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## *Health-oriented fitness of type 2 diabetic patients with distal peripheral diabetic neuropathy*

*La condición física orientada a la salud de pacientes diabéticos tipo 2, con neuropatía diabética periférica distal*

*Aptidão física voltada para a saúde de pacientes diabéticos tipo 2 com neuropatia diabética periférica distal*

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## ABSTRACT

The physical culture professional makes important contributions, such as the implementation of physical exercise, to the programs applied in rehabilitation. The objective of this work was to develop a methodology to improve the health-oriented physical condition in type 2 diabetic patients, complicated by distal peripheral diabetic neuropathy. A quasi-experimental design study was carried out with pretest and posttest in two groups, lasting two years (2022-2023), and the sample was randomly selected using the raffle procedure. Theoretical and empirical methods such as analysis-synthesis, inductive-deductive, systemic-structural-functional, measurement, experiment and descriptive statistics were used, as well as research techniques such as documentary analysis, observation, interview and survey. The diagnosis made showed difficulties with the alteration of the somatosensory system and gait, high risk of falls, and problems in mobility, swing and equilibrium; therefore, a methodology aimed at the health of these patients was proposed in Granma; the study showed improvements in physical condition through the implementation of specific therapeutic physical exercises.

**Keywords:** therapeutic physical culture, physical exercises, type 2 diabetes, methodology

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## RESUMEN

El profesional de cultura física contribuye con aportes importantes, como la implementación del ejercicio físico, a los programas aplicados en la rehabilitación. El objetivo de este trabajo consistió en elaborar una metodología para mejorar la condición física orientada a la salud en pacientes diabéticos tipo 2, complicados con neuropatía diabética periférica distal. Se realizó un estudio de diseño cuasiexperimental con pretest y posttest en dos grupos, con dos años de duración (2022-2023), y se seleccionó de forma aleatoria la muestra, mediante el procedimiento de tómbola. Se emplearon métodos teóricos y empíricos como el análisis-síntesis, el inductivo-deductivo, el sistémico-estructural-funcional, la medición, el experimento y la estadística descriptiva, así como técnicas de investigación como el análisis documental, la observación, la entrevista y la encuesta. El diagnóstico realizado mostró dificultades con la alteración del sistema somatosensorial y la marcha, alto riesgo de caídas,



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y problemas en la movilidad, balanceo y equilibrio; por lo que se propuso una metodología, orientada a la salud de estos pacientes, en Granma; el estudio mostró mejorías en la condición física, mediante la implementación de ejercicios físicos terapéuticos específicos.

**Palabras clave:** cultura física terapéutica, ejercicios físicos, diabetes tipo 2, metodología

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### **RESUMO**

O profissional de cultura física contribui com importantes contribuições aos programas, aplica a reabilitação por meio de exercícios físicos em diversas doenças e contribui para sua qualidade de vida. O objetivo deste trabalho foi desenvolver uma metodologia para melhorar a condição física orientada para a saúde em pacientes diabéticos tipo 2 complicados com Neuropatia Diabética Periférica Distal (DPND). Para tanto, foi realizado um estudo de delineamento quase experimental com pré-teste e pós-teste para dois grupos, com duração de dois anos (2022-2023). A amostra selecionada foi realizada de forma aleatória, com procedimento de tombola. Foram utilizados métodos dos níveis teórico e empírico, tais como: análise e síntese, indutivo-dedutivo, sistêmico-estrutural-funcional, medição, experimento e estatística descritiva, além de técnicas de pesquisa, dentre as quais análise documental, observação, entrevista stand fora e pesquisa respectivamente. A metodologia foi realizada por meio da execução de exercícios físicos terapêuticos. Participaram 20 pacientes com diabetes tipo 2 complicado por Neuropatia Diabética Periférica Distal (NDPD) do município de Manzanillo, Granma. Com base no diagnóstico realizado, determinou-se que o equilíbrio (85%) apresentava problemas devido à alteração do sistema somatossensorial e a marcha (55%) apresentava alto risco de queda devido a problemas de mobilidade, oscilação e equilíbrio. O estudo mostrou que a aptidão física orientada para a saúde pode ser melhorada em pacientes diabéticos tipo 2 complicados com Neuropatia Diabética Periférica Distal.

**Palavras-chave:** Cultura Física Terapêutica; aptidão física orientada para a saúde; pacientes, diabetes tipo 2 complicado.

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## INTRODUCTION

Lower extremity neuropathy is one of the most important chronic complications of type 2 diabetes (T2D) that can manifest as the disease progresses, in up to 50% of diabetic patients (Sánchez, 2020); it manifests itself with motor deficit and pain, negatively impacts daily life and harms the physical, emotional and social well-being of those who suffer from it, and their families. In addition, it increases morbidity and mortality, causes direct economic damage to patients, their family environment and national health systems.

There is a high prevalence of people with T2D, complicated by distal diabetic peripheral neuropathy (DPDN), a disease that causes damage to the nerves in the arms and legs, numbness due to pain and temperature, tingling sensation, loss of balance and coordination, and limited knowledge about rehabilitative treatment from therapeutic physical culture (CFT in Spanish), and generates the need to create a therapeutic alternative from physical exercise, to complement the patient's treatment.

To date, there are limited pharmacological therapeutic alternatives capable of curing or preventing the disease, which is why several organizations such as ADA (2020); ALAD (2020); FID (222); IDF (2022); MINSAP (2019); WHO (2020), and researchers such as Anichini et al. (2020); Sánchez (2020), who are related to the search for a drug treatment to combat NDPD, are concerned both nationally and internationally.

However, therapeutic physical exercise has been shown to be one of the fundamental pillars in the treatment of these patients, a topic addressed in the studies by Cox et al. (2020); Díaz and Herrera (2020); Ferreira et al. (2019); Melese et al. (2020); Monteiro et al. (2018), (2020); Pérez and Carreras (2020); Shi et al. (2022); Vrátná et al. (2022), with results focused on preliminary studies to evaluate the possible application of strength physical exercises, but in type 1 diabetics, and in patients with diabetic foot, to improve the motor skills of the lower limbs.

In the studies carried out on the physical rehabilitation of patients with T2D with NDPD, the novelty and relevance of such contributions is recognized; however, it is valid to



highlight that they focus on the influence of physical exercise on some complications of diabetes, but not on NDPD; this corroborates the insufficient approach to the functional state of the neurological system of these patients and the influence that physical exercise exerts on several of the complications that may arise.

For his part, Fernández (2022) states that little has been addressed regarding the treatment from CFT applied to these patients, and the effect that it has on the nervous, endocrine and vascular systems; in this sense, the study of the application of rehabilitative therapies, from physical exercise, is considered to be of additional importance.

Previous studies carried out on patients and specialists working with DT2 with NDPD, at the Celia Sánchez Manduley clinical surgical university hospital, in the municipality of Manzanillo, in the province of Granma, showed that the procedures, methodological guidelines and treatments are in place, but they are of a pharmacological nature, insufficient to improve the physical condition of these patients.

The above causes that Physical Culture teachers working in health areas, during the development of rehabilitation sessions, do not pay the required attention, as they lack methodological tools to be able to face the treatment with quality and results, from the physical point of view of these patients; therefore, the objective of this work was proposed to develop a methodology to improve the physical condition oriented to the health of patients with DT2, complicated with NDPD.

## ***MATERIALS AND METHODS***

To confirm the mobility difficulties in terms of balance and gait, a sample of 20 patients with T2D pathology, complicated by NDPD and an average age of 57.35 years, was selected from a population of 35 patients; the selection technique was random, using the raffle procedure. All those selected participated in the rehabilitation sessions in the therapeutic area of the Celia Sánchez Manduley Hospital.

The sample also included 30 physical education teachers who worked in the municipality's public health areas, with an average age of 10.8 years since graduation and more than five



years of work in the health areas of the Cuban Ministry of Public Health (MINSAP in Spanish). All of them signed the informed consent and agreed to participate in the research.

Various scientific methods were applied at the theoretical and empirical level, as well as research techniques that provided the collection of information on the current state of the health-oriented physical condition of patients with T2D, with NDPD such as analysis and synthesis, inductive-deductive, systemic-structural-functional, documentary analysis, observation, survey and methodological triangulation, which allowed the development of the methodology, obtaining and processing the results of the quasi-experiment.

The survey was applied to the 30 Physical Education teachers who worked in the health areas of the municipalities of Manzanillo. Using this instrument, the cognitive dimension was diagnosed through the following indicators:

- Theoretical knowledge of Physical Education teachers who worked in health areas, on the main alterations of T2D patients, with NPDP.
- Preparation of Physical Education teachers who worked in health areas, to improve health-oriented physical fitness in T2D patients with DPDP.

Scientific observation was used to obtain information on the methodological preparation, before the projection and implementation of solutions to the existing problem, five CFT sessions were observed, in the rehabilitation room of the Celia Sánchez Manduley Hospital, in the municipality of Manzanillo, in the province of Granma, and the clinical histories of the participants were reviewed; with the use of this instrument, the methodological dimension was diagnosed through the indicators:

- Methodological action of Physical Culture teachers who worked in health areas, in care to improve health-oriented physical condition in patients with T2D, with DPDP.
- Use of therapeutic physical exercises in the three parts of the Physical Culture session.

In the document review, the CFT Program for diabetic patients was analyzed; using this instrument, the application dimension was diagnosed through the following indicators:



- Rehabilitative actions of the CFT program, for the T2D patient, with DPDP, from attention to physical condition oriented towards health, specifically regarding balance and gait.
- Assessment of balance and gait disorders in patients with T2D, with DPDP.

Balance and gait tests were performed to demonstrate the existence of mobility alterations in these patients. The Berg balance test or scale was applied, considered an evaluation tool to identify the deterioration of balance during functional activities. The results were also applied in the development of treatments, to restore the patient's balance; mobility or the identification of interventions, to help prevent falls; and to evaluate and document progress over time.

Through this, various aspects were assessed, such as transfers from sitting to standing, standing with eyes closed or feet together, single-leg standing, tandem standing, functional reach, picking up an object from the ground, among others. Its maximum score is 56 points and when it is less than 46 it predicts the appearance of falls.

In most items, the patient was asked to maintain a given position for a given time. Points were progressively reduced if the set time or distance was not achieved, if the patient's performance required supervision, if the patient touched an external support or received help from the examiner.

The equipment required for the test consisted of a stopwatch or clock with a second hand, a ruler or other indicator measuring 5, 12 and 25 cm. The chairs used had to be of a reasonable height.

**0-20:** High risk of falling.

**21-40:** Moderate risk of falling.

**41-56:** Slight risk of falling.





Time Up and Go test was applied, as an auxiliary test in the diagnosis of gait and balance disorders, and their association with a certain risk of falls. Its advantages were the speed and ease of its performance and the low requirement of material and physical space, in which the patient can have their usual shoes and any assistance device that they normally use. Its objective was to evaluate basic mobility in patients with T2D, with DPDP and their probable gait and balance disorders.

**Application time:** 10 minutes.

**According to the results, the following categories were considered:**

- Normal: <10 seconds.
- Mild mobility impairment: 11-13 seconds.
- High risk of falls: >13 seconds.

## **RESULTS AND DISCUSSION**

After obtaining information from observation, survey, testing, and document analysis, outcomes were determined throughout the process of health-oriented physical fitness in diabetic T2D patients with NDPD.

As a result of the cognitive dimension, the theoretical and methodological knowledge of Physical Culture professionals who worked in health areas was determined to be insufficient; this denoted the need to provide theoretical and methodological tools that contributed to preparing them to achieve the concretization of this subject in social practice, in their areas of performance.

In the methodological dimension, a limited use of the potential of the CFT means and mechanisms to improve the health-oriented physical condition of these patients was noted.

The results derived from the observation of the rehabilitation sessions showed deficiencies, since only a minority of four teachers, 13.4%, used methods, means and procedures to contribute to the improvement of physical condition oriented towards health.



In this sense, the majority of the teachers surveyed (26, 86.6%) did not apply them, as they stated that in this pathology the alterations in mobility predominated. This aspect justified the need to design an adequate preparation that enables them to apply methodological tools that enhance attention to the mobility alterations that patients present.

As a result of the application dimension, It was determined that the CFT Program contemplated treatment for patients with diabetes mellitus, but did not reflect specific content for improving physical condition oriented towards health in patients with T2D, complicated by NDPD.

Overall, it was shown that CFT, to improve health-oriented physical fitness in patients with T2D complicated by NDPD, required a theoretical orientation for its characterization.

Balance and gait test results

*Table 1. Balance test assessment. Risk of falling.*

Patient sex and Berg Scale (Risk of Fall before AFT)						
			BERG SCALE BEFORE THE AFT			Total
			0-20: HIGH RISK OF FALLING	21-40: MODERATE RISK OF FALL	41-56: MILD RISK OF FALL	
Patient Sex	Male	Amount	9	4	-	
		% within Patient Sex	81.81 %	30.76 %	0 %	
	Female	Amount	2	3	2	
% within Patient Sex		15.38 %	42.85 %	28.57 %		
Total			11	7	2	



			55 %	35 %	10 %	
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The initial assessment of the first balance test determined that 55% of the patients in the study had problems due to the alteration of the somatosensory system, which included loss of sensitivity, muscle weakness, strength and reflexes in the lower limbs. It was highlighted, as an important premise in the study, that this type of patient was conditioned by chronological age and by the time of evolution of the pathology, factors that constituted an important element, since with the progressive loss of the function of the sensory organs, balance decreased, this caused incoordination, staggering, postural instability and increased risk of falling, which made balance more difficult.

During the initial study, it was found that of the total number of patients studied, 11 presented a high risk of falling (55%), nine male patients (81.81%) of the total of their gender (13) showed a significant worsening of postural instability and balance, which increased the risk of falling and foot damage, a common problem in this disease.

In the comprehensive assessment of balance, seven patients (35%) presented a moderate risk of falling; 42.85% of the women were more prone to falls, as the male gender had 30.76%. Only 10% of the group studied presented a slight risk of falling and within this total percentage, it was the female gender who contributed 28.57%, with two patients in this category.

*Table 2. Assessment of the gait test*

No.	Gender	Age	High risk of falls:	Mild mobility disability	Normal:
1	Male	50		11.47	
2	Female	66	14.21		
3	Male	44		12.94	
4	Male	64	15.03		
5	Male	68	14.86		
6	Male	36			9.3
7	Male	62	13.55		



8	Male	55		11.86	
9	Female	65	13.69		
10	Female	57		12.14	
11	Male	69	14.87		
12	Female	47		12.26	
13	Male	64	15.23		
14	Female	59	17.03		
15	Female	61	14.08		
16	Male	39			9.0
17	Male	62	15.44		
18	Female	59		12.16	
19	Male	71	16.21		
20	Male	49		12.04	
			11	7	2

Time Up and Go test provided data regarding the deterioration of the overall health of the T2D patient, with NDPD in which limitations specific to the pathology appeared; in relation to disability in daily life, gait and falls, it provided data that allowed the evaluation of basic mobility and its probable gait and balance disorders.

The 55% (11) of the patients had a high risk of falling due to problems with mobility, balance and swaying, and this was an important point to address during the execution of the CFT. Seven patients evaluated in this study showed mild disability and/or limitation of movement and swaying, and only two had a normal gait.

The data obtained provided information that 90% required more time to start and complete gait, although they were able to recover after the test. This was obviously due to the high disability they presented, which led to problems during gait and the ability to make quick and precise movements, which was very important to prevent falls and improve safety in daily environments.

The theoretical-methodological and empirical deficiencies that emerged as a result of the diagnosis demonstrated the need for a contextualized integrative approach, so a methodology was proposed to improve the health-oriented physical condition of T2D patients with NDPD.



The methodology went through four stages, each of which was developed in steps that included specific actions, and close relationships of interdependence and continuity were established between them.

### **First Stage: Introductory**

At this stage, the following instruments were selected: structured observation and survey for teachers and two tests (balance and gait) for patients who were part of the sample, as an essential step to understand the characteristics of the development of health-oriented physical fitness in patients with T2D and NDPD and to establish the level of demand in the execution of these activities at a collective and individual level.

An insufficient methodological action was evident, regarding the use of methods and procedures and the fulfillment of the objectives regarding the health-oriented physical condition of patients with T2D, with NDPD, from the didactic application. Promoting the inclusion and care of patients in primary health institutions, from the characteristics, methods, means and procedures of the CFT allowed an articulation between the measured, biological and pedagogical sciences.

Most of the teachers surveyed (56.7%) said they did not feel prepared to improve the health-related physical condition of these patients. The most up-to-date recommendations for this entity indicated that patients with DT2, with NDPD, presented alterations in their health-related physical condition, so it is recommended that scientific research be carried out on this specific topic.

### **Second stage: planning**

This stage was conceived after the diagnosis of the physical condition of patients with T2D with NDPD was made. From an organizational point of view, it allowed the general planning of the scientific logic of the rest of the stages. Planning was key, since the system of actions and the plan of therapeutic physical activities for these patients were developed. Its objective was to improve the health-oriented physical condition of patients with T2D with NDPD. To do this, the following were proposed:



1. Breathing exercises.
2. Warm-up exercises: stretching, flexibility and joint mobility.
3. Aerobic exercises or aerobic capacity (cardiovascular endurance)
4. Massages.
5. Strength exercises with and without implements.
6. Gait correction exercises.
7. Balance exercises, exercises for joint mobility.
8. Specific exercise for ankle and independent foot.
9. Free active and strengthening exercises.
10. Muscle relaxation exercises.

### **Third stage: application**

Its objective was to implement what was planned to achieve the improvement of the physical condition oriented to the health of patients with T2D with NDPD, where each patient and teacher became aware of the need to carry out the process and its importance from the psychosocial, educational and therapeutic point of view.

### **Fourth stage: evaluation**

The objective was to evaluate the results obtained in the process of improving the health-oriented physical condition of diabetic patients with DT2 with NDPD, and to obtain information on the fulfillment of the planned results. It was structured in two phases: process control and adjustment of the corresponding plans.

There was a direct coordination relationship between the stages of the methodology because the elements of the first stage create the bases and are articulated with the others. The direct connection between the stages of application and evaluation was in the feedback which, together with the previous stages, if carried out satisfactorily, led to the systemic nature of the methodology.

**Methods used:** game method, sensory-perceptive methods and practical methods.



Based on the establishment and diversification of the areas of comprehensive rehabilitation by the MINSAP, physical-therapeutic care was achieved for patients, in primary health care, and at the grassroots level, in sports complexes.

Based on the results presented, it was determined that there were difficulties in improving health-oriented physical condition in T2D patients with NDPD; therefore, when analyzing proposals and alternatives from authors to treat it, the contributions of Alad (2020); Nadi et al. (2019); Pérez (2020) were reviewed, which demonstrated that therapeutic physical exercise was a fundamental pillar in the treatment of these patients.

Other authors, such as Aleh (2020); Kumar et al. (2019); Yang et al. (2020), addressed alternatives aimed at reducing the progression of peripheral nerve damage not only as a pharmacological treatment, but also with physical exercise as a rehabilitative agent, with the aim of improving the health-oriented physical condition of these patients; however, the methodological guidelines were not always consistent with the need to adapt the objectives, content, methods and evaluation of the process to the attention of individual differences.

Although this problem was generally addressed through actions carried out at home, with exercises and games to strengthen the lower limbs, in none of the cases was a methodology taken into account that would allow better preparation from the CFT to put it into practice.

The challenges, although they involved the search for tools and techniques, were assumed from the definition of criteria and principles that allowed structuring a methodology to plan, design, execute, evaluate and systematize orderly and coherent processes, with a cumulative logical sequence that resulted in a qualitative transformation from which it started, to improve the health-oriented physical condition of T2D patients with NDPD.

## CONCLUSIONS

The literature review confirmed that the progress of health-oriented physical fitness in patients with T2D with NDPD was based on categories and theoretical bases of biological, medical and pedagogical sciences, in general and, in particular, of CFT. The study of the



consulted sources revealed the lack of methodologies related to the way of arguing and improving the subject in question.

The deficiencies detected in the diagnostic study showed the need to deepen the attention to the health-oriented physical condition of patients with T2D with NDPD, from the integrative and contextualized nature that this process demanded; microvascular complications were identified in these patients, which limited their performance in the CFT process and the lack of procedures and methodological orientations of the Physical Culture professionals who worked in both the therapeutic and health areas.

The proposed methodology for the improvement of the CFT process to improve the health-oriented physical condition of T2D patients with NDPD was designed from four stages; the therapeutic physical exercises were ordered in a systemic manner, which allowed the theoretical postulates of the developed concept to be put into practice and to take into account the coherent use of human, material and institutional resources of the community, as a response to the research problem, with a positive impact on the family, health and daily development of the patients.

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***Conflict of interest statement:***

The author declares that there are no conflicts of interest.

***Author's contribution:***

The author is responsible for writing the work and analyzing the documents.



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