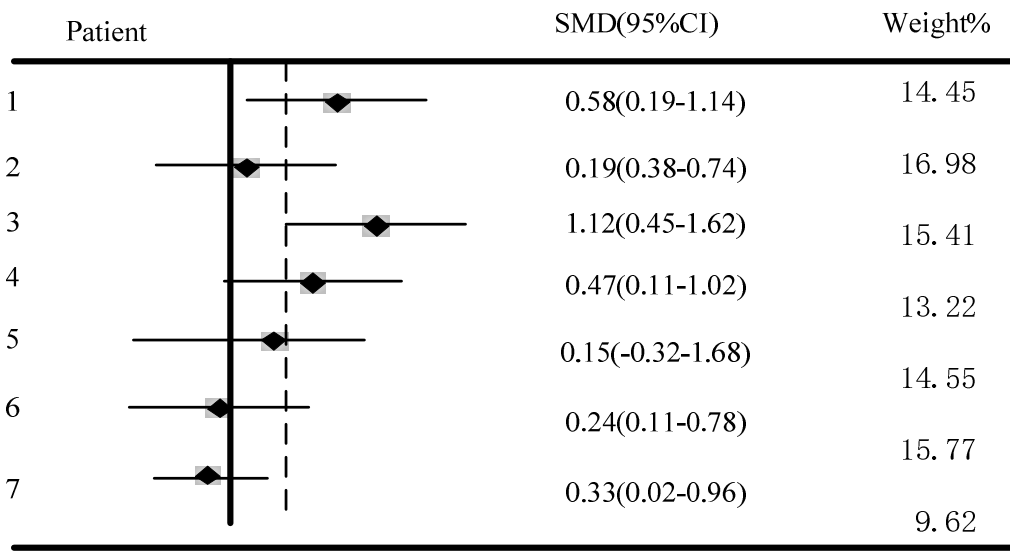

Fig. 1: Treatment effect of the treatment group

The results showed that after the intervention, the unhealthy living habits and eating habits of patients were significantly improved and the number of patients without exercise was reduced from 81 to 2. The results show that targeted exercise intervention can effectively improve the unhealthy habits and living habits of patients and promote the rehabilitation of the disease.

DISCUSSION

Pharmacological mechanisms

If the patients eat too much carbohydrate and fatty food in their daily diet, it will lead to an increase in blood glucose level, which will affect the efficacy of drugs (Lasa *et al*., 2022). Scientific and reasonable diet control will ensure that patients eat strictly according to the principle of low sugar, low fat and low salt, so as to prevent unhealthy diet from increasing blood glucose, regulate the body's glucose and lipid metabolism level and play a significant role in sugar control in combination with drugs. Exercise therapy is also one of the common treatment options for patients. Regular and reasonable exercise can improve the metabolism level of the body, effectively reduce the utilization rate of glucose, accelerate fat consumption, control weight, improve body quality and effectively improve the blood glucose level. The implementation of drug combined with diet control and exercise therapy will achieve a synergistic mechanism, comprehensively reduce the blood glucose level of patients, significantly improve the condition and optimize the prognosis. After the implementation of drug combined with diet control and exercise therapy, patients can obtain good clinical curative effect, effectively reduce the blood lipid and blood glucose levels of patients, which is very conducive to the control of the disease and has high clinical application value (Belluomini *et al*., 2024).

Policy implications

Practitioners generally follow the principles of experience or experts, but how to distinguish these experiences or experts' opinions is an issue to be paid attention to. For example, some experts suggest that training under the lactate threshold can best improve endurance, or the group with the maximum number of repetitions of 8-12 is the best scheme for developing muscle hypertrophy (Queiros *et al*., 2024). What cannot be ignored is that these training programs lack research or experimental data to support these theories. When judging practice, we usually pay attention to the average effect of the intervention. There may be four cases of the intervention, namely, adverse reaction, non-reaction, average reaction and extreme reaction. At present, medicine has recognized this problem and is now in the research stage. This type of medicine is called personalized or precision medicine. However, the highly variable response to treatment is not limited to drugs. Similarly, the changes of VO2max, risk factors and strength and muscle mass after resistance training vary from person to person. Some people will have a negative impact on their VO2max and strength after exercise training. A key to the formulation of training plans and exercise prescriptions is to avoid lengthy and expensive training or intervention for individuals. After long-term exercise training and intervention, it is found that the intervention is ineffective or causes harm, which will greatly affect the physical and mental health of practitioners and the practice process. Therefore, personalized medical treatment or policy-making should monitor the biomarkers of practitioners in real time, such as DNA sequence variants or circulating molecules, in order to tell whether individuals respond to treatment.

Future directions

Sports can effectively improve human health index and physiological function, but for people who need long-term medication, the impact of sports on their health is complex. Exercise may increase the absorption of drugs, improve the efficacy and may also bring serious adverse reactions. Therefore, further deepening the basic research on the relationship between exercise and pharmacokinetics can not only provide patients with medication strategies and exercise programs that are more suitable for their own conditions, but also provide important theoretical basis for building a more comprehensive, systematic, healthy and scientific precision medical system (Yang *et al*., 2020, Lundgren *et al*., 2021).

CONCLUSION

This study highlights the synergistic potential of combining exercise planning with medication to improve compliance, reduce side effects and optimize health outcomes. By combining exercise plans with drug programs, collaborative governance can achieve treatment and public health goals. These findings provide the basis for innovative policies that promote the overall health strategy through interdisciplinary collaboration. The conclusions are as follows:

(1) The score of the treatment group was significantly higher than that of the control group, from 50.81 ± 8.06 to 85.17 ± 9.28, indicating that the combined intervention of exercise and drugs can significantly improve the drug compliance of patients with chronic diseases than drug therapy alone.

(2) In the comparison of adverse reactions, hypoglycemia occurred in 6 cases (6.66%) in the control group and 1 case (1.11%) in the observation group. Exercise intervention made the health of the change better controlled.

(3) The variance decomposition results showed that the SMD scores of the treatment group were greater than 0 and the effect was better than that of the control group. In conclusion, exercise intervention combined with drug therapy can effectively improve the therapeutic effect.

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Author's contributions
This research was independently completed by me. I was responsible for all aspects of the research, including: research conception and design, literature review, experimental implementation, data collection and analysis, and the writing and revision of the paper. I have read and finally approved this manuscript.

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Data availability
Data is provided within the manuscript or supplementary information files.

Ethical approval
This study has been reviewed and approved by the Ethics Review Committee of the Affiliated Hospital of China Pharmaceutical University. All the participants in the study signed a written informed consent form voluntarily before the study began. Ethical approval No. RT2025(0083).

Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this document. The authors confirm that neither I nor any of my collaborators have any financial or personal relationships that could inappropriately influence or bias the content of this work.

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