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Tele-Physical Therapy: A Comprehensive Review in Analyzing Opportunities and Challenges in the Management of Type 2 Diabetes

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Abstract

Background: Type 2 diabetes is a global health crisis with an increasing prevalence, affecting approximately 537 million individuals worldwide. Effective management strategies, including exercise interventions, are crucial to mitigate the risk of complications such as cardiovascular disease and neuropathy. However, traditional supervised exercise programs often face barriers like transportation and time constraints, particularly for those with physical limitations.

Methods: This review systematically analyzes the existing literature on tele-exercise therapies as a viable solution for promoting physical activity among individuals with type 2 diabetes. Four electronic databases—MEDLINE, PubMed, Web of Science, and the Physiotherapy Evidence Database (PEDro)—were searched for relevant studies published up to 2023, focusing on the implementation and efficacy of tele-exercise programs.

Results: The findings indicate that tele-exercise interventions significantly improve various health outcomes, including glycemic control, functional ability, and quality of life, comparable to traditional supervised exercise programs. The review highlights the effectiveness of both synchronous and asynchronous modalities in delivering exercise regimens, with evidence supporting improvements in muscle strength and cardiovascular health.

Conclusion: Tele-exercise therapies represent a promising approach to enhancing physical activity among individuals with type 2 diabetes, addressing barriers to participation in traditional programs. While results are encouraging, further research with larger sample sizes and diverse populations is necessary to validate these findings and explore participant preferences regarding tele-exercise modalities.

Keywords: tele-physical therapy, type 2 diabetes, exercise intervention, tele-rehabilitation, health outcomes.

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1. Introduction

Type 2 diabetes is a prevalent chronic metabolic disorder impacting individuals of all ethnicities [1]. The International Diabetes Federation estimates that almost 537 million people globally have diabetes. The figure is projected to rise to 783 million by 2045 [2]. Type 2 diabetes occurs when the body's insulin-sensitive tissues inadequately react to insulin, coupled with insufficient insulin synthesis to counteract this resistance. Insulin is a hormone that lowers blood sugar levels by facilitating the absorption, use, and storage of glucose. These complications with insulin function and synthesis lead to increased blood glucose levels, referred to as hyperglycemia [2].

Improperly controlled Type 2 diabetes may lead to several consequences, such as cardiovascular disease, neuropathy, nephropathy, and retinopathy [1,3]. Moreover, sarcobesity, defined as the simultaneous presence of diminished muscle mass and augmented fat mass, is prevalent among individuals with type 2 diabetes [4-6]. These problems elevate the chance of impairment and diminish the quality of life in individuals with this disorder [7,8]. Prior research indicated that individuals with type 2 diabetes had worse performance on functional assessments compared to those without the illness [6,9-12].

Exercise therapies are a crucial element in the management of type 2 diabetes. Aerobic and resistance activities have cardiovascular and metabolic advantages in individuals with type 2 diabetes [13-17]. Aerobic activities, like walking and cycling, enhance insulin sensitivity and glycemic regulation while mitigating other cardiovascular risk factors, such as cholesterol levels, blood pressure, and body composition [18-23]. Resistance activities, including the use of free weights or elastic bands, have substantial benefits for glycemic regulation and also enhance muscular strength and functional ability [13-17,21]. Research indicates that combined aerobic and resistance workouts have more benefits than either aerobic or resistance exercises performed in isolation [14,19,24,25].

The existing type 2 diabetes recommendations advise that persons with type 2 diabetes participate in at least 150 minutes of moderate aerobic activity weekly, in addition to two or three sessions of resistance training. Balance exercises are particularly advised for those with physical disabilities [18,26,27]. Moreover, diabetes guidelines advocate for the implementation of supervised exercise programs [18,27]. Research indicates that supervised exercise programs are more effective than unsupervised exercise or mere physical activity recommendations [25,28,29]. Nonetheless, some individuals have challenges in engaging in supervised exercise because of factors such as physical restrictions, time limitations, and transportation difficulties. Consequently, effective measures to promote the participation of individuals with type 2 diabetes in supervised exercise programs are essential.

Recently, tele-exercise therapies, a kind of telerehabilitation, have surfaced as a potential method for addressing obstacles to exercise and enhancing health-related results [30,31]. These treatments include the provision of exercise programs remotely via the Internet and telecommunication technologies, allowing participants to engage in supervised exercise from their residences [30,31]. Tele-exercise therapies have shown promising results in improving health-related outcomes across several chronic diseases [30-34]. Tella et al. [34] discovered that tele-exercise sessions improved motor symptoms in individuals with multiple sclerosis [34]. A recent systematic review examined the efficacy of tele-exercise therapies across diverse chronic illnesses, concluding that these interventions were both practicable and beneficial in enhancing physical capability and quality of life [31]. Of the 32-research included in this analysis, only one study examined individuals with diabetes [31]. This scoping review aims to examine the available evidence

on the effects of tele-exercise programs in persons with type 2 diabetes. The outcomes of this research are expected to assist healthcare professionals, including physical therapists, exercise physiologists, and primary care doctors, in modifying their clinical practices to include tele-exercise for patients with type 2 diabetes.

2. Methods

Four electronic databases were systematically examined from their origin until 2023, in collaboration with a librarian, to locate pertinent research. The databases used were MEDLINE, PubMed, Web of Science, and the Physiotherapy Evidence Database (PEDro). The objective of the integrated search of these specialized and interdisciplinary databases was to reduce the risk of overlooking relevant research [36].

3. Attributes of Tele-Exercise Programs

In one research, breathing exercises were suggested for individuals with type 2 diabetes and dyspnea after COVID-19 infection [38-40]. Balance exercise was used as an extra element in three studies examining older persons with type 2 diabetes [41,42] or assessing physical ability as an outcome [43-45].

All studies suggested workouts of moderate intensity. To assess intensity, a subjective effort scale and/or heart rate reserve using heart rate monitors were used in six trials [43-47]. One study included both one repetition maximum for weight training and a perceived effort measure for aerobic exercise [41]. The exercise treatments were generally given at a frequency of three times per week, with one research recommending two sessions per week [41] and another study four times per week [43]. Most studies suggested exercise sessions lasting between 30 and 60 minutes.

4. Approaches to Implementing Exercise Interventions

The workout regimens were administered using both synchronous and asynchronous modalities. A synchronous mode, whereby exercise sessions were conducted instantly in real-time, was used in four experiments [43-46]. The therapists conducted virtual meetings with participants using videoconferencing technologies that included audio and visual assistance (e.g., Zoom or Skype) [43-46]. This facilitated direct oversight and direction from the attending therapist.

Conversely, three research used an asynchronous format, providing participants with pre-recorded workout videos and/or textual materials that detailed the activities [41,42,47]. The technological platforms used for delivering these treatments included electronic mail [41], websites [42], and mobile apps [47]. In this method, participants accessed the intervention remotely at their leisure. Various elements were included to provide help and direction to the participants. The components were SMS reminder messages, online contact with treating physiotherapists as necessary, self-tracking, heart rate monitoring for intensity adjustment, voice instructions, and written materials detailing the exercises [41,42,47]. Moreover, wearable gadgets were used to assess physical activity levels and provide feedback to individuals [47].

5. Effects of Tele-Exercise Interventions

The seven studies assessed the effects of tele-exercise treatments in comparison to standard care, active exercise interventions, or a combination of both, and documented various diabetes-related outcomes. Four randomized controlled trials with a two-arm design evaluated the efficacy of tele-exercise in comparison to either standard treatment [39,41,42] or an unsupervised exercise regimen [40]. Blioumpa et al. [42] investigated the impact of a six-week tele-exercise program, including aerobic and resistance training, on glycemic management, functional ability, muscular strength, quality of life, and body composition in individuals with type 2 diabetes. The findings indicated that all outcomes considerably improved after the intervention in comparison to the usual care group.

Duruturk and Özköslü [41] investigated the impact of a six-week tele-exercise regimen. In this trial, individuals were randomly allocated to receive standard care or a tele-exercise intervention including strength exercises using calisthenics. After six weeks, the findings indicated that, relative to the baseline, only individuals in the intervention group exhibited substantial improvements in glycemic control,

functional ability, muscular strength, and psychological state. The improvements were notable in comparison to standard treatment, excluding glycemic control. Nambi et al. [39] evaluated the effects of an eight-week tele-exercise program with standard therapy in individuals with type 2 diabetes post-COVID-19 infection. Multiple outcomes were evaluated before and during the therapies, including glycemic control, pulmonary function, functional ability, and quality of life. Upon conclusion of the programs, the findings indicated that tele-exercise was much more successful than standard care in enhancing all outcomes.

Additionally, Terkes et al. [40] evaluated the outcomes of a six-week tele-exercise intervention vs an unsupervised exercise regimen. This research required both groups to engage in a mixed aerobic and resistance training regimen. The researchers then evaluated the following outcomes: body composition, stress recovery as measured by the Brief Resilience Scale, and quality of life. The findings of this research indicated that all previously stated outcomes greatly improved in the tele-exercise group, with these enhancements being statistically significant in comparison to the unsupervised exercise group.

Two randomized controlled trials with three groups examined the impact of tele-exercise relative to a control condition and another supervised active intervention [38,43]. Akinci et al. [38] evaluated the impact of an eight-week tele-exercise intervention against standard care and a supervised exercise regimen. The researchers discovered that, relative to standard care, both tele-exercise and supervised exercise programs resulted in comparable statistically significant improvements in glycemic control (HbA1c levels), functional ability, blood lipid profiles, body composition, and quality of life. Timurtas et al. [43] investigated the impacts of two tele-exercise treatments (namely, a mobile app group and a mobile app + wearable wristwatch group) in comparison to a supervised exercise program. The findings demonstrated that, relative to the baseline, all therapies resulted in substantial improvements in glycemic regulation, functional ability, muscular strength, and pulmonary function. Nevertheless, the disparity between groups was not statistically significant regarding the influence on these outcomes.

The subsequent trial was a CCT that compared the effects of a tele-exercise intervention administered by electronic mail with those of an exercise program disseminated using printed materials [41]. In this research, both groups were given access to local fitness facilities to execute their specified workouts. After six weeks, the researchers observed that both therapies resulted in comparable enhancements in muscular strength and functional ability in patients with type 2 diabetes relative to the baseline.

6. Discussion

This research sought to examine current tele-exercise programs for individuals with type 2 diabetes. The data given in this evaluation was favorable for the effectiveness of tele-exercise in managing individuals with type 2 diabetes. In comparison to standard care, tele-exercise interventions significantly enhanced various diabetes-related outcomes across multiple domains, including glycemic control (i.e., HbA1c), blood lipid profiles, functional capacity, muscle strength, body composition, pulmonary function, and psychological well-being and quality of life. These results are significantly linked to various issues related to diabetes [48-50]. Individuals exhibiting inadequate glycemic control, as indicated by HbA1c levels, were identified as having an elevated risk of developing cardiovascular disease [48,49].

Moreover, the results indicate that tele-exercise treatments provide benefits comparable to those of conventional supervised exercise programs. The present research indicates that tele-exercise therapies are as beneficial as conventional exercise programs in enhancing health outcomes for persons with type 2 diabetes [41,42,47]. This aligned with other research investigating the effectiveness of tele-exercise in individuals with various chronic illnesses [50,51]. A recent analysis assessed the efficacy of tele-medically administered therapeutic exercise and determined that tele-exercise therapies were comparable to in-person exercise programs for satisfaction, functional capacity, and quality of life [51].

Nonetheless, it is important to recognize that the elements of exercise treatments are essential for attaining health benefits. The present analysis indicates that most trials included moderate mixed aerobic and resistance exercise regimens conducted at least three times weekly, aligning with the recommended

physical activity levels for individuals with type 2 diabetes [18,27]. Only one investigation used resistance activities via calisthenics and did not demonstrate any enhancements in glycemic control [45]. Prior research examining the impacts of various exercise regimens indicated that combined exercise treatments were more effective than either aerobic or resistance exercises conducted in isolation [24,49]. Schwingshackl et al. indicated that combined exercise training resulted in a more significant decrease in HbA1c levels than either aerobic or resistance training alone in individuals with type 2 diabetes [49]. Moreover, prior research has shown that an increased volume of exercise correlates with enhanced benefits from tele-exercise programs.

The results in the present review also endorse the use of both synchronous and asynchronous forms of distribution. Research using any of these delivery methods had favorable outcomes [41-47]. Nonetheless, although both modalities aim to provide remote exercise treatments, they markedly vary in their delivery and implementation methods. Synchronous modes, executed in real time, provide fast feedback and assistance, particularly for those necessitating tighter supervision or encouragement [52,53]. However, this style may be unhelpful for those with schedule problems or other limitations [52-54].

Conversely, asynchronous modes provide freedom about the timing and location of the exercise, enabling people to integrate it into their schedules [52-54]. Nevertheless, there may be limited possibilities for immediate inspiration and direction from the therapist [54,55,56]. This review's studies implemented various strategies to address these issues, such as text reminders, online communication with physiotherapists, self-tracking, heart rate monitoring for intensity adjustment, verbal instructions, and written materials detailing the exercises [42,45,47]. These attributes were suggested in prior studies. A recent evaluation indicated that text message reminders may promote adherence to fitness regimens, while online contact with healthcare practitioners can improve support and advice [55]. Moreover, the use of self-monitoring devices such heart rate monitors enables persons with type 2 diabetes to modulate exercise intensity and maintain safety from a distance [56].

Given that both synchronous and asynchronous delivery modalities include distinct benefits and drawbacks, the selection of a delivery method in tele-exercise treatments must reflect individual preferences, requirements, and available resources [52,54,57]. The technology acceptance model posits that individuals adopt and use technology when they see it as user-friendly and beneficial. Prior studies have identified many aspects that may affect the acceptability and effective implementation of tele-exercise, such as technical competence, availability of a stable internet connection, and individual preferences [47,58,59]. Nonetheless, none of the research elucidated the extent of end-user involvement in the intervention design, nor did they assess the intervention's acceptance among participants post-implementation. Consequently, future research must investigate end-users' preferences to guarantee that the selected method of distribution corresponds with their requirements and inclinations.

7. Clinical Implications, Constraints, and Prospective Research

This is, to the author's knowledge, the first scoping review concentrating on tele-exercise for individuals with type 2 diabetes. The bulk of the trials were published from 2018 to 2023, suggesting a recent interest in this area of research. Consequently, the results may assist healthcare practitioners in making educated choices about the provision of services to persons with type 2 diabetes. The research indicates that tele-exercise programs may be equivalent to typical supervised exercise programs for enhancements in glycemic management and other health outcomes, including functional capacity and quality of life. Nonetheless, it is crucial to recognize several limits of this study. There exists a paucity of research examining the use of tele-exercise for individuals with type 2 diabetes. This hindered the comparison of the efficacy of various tele-exercise regimens. Moreover, most of the research examined were carried out in Turkey, complicating the ability to reach conclusive determinations on the effectiveness of tele-exercise in other nations. Moreover, the limited sample sizes in the studies may have influenced the outcomes of this study.

Furthermore, the studies evaluated did not examine the participants' acceptability of tele-exercise. Consequently, it was infeasible to get a definitive conclusion on the participants' acceptance and pleasure.

A further disadvantage is that the search filtering and data extraction were performed by a single researcher, potentially introducing bias. Subsequent investigations in this domain should prioritize bigger sample sizes, including individuals from diverse ethnic origins, to enhance the evidentiary foundation for tele-exercise in the treatment of type 2 diabetes. Moreover, further investigation is required to assess the acceptability of tele-exercise in relation to conventional supervised programs.

8. Conclusions

Tele-exercise therapies seem to be viable and as beneficial as supervised exercise programs in improving glycemic control, blood lipid levels, functional ability, muscular strength, body composition, and quality of life for individuals with type 2 diabetes. Nonetheless, there is a need for more extensive and rigorous research to validate these results, investigate the preferences and requirements of participants, and formulate recommendations for the integration of tele-exercise in the treatment of type 2 diabetes.

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العلاج الطبيعي عن بُعد: مراجعة شاملة لتحليل الفرص والتحديات في إدارة مرض السكري من النوع 2

الملخص

الخلفية :يُعتبر مرض السكري من النوع 2 أزمة صحية عالمية تتزايد انتشارها، حيث يؤثر على حوالي 537 مليون فرد حول العالم. إن استراتيجيات الإدارة الفعالة، بما في ذلك التدخلات الرياضية، ضرورية لتقليل مخاطر المضاعفات مثل أمراض القلب والأوعية الدموية والاعتلال العصبي. ومع ذلك، غالبًا ما تواجه برامج التمارين التقليدية المراقبة عوائق مثل النقل وقيود الوقت، خاصةً بالنسبة لأولئك الذين يعانون من قيود جسدية.

الطرق :تقوم هذه المراجعة بتحليل منهجي للأدبيات الموجودة حول العلاجات الرياضية عن بُعد كحل قابل للتطبيق لتعزيز النشاط البدني بين الأفراد المصابين بمرض السكري من النوع 2. تم البحث في أربع قواعد بيانات إلكترونية MEDLINE—وPubMed وWeb of Science و—Physiotherapy Evidence Database (PEDro)للعثور على الدراسات ذات الصلة المنشورة حتى عام 2023، مع التركيز على تنفيذ وفعالية برامج التمارين الرياضية عن بُعد.

النتائج :تشير النتائج إلى أن التدخلات الرياضية عن بُعد تحسن بشكل كبير من مجموعة متنوعة من النتائج الصحية، بما في ذلك التحكم في نسبة السكر في الدم، والقدرة الوظيفية، وجودة الحياة، مقارنةً ببرامج التمارين التقليدية المراقبة. تسلط المراجعة الضوء على فعالية كل من الأساليب المتزامنة وغير المتزامنة في تقديم نظم التمارين، مع وجود أدلة تدعم تحسينات في قوة العضلات وصحة القلب والأوعية الدموية.

الخاتمة :تمثل العلاجات الرياضية عن بُعد نهجًا واعدًا لتعزيز النشاط البدني بين الأفراد المصابين بمرض السكري من النوع 2، مما يعالج العوائق أمام المشاركة في البرامج التقليدية. في حين أن النتائج مشجعة، فإن المزيد من الأبحاث مع أحجام عينات أكبر وسكان متنوعين ضرورية للتحقق من هذه النتائج واستكشاف تفضيلات المشاركين بشأن أساليب التمارين الرياضية عن بُعد.

الكلمات المفتاحية :العلاج الطبيعي عن بُعد، مرض السكري من النوع 2، تدخلات التمارين، إعادة التأهيل عن بُعد، النتائج الصحية.